ATTACHMENT 1

TENNESSEE VALLEY AUTHORITY
KNOXVILLE, TENNESSEE 37902

RECEIVED
MAY 18 1971

May 14, 1971

OFFICE OF THE BOARD OF DIRECTORS

Dr. P. A. Morris, Director
Division of Reactor Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Regulatory File Cy. 50- 390

Dear Dr. Morris:

Subject: LICENSE APPLICATION - WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

Pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's Regulations thereunder, the Tennessee Valley Authority hereby applies for construction permits and class 103 licenses necessary for the construction and operation of a two-unit nuclear power plant to be located at its Watts Bar site in Rhea County, Tennessee. Twenty-eight copies of the application are enclosed, three of which are signed originals. Operators' licenses, special nuclear material license, source material license, and byproduct material license are not requested at this time but will be covered by separate applications as and when required.

The information required to be furnished as part of this application is set out in this letter and in (1) an accompanying statement of general information furnished pursuant to 10 CFR Section 50.33 of the Commission's Regulations, and (2) an accompanying Preliminary Safety Analysis Report (PSAR) pursuant to 10 CFR Section 50.34 of the Commission's Regulations.

Included as part of the PSAR is a separate proprietary document entitled Appendix 7A, Instrumentation and Control Logic Diagrams, Drawing 5655D30 Sheets 1 through 17. Westinghouse Electric Corporation, supplier of the nuclear steam supply system, has informed us that all of these drawings contain information on work performed at considerable Westinghouse expense, and that the release of this information to the public would be detrimental to Westinghouse and would seriously affect their competitive position. Accordingly, it is hereby requested pursuant to 10 CFR Part 2, Section 2.790 of the Commission's Regulations, that these drawings be withheld from public disclosure.

DOCKETED USAEC
MAY 18 1971
REGULATORY MAIL SECTION DOCKET CLERK

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The draft environmental statement required by Section 102 of the National Environmental Policy Act of 1969 has been prepared by TVA and is being submitted to Federal and state agencies for review and comment in accordance with the guidelines of the Council on Environmental Quality. This statement includes the information required by Appendix D to 10 CFR 50 and 150 copies are enclosed.

No restricted data as defined in Section 50.2 of the Commission's Regulations are included in the material now being furnished. In the event restricted data are included in any supplement or amendment to the application, the restricted data will be appropriately separated from any unclassified information.

It is noted that in accordance with the provisions of Part 170 of the Commission's Regulations, TVA as a government agency is exempt from the requirement of fees in connection with this application.

Pursuant to Section 50.37 of the Commission's Regulaticns, the applicant agrees that it will not permit any individual to have access to any restricted data until the Civil Service Commission shall have made an investigation and report to the Atomic Energy Commission on the character, associations, and loyalty of such individual and the Atomic Energy Commission shall have determined that permitting such individual to have access to restricted data will not endanger the common defense and security.

With regard to the requirement of paragraph 50.33(i) of the Commission's Regulations, Section 15d(f) of the TVA Act imposes on the TVA Board of Directors responsibility for charging rates for power sufficient to produce gross revenues to cover specified items and a margin considered desirable by the Board. The Act also makes the Board responsible for determining provisions to be included in TVA contracts relating to power service. Neither TVA's rates nor services are subject to the jurisdiction of regulatory bodies. Accordingly, this part of § 50.33(i) is not applicable to TVA.

Dr. P. A. Morris May 14, 1971

In accordance with Section 2.101(b) of the Commission's Regulations, a copy of the application will be served promptly on Judge Malcolm Gholdstone who is the chief executive officer of Rhea County. When this has been done, we will forward you an affidavit from the person effecting the service.

It is requested that any correspondence with respect to this application be sent to the applicant at the following address:

Mr. James E. Watson
Manager of Power
Tennessee Valley Authority
818 Power Building
Chattanooga, Tennessee 37401

Sincerely yours,

Aubrey J. Wagner
Chairman

Enclosures

State of Tennessee)
)
County of Knox)

On the 14th day of May, 1971, Aubrey J. Wagner personally appeared before me and, first being duly sworn, stated that he is Chairman of the Tennessee Valley Authority and that he is duly authorized to execute and file the foregoing application in the name and on behalf of the Tennessee Valley Authority, and that the statements in said application are true to the best of his knowledge and belief.

s/ Shirley W. Kerr
Notary Public

My Commission expires 4/23/74

ATTACHMENT 2

History of Watts Bar Unit 2 Reactivation

The Watts Bar Nuclear Power Plant (WBN) is located in southeastern Tennessee approximately 50 miles northeast of Chattanooga, and is owned by Tennessee Valley Authority (TVA). The site has two Westinghouse−designed pressurized water reactors. WBN Unit 1 received a full power operating license in early 1996, and is presently the last power reactor to be licensed in the United States. TVA has not completed construction of WBN Unit 2.

WBN Units 1 and 2 have a unique licensing history and regulatory framework. TVA received a construction permit for each unit in 1973 under 10 CFR Part 50. Construction proceeded until 1985, when WBN Unit 1 was thought to be essentially complete and nearly ready to receive an operating license (OL), as documented in NUREG-0847, "Safety Evaluation Report Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2," through Supplement 4.

As a consequence of the identification of a large number of deficiencies shortly before the WBN Unit 1 license was expected to be issued, the Nuclear Regulatory Commission (NRC) sent a letter to TVA on September 17, 1985, requesting information under 10 CFR 50.54(f), on TVA's plans to address the deficiencies for its operating and construction activities at Watts Bar and TVA's other nuclear facilities. In response to this letter, TVA developed a Nuclear Performance Plan (NPP) to address corporate and site−specific issues, establishing programs to address a wide variety of material, design, and programmatic deficiencies. WBN Unit 2 construction was suspended at about that time, with major structures in place and equipment such as reactor coolant system piping installed. On October 13, 1999, TVA filed a request for extension of the completion date for Unit 2, and by letter dated July 14, 2000, TVA informed the NRC that WBN Unit 2 meets the NRC's definition for deferred nuclear plant units as described in the Commission's Policy Statement on Deferred Plants, 52 FR 38077 (Oct. 14, 1987). On October 24, 2000, the NRC issued an order extending the Unit 2 construction permit to December 31, 2010.

The NRC staff reviewed components of the NPP for WBN Unit 1 and, as documented in NUREG-1232, Volume 4, "Safety Evaluation Report on Tennessee Valley Authority: Watts Bar Nuclear Performance Plan, Watts Bar Unit 1" (January 1990), the staff endorsed the general approaches of various corrective actions. The staff determined that when implemented thoroughly, the proposed corrective actions should address the identified deficiencies for Unit 1; however, no conclusions were stated for WBN Unit 2.

TVA addressed WBN Unit 1 construction quality issues as part of the implementation of its NPP. Inspection Manual Chapter (IMC) 2512, "Light Water Reactor Inspection Program − Construction Phase," was used to ensure that WBN Unit 1 was constructed in accordance with NRC−approved design and construction standards. In 1985, the NRC had completed its initial IMC 2512 inspection program

for the construction of WBN Unit 1. However, the initial WBN inspection program was found to have some weaknesses, which were identified and corrected after the construction inspection program was completed for Unit 1, but before the facility was licensed. Because of the complexity of the rework activities under the NPP, the NRC implemented a "reconstitution" of the construction inspection program to verify that construction−related inspections conducted after 1985 met the requirements of the IMC 2512 program. The results of this program were published in NUREG-1528, "Reconstitution of the Manual Chapter 2512 Construction Inspection Program for Watts Bar Unit 1." Simultaneously, the staff had completed a substantial number of IMC 2512 inspections for WBN Unit 2, as well; however, TVA suspended WBN Unit 2 construction before the inspection program was completed, and the staff then suspended its licensing and inspection activities.

Satisfactory resolution of NPP topics for WBN Unit 1 is documented in the later supplements of NUREG-0847, with Supplement 19 supporting issuance of the low power license for WBN Unit 1 in November 1995, and Supplement 20 supporting issuance of the full power license for WBN Unit 1 in February 1996. These supplements concluded that WBN Unit 1 met applicable regulations and guidance; however, no conclusions were stated for WBN Unit 2.

TVA informed the NRC in a November 14, 2006, letter of its intent to perform a study of the feasibility of completing WBN Unit 2, with the goal of producing power from the reactor in 2013.

Results of this study were presented to the TVA Board of Directors in August 2007. The Board decided to resume construction of Unit 2 and TVA notified 120 days in advance the Director of the Office of Nuclear Reactor Regulation (NRR) in accordance with the Commission Policy Statement on Deferred Plants via letter dated August 3, 2007.

On March 4, 2009, TVA provided an update to its original operating license application dated June 30, 1976, as supplemented September 15, 1976. Following the requirements in 10 CFR 50.43, the NRC noticed the receipt of updated operating license application in the *Federal Register* and in the local newspapers. The Governor of the State of Tennessee was notified by letter dated April 9, 2009, of the update to the operating license application.

The NRC review of the operating license application is in progress.

Page Last Reviewed/Updated Friday, April 01, 2011

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ATTACHMENT 3

830 Power Building
TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401

June 30, 1976

RECEIVED 7-2-76 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. Benard C. Rusche
Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Regulatory Docket File

Dear Mr. Rusche:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

The Tennessee Valley Authority hereby submits Amendment No. 23 to its application for Class 103 permits to construct and licenses to operate the Watts Bar Nuclear Plant units 1 and 2, and requests authorization to operate each unit for a period of 40 years at power levels up to 3,411 MW thermal. In addition, TVA also requests such special nuclear material and byproduct material licenses necessary and appropriate to the fueling and operation of each unit. TVA will require the operating licenses on or before December 1, 1978, for unit 1 and September 1, 1979, for unit 2.

The information contained in this amendment is listed below along with the number of copies sent for your completeness review.

1. Fifteen copies of the Watts Bar Nuclear Plant Final Safety Analysis Report (FSAR), including seven copies of EI&C drawings required by section 1.7.

2. Ten copies of the revised Information Pursuant to 10 CFR Section 50.33 of the Commission's Rules and Regulations.

3. Three copies of the Watts Bar Nuclear Plant Physical Security Plan. (Pursuant to 10 CFR Section 2.790 we hereby request that this document be treated as proprietary information.)

4. Fifteen copies of the Watts Bar Nuclear Plant Radiological Emergency Plan will follow within two weeks.

Upon your determination of the acceptability of this amendment to the application for docketing, which we understand will require approximately 30 days, we will formally submit the required number of copies of our application.

DOCKETED USNRC JUL 2 1976 Mail Section Docket Clerk

6599

Mr. Benard C. Rusche June 30, 1976

As indicated in J. E. Gilleland's letter to you dated April 9, 1976, and in our meeting of May 25, 1976, TVA is conducting a review to determine whether matters discussed in the November 1972 environmental statement have changed or whether there is new information in addition to that discussed in the environmental statement. As discussed in that meeting, the length of time necessary for environmental review will probably be substantially less than the period required for the health and safety review. Consequently, we expect that a timely resolution of our respective environmental responsibilities will not impact the operating license review schedule. In the near future, we will communicate further with you regarding the operating stage environmental review.

The Watts Bar FSAR has generally been prepared under Revision 2 of Regulatory Guide 1.70. The format of the FSAR conforms to the Revision 2 format with exception of chapters 4, 5, and 15 which are written to Revision 1 format.

Very truly yours,

T. Graham Wells, Jr.
Assistant Manager of Power

Subscribed and sworn to before
me this 30th day of June 1976

Notary Public

My Commission Expires 10/15/78

Enclosure

Enclosure 3

Distribution for Tendered Application

Central Files, 1 set Appl, SAR [redacted]
NRC PDR, 1 set Appl, SAR, [redacted]
Local PDR, 1 set Appl, SAR, [redacted] - DAYTON, TN
LPM, 1 set Appl, SAR, [redacted] - SILVER
EPM, [redacted], 1 cy Section 2 SAR - SCALETTI
~~ANG~~, 3 cys Appl, [redacted]
LA (Safety) - Appl only - SERVICE

Regulatory Docket File

Divison of Project Management:
- Operator Licensing, Section 13 SAR - P. COLLINS
- Quality Assurance, Sections 13, 14 & 17 of SAR - HELETEMES
- Ind. Sec. & Emergency Planning, Sections 13 & 14 SAR - HOUSTON

Divison of Systems Safety:
- Engineering Branches, SAR - McCARRY
- Reactor Systems, SAR (less Sections 2 and 13) - NOVAK
- Core Performance, Section 4 & 15 of SAR - P. CHECK
- Analysis, SAR (less Sections 2 and 13) - ROSZTOCZY
- Aux & Power Conv Systems, SAR (less Section 4 & 15) - BENAROYA
- EI & CS, SAR (less Sections 13 & 14) - IPPOLITO
- Containment Systems, SAR - LAINAS

Divison of Site Safety and Environmental Analysis: \
- Accident Analysis, SAR [redacted] - BUNCH
- Effluent Treatment Systems, [redacted] SAR (less Sections 13, 14 & 17) J. COLLINS
- Radiological Assessment, [redacted] SAR (less Section 17) - KREGER
- [redacted]
- Geology-Seismology, [redacted] SAR - STEPP
- Hydrology-Meteorology, [redacted] SAR - HULMAN

Inspection & Enforcement
- Regional Office, SAR WILDA MULLINEX [redacted]
- Division of Field Operations, SAR Section 17 (2 copies)

[redacted]

The following receive submittal letters only to serve as notification:

- Director, DPM - BOYD
- Director, DSS - HEINEMAN
- Director, DSE - DENTON
- Assistant Directors, DPM, DSS, DSE — VOLLMER, DEYOUNG, DENISE, SKOVHOLT, C. JOHNSON, N. HUGHES, PANZARELLA, KENNEKE, GAMMILL, ROSS, ERNST, TEDESCO, V MOORE
- OMIPC (2 copies)
- OELD
- DSS Program Analyst
- DSE Scheduling Analyst
- OPA - B.J. RIORDAN
- Chief, Antitrust & Indemnity Group - SALTZMAN

DISTRIBUTION FOR ENCLOSURE #2 AS FOLLOWS:
(1) KNIEL
(2) REG FILE
(3) I & E
(4) IPPOLITO

ATTACHMENT 4

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-390

WATTS BAR NUCLEAR PLANT, UNIT 1

FACILITY OPERATING LICENSE

License No. NPF-90

1. The Nuclear Regulatory Commission (the Commission or the NRC) has found that:

   A. The application for license filed by the Tennessee Valley Authority (TVA, the licensee) complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I, and all required notifications to other agencies or bodies have been duly made;

   B. Construction of the Watts Bar Nuclear Plant, Unit 1 (the facility) has been substantially completed in conformity with Construction Permit No. CPPR-91 and the application, as amended, the provisions of the Act and the rules and regulations of the Commission;

   C. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission (except as exempted from compliance in Section 2.D below);

   D. There is reasonable assurance: (i) that the activities authorized by this operating license can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I (except as exempted from compliance in Section 2.D below);

   E. TVA is technically qualified to engage in the activities authorized by this license in accordance with the Commission's regulations set forth in 10 CFR Chapter I;

   F. TVA has satisfied the applicable provisions of 10 CFR Part 140, "Financial Protection Requirements and Indemnity Agreements," of the Commission's regulations;

ENCLOSURE 1

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G. The issuance of this license will not be inimical to the common defense and security or to the health and safety of the public;

H. After weighing the environmental, economic, technical and other benefits of the facility against environmental and other costs and considering available alternatives, the issuance of this Facility Operating License No. NPF-90, subject to the conditions for protection of the environment set forth in the Environmental Protection Plan attached as Appendix B, is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied; and

I. The receipt, possession, and use of source, byproduct and special nuclear material as authorized by this license will be in accordance with the Commission's regulations in 10 CFR Parts 30, 40, and 70 (except that an exemption to the provisions of 70.24 is granted as described in paragraph 2.D below).

2. Based on the foregoing findings regarding this facility, Facility Operating License NPF-20 (dated November 9, 1995), is superseded by Facility Operating License No. NPF-90, and is hereby issued to the Tennessee Valley Authority to read as follows:

A. This license applies to the Watts Bar Nuclear Plant, Unit 1, a pressurized water reactor and associated equipment (the facility) owned by TVA. The facility is located on the west bank of the Chickamauga Lake on TVA's site in Rhea County, Tennessee, and is described in TVA's Final Safety Analysis Report, as supplemented and amended up to Amendment No. 91 and in the Environmental Report, as supplemented and amended;

B. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses:

(1) TVA, pursuant to Section 103 of the Act and 10 CFR Part 50, to possess, use, and operate the facility at the designated location in Rhea County, Tennessee, in accordance with the procedures and limitations set forth in this license;

(2) TVA, pursuant to the Act and 10 CFR Part 70, to receive, possess, and use at any time, special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, and as described in the Final Safety Analysis Report, as supplemented and amended;

(3) TVA, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time, any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) TVA, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required, any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis, instrument calibration, or other activity associated with radioactive apparatus or components; and

(5) TVA, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified or incorporated below.

(1) Maximum Power Level

TVA is authorized to operate the facility at reactor core power levels not in excess of 3411 megawatts thermal.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Safety Parameter Display System (SPDS) (Section 18.2 of SER Supplements 5 and 15)

Prior to startup following the first refueling outage, TVA shall accomplish the necessary activities, provide acceptable responses, and implement all proposed corrective actions related to having the Watts Bar Unit 1 SPDS operational.

(4) Vehicle Bomb Control Program (Section 13.6.9 of SSER 20)

During the period of the exemption granted in paragraph 2.D.(3) of this license, in implementing the power ascension phase of the approved initial test program, TVA shall not exceed 50% power until the requirements of 10 CFR 73.55(c)(7) and (8) are fully implemented. TVA shall submit a letter under oath or affirmation when the requirements of 73.55(c)(7) and (8) have been fully implemented.

D. The following exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security. Therefore, these exemptions are granted pursuant to 10 CFR 50.12.

(1) The facility requires a schedular exemption from 10 CFR 50, Appendix J, Section III.D.2(b)(ii). The justification for this exemption is contained in Section 6.2.6 of Supplements 4 and 19 to the Safety Evaluation Report. The staff's environmental assessment was published on April 18, 1985 (50 FR 15516). Therefore, pursuant to 10 CFR 50.12(a)(1) and 50.12(a)(2)(ii) and (iii), the facility is exempt from the cited requirement and, instead, is required to perform the overall air lock leak test at pressure P_a before establishing containment integrity if air lock maintenance has been performed that could affect the air lock sealing capability. This schedular exemption expires at startup from the first refueling outage.

(2) The facility was previously granted an exemption from the criticality monitoring requirements of 10 CFR 70.24 (see Special Nuclear Material License No. SNM-1861 dated September 5, 1979). The technical justification is contained in Section 9.1 of Supplement 5 to the Safety Evaluation Report, and the staff's environmental assessment was published on April 18, 1985 (50 FR 15516). The facilty is hereby exempted from the criticality alarm system provisions of 10 CFR 70.24 so far as this section applies to the storage of fuel assemblies held under this license.

(3) The facility requires an exemption from 10 CFR 73.55(c)(10). The justification for this exemption is contained in Section 13.6.9 of Supplement 15 and 20 to the Safety Evaluation Report. The staff's environmental assessment was published on April 25, 1995 (60 FR 20291). Pursuant to 10 CFR 73.5, the facility is exempted from the stated implementation schedule of the surface vehicle bomb rule, and may implement the same as late as February 17, 1996.

(4) The facility was previously granted an exemption from certain requirements of 10 CFR 73.55(d)(5) relating to the returning of picture badges upon exit from the protected areas, such that individuals not employed by TVA who are authorized unescorted access into protected areas can take their badges offsite (see 59 FR 66061, December 22, 1994). The granting of this exemption is hereby affirmed.

(5) The facility was previously granted an exemption from certain requirements of 10 CFR 50, Appendix E, such that the State of Tennessee, which is within the ingestion exposure pathway emergency planning zone, need not participate in the November 1995 full-participation exercise (see 60 FR 54526, October 24, 1995). The granting of this exemption is hereby affirmed.

E. TVA shall fully implement and maintain in effect all provisions of the physical security, personnel training and qualification, and safeguards contingency plans previously approved by the Commission and all amendments and revisions to such plans made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The plans, which contain safeguards information protected under 10 CFR 73.21, are entitled "Watts Bar Nuclear Plant Physical Security Plan," with revisions submitted through March 1, 1994; "Watts Bar Nuclear Plant Personnel Training and Qualification Plan," with revisions submitted through April 1, 1994; and "Watts Bar Nuclear Plant Safeguards Contingency Plan," with revisions submitted through October 1, 1990.

F. TVA shall implement and maintain in effect all provisions of the approved fire protection program as described in the Fire Protection Report for the facility, as approved in Supplements 18 and 19 of the SER (NUREG-0847) subject to the following provision:

TVA may make changes to the approved fire protection program without prior approval of the Commission, only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

G. Except as otherwise provided in the Technical Specifications (Appendix A to this license) or Environmental Protection Plan (Appendix B to this license), TVA shall report any violations of the requirements contained in Section 2.C of this license in the following manner: initial notification shall be made within twenty-four (24) hours to the NRC Operations Center via the Emergency Notification System with written follow-up within 30 days in accordance with the procedures described in 10 CFR 50.73 (b), (c), and (e).

H. The licensee shall have and maintain financial protection of such types and in such amounts as the Commission shall require in accordance with Section 170 of the Atomic Energy Act of 1954, as amended, to cover public liability claims.

I. This license is effective as of the date of issuance and shall expire at midnight on November 9, 2035.

FOR THE NUCLEAR REGULATORY COMMISSION

W. Russell

William T. Russell, Director
Office of Nuclear Reactor Regulation

Appendices: 1. Appendix A -
Technical Specifications
2. Appendix B -
Environmental Protection Plan

Date of Issuance: February 7, 1996

ATTACHMENT 5

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

August 3, 2007

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop: OWFN P1-35
Washington, D.C. 20555-0001

Gentlemen:

In the Matter of) Docket No. 50-391
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) - UNIT 2 - REACTIVATION OF CONSTRUCTION ACTIVITIES

The purpose of this letter is to inform the Nuclear Regulatory Commission (NRC) Staff of TVA's intention to reactivate and complete construction activities at WBN Unit 2. As set forth in the TVA's Key Assumptions letter (Reference 1) and recognized by the Commission in the NRC Staff Requirements Memorandum (Reference 2), TVA will complete the project under the existing construction permit and request an Operating License (OL) pursuant to 10 CFR Part 50.

As background, on October 4, 1976, TVA submitted a dual-unit WBN OL application for both WBN Unit 1 and Unit 2 (Reference 3). WBN Unit 1 received a full power OL on February 7, 1996. WBN Unit 2, which currently is in deferred status, would be operationally the same at startup as WBN Unit 1. Therefore, TVA believes that, from regulatory, safety and plant operational perspectives, significant benefit is gained from aligning the licensing and design bases of WBN Units 1 and 2 to the fullest extent practicable. The Commission recognized these benefits in Reference 2.

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In furtherance of this objective, TVA will complete WBN Unit 2 in compliance with applicable regulations promulgated prior to and after the issuance of the WBN Unit 1 OL. In addition, the WBN Unit 2 licensing and design bases will incorporate modifications made to WBN Unit 1, and those modifications currently captured in the WBN Unit 1 five-year plan. This alignment of the WBN Unit 1 and 2 licensing and design bases will ensure that there is operational fidelity between the units and at the same time demonstrate and ensure that WBN Unit 2 complies with applicable NRC regulatory requirements.

In combination, the enclosure to this letter and the accompanying attachments provide the information to be submitted by a licensee at least 120 days prior to the reactivation of construction in accordance with Generic Letter 87-15, "Commission Policy Statement on Deferred Plants" (52 FR 38077, October 14, 1987). Some of the key points discussed in the enclosure include the following:

TVA currently plans to resume unrestricted construction activities in support of completion of WBN Unit 2 on December 3, 2007. TVA expects to complete construction and request an operating license prior to April 1, 2012.

TVA will submit a regulatory framework document for Watts Bar Unit 2 similar to the Browns Ferry Status of Unit 1 Restart Issues letters. This regulatory framework document will reference key correspondence, describe the open issues or commitments that need to be resolved to obtain an OL for WBN Unit 2, discuss the background of the issues or commitments, and describe their completion or status, as appropriate. This document will be periodically updated.

TVA anticipates making no changes to the Site Security Plan or the Site Emergency Plan for purposes of WBN Unit 2 construction reactivation. Should any changes to the Site Security Plan or the Site Emergency Plan be necessary they will be evaluated and submitted to NRC as required by applicable regulations.

A Unit Separation Program will ensure that WBN Unit 2 construction activities do not adversely affect the continued safe operation of WBN Unit 1. As part of this program, unit separation isolation boundaries will be

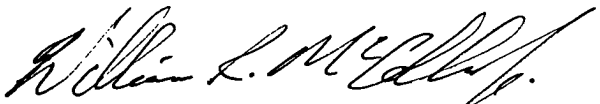
administratively controlled using design output (i.e., engineering drawings) or the Equipment Clearance Procedure. Feasibility studies are underway to evaluate the possible creation of construction openings into WBN Unit 2 containment (both equipment and personnel access). The Unit Separation Program will require moving the secondary containment boundary back to the Auxiliary Building wall and removing the WBN Unit 2 Reactor Building from the Vital Area as well as the Radiological Controlled Area. This will allow construction access to the WBN Unit 2 containment and minimize traffic in the operating unit.

Prior to resuming construction activities on quality or safety-related structures, systems or components, the Quality Assurance program and procedures will be put in place.

TVA will work with the NRC staff to review any exemptions, reliefs and other actions which were specifically granted for WBN Unit 1 to determine whether the same allowance is appropriate for WBN Unit 2.

TVA's successful operation of WBN Unit 1 provides reasonable assurance that WBN Unit 2 also can be completed successfully and then started and operated in a safe and reliable manner. If you have any questions, please contact me at (423) 751-6016 or Masoud Bajestani, WBN Unit 2 Vice-President, at (423) 365-2351.

Sincerely,



William R. McCollum, Jr.
Chief Operating Officer

References:

1. TVA letter, Watts Bar Nuclear Plant (WBN) - Unit 2 - Key Assumptions for the Possible Completion of Construction Activities, dated April 3, 2007.
2. NRC Staff Requirements - SECY-07-0096 - Possible Reactivation of Construction and Licensing Activities for the Watts Bar Nuclear Plant Unit 2, dated July 25, 2007.

3. TVA letter, Final Safety Analysis Report for Operating License for Watts Bar, Units 1 and 2, dated October 4, 1976.

RRB:JEM:BQP
Enclosures

cc (Enclosures):
Catherine Haney, Director
U.S. Nuclear Regulatory Commission
MS 08G9
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738

Lakshminarasimh Raghavan
U.S. Nuclear Regulatory Commission
MS 08H4A
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738

Loren R. Plisco, Deputy Regional Administrator for Construction
U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center, Suite 23T85
61 Forsyth Street, SW,
Atlanta, Georgia 30303-8931

U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-8931

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

cc (w/o Enclosures):
M. Bajestani, EQB 1B-WBN
R. R. Baron, EQB 1B-WBN
A. S. Bhatnagar, LP 6A-C
R. H. Bryan, BR 4X-C
J. C. Fornicola, LP 6A-C
M. D. Skaggs, ADM-1V-WBN
J. Valente, EQB 1B-WBN
E. J. Vigluicci, ET 11A-K
EDMS, WT 3B-K, w/Enclosures

ATTACHMENT 6

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

March 4, 2009

10 CFR 50.30
10 CFR 50.33
10 CFR 50.34
10 CFR 50.40

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop: OWFN P1-35
Washington, D.C. 20555-0001

In the Matter of)
Tennessee Valley Authority)

Docket No. 50-391

WATTS BAR NUCLEAR PLANT (WBN) UNIT 2 - OPERATING LICENSE APPLICATION UPDATE

In References 1 and 2, TVA requested NRC authorization to operate WBN Units 1 and 2 for a period of 40 years at power levels up to 3,411 MWt. In Reference 3, TVA notified the NRC of its intention to complete construction activities at WBN Unit 2 and request an operating license (OL), pursuant to 10 CFR Part 50 on or before April 1, 2012. The purpose of this submittal is to provide an update of TVA's OL application.

Section 50.33 of 10 CFR Part 50 specifies the general information required to be contained in an application for an OL. 10 CFR §50.33 (f) requires TVA to provide information to demonstrate its financial qualification. This information is contained in the annual reports TVA files with the Securities and Exchange Commission. TVA's 2008 annual report is available at the following URL:

http://www.tva.gov/finance/reports/forwardlooking_sec.htm

10 CFR §50.33 (g) concerns Emergency Plans for state and local governments. The applicable plans are available at the WBN site.

10 CFR §50.33 (k) requires TVA provide a report, as described in 10 CFR 50.75, indicating how reasonable assurance will be provided that funds will be available for decommissioning the facility. Enclosure 1 provides the Decommissioning Report. A decommissioning trust fund will be established for WBN Unit 2 prior to fuel load.

D030
NRR

Section 50.34 of 10 CFR Part 50 specifies the technical information required to be contained in an application for an OL. 10 CFR §50.34 (b) requires that an application for an OL include a final safety analysis report (FSAR) that includes information that describes the facility, presents the design bases and the limits of its operation, and presents a safety analysis of the structures, systems, and components and of the facility as a whole. In Reference 4, TVA submitted an update to the WBN Unit 2 FSAR. TVA intends to submit periodic updates to the FSAR during 2009 as engineering is completed.

FSAR Chapter 13 provides information on TVA's organizational structure by reference to the TVA Topical Report, TVA-NPOD89, *Nuclear Power Plant Description*. This topical report is applicable to WBN Unit 2. At the time of fuel load and beyond, the Site Vice President will be accountable for activities at the site, including WBN Unit 2. The latest revision of the report was provided in Reference 5.

FSAR Chapter 13 provides information on TVA's quality assurance plan by reference to the Nuclear Quality Assurance Plan, TVA-NQA-PLN89-A. This plan is applicable to WBN Unit 2. At fuel load, Appendix F, which currently provides the WBN Unit 2 Construction Completion Project Organization, will be removed and WBN Unit 2 activities will be addressed consistent with TVA's other operating units. The latest revision of the plan was provided in Reference 6. Section 50.40 requires that TVA be technically qualified to engage in the proposed activities. In addition to the Nuclear Quality Assurance Plan, personnel qualification requirements are provided in the WBN Unit 2 FSAR Chapter 13.

The TVA Radiological Emergency Plan (REP) has been developed to provide protective measures for TVA personnel and to protect the health and safety of the public in the event of a radiological emergency resulting from an accident at WBN. The REP contains site-specific appendices for each TVA plant. WBN's radiological emergency information is in Appendix C of the REP. A template of the WBN Appendix C is provided. The WBN Unit 2 specific data and references provided are preliminary; final verification will be provided as part of the construction completion of WBN Unit 2. REP Appendix E provides references to the applicable state radiological emergency response plans.

Proposed Technical Specifications (TS) and a proposed Technical Requirements Manual (TRM) are discussed in Enclosure 2. Templates of the WBN Unit 2 TS and TRM are provided. TVA used the WBN Unit 1 TS and TRM to develop the proposed templates of the WBN Unit 2 TS and TRM. The numbers, setpoints, and parameters provided are preliminary in nature; final verification will be provided as part of the construction completion of WBN Unit 2.

TVA will use the established Operator Training and Requalification Program in place for WBN Unit 1 for WBN Unit 2, supplemented with training on unit differences. The licensed operator requalification program was reviewed by NRC in Reference 7.

The Physical Security Plan and Safeguards Contingency Plan exist and do not require change for the completion and operation of WBN Unit 2. The latest revision of the plan was provided in Reference 8. TVA understands NRC will review the current plans taking WBN Unit 2 into account.

Applicable Three Mile Island (TMI)-related requirements were reviewed and their current status provided in Reference 9. NRC documented its review of the status of TMI-related requirements in Reference 10.

Section 50.30(f) of 10 CFR Part 50 requires an environmental report be submitted along with an application for an OL. The WBN Unit 2 Final Supplemental Environmental Impact Statement (FSEIS) for the Completion and Operation of WBN Unit 2 (June 2007) was submitted to NRC on February 15, 2008 (Reference 11). NRC requested additional information by letter dated June 3, 2008 (Reference 12). By letter dated July 2, 2008 (Reference 13), TVA responded to the NRC request for additional information and provided an open action required for licensing. TVA committed to submit by January 30, 2009, a WBN Unit 2 Severe Accident Management Alternatives (SAMA) analysis consistent in scope and content with the SAMA analyses provided in support of recent license renewal applications. TVA submitted the SAMA analysis by letter dated January 27, 2009 (Reference 14).

The FSEIS supplements TVA's original 1972 "Final Environmental Statement, Watts Bar Nuclear Plant Units 1 and 2" (1972 FES) and updates subsequent related documents identified below. In December 1978, NRC issued a "Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant Units 1 and 2, NUREG-0498" (1978 NRC FES-OL). This environmental review dealt with the impacts of operation of WBN Units 1 and 2.

In 1993, TVA conducted a review of the TVA and NRC documents to determine whether an additional environmental review was needed to inform decision makers about whether to complete both units and concluded that neither plant design nor environmental considerations had changed in a manner that materially altered the environmental impact analysis set forth in its 1972 FES. In 1994, NRC requested TVA provide updated environmental information in accordance with 10 CFR 51.92 to determine if it was necessary to issue a supplement to the 1978 NRC FES-OL. TVA provided additional analyses and information in support of NRC's "Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2, NUREG-0498 Supplement 1," for the operation of WBN Units 1 and 2, which was issued in April 1995. The NRC concluded that there were no significant changes in the environmental impacts since the 1978 NRC FES-OL from changes in plant design, proposed methods of operation, or changes in the environment. Following an independent review of NRC's analyses and a new analysis of the need for additional power, TVA adopted NRC's 1995 FES in July 1995.

Enclosure 3 provides the listing of open actions required for licensing made in this letter.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 4th day of March, 2009.

If you have any questions, please contact me at (423) 365-2351.

Sincerely,

M. Bajestani

Masoud Bajestani
Watts Bar Unit 2 Vice President

Enclosures
cc: See page 6

Document Components:
001 REP APP C r88_2_2-5-09 2,700,000 bytes
002 Proposed TS and TS Bases 17,300,000 bytes
003 Proposed TRM and TRM Bases 6,500,000 bytes
004 Review Matrix 426,000 bytes
005 Developmental Information 71,000,000 bytes

References:

1. TVA letter dated June 30, 1976, from T. Graham Wells to Benard C. Rusche, NRC

2. TVA letter dated September 27, 1976, from J. E. Gilleland to Roger S. Boyd, NRC (761004B0199)

3. TVA letter dated August 3, 2007, " Watts Bar Nuclear Plant (WBN) - Unit 2 - Reactivation of Construction Activities" (T90 070803 001)

4. TVA letter dated December 18, 2008, " Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Safety Analysis Report (FSAR), Amendment 92" (T02 081218 001)

5. TVA letter dated August 29, 2008, "TVA Nuclear Quality Assurance (NQA) Plan (TVA-NQA-PLN89-A) and Organizational Topical Report (TVA-NPOD89-A) - Browns Ferry, Sequoyah, and Watts Bar Nuclear Plants - Annual Update" (L44 080828 019)

6. TVA letter dated December 5, 2008, "Browns Ferry Nuclear Plant (BFN) Units 1, 2 and 3, Sequoyah Nuclear Plant (SQN) Units 1 and 2, and Watts Bar Nuclear Plant (WBN) Unit 1 and 2 - TVA's Nuclear Quality Assurance (NQA) Plan (TVA-NQA-PLN89-A)" (L44 081205 001)

7. NRC letter dated February 12, 2009, "Watts Bar Nuclear Plant- NRC Integrated Inspection Report 05000390/2008005, 05000391/2008005 and 05000390/2008501 and Exercise of Enforcement Discretion" (L44 090225 004)

8. TVA letter dated February 27, 2008, "Watts Bar Nuclear Plant (WBN) Unit 1 and 2 - Security, Training and Qualification Plan, and Safeguards Contingency Plan, Revision 7" (T04 080227 857)

9. TVA letter dated March 20, 2008, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Generic Communications Status for Unit 2-Restructured Tables" (T02 080320 001)

10. NRC letter dated May 28, 2008," Watts Bar Nuclear Plant, Unit 2 - Status of Generic Communications for Review (TAC NO. MD8314)" (T02 080604 001)

11. TVA letter dated February 15, 2008, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Supplemental Environmental Impact Statement for the Completion and Operation of Unit 2" (T02 080215 001)

12. NRC letter dated June 3, 2008, "Watts Bar Nuclear Plant, Unit 2 - Request for Supplemental Information for Review of Supplemental Environmental Statement (TAC MD8203)" (A02 080606 002)

13. TVA letter dated July 2, 2008, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Supplemental Environmental Impact Statement - Request for Additional Information (TAC MD8203)" (T02 080702 003)

14. TVA letter dated January 27, 2009, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Supplemental Environmental Impact Statement - Severe Accident Management Alternatives (TAC MD8203)" (T02 090127 001)

cc (Enclosures):

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NRC Resident Inspector Unit 2
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Pursuant to the requirements of 10 CFR §50.33(k)(1), an application for an operating license (OL) or combined license for a production or utilization facility will contain information in the form of a report, as described in 10 CFR §50.75, indicating how reasonable assurance will be provided that funds will be available to decommission the facility.

10 CFR §50.75(b) requires that each power reactor applicant for or holder of an OL and each applicant for a combined license under subpart C of 10 CFR part 52 for a production or utilization facility of the type and power level specified in 10 CFR §50.75 (c) shall submit a decommissioning report, as required by §50.33(k).

(1) For an applicant for or holder of an OL under part 50, the report must contain a certification that financial assurance for decommissioning will be (for a license applicant) provided in an amount which may be more, but not less, than the amount stated in the table in 10 CFR §50.75(c)(1) adjusted using a rate at least equal to that stated in paragraph 10 CFR §50.75(c)(2).
(2) The amount to be provided must be adjusted annually using a rate at least equal to that stated in 10 CFR §50.75(c)(2).
(3) The amount must use one or more of the methods described in 10 CFR §50.75(e) as acceptable to the NRC.
(4) The amount stated in the applicant's certification may be based on a cost estimate for decommissioning the facility. As part of the certification, a copy of the financial instrument obtained to satisfy the requirements of 10 CFR §50.75 (e) must be submitted to the NRC.

10 CFR §50.75(c) provides the minimum amounts (January 1986 dollars) required to demonstrate reasonable assurance of funds for decommissioning by reactor type and power level and an adjustment factor to account for escalation of labor, energy, and waste burial costs. (Amounts are based on activities related to the definition of "decommission" in 10 CFR §50.2 and do not include the cost of removal and disposal of spent fuel, nonradioactive structures, or materials beyond that necessary to terminate the license.)

For a pressurized water reactor (PWR) with a core thermal power rating of greater than or equal to 3,400 MWt, such as the WBN Unit 2 reactor design, 10 CFR §50.75(c)(1)(i) specifies the minimum amount required to demonstrate reasonable assurance of funds for decommissioning as $105 million (1986 dollars). This amount is subject to an adjustment factor at least equal to 0.65 L + 0.13 E + 0.22 B, where L and E are escalation factors for labor and energy, respectively, and are to be taken from regional data of U.S. Department of Labor Bureau of Labor Statistics (BLS), and B is an escalation factor for waste burial and is to be taken from NRC report NUREG-1307, "Report on Waste Burial Charges."

WBN UNIT 2 DECOMMISSIONING COST ESTIMATE

The WBN plant is a two-unit PWR (Units 1 and 2) facility with nuclear steam supply systems designed by Westinghouse Electric Corporation. WBN Unit 2 has a thermal power rating of 3,411 MWt. In accordance with 10 CFR §50.75(c), and using NUREG-1307, Revision 13, the minimum funding is computed on a per-unit basis, as follows (in 2008 dollars):

Minimum Funding = $105 million [0.65(L) + 0.13(E) + 0.22(B)]

L = 2.16 (from BLS Employment Cost Index (ECI) – December 2008, Table 6, South Region), and computed as follows: (109.3 x 1.98)/100; where 109.3 is the December 2008 ECI for the South Region, 1.98 is the base Labor Adjustment Factor for December 2005 (from NUREG-1307, Table 3.2). (109.3 x 1.98)/100 = 2.16414 = 2.16

$E = [(0.58 \times P_x) + (0.42 \times F_x)$

P_x = 190.6 (from BLS December 2008 Preliminary data) ÷ 114.2 (January 1986 reference value) = 1.669

F_x = 165.5 (from BLS December 2008 Preliminary data) ÷ 82.0 (January 1986 reference value) = 2.018

E = [0.58 (1.669) + 0.42 (2.018)] = 0.96802 + 0.84756 = 1.81558 = 1.816

B = 9.872 (from NUREG-1307 Table 2.1 for a PWR, Generic Low-Level Waste Disposal Site, Direct Disposal with Vendors)

Minimum Funding = $105 million [0.65 (2.16) + 0.13 (1.816) + 0.22 (9.872)]

Minimum Funding = $105 million [1.404 + 0.23608 + 2.17184]

Minimum Funding = $105 million [3.81192]

Minimum Funding = $400.3 million (2008 dollars) for WBN Unit 2

This funding calculation is updated annually using the adjustment factor formula described in 10 CFR §50.75(c)(2).

<u>WBN Unit 2 Decommissioning Funding Mechanism</u>

TVA currently has a Master Decommissioning Trust Agreement in place with The Bank of New York Mellon Corporation serving as Trustee. This Agreement establishes separate Funds under a Master Trust which provides financial assurance for the decommissioning of the existing operating plants owned and operated by TVA. It currently provides Funds for Browns Ferry Unit 1, Browns Ferry Unit 2, Browns Ferry Unit 3, Sequoyah Unit 1, Sequoyah Unit 2; and Watts Bar Unit 1. The decommissioning funding status for these existing operating plants is reported to the NRC every two years;

the most recent reporting was March 28, 2007 (Reference 1). Any changes to this Master Decommissioning Trust Agreement are also provided to the NRC as a part of the status reporting. The requirements of 10 CFR §50.75 will continue to be satisfied through this Master Decommissioning Trust Agreement.

Consistent with this current practice and pursuant to 10 CFR §50.75(e)(1), a Fund will be established within the Master Decommissioning Trust Agreement for Watts Bar Unit 2 prior to fuel load.

Decommissioning Costs and Funding – Status Reporting

In accordance with 10 CFR §50.75(f)(2), TVA will periodically report on the status of decommissioning funding for WBN Unit 2.

Recordkeeping Plans Related to Decommissioning Funding

In accordance with 10 CFR §50.75(g), TVA will retain records, until the termination of the license, of information important to safe and effective decommissioning.

REFERENCE:

1. Tennessee Valley Authority, "Decommissioning Funding Status Report – Browns Ferry (BFN), Sequoyah (SQN), and Watts Bar (WBN) Nuclear Plants," dated March 28, 2007 [ADAMS Accession No. ML071170573] (L44 070328 001)

Enclosure 2
Proposed Technical Specifications
And Technical Requirements Manual

References:
1. NRC Staff Requirements Memorandum SECY-07-0096, dated July 25, 2007, "Possible Reactivation of Construction and Licensing Activities for the Watts Bar Nuclear Plant Unit 2"
2. TVA letter dated August 27, 1992, "Watts Bar Nuclear Plant (WBN) Unit 1 - Proposed Technical Specifications (TS)" (T04 920827 975)

As previously directed in the NRC staff requirements memorandum SECY-07-0096 (Reference 1), the current licensing basis for WBN Unit 1 will be used as the reference basis for the review and licensing of WBN Unit 2.

When TVA submitted proposed Technical Specifications (TS) for WBN Unit 1 on August 27, 1992 (Reference 2), it noted that the package contained a markup of the draft of NUREG-1431 (Standard Technical Specifications Westinghouse Plants).

Chapter 16 (Technical Specifications) of NUREG-0800 (Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants) specifies reviews required of proposed TSs. To help facilitate the required reviews, the proposed WBN Unit 2 TS and TS Bases were developed by marking up Revision 0 of NUREG-1431 to indicate the WBN Unit 1 TS and TS Bases approved (as appropriate) through Amendment 70 and Revision 91, respectively. A review matrix was also developed that indicated, for each TS and TS Bases subsection, the amendments and revisions that applied to that subsection. Where applicable, this review matrix also indicates those amendments / revisions that will not be applied to Unit 2.

Attachment 002 contains the proposed template for the WBN Unit 2 TS and TS Bases. The numbers, setpoints, and parameters provided are preliminary in nature. Verification of these items will be provided during the certification stage of the TS process.

Attachment 004 contains the review matrix that shows the result of the review of Revision 0 of NUREG-1431 and the proposed WBN Unit 2 TS and TS Bases.

Attachment 005 contains the markup of Revision 0 of NUREG-1431 to reflect WBN Unit 2 specific changes. For ease of review, each subsection consists of the applicable portions of the TS and TS Bases preceded by the applicable excerpt of the review matrix.

The proposed WBN Unit 2 Technical Requirements Manual (TRM) and Bases were developed by marking up the photo-ready version for WBN Unit 1 to indicate the WBN Unit 1 TRM and TRM Bases approved (as appropriate) through Revision 44. A review matrix was also developed that indicated, for each TRM and TRM Bases subsection, the revisions that applied to that subsection. Where applicable, this review matrix also indicates those revisions that will not be applied to Unit 2.

Attachment 003 contains the proposed template for the WBN Unit 2 TRM and TRM Bases. The numbers, setpoints, and parameters provided are preliminary in nature. Verification of these items will be provided during the certification stage of the TRM process.

Attachment 004 contains the review matrix that shows the result of the review of the photo-ready version of the WBN Unit 1 TRM and TRM Bases and the proposed WBN Unit 2 TRM and TRM Bases.

Attachment 005 contains the markup of the photo-ready version of the WBN Unit 1 TRM and TRM Bases to reflect WBN Unit 2 specific changes. For ease of review, each subsection consists of the applicable portions of the TRM and TRM Bases preceded by the applicable excerpt of the review matrix.

Enclosure 3
Open Actions Required for Licensing

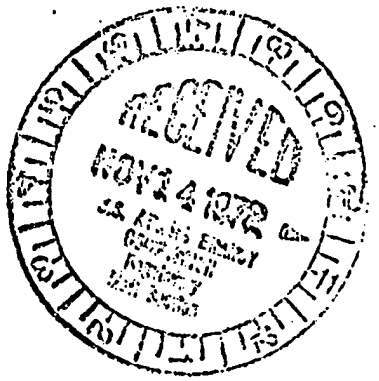
1. A decommissioning trust fund will be established for WBN Unit 2 prior to fuel load.

ATTACHMENT 7

Regulatory File Cy.

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401



November 9, 1972

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
United States Atomic Energy Commission
Washington, DC 20545

Dear Mr. Muller:

In the Matter of the Applications of) Docket Nos. ~~50-390~~
Tennessee Valley Authority) 50-391

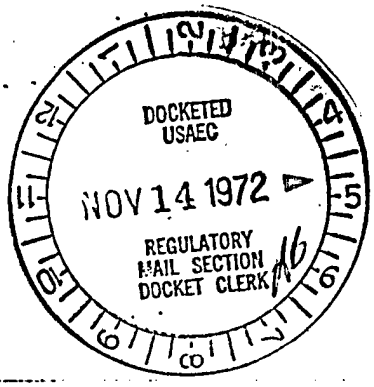
The final environmental statement for the Watts Bar Nuclear Plant has been prepared by TVA and is being submitted to the Council on Environmental Quality in accordance with its guidelines. Included in the front of the statement is the November 7, 1972, letter from Mr. Giambusso in which the AEC indicates that they believe the Watts Bar environmental statement satisfies applicable requirements and is adequate to support the licensing actions. Additional treatment of the topics referred to in Mr. Giambusso's letter has been incorporated into this statement. Submitted herewith are twenty-five copies for your use and additional copies are available at your request.

Very truly yours,

J. E. Gilleland

J. E. Gilleland
Assistant to the Manager of Power

Enclosure (under separate cover)



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An Equal Opportunity Employer

LB

ATTACHMENT 8

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

February 15, 2008

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop: OWFN P1-35
Washington, D.C. 20555-0001

Gentlemen:

In the Matter of) Docket No. 50-391
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) - UNIT 2 – FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE COMPLETION AND OPERATION OF UNIT 2

References: 1. TVA letter dated January 29, 2008, "Watts Bar Nuclear Plant (WBN) - Unit 2 – Regulatory Framework for the Completion of Construction and Licensing Activities for Unit 2"

2. TVA letter dated August 3, 2007, "Watts Bar Nuclear Plant (WBN) Unit 2 - Reactivation of Construction Activities"

This letter provides the Final Supplemental Environmental Impact Statement (FSEIS), "Completion and Operation of Watts Bar Nuclear Plant Unit 2", as committed in TVA's January 29, 2008, letter to the NRC, "Regulatory Framework for the Completion of Construction and Licensing Activities for Unit 2" (Reference 1).

TVA's FSEIS was issued on June 23, 2007. The TVA Board authorized completion of WBN Unit 2 on August 1, 2007. Subsequently, TVA informed the NRC of its intention to reactivate and complete construction activities at WBN Unit 2 (Reference 2). The TVA Board Record of Decision was posted in the Federal Register on August 15, 2007. The FSEIS includes an evaluation of the need for increased baseload power; an analysis of potential socioeconomic, cultural, and environmental effects of completing WBN Unit 2; and it identifies potential mitigation measures.

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This FSEIS supplements TVA's original 1972 "Final Environmental Statement, Watts Bar Nuclear Plant Units 1 and 2." In December 1978, NRC issued a "Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant Units 1 and 2, NUREG-0498." In 1993, TVA conducted a review to determine whether additional environmental review was needed to inform decision makers about whether to complete both units and concluded that neither plant design nor environmental considerations had changed in a manner that materially altered the environmental impact analysis set forth in its 1972 Final Environmental Statement (FES). TVA provided additional analyses and information in support of NRC's "Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2, NUREG-0498," which was issued in April 1995. Following an independent review of NRC's analyses and a new analysis of the need for additional power, TVA adopted NRC's 1995 FES in July 1995. Other major reviews of WBN environmental impacts include TVA's cooperation with the U. S. Department of Energy in evaluating the production of tritium in commercial light water reactors, which resulted in a 1999 "Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor." Also, in February 2004, TVA issued its "Reservoir Operations Study Final Programmatic Environmental Impact Statement" evaluating the impacts of alternative ways of operating TVA's reservoir system, the water supply needs of TVA's generating facilities, including WBN, and compliance with environmental permits. A more detailed description of environmental reviews and studies pertaining to the operation and construction of WBN is provided in the FSEIS.

TVA's assessment of the actions required to complete WBN Unit 2 as described in the enclosed FSEIS remains valid, and no additional environmental reviews are anticipated at this time. TVA will, of course, review and assess any supplemental environmental review completed by the NRC in connection with the completion and operation of WBN Unit 2 in the future. Background information and analyses used in the preparation of TVA's FSEIS, including that associated with the severe accident analysis section, are available at the WBN site for review.

This submittal contains no new commitments. If you have any questions, please contact me at (423) 365-2351.

Sincerely,

M. Bajestani

Masoud Bajestani
Watts Bar Unit 2 Vice President

Enclosure
cc: See page 3

cc (Enclosure):

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ATTACHMENT 9

Comparison of Fish Species Occurrence and Trends in Reservoir Fish Assemblage Index Results in Chickamauga Reservoir before and after Watts Bar Nuclear Plant Unit 1 Operation

Prepared by:

Jeffrey W. Simmons

Table preparation and data assistance by:

John C. Justice
Kurt M. Lakin
Gregory P. Shaffer
Amy K. Wales
Charles F. Walton

Tennessee Valley Authority

Aquatic Monitoring and Management
Chattanooga, Tennessee

September 2009

Updated June 2010

Changes made from the previous version of this document:

The previous version of this report was drafted prior to collection of 2009 data. This updated version includes 2009 fish collection data from all TVA sampling sites in Chickamauga Reservoir and from Watts Bar Reservoir forebay, located upstream of Watts Bar Nuclear Plant.

Prior to the September 2009 version of this report, TVA reservoir fish data collected during 1993 to 1998 had not been entered into the current TVA database, which houses data collected from 1999 to 2009, due to computer software/hardware compatibility issues. Most data collected during the 1990's were hand-recorded on field datasheets and then entered into spreadsheets for analysis. Data collected from 1999 to present were recorded on a digital field data-logger, which were then directly uploaded to the database for analysis and scoring. Any revisions to scoring criteria used to rate the ecological integrity of a site using the Reservoir Fish Assemblage Index (RFAI) were not reflected in 1993 to 1998 datasets because they were not incorporated into the database. During January 2010, raw data from 1993 to 1998 were hand-entered into data-loggers and uploaded into the database. This process provided an opportunity to thoroughly review the historical data and make corrections to any probable entry errors that may have occurred in these datasets when they were originally entered into spreadsheets for scoring and analysis. As a result, slight changes occurred in 1996 and 1997 Chickamauga Reservoir RFAI scores. The score for the 1996 sample conducted in the transition zone station (Tennessee River Mile 490.5) changed from a 43 to a 44; the score for the 1997 sample conducted in the inflow zone station (Tennessee River Mile 529) changed from a 46 to a 44; and the score for the 1997 sample conducted in the Hiwassee River embayment of Chickamauga Reservoir (Hiwassee River Mile 8.5) changed from a 38 to a 40. All scores shown in Table 4 of this document now reflect the current RFAI scoring criteria as shown in Table 1. All individual observed values, RFAI metric scores, and overall RFAI scores listed in Appendix 2 have also been updated.

Introduction

Section 316(a) of the Clean Water Act (CWA) is intended to regulate facilities with a thermal discharge from a point source to assure the protection of Balanced Indigenous Populations (BIP) of aquatic life. TVA uses its existing Vital Signs (VS) monitoring program, supplemented with additional fish community monitoring upstream and downstream of fossil and nuclear power plants, to evaluate effects of thermal discharges to aquatic communities in the receiving water body. The VS monitoring program began in 1990 in the Tennessee River System. This program was implemented to evaluate ecological health conditions in major reservoirs as part of TVA's stewardship role. One of the 5 indicators used in the VS program to evaluate reservoir health is the Reservoir Fish Assemblage Index (RFAI) methodology which was implemented beginning in 1993. RFAI has been thoroughly tested on TVA and other reservoirs and published in peer-reviewed literature (Jennings, et al., 1995; Hickman and McDonough, 1996; McDonough and Hickman, 1999). Fish communities are used to evaluate ecological conditions because of their importance in the aquatic food web and because fish life cycles are long enough to integrate conditions over time.

The purpose of this report is to: (1) provide a detailed explanation of the RFAI methodology and its application to fish community evaluation in relation to thermal discharges as specified by 316(a) of the Clean Water Act; (2) compare fish community structure of Chickamauga Reservoir before (1993-1995) and after (1996-2009) Watts Bar Nuclear Plant (WBN) Unit 1 became operational using existing TVA RFAI data; and (3) compare temporal differences in RFAI scores at the site within the WBN thermal discharge and at other monitoring sites within Chickamauga Reservoir from 1993 to 2009.

Plant Description

Watts Bar Nuclear Plant is located on the right descending (west) bank of upper Chickamauga Reservoir near Tennessee River Mile (TRM) 528, approximately two miles downstream of Watts Bar Dam (TRM 529.9) (Figure 1). This one-unit nuclear generating plant went into commercial operation on May 27, 1996.

In the original design, nearly all the waste heat created by the plant was dissipated in the atmosphere by the cooling towers. A small fraction of the waste heat was dissipated in the Tennessee River by the cooling tower blowdown. Blowdown from the cooling tower is discharged through multi-port diffusers located in the main river channel at TRM 527.9. Makeup water and other water supply requirements are obtained from an intake channel and pumping station at TRM 528. Intake pumping flow rate is 80 cfs, and maximum diffuser discharge is about 135 cfs.

The WBN Supplemental Condenser Cooling Water System (SCCW) system became operational in July, 1999. The SCCW system withdraws water from the intake structure located immediately upstream of Watts Bar Dam at TRM 529.9, which formerly served WBF. The temperature of the water in the SCCW system is usually lower than that provided by the Unit 1 cooling tower, so the SCCW flow reduces the temperature of the Unit 1 condenser flow and enhances the performance of the steam cycle. The SCCW is designed to provide a maximum of 365 cfs. Water from the SCCW system is discharged through the old Watts Bar Fossil Plant discharge structure located on the Tennessee River approximately 1.1 miles upstream of the nuclear plant intake (Figure 1).

The SCCW system was designed and constructed as a discretionary system. The SCCW system has no significant impact on the original blowdown system, allowing the plant to operate with or without the SCCW system in service. When the SCCW system is in service, the fraction of waste heat dissipated in the Tennessee River can be higher than that of the original full closed-mode operation.

Methods

Fish Sample Locations Upstream and Downstream of WBN

Reservoirs are typically divided into three zones for VS monitoring – inflow, transition, and forebay. The inflow zone is generally in the upper reaches of the reservoir and is riverine in nature; the transition zone or mid-reservoir is the area where water velocity decreases due to increased cross-sectional area; and the forebay is the lacustrine area near the dam. The

Chickamauga Reservoir inflow RFAI sample site is located at TRM 529.0 below Watts Bar Dam and extends downstream to TRM 526.3 (Figure 2). This station is used to provide downstream fish community data in the vicinity of the WBN thermal discharge. Since the WBN discharge is located within Chickamauga Reservoir inflow zone, no upstream control site data are available for comparison. Watts Bar Reservoir RFAI forebay site (TRM 531) is used to document any notable changes in Tennessee River ecological conditions above the WBN discharge but is not used for upstream/downstream comparisons of RFAI scores (Figure 2).

TVA has four additional monitoring sites on Chickamauga Reservoir. A site in the transition zone is located at TRM 490.5, two sites in the forebay are located at TRM 482 and 472.3, and a site on the Hiwassee River embayment of Chickamauga Reservoir is located at Hiwassee River mile (HiRM) 8.5 (Figure 2).

Fish Community Sampling Methods and Data Analysis for Sites Upstream and Downstream of WBN

Fish sampling immediately downstream of WBN was conducted by boat electrofishing (Reynolds, 1996). Fish sampling in Watts Bar Reservoir forebay (upstream of WBN) and at all other Chickamauga Reservoir sites were conducted by boat electrofishing and gill netting (Hubert, 1996; Reynolds, 1996). Electrofishing methodology consisted of fifteen electrofishing boat runs near the shoreline, each 300 meters long, with a duration of approximately 10 minutes each. The total near-shore area sampled is approximately 4,500 meters (15,000 feet). Experimental gill nets (so called because of their use for research as opposed to commercial fishing) are used as an additional gear type to collect fish from deeper habitats not effectively sampled by electrofishing. Each experimental gill net consists of five-6.1 meter panels for a total length of 30.5 meters (100.1 feet). The distinguishing characteristic of experimental gill nets is mesh size that varies between panels. For this application, each net has panels with mesh sizes of 2.5, 5.1, 7.6, 10.2, and 12.7 cm. Experimental gill nets are typically set perpendicular to river flow extending from near-shore to the main channel of the reservoir. Ten overnight experimental gill net sets were used at all sampling stations in Chickamauga Reservoir, with the exception of the inflow site downstream of the WBN discharge. Flows prevent effective use of

gill nets at the site located just downstream of WBN in the inflow zone of Chickamauga Reservoir (TRM 529).

Fish collected were identified by species, counted, and examined for anomalies (such as disease, deformations, or hybridization). The resulting data were analyzed using RFAI methodology.

The RFAI uses 12 fish community metrics from four general categories: Species Richness and Composition; Trophic Composition; Abundance; and Fish Health. Individual species can be utilized for more than one metric. Together, these 12 metrics provide a balanced evaluation of fish community integrity. The individual metrics are shown below, grouped by category:

Species Richness and Composition

1. **Total number of species** -- Greater numbers of species are considered representative of healthier aquatic ecosystems. As conditions degrade, numbers of species at an area decline.
2. **Number of centrarchid species** -- Sunfish species (excluding black basses) are invertivores and a high diversity of this group is indicative of reduced siltation and suitable sediment quality in littoral areas.
3. **Number of benthic invertivore species** -- Due to the special dietary requirements of this species group and the limitations of their food source in degraded environments, numbers of benthic invertivore species increase with better environmental quality.
4. **Number of intolerant species** -- This group is made up of species that are particularly intolerant of physical, chemical, and thermal habitat degradation. Higher numbers of intolerant species suggest the presence of fewer environmental stressors.
5. **Percentage of tolerant individuals** (excluding young-of-year) -- This metric signifies poorer water quality with increasing proportions of individuals tolerant of degraded conditions.
6. **Percentage dominance by one species** -- Ecological quality is considered reduced if one species inordinately dominates the resident fish community.

7. **Percentage of non-native species** -- Based on the assumption that non-native species reduce the quality of resident fish communities.
8. **Number of top carnivore species** -- Higher diversity of piscivores is indicative of the availability of diverse and plentiful forage species and the presence of suitable habitat.

Trophic Composition

9. **Percent of individuals as top carnivores** -- A measure of the functional aspect of top carnivores which feed on major planktivore populations.
10. **Percentage of individuals as omnivores** -- Omnivores are less sensitive to environmental stresses due to their ability to vary their diets. As trophic links are disrupted due to degraded conditions, specialist species such as insectivores decline while opportunistic omnivorous species increase in relative abundance.

Abundance

11. **Average number per run** -- (number of individuals) -- This metric is based upon the assumption that high quality fish assemblages support large numbers of individuals.

Fish Health

12. **Percentage individuals with anomalies** -- Incidence of diseases, lesions, tumors, external parasites, deformities, blindness, and natural hybridization are noted for all fish measured, with higher incidence indicating less favorable environmental conditions.

RFAI methodology addresses all four attributes or characteristics of a "balanced indigenous population" defined by the CWA, as described below:

A biotic community characterized by diversity appropriate to the ecoregion: Diversity is addressed by the metrics in the Species Richness and Composition category, especially metric 1:

Total number of species. Determination of reference conditions based on the inflow zones of upper mainstem Tennessee River reservoirs (as described below) ensures appropriate species expectations for the ecoregion.

The capacity for the community to sustain itself through cyclic seasonal change: TVA uses an autumn data collection period for biological indicators, for both VS and upstream/downstream monitoring. Autumn monitoring is used to document condition or health after being subjected to the wide variety of stressors throughout the year.

One of the main benefits of using biological indicators is their ability to integrate stressors through time. Examining the condition or health of a community at the end of the "biological year" (i.e., autumn) provides insights into how well the community has dealt with the stresses through an annual seasonal cycle. Likewise, evaluation of the condition of individuals in the community (in this case, individual fish as reflected in Metric 12) provides insights into how well the community can be expected to withstand stressors through winter. Further, multiple sampling years during the permit renewal cycle adds to the evidence of whether or not the autumn monitoring approach has correctly demonstrated the ability of the community to sustain itself through repeated seasonal changes.

The presence of necessary food chain species: Integrity of the food chain is measured by the Trophic Composition metrics, with support from the Abundance metric and Species Richness and Composition metrics. Existence of a healthy fish community indicates presence of necessary food chain species because the fish community is comprised of species that utilize multiple feeding mechanisms that transcend various levels in the aquatic food web. Basing evaluations on a sound multi-metric system such as the RFAI enhances the ability to discern alterations in the aquatic food chain.

A lack of domination by pollution-tolerant species: Domination by pollution-tolerant species is measured by metrics 3 (Number of benthic invertivore species), 4 (Number of intolerant species), 5 (Percentage of tolerant individuals), 6 (Percentage dominance by one species), and 10 (Percentage of individuals as omnivores).

Scoring categories are based on "expected" fish community characteristics in the absence of human-induced impacts other than impoundment of the reservoir. These categories were developed from historical fish assemblage data representative of inflow, transition, and forebay zones from upper mainstem Tennessee River reservoirs (Hickman and McDonough, 1996; McDonough and Hickman, 1999). Attained values for each of the 12 metrics were compared to the scoring criteria and assigned scores to represent relative degrees of degradation: least degraded (5); intermediate degraded (3); and most degraded (1). Scoring criteria for upper mainstem Tennessee River reservoirs are shown in Table 1. The Hiwassee River embayment site is scored with RFAI transition zone scoring criteria.

If a metric was calculated as a percentage (e.g. Percent tolerant individuals), the data from electrofishing and gill netting were scored separately and allotted half the total score for that individual metric. Inflow areas are scored only using electrofishing data and scoring criteria were developed to account for the lack of gill net data. Individual metric scores for a sampling area are summed to obtain the RFAI score.

TVA uses RFAI results to determine maintenance of BIP using 2 approaches. One is "absolute" in that it compares the RFAI scores and individual metrics to predetermined values. The other is "relative" in that it compares RFAI scores attained downstream to the upstream control site. The "relative" approach does not apply to WBN since the upstream site is located upstream of Watts Bar Dam. The downstream site is compared to the previous year's data at this site to examine if any changes had occurred throughout the year. The upstream site is used to evaluate water quality conditions upstream of WBN, but is not used for upstream comparison due to significant aquatic habitat differences (inflow versus forebay). The "absolute" approach is based on Jennings et al. (1995) who suggested that favorable comparisons of the attained RFAI score from the potential impact zone to a predetermined criterion can be used to identify the presence of normal community structure and function and hence existence of BIP.

RFAI scores range from 12 to 60. For multi-metric indices such as RFAI, TVA uses two criteria to ensure a conservative screening of BIP. First, if an RFAI score reaches 70% of the highest

attainable score of 60, and second, if fewer than half of RFAI metrics receive a low (1) or moderate (3) score, then normal community structure and function would be present indicating that BIP had been maintained, thus no further evaluation would be needed. Therefore, any location that attains an RFAI score of 42 or higher (70% of 60) would be considered to have BIP. The cutoff of $\geq$ 70% to determine BIP was calculated by trisecting the reservoir data from which the RFAI was developed to set limits to determine fish population health, structure, and function, thus resulting in the current scoring criteria ranges used for individual RFAI metric scores. It must be stressed that scores below this threshold do not necessarily reflect an adversely impacted fish community. The threshold is used to serve as a conservative screening level; i.e., any fish community that meets these criteria is obviously not adversely impacted. RFAI scores below this level would require a more in-depth look to determine if BIP exists. An inspection of individual RFAI metric results and species of fish used in each metric would be an initial step to help identify if operation of WBN is a contributing factor. This approach is appropriate because a validated multi-metric index is being used and scoring criteria applicable to the zone of study are available.

The Quality Assurance (QA) component of VS monitoring deals with how well the RFAI scores can be repeated and is accomplished by collecting a second set of samples at 15%-20% of the sites each year. Previous statistical analyses with the QA component of VS has shown that the comparison of RFAI index scores from 54 paired sample sets collected over a seven year period ranged from 0 to 18 points. Based on these findings, the 75th percentile was 6 and the 90th percentile was 12. The mean difference between these 54 paired scores was 4.6 points with 95 percent confidence limits of 3.4 and 5.8. Therefore, a difference of 6 points or less was the value selected for defining "similar" scores between years sampled at the downstream site. That is, if the downstream RFAI score is within 6 points compared to the prior year's score then the fish communities will be considered similar (e.g. previous year's score was 48 $\pm$ 3 and current sample's score is 42 $\pm$ 3; these scores would be considered similar because they are within 6 points). It is important to bear in mind that differences greater than 6 points can be expected simply due to method variation (25% of the QA paired sample sets exceeded that value). When this occurs, a metric-by-metric examination will be conducted to determine what caused the difference in scores and the potential for the difference to be thermally related.

The average variation for RFAI scores in TVA reservoirs is 6 (± 3). This variability comes from various sources, including annual variations in air temperature and stream flow; variations in pollutant loadings from nonpoint sources; changes in habitat, such as extent and density of aquatic vegetation; natural population cycles and movements of the species being measured (TWRC, 2006). Another source of variability arises from the fact that nearly any practical measurement, lethal or non-lethal, of a biological community is a sample rather than a measurement of the entire population. As long as the score is within the 6-point range of variability from the previous year, there is no certainty that any real change has taken place beyond method variability

Results and Discussion

Fish Species Occurrence Analysis

During RFAI sampling from 1993 to 2009 at the Chickamauga Reservoir inflow station (TRM 529), located within the thermal discharge of WBN Plant, 48 fish species were collected (Table 2). Prior to WBN operation (1993 to 1995), 39 fish species were collected. During initial WBN operation (1996 to 1997), 34 fish species were encountered. Sampling during subsequent years (1999 to 2009) has resulted in 45 species at this site.

Skipjack herring is the only species that has not been encountered at this site that was encountered prior to operation of WBN (Table 2). This species was never collected in large numbers at this site; 25 individuals in 1993, 10 individuals in 1994, and 1 individual in 1995. It is commonly collected at other sites throughout Chickamauga Reservoir (Appendix 1).

In recent years (1999 to 2009), six native species (bullhead minnow, river redhorse, rock bass, smallmouth redhorse, spotted gar, and walleye) and one non-native species (inland silverside) have been collected at this site that were not encountered in WBN pre-operational samples (Table 2, Appendix 1).

Chestnut lamprey (1 individual) and mooneye (1 individual) were collected in samples at this site during monitoring during initial operation (1997) but were not collected in pre-operational samples or samples during subsequent years (Table 2; Appendix 1). Chestnut lamprey is a

parasitic fish that feeds on larger bodied fishes. It has been sporadically collected throughout Chickamauga Reservoir during 1993 to 2009 RFAI samples (Appendix1). Only 7 mooneye, including the 1 individual collected at this site in 1997 have been collected in Chickamauga Reservoir during 1993 to 2009 (Appendix 1).

During RFAI sampling from 1993 to 2009 at all sampling sites in Chickamauga Reservoir, 60 fish species have been collected (Table 3). Prior to WBN operation (1993 to 1995), 47 fish species were collected. During initial WBN operation (1996 to 1997), 43 fish species were encountered. Sampling during subsequent years (1999 to 2009) has resulted in collection of 57 species in Chickamauga Reservoir.

Two native species (highfin carpsucker and river carpsucker) and one non-native species (grass carp) were collected in Chickamauga Reservoir prior to WBN operations that have not been collected post WBN operations (Table 3). Both of these native species were represented by 1 individual at the Chickamauga transition zone site (TRM 490.5) in 1994 (Appendix 1). This site is located ~38 river miles downstream of WBN which precludes any possible thermal impact from WBN to the known occurrence of these species in Chickamauga Reservoir.

Nine native species (black buffalo, brown bullhead, dusky darter, lake sturgeon, mooneye, river redhorse, rock bass, smallmouth redhorse, and western mosquitofish,) and three non-native species (alewife, Atlantic needlefish, and inland silverside) have been collected in recent RFAI samples (1999 to 2009) that were not collected before WBN operation in Chickamauga Reservoir (Table 3, Appendix 1).

In conclusion, there has not been a decline in the number of species or overall fish community composition at the site located within the thermal discharge of WBN or within Chickamauga Reservoir since WBN began operations.

RFAI Analysis

RFAI scores for the inflow site (TRM 529) downstream from the WBN thermal discharge have averaged a score of 45 during the 16 sample years from 1993 to 2009 (Table 4). Scores from

every sample year were ≥ 70% of the highest attainable score of 60 indicating that BIP had been maintained. Individual metric scores and overall RFAI scores for all sites in Chickamauga Reservoir and the Watts Bar Reservoir forebay site upstream of WBN are listed in Appendix 2-A to Appendix 2-Q.

The greatest score difference between consecutive sample years at this site was six points, which has been observed twice throughout the duration of RFAI sampling at this site (Table 4). This site received a score of 48 in 1995 and dropped to a 42 the following year. An evaluation of individual metrics showed that the 1996 sample scored 2 points lower for 3 metrics (percent dominance by one species, percent top carnivores, and percent omnivores) (Appendices 2-N, 2-O). Collection of 3,577 gizzard shad during 1996, compared to 790 during 1995 was predominantly responsible for these score differences (Appendix 1). Species composition and abundance of top carnivore species was similar between years but collection of such a large number of gizzard shad reduced the overall percentage of top carnivores present in the sample and subsequently increased the percent dominance by one species and the percentage of omnivores in the overall sample. Metrics that indicate degradation such as "number of benthic invertivores" and "number of intolerant species" received the same score during both sample years.

The second occurrence of a score difference of six points was during 2003 (score of 48) and 2004 (score of 42). An evaluation of individual metrics showed that the 2004 sample scored 2 points lower for 4 metrics (percent tolerant individuals, percent dominance by one species, percent omnivores, and number of intolerant species), while the 2003 sample received a 2 point lower score for the metric "percent top carnivores" (Appendices 2-F, 2-G). Once again, collection of large numbers of gizzard shad during 2004 was the primary the reason for lower metric scores. During 2004, 750 gizzard shad were collected compared to 178 during 2003 (Appendix 1). This resulted in lower scores for "percent tolerant individuals", "percent dominance by one species", and "percent omnivores". Although the 2003 sample received a higher score for the metric "percent tolerant individuals", observed values were similar (57.7% in 2003 compared to 64.8% in 2004). The lower score for the metric "number of intolerant species" during 2004 was the result of collection of 1 less intolerant species. The same intolerant

species were collected during both sample years with the exception of 6 black redhorse during 2003 (Appendix 1). Although less intolerant species were collected during 2004, 69 intolerant individuals were collected compared to 25 individuals during 2003.

Long-term RFAI data from inflow stations throughout the entire length of the Tennessee River were compared to evaluate similarities in RFAI scores. Lower mainstem Tennessee River reservoir inflow stations (Kentucky, Pickwick, Wilson, Wheeler, and Guntersville reservoirs) were sampled using RFAI methodology during 1993 to 2009 (N = 49 samples). RFAI scores for these inflow sites have averaged a score of 40.6 $\pm$ 1.7 at the 95% confidence level. Upper mainstem Tennessee River reservoir inflow stations (Nickajack, Chickamauga, Watts Bar, and Fort Loudon reservoirs) were also sampled using RFAI methodology during 1993 to 2009. RFAI scores for these inflow sites (excluding Chickamauga Reservoir inflow) have averaged a score of 42.8 $\pm$ 2.2 at the 95% confidence level (N = 46 samples). The Chickamauga Reservoir inflow station has averaged a RFAI score of 45.1 $\pm$ 1.9 at the 95% confidence level (N = 16 sample years). These long-term data trends suggest that the ecological health of the fish community in Chickamauga Reservoir inflow has been maintained and has averaged a higher RFAI score than the combined long-term averages of other upper and lower mainstem Tennessee River reservoirs.

Other RFAI samples in Chickamauga Reservoir (transition, forebay {2 sites}, and embayment) have averaged scores $\geq$ 42 from 1993 to 2009 which are $\geq$ 70% of the highest attainable score of 60 indicating that BIP had been maintained throughout Chickamauga Reservoir (Table 4). Lower scores at some sites have been observed in recent years, most notably during 2007 and 2008. This was a severe drought period which may have stressed fish communities at sites within the transition and forebay zones of the reservoir. This was also observed in Watts Bar Reservoir forebay which is upstream of the WBN thermal discharge (Table 4). RFAI scores at the Chickamauga Reservoir inflow site in the vicinity of WBN did not noticeably change during this drought period. Long-term trends in RFAI scores do not indicate that overall fish community health, diversity, or structure has declined at these sites within Chickamauga Reservoir.

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Table 1. Scoring criteria for forebay, transition, and inflow sections of upper mainstream Tennessee River reservoirs. Upper mainstream reservoirs include Chickamauga, Fort Loudoun, Melton Hill, Nickajack, Tellico, and Watts Bar.

		Scoring Criteria								
		Forebay			Transition			Inflow		
Metric	Gear	1	3	5	1	3	5	1	3	5
1. Total species	Combined	<14	14-27	>27	<15	15-29	>29	<14	14-27	>27
2. Total Centrarchid species	Combined	<2	2-4	>4	<2	2-4	>4	<3	3-4	>4
3. Total benthic invertivores	Combined	<4	4-7	>7	<4	4-7	>7	<3	3-6	>6
4. Total intolerant species	Combined	<2	2-4	>4	<2	2-4	>4	<2	2-4	>4
5. Percent tolerant individuals	Electrofishing	>62%	31-62%	<31%	>62%	31-62%	<31%	>58%	29-58%	<29%
	Gill netting	>28%	14-28%	<14%	>32%	16-32%	<16%	---	---	---
6. Percent dominance by 1 species	Electrofishing	>50%	25-50%	<25%	>40%	20-40%	<20%	>46%	23-46%	<23%
	Gill netting	>29%	15-29%	<15%	>28%	14-28%	<14%	---	---	---
7. Percent non-native species	Electrofishing	>4%	2-4%	<2%	>6%	3-6%	<3%	>17%	8-17%	<8%
	Gill netting	>16%	8-16%	<8%	>9%	5-9%	<5%	---	---	---
8. Total top carnivore species	Combined	<4	4-7	>7	<4	4-7	>7	<3	3-6	>6
9. Percent top carnivores	Electrofishing	<5%	5-10%	>10%	<6%	6-11%	>11%	<11%	11-22%	>22%
	Gill netting	<25%	25-50%	>50%	<26%	26-52%	>52%	---	---	---
10. Percent omnivores	Electrofishing	>49%	24-49%	<24%	>44%	22-44%	<22%	>55%	27-55%	<27%
	Gill netting	>34%	17-34%	<17%	>46%	23-46%	<23%	---	---	---
11. Average number per run	Electrofishing	<121	121-241	>241	<105	105-210	>210	<51	51-102	>102
	Gill netting	<12	12-24	>24	<12	12-24	>24	---	---	---
12. Percent anomalies	Electrofishing	>5%	2-5%	<2%	>5%	2-5%	<2%	>5%	2-5%	<2%
	Gill netting	>5%	2-5%	<2%	>5%	2-5%	<2%	---	---	---

Table 2. Comparison of fish species collected during autumn RFAI sampling at the Chickamauga Reservoir inflow site located within the WBN thermal discharge (TRM 529) pre-operation (1993-1995), during initial operation (1996-1997), and in subsequent years (1999-2009) during operation of WBN Unit 1. Species are listed in alphabetical order by common name.

	Common Name	**Scientific Name**	**1993-1995**	**1996-1997**	**1999-2009**
1	Black crappie	*Pomoxis nigromaculatus*	X	X	X
2	Black redhorse	*Moxostoma duquesnei*	X	X	X
3	Blue catfish	*Ictalurus furcatus*	X	---	X
4	Bluegill	*Lepomis macrochirus*	X	X	X
5	Bluntnose minnow	*Pimephales notatus*	X	X	X
6	Brook silverside	*Labidesthes sicculus*	X	---	X
7	Bullhead minnow	*Pimephales vigilax*	---	---	X
8	Channel catfish	*Ictalurus punctatus*	X	X	X
9	Chestnut lamprey	*Ichthyomyzon castaneus*	---	X	---
10	Common carp	*Cyprinus carpio*	X	X	X
11	Emerald shiner	*Notropis atherinoides*	X	X	X
12	Flathead catfish	*Pylodictis olivaris*	X	X	X
13	Freshwater drum	*Aplodinotus grunniens*	X	X	X
14	Gizzard shad	*Dorosoma cepedianum*	X	X	X
15	Golden redhorse	*Moxostoma erythrurum*	X	X	X
16	Golden shiner	*Notemigonus crysoleucas*	X	X	X
17	Green sunfish	*Lepomis cyanellus*	X	X	X
18	Inland silverside	*Menidia beryllina*	---	---	X
19	Largemouth bass	*Micropterus salmoides*	X	X	X
20	Largescale stoneroller	*Campostoma oligolepis*	X	---	X
21	Logperch	*Percina caprodes*	X	X	X
22	Longear sunfish	*Lepomis megalotis*	X	X	X
23	Longnose gar	*Lepisosteus osseus*	X	X	X
24	Mooneye	*Hiodon tergisus*	---	X	---
25	Northern hog sucker	*Hypentelium nigricans*	X	X	X
26	Redbreast sunfish	*Lepomis auritus*	X	X	X
27	Redear sunfish	*Lepomis microlophus*	X	X	X
28	River redhorse	*Moxostoma carinatum*	---	X	X
29	Rock bass	*Ambloplites rupestris*	---	---	X
30	Sauger	*Sander canadensis*	X	X	X
31	Skipjack herring	*Alosa chrysochloris*	X	---	---
32	Smallmouth bass	*Micropterus dolomieu*	X	X	X
33	Smallmouth buffalo	*Ictiobus bubalus*	X	---	X
34	Smallmouth redhorse	*Moxostoma breviceps*	---	---	X
35	Spotfin shiner	*Cyprinella spiloptera*	X	X	X
36	Spotted bass	*Micropterus punctulatus*	X	X	X
37	Spotted gar	*Lepisosteus oculatus*	---	---	X
38	Spotted sucker	*Minytrema melanops*	X	X	X
39	Steelcolor shiner	*Cyprinella whipplei*	X	---	X
40	Striped bass	*Morone saxatilis*	X	---	X
41	Striped shiner	*Luxilus chrysocephalus*	X	---	X
42	Threadfin shad	*Dorosoma petenense*	X	X	X
43	Walleye	*Sander vitreus*	---	---	X
44	Warmouth	*Lepomis gulosus*	X	X	X
45	White bass	*Morone chrysops*	X	X	X
46	White crappie	*Pomoxis annularis*	X	X	X
47	Yellow bass	*Morone mississippiensis*	X	X	X
48	Yellow perch	*Perca flavescens*	X	X	X
---	Hybrid stripped x white bass	*Morone saxatilis x chrysops*	---	X	---
---	Hybrid sunfish	*Lepomis* sp.	X	X	X
	Total number of species (excluding hybrids)		**39**	**34**	**45**

Table 3. Comparison of fish species collected during autumn RFAI sampling at all sites in Chickamauga Reservoir pre-operation (1993-1995), during initial operation (1996-1997), and in subsequent years (1999-2009) during operation of WBN Unit 1. Species are listed in alphabetical order by common name.

	Common Name	Scientific Name	1993-1995	1996-1997	1999-2009
1	Alewife	*Alosa pseudoharengus*	---	---	X
2	Atlantic needlefish	*Strongylura marina*	---	---	X
3	Black buffalo	*Ictiobus niger*	---	---	X
4	Black crappie	*Pomoxis nigromaculatus*	X	X	X
5	Black redhorse	*Moxostoma duquesnei*	X	X	X
6	Blue catfish	*Ictalurus furcatus*	X	X	X
7	Bluegill	*Lepomis macrochirus*	X	X	X
8	Bluntnose minnow	*Pimephales notatus*	X	X	X
9	Brook silverside	*Labidesthes sicculus*	X	X	X
10	Brown bullhead	*Ameiurus nebulosus*	---	---	X
11	Bullhead minnow	*Pimephales vigilax*	X	X	X
12	Channel catfish	*Ictalurus punctatus*	X	X	X
13	Chestnut lamprey	*Ichthyomyzon castaneus*	X	X	X
14	Common carp	*Cyprinus carpio*	X	X	X
15	Dusky darter	*Percina sciera*	---	---	X
16	Emerald shiner	*Notropis atherinoides*	X	X	X
17	Flathead catfish	*Pylodictis olivaris*	X	X	X
18	Freshwater drum	*Aplodinotus grunniens*	X	X	X
19	Gizzard shad	*Dorosoma cepedianum*	X	X	X
20	Golden redhorse	*Moxostoma erythrurum*	X	X	X
21	Golden shiner	*Notemigonus crysoleucas*	X	X	X
22	Grass carp	*Ctenopharyngodon idella*	X	---	---
23	Green sunfish	*Lepomis cyanellus*	X	X	X
24	Highfin Carpsucker	*Carpiodes velifer*	X	---	---
25	Inland silverside	*Menidia beryllina*	---	---	X
26	Lake sturgeon	*Acipenser fulvescens*	---	---	X
27	Largemouth bass	*Micropterus salmoides*	X	X	X
28	Largescale stoneroller	*Campostoma oligolepis*	X	---	X
29	Logperch	*Percina caprodes*	X	X	X
30	Longear sunfish	*Lepomis megalotis*	X	X	X
31	Longnose gar	*Lepisosteus osseus*	X	X	X
32	Mooneye	*Hiodon tergisus*	---	X	X
33	Northern hog sucker	*Hypentelium nigricans*	X	X	X
34	Redbreast sunfish	*Lepomis auritus*	X	X	X
35	Redear sunfish	*Lepomis microlophus*	X	X	X
36	River carpsucker	*Carpiodes carpio*	X	---	---
37	River redhorse	*Moxostoma carinatum*	---	X	X
38	Rock bass	*Ambloplites rupestris*	---	---	X
39	Sauger	*Sander canadensis*	X	X	X
40	Skipjack herring	*Alosa chrysochloris*	X	X	X
41	Silver redhorse	*Moxostoma anisurum*	X	---	X
42	Smallmouth bass	*Micropterus dolomieu*	X	X	X
43	Smallmouth buffalo	*Ictiobus bubalus*	X	X	X
44	Smallmouth redhorse	*Moxostoma breviceps*	---	---	X
45	Spotfin shiner	*Cyprinella spiloptera*	X	X	X
46	Spotted bass	*Micropterus punctulatus*	X	X	X

Table 3. (Continued)

	Common Name	Scientific Name	1993-1995	1996-1997	1999-2009
47	Spotted gar	*Lepisosteus oculatus*	X	X	X
48	Spotted sucker	*Minytrema melanops*	X	X	X
49	Steelcolor shiner	*Cyprinella whipplei*	X	---	X
50	Striped bass	*Morone saxatilis*	X	X	X
51	Striped shiner	*Luxilus chrysocephalus*	X	---	X
52	Threadfin shad	*Dorosoma petenense*	X	X	X
53	Walleye	*Sander vitreus*	X	X	X
54	Warmouth	*Lepomis gulosus*	X	X	X
55	Western mosquitofish	*Gambusia affinis*	---	---	X
56	White bass	*Morone chrysops*	X	X	X
57	White crappie	*Pomoxis annularis*	X	X	X
58	Yellow bass	*Morone mississippiensis*	X	X	X
59	Yellow bullhead	*Ameiurus natalis*	---	X	X
60	Yellow perch	*Perca flavescens*	X	X	X
---	Hybrid bass	*Micropterus* sp.	---	---	X
---	Hybrid shad	*Dorosoma* sp.	X	X	X
---	Hybrid stripped x white bass	*Morone saxatilis x chrysops*	X	X	X
---	Hybrid sunfish	*Lepomis* sp.	X	X	X
---	Hybrid walleye x sauger	*Sander vitreus x canadensis*	---	---	X
	Total number of species (excluding hybrids):		**47**	**43**	**57**

Table 4. Summary of RFAI scores from sites located directly upstream and downstream of Watts Bar Nuclear Plant as well as scores from sampling conducted during 1993-2009 as part of the Vital Signs Monitoring Program in Chickamauga Reservoir.

Station	Location	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	**Average**
WBN Upstream Forebay	TRM 531.0	44	48	---	43	---	41	36	44	39	39	45	43	46	42	36	36	45	**42**
WBN Downstream Inflow	TRM 529.0	52	52	48	42	44	---	42	44	46	48	48	42	42	42	42	44	44	**45**
Transition	TRM 490.5	51	40	48	44	39	---	45	46	45	51	42	49	46	47	44	34	41	**45**
Forebay	TRM 482.0	---	---	---	47	---	---	41	48	46	43	45	41	39	35	38	38	37	**42**
Forebay	TRM 472.3	43	44	47	---	40	---	45	45	48	46	43	43	46	43	41	41	42	**44**
Hiwassee River Embayment	HiRM 8.5	46	39	39	---	40	---	43	43	47	---	36	42	45	---	41	---	42	**42**

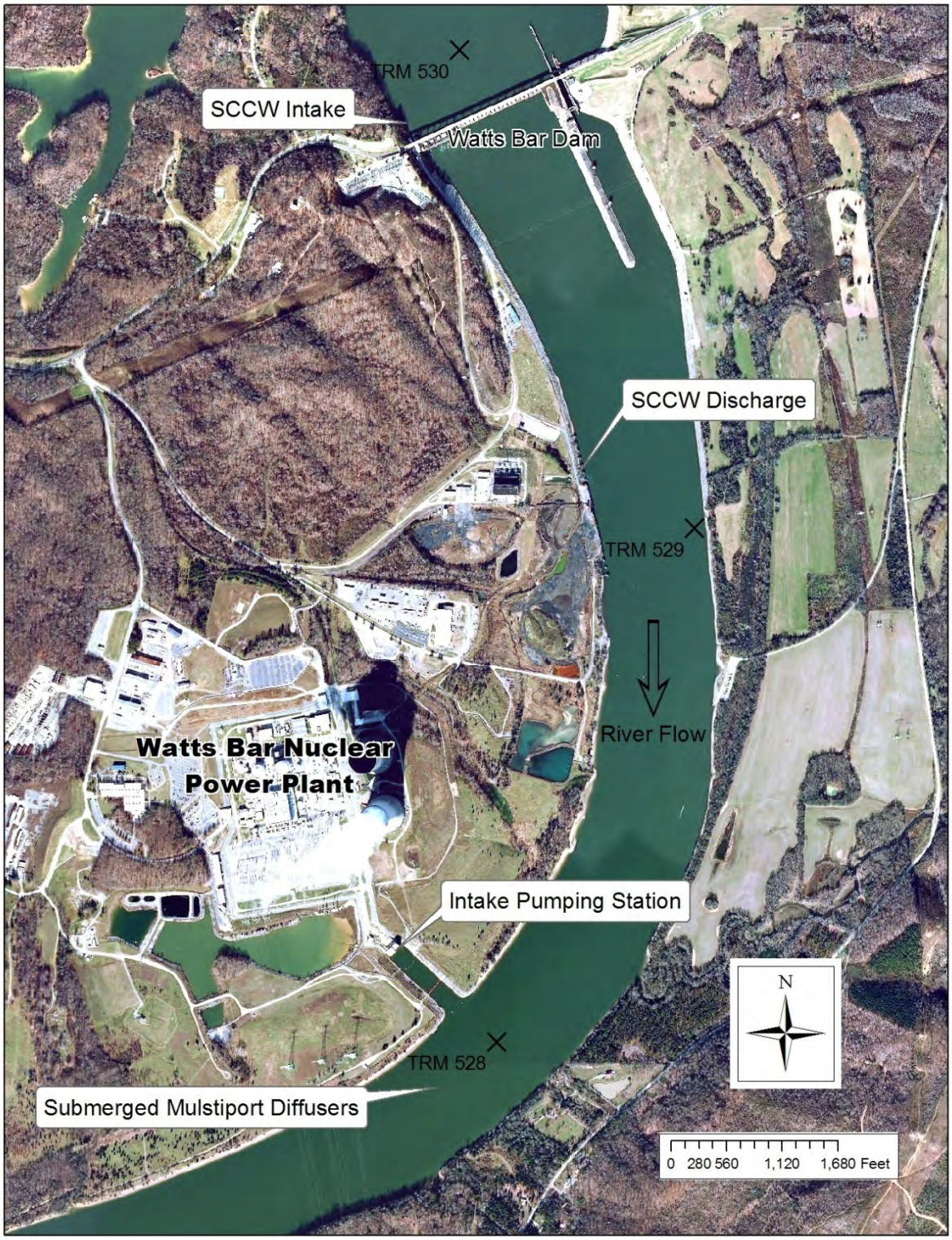

Figure 1. Map of WBN showing location of SCCW intake and discharge.

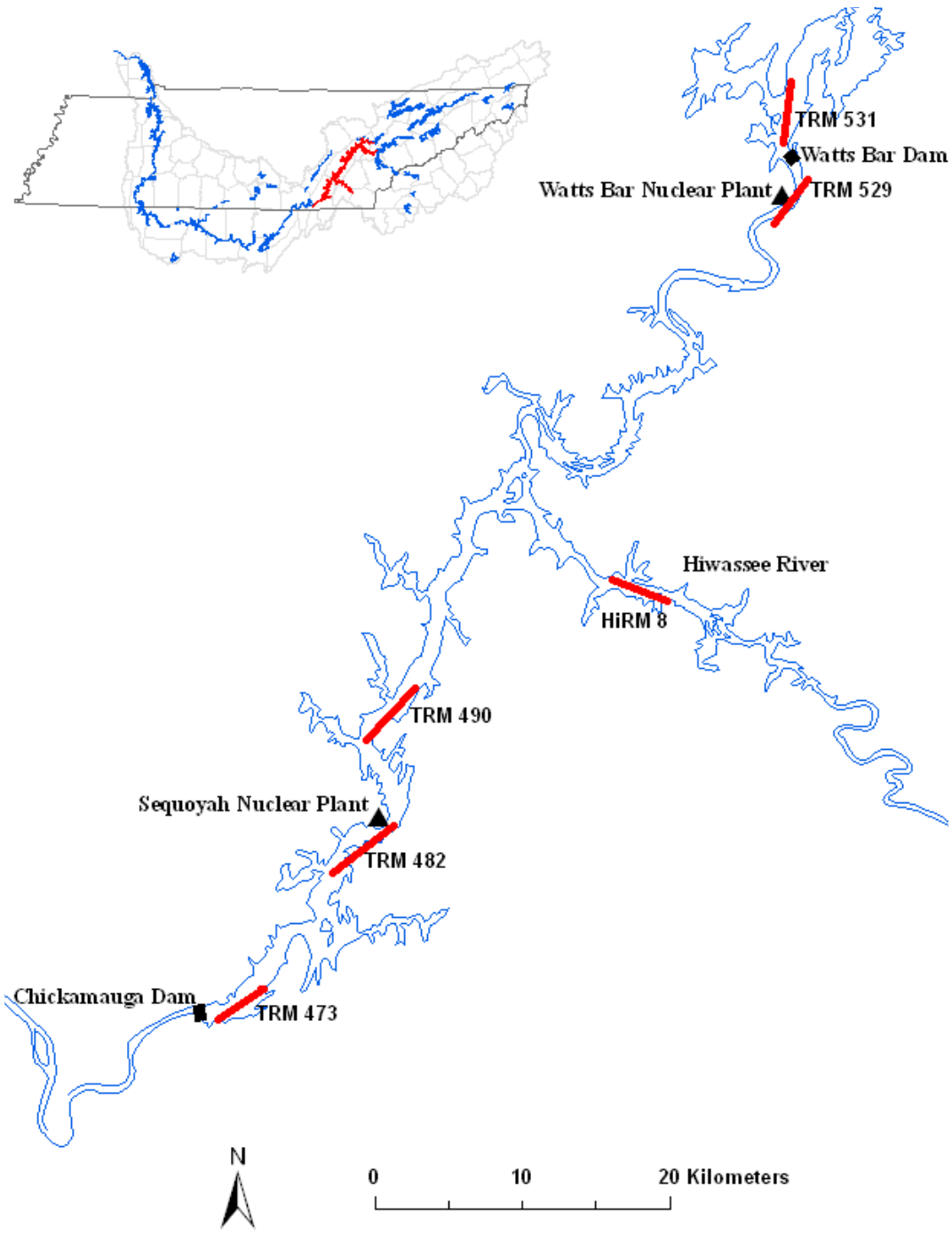

Figure 2. Reservoir Fish Assemblage Index (RFAI) monitoring sites in Chickamauga Reservoir and Watts Bar Reservoir forebay. Tennessee River Miles (TRM) displayed are positioned near the midpoint of each sample area (as represented by red line), with the exception of TRM 529, which is near the upstream end of the sample area.

Appendix 1. Species list and number of fish collected by year and Tennessee River mile (TRM) in Chickamauga Reservoir (TRM 529, 490.5, 482, 472.2, and Hiwassee River mile {HIRM} 8.4) and Watts Bar Reservoir forebay (TRM 531) during autumn RFAI sampling (electro-fishing {EF} and gill netting), 1993 to 2009. Species are listed in alphabetical order by common name.

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Alewife	*Alosa pseudoharengus*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Alewife	*Alosa pseudoharengus*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Atlantic needlefish	*Strongylura marina*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Atlantic needlefish	*Strongylura marina*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	---	1
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Black buffalo	*Ictiobus niger*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	1	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	3	---	3
			482.0	---	---	---
			472.3	1	---	1
			HIRM 8.5	1	---	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Black buffalo	*Ictiobus niger*					
		2002	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	1	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	12	---	12
		2004	531.0	2	---	2
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	6	---	6
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	2	3	5
		2006	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	2	1	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Black crappie	*Pomoxis nigromaculatus*					
		1993	531.0	3	4	7
			529.0	15	---	15
			490.5	19	14	33
			472.3	---	14	14
			HIRM 8.5	1	47	48
		1994	531.0	1	---	1
			529.0	7	---	7
			490.5	3	---	3
			472.3	1	2	3
			HIRM 8.5	7	---	7
		1995	529.0	6	---	6
			490.5	10	1	11
			472.3	7	16	23
			HIRM 8.5	1	1	2
		1996	531.0	---	---	---
			529.0	16	---	16
			490.5	---	---	---
			482.0	---	18	18
		1997	529.0	12	---	12
			490.5	---	---	---
			472.3	---	2	2
			HiRM 8.5	1	---	1
		1998	531.0	---	1	1
		1999	531.0	---	1	1
			529.0	4	---	4
			490.5	1	1	2
			482.0	---	---	---
			472.3	1	4	5
			HIRM 8.5	6	3	9
		2000	531.0	7	2	9
			529.0	43	---	43
			490.5	18	9	27
			482.0	2	2	4
			472.3	---	4	4
			HIRM 8.5	14	5	19
		2001	531.0	2	34	36
			529.0	---	---	---
			490.5	6	5	11
			482.0	---	32	32
			472.3	1	41	42
			HIRM 8.5	12	15	27

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Black crappie	*Pomoxis nigromaculatus*					
		2002	531.0	1	25	26
			529.0	18	---	18
			490.5	17	8	25
			482.0	3	1	4
			472.3	1	23	24
		2003	531.0	6	7	13
			529.0	13	---	13
			490.5	19	8	27
			482.0	4	1	5
			472.3	---	8	8
			HIRM 8.5	12	---	12
		2004	531.0	---	13	13
			529.0	23	---	23
			490.5	23	10	33
			482.0	5	4	9
			472.3	5	14	19
			HIRM 8.5	25	7	32
		2005	531.0	1	52	53
			529.0	26	---	26
			490.5	3	4	7
			482.0	6	2	8
			472.3	2	8	10
			HIRM 8.5	14	3	17
		2006	531.0	3	29	32
			529.0	5	---	5
			490.5	12	18	30
			482.0	2	13	15
			472.3	1	47	48
		2007	531.0	---	44	44
			529.0	4	---	4
			490.5	2	56	58
			482.0	1	21	22
			472.3	1	57	58
			HIRM 8.5	18	1	19
		2008	531.0	---	7	7
			529.0	5	---	5
			490.5	8	22	30
			482.0	3	20	23
			472.3	1	30	31
		2009	531.0	1	26	27
			529.0	9	---	9
			490.5	94	8	102
			482.0	24	11	35
			472.3	---	15	15
			HIRM 8.5	12	10	22

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Black redhorse	*Moxostoma duquesnei*					
		1993	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	6	---	6
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	4	---	4
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	4	---	4
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	5	---	5
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	---	---
			529.0	2	---	2
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Black redhorse	*Moxostoma duquesnei*					
		2003	531.0	---	---	---
			529.0	6	---	6
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	2	---	2
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2006	531.0	---	---	---
			529.0	6	---	6
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	2	---	2
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	6	---	6
		2008	531.0	---	---	---
			529.0	3	---	3
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	---	1
		2009	531.0	---	---	---
			529.0	5	---	5
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Blue catfish	*Ictalurus furcatus*					
		1993	531.0	---	10	10
			529.0	1	---	1
			490.5	1	8	9
			472.3	1	4	5
			HIRM 8.5	---	1	1
		1994	531.0	---	4	4
			529.0	1	---	1
			490.5	---	4	4
			472.3	---	7	7
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	6	6
			472.3	---	9	9
			HIRM 8.5	1	7	8
		1996	531.0	---	6	6
			529.0	---	---	---
			490.5	---	7	7
			482.0	---	2	2
		1997	529.0	---	---	---
			490.5	---	6	6
			472.3	---	---	---
			HiRM 8.5	---	3	3
		1998	531.0	---	7	7
		1999	531.0	---	37	37
			529.0	---	---	---
			490.5	---	4	4
			482.0	---	15	15
			472.3	---	18	18
			HIRM 8.5	---	3	3
		2000	531.0	---	8	8
			529.0	1	---	1
			490.5	---	---	---
			482.0	10	8	18
			472.3	---	22	22
			HIRM 8.5	---	---	---
		2001	531.0	---	5	5
			529.0	11	---	11
			490.5	---	17	17
			482.0	2	18	20
			472.3	---	38	38
			HIRM 8.5	---	1	1
		2002	531.0	---	11	11
			529.0	---	---	---
			490.5	---	---	---
			482.0	8	2	10
			472.3	---	5	5

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Blue catfish	*Ictalurus furcatus*					
		2003	531.0	---	3	3
			529.0	2	---	2
			490.5	---	26	26
			482.0	---	12	12
			472.3	---	16	16
			HIRM 8.5	---	1	1
		2004	531.0	---	3	3
			529.0	---	---	---
			490.5	---	15	15
			482.0	---	8	8
			472.3	---	14	14
			HIRM 8.5	---	---	---
		2005	531.0	---	4	4
			529.0	2	---	2
			490.5	---	17	17
			482.0	---	23	23
			472.3	---	29	29
			HIRM 8.5	---	---	---
		2006	531.0	---	2	2
			529.0	1	---	1
			490.5	---	1	1
			482.0	---	15	15
			472.3	---	5	5
		2007	531.0	---	3	3
			529.0	---	---	---
			490.5	---	7	7
			482.0	1	32	33
			472.3	---	11	11
			HIRM 8.5	2	2	4
		2008	531.0	---	9	9
			529.0	2	---	2
			490.5	---	7	7
			482.0	4	12	16
			472.3	---	14	14
		2009	531.0	---	13	13
			529.0	---	---	---
			490.5	---	3	3
			482.0	---	19	19
			472.3	---	17	17
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Bluegill	*Lepomis macrochirus*					
		1993	531.0	102	2	104
			529.0	460	---	460
			490.5	372	3	375
			472.3	160	3	163
			HIRM 8.5	361	6	367
		1994	531.0	348	3	351
			529.0	483	---	483
			490.5	217	1	218
			472.3	382	3	385
			HIRM 8.5	321	1	322
		1995	529.0	306	---	306
			490.5	148	2	150
			472.3	82	4	86
			HIRM 8.5	103	2	105
		1996	531.0	136	1	137
			529.0	459	---	459
			490.5	115	1	116
			482.0	442	1	443
		1997	529.0	222	---	222
			490.5	---	1	1
			472.3	52	2	54
			HiRM 8.5	27	---	27
		1998	531.0	156	1	157
		1999	531.0	46	1	47
			529.0	52	---	52
			490.5	29	1	30
			482.0	25	3	28
			472.3	14	1	15
			HIRM 8.5	159	1	160
		2000	531.0	329	1	330
			529.0	355	---	355
			490.5	83	4	87
			482.0	311	3	314
			472.3	126	1	127
			HIRM 8.5	148	6	154
		2001	531.0	264	5	269
			529.0	166	---	166
			490.5	97	23	120
			482.0	405	3	408
			472.3	36	2	38
			HIRM 8.5	262	4	266

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Bluegill	*Lepomis macrochirus*					
		2002	531.0	254	---	254
			529.0	244	---	244
			490.5	361	---	361
			482.0	178	---	178
			472.3	184	2	186
		2003	531.0	419	---	419
			529.0	354	---	354
			490.5	193	---	193
			482.0	170	4	174
			472.3	144	7	151
			HIRM 8.5	272	---	272
		2004	531.0	368	---	368
			529.0	89	---	89
			490.5	219	2	221
			482.0	277	5	282
			472.3	112	2	114
			HIRM 8.5	449	2	451
		2005	531.0	540	---	540
			529.0	177	---	177
			490.5	247	5	252
			482.0	220	2	222
			472.3	236	6	242
			HIRM 8.5	190	2	192
		2006	531.0	485	1	486
			529.0	250	---	250
			490.5	171	8	179
			482.0	307	5	312
			472.3	309	1	310
		2007	531.0	281	2	283
			529.0	402	---	402
			490.5	228	3	231
			482.0	203	8	211
			472.3	376	7	383
			HIRM 8.5	322	1	323
		2008	531.0	935	2	937
			529.0	892	---	892
			490.5	698	---	698
			482.0	695	---	695
			472.3	1306	5	1311
		2009	531.0	468	---	468
			529.0	471	---	471
			490.5	903	2	905
			482.0	534	6	540
			472.3	1011	1	1012
			HIRM 8.5	453	1	454

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Bluntnose minnow	*Pimephales notatus*					
		1993	531.0	19	---	19
			529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1994	531.0	1	---	1
			529.0	24	---	24
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1996	531.0	1	---	1
			529.0	1	---	1
			490.5	1	---	1
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	4	---	4
		1998	531.0	19	---	19
		1999	531.0	---	---	---
			529.0	2	---	2
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2000	531.0	9	---	9
			529.0	---	---	---
			490.5	---	---	---
			482.0	12	---	12
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2001	531.0	3	---	3
			529.0	1	---	1
			490.5	21	---	21
			482.0	4	---	4
			472.3	---	---	---
			HIRM 8.5	13	---	13
		2002	531.0	2	---	2
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Bluntnose minnow	*Pimephales notatus*					
		2003	531.0	2	---	2
			529.0	2	---	2
			490.5	12	---	12
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	20	---	20
		2004	531.0	---	---	---
			529.0	1	---	1
			490.5	5	---	5
			482.0	3	---	3
			472.3	---	---	---
			HIRM 8.5	3	---	3
		2005	531.0	1	---	1
			529.0	---	---	---
			490.5	2	---	2
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2006	531.0	21	---	21
			529.0	---	---	---
			490.5	1	---	1
			482.0	30	---	30
			472.3	---	---	---
		2007	531.0	1	---	1
			529.0	---	---	---
			490.5	3	---	3
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	14	---	14
			472.3	---	---	---
		2009	531.0	19	---	19
			529.0	6	---	6
			490.5	25	---	25
			482.0	8	---	8
			472.3	1	---	1
			HIRM 8.5	7	---	7

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Brook silverside	*Labidesthes sicculus*					
		1993	531.0	94	---	94
			529.0	12	---	12
			490.5	130	---	130
			472.3	127	---	127
			HIRM 8.5	1	---	1
		1994	531.0	6	---	6
			529.0	28	---	28
			490.5	---	---	---
			472.3	234	---	234
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	624	---	624
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1996	531.0	16	---	16
			529.0	---	---	---
			490.5	10	---	10
			482.0	16	---	16
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	4	---	4
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	9	---	9
			HIRM 8.5	---	---	---
		2000	531.0	24	---	24
			529.0	---	---	---
			490.5	1	---	1
			482.0	2	---	2
			472.3	152	---	152
			HIRM 8.5	3	---	3
		2001	531.0	14	---	14
			529.0	19	---	19
			490.5	7	---	7
			482.0	6	---	6
			472.3	4	---	4
			HIRM 8.5	12	---	12

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Brook silverside	*Labidesthes sicculus*					
		2002	531.0	4	---	4
			529.0	20	---	20
			490.5	13	---	13
			482.0	11	---	11
			472.3	51	---	51
		2003	531.0	70	---	70
			529.0	2	---	2
			490.5	10	---	10
			482.0	14	---	14
			472.3	11	---	11
			HIRM 8.5	12	---	12
		2004	531.0	36	---	36
			529.0	8	---	8
			490.5	13	---	13
			482.0	10	---	10
			472.3	41	---	41
			HIRM 8.5	2	---	2
		2005	531.0	52	---	52
			529.0	1	---	1
			490.5	5	---	5
			482.0	6	---	6
			472.3	10	---	10
			HIRM 8.5	7	---	7
		2006	531.0	3	---	3
			529.0	15	---	15
			490.5	---	---	---
			482.0	---	---	---
			472.3	3	---	3
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	2	---	2
			HIRM 8.5	---	---	---
		2008	531.0	2	---	2
			529.0	2	---	2
			490.5	---	---	---
			482.0	1	---	1
			472.3	2	---	2
		2009	531.0	7	---	7
			529.0	20	---	20
			490.5	23	---	23
			482.0	6	---	6
			472.3	2	---	2
			HIRM 8.5	2	---	2

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Brown bullhead	*Ameiurus nebulosus*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Brown bullhead	*Ameiurus nebulosus*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	---	1
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Bullhead minnow	*Pimephales vigilax*					
		1993	531.0	10	---	10
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	1	---	1
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	1	---	1
			472.3	2	---	2
			HIRM 8.5	3	---	3
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	---	---
			529.0	6	---	6
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Bullhead minnow	*Pimephales vigilax*					
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	2	---	2
			472.3	---	---	---
		2007	531.0	1	---	1
			529.0	---	---	---
			490.5	1	---	1
			482.0	3	---	3
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	6	---	6
			529.0	1	---	1
			490.5	9	---	9
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	3	---	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Channel catfish	*Ictalurus punctatus*					
		1993	531.0	1	11	12
			529.0	10	---	10
			490.5	---	11	11
			472.3	---	3	3
			HIRM 8.5	---	5	5
		1994	531.0	1	3	4
			529.0	10	---	10
			490.5	---	4	4
			472.3	1	7	8
			HIRM 8.5	---	6	6
		1995	529.0	28	---	28
			490.5	4	9	13
			472.3	15	8	23
			HIRM 8.5	---	---	---
		1996	531.0	1	3	4
			529.0	7	---	7
			490.5	3	7	10
			482.0	7	4	11
		1997	529.0	1	---	1
			490.5	4	2	6
			472.3	---	---	---
			HiRM 8.5	---	11	11
		1998	531.0	---	6	6
		1999	531.0	---	11	11
			529.0	4	---	4
			490.5	2	3	5
			482.0	4	16	20
			472.3	---	4	4
			HIRM 8.5	---	5	5
		2000	531.0	2	8	10
			529.0	3	---	3
			490.5	21	---	21
			482.0	8	1	9
			472.3	---	4	4
			HIRM 8.5	---	8	8
		2001	531.0	1	10	11
			529.0	11	---	11
			490.5	17	11	28
			482.0	8	4	12
			472.3	2	6	8
			HIRM 8.5	1	11	12
		2002	531.0	1	5	6
			529.0	22	---	22
			490.5	17	3	20
			482.0	13	9	22
			472.3	1	2	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Channel catfish	*Ictalurus punctatus*					
		2003	531.0	5	5	10
			529.0	5	---	5
			490.5	2	14	16
			482.0	6	15	21
			472.3	---	10	10
			HIRM 8.5	1	5	6
		2004	531.0	2	8	10
			529.0	9	---	9
			490.5	10	7	17
			482.0	15	7	22
			472.3	11	12	23
			HIRM 8.5	2	6	8
		2005	531.0	10	2	12
			529.0	15	---	15
			490.5	---	6	6
			482.0	6	13	19
			472.3	---	5	5
			HIRM 8.5	---	5	5
		2006	531.0	4	1	5
			529.0	20	---	20
			490.5	4	4	8
			482.0	3	14	17
			472.3	5	2	7
		2007	531.0	4	2	6
			529.0	12	---	12
			490.5	1	2	3
			482.0	12	8	20
			472.3	3	6	9
			HIRM 8.5	5	6	11
		2008	531.0	3	3	6
			529.0	16	---	16
			490.5	3	2	5
			482.0	18	5	23
			472.3	2	5	7
		2009	531.0	5	5	10
			529.0	35	---	35
			490.5	19	5	24
			482.0	18	11	29
			472.3	31	6	37
			HIRM 8.5	6	7	13

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Chestnut lamprey	*Ichthyomyzon castaneus*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	4	---	4
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	3	---	3
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	1	---	1
			490.5	4	---	4
			472.3	2	---	2
			HiRM 8.5	1	---	1
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	4	---	4
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Chestnut lamprey	*Ichthyomyzon castaneus*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	3	---	3
			482.0	---	---	---
			472.3	1	---	1
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	2	---	2
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	2	---	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	2	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Common Carp	*Cyprinus carpio*					
		1993	531.0	4	6	10
			529.0	23	---	23
			490.5	16	1	17
			472.3	4	---	4
			HIRM 8.5	19	2	21
		1994	531.0	28	---	28
			529.0	13	---	13
			490.5	21	---	21
			472.3	15	1	16
			HIRM 8.5	31	5	36
		1995	529.0	7	---	7
			490.5	7	---	7
			472.3	4	---	4
			HIRM 8.5	30	2	32
		1996	531.0	10	5	15
			529.0	10	---	10
			490.5	7	1	8
			482.0	12	---	12
		1997	529.0	49	---	49
			490.5	12	---	12
			472.3	4	---	4
			HiRM 8.5	---	---	---
		1998	531.0	16	4	20
		1999	531.0	13	6	19
			529.0	4	---	4
			490.5	3	---	3
			482.0	11	---	11
			472.3	---	---	---
			HIRM 8.5	4	1	5
		2000	531.0	11	---	9
			529.0	38	---	38
			490.5	13	---	13
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	5	2	7
		2001	531.0	8	2	10
			529.0	2	---	2
			490.5	11	---	11
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2002	531.0	7	3	10
			529.0	7	---	7
			490.5	7	---	7
			482.0	3	---	3
			472.3	3	1	4

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Common carp	*Cyprinus carpio*					
		2003	531.0	8	4	12
			529.0	6	---	6
			490.5	6	---	6
			482.0	2	1	3
			472.3	5	---	5
			HIRM 8.5	3	---	3
		2004	531.0	7	1	8
			529.0	6	---	6
			490.5	4	---	4
			482.0	8	---	8
			472.3	3	---	3
			HIRM 8.5	4	---	4
		2005	531.0	7	3	10
			529.0	6	---	6
			490.5	1	---	1
			482.0	2	---	2
			472.3	---	1	1
			HIRM 8.5	5	1	6
		2006	531.0	9	4	13
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	4	1	5
		2007	531.0	7	1	8
			529.0	1	---	1
			490.5	4	---	4
			482.0	1	---	1
			472.3	---	1	1
			HIRM 8.5	6	---	6
		2008	531.0	2	4	6
			529.0	---	---	---
			490.5	---	---	---
			482.0	2	---	2
			472.3	1	1	2
		2009	531.0	6	---	6
			529.0	2	---	2
			490.5	7	---	7
			482.0	3	---	3
			472.3	3	---	3
			HIRM 8.5	1	2	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Dusky darter	*Percina sciera*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Dusky darter	*Percina sciera*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Emerald shiner	*Notropis atherinoides*					
		1993	531.0	10	---	10
			529.0	885	---	885
			490.5	901	---	901
			472.3	754	---	754
			HIRM 8.5	193	---	193
		1994	531.0	1638	---	1638
			529.0	60	---	60
			490.5	87	---	87
			472.3	94	---	94
			HIRM 8.5	37	---	37
		1995	529.0	---	---	---
			490.5	868	---	868
			472.3	705	---	705
			HIRM 8.5	352	---	352
		1996	531.0	19	---	19
			529.0	3	---	3
			490.5	325	---	325
			482.0	1015	---	1015
		1997	529.0	21	---	21
			490.5	1	---	1
			472.3	20	---	20
			HiRM 8.5	117	---	117
		1998	531.0	1428	---	1428
		1999	531.0	6	---	6
			529.0	6	---	6
			490.5	27	---	27
			482.0	48	---	48
			472.3	15	---	15
			HIRM 8.5	46	---	46
		2000	531.0	---	---	---
			529.0	4	---	4
			490.5	26	---	26
			482.0	83	---	83
			472.3	164	---	164
			HIRM 8.5	65	---	65
		2001	531.0	---	---	---
			529.0	33	---	33
			490.5	69	---	69
			482.0	98	---	98
			472.3	20	---	20
			HIRM 8.5	59	---	59
		2002	531.0	---	---	---
			529.0	2	---	2
			490.5	54	---	54
			482.0	19	---	19
			472.3	64	---	64

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Emerald shiner	*Notropis atherinoides*					
		2003	531.0	---	---	---
			529.0	3	---	3
			490.5	15	---	15
			482.0	93	---	93
			472.3	95	---	95
			HIRM 8.5	4	---	4
		2004	531.0	11	---	11
			529.0	9	---	9
			490.5	62	---	62
			482.0	183	---	183
			472.3	260	---	260
			HIRM 8.5	55	---	55
		2005	531.0	2	---	2
			529.0	44	---	44
			490.5	21	---	21
			482.0	71	---	71
			472.3	51	---	51
			HIRM 8.5	8	---	8
		2006	531.0	---	---	---
			529.0	19	---	19
			490.5	23	---	23
			482.0	26	---	26
			472.3	10	---	10
		2007	531.0	---	---	---
			529.0	6	---	6
			490.5	36	---	36
			482.0	40	---	40
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	5	---	5
			490.5	3	---	3
			482.0	4	---	4
			472.3	1	---	1
		2009	531.0	---	---	---
			529.0	1	---	1
			490.5	4	---	4
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Flathead catfish	*Pylodictis olivaris*					
		1993	531.0	1	9	10
			529.0	10	---	10
			490.5	1	6	7
			472.3	1	2	3
			HIRM 8.5	1	3	4
		1994	531.0	3	7	10
			529.0	7	---	7
			490.5	1	5	6
			472.3	4	3	7
			HIRM 8.5	---	4	4
		1995	529.0	4	---	4
			490.5	7	2	9
			472.3	1	2	3
			HIRM 8.5	---	1	1
		1996	531.0	3	6	9
			529.0	9	---	9
			490.5	1	5	6
			482.0	1	3	4
		1997	529.0	4	---	4
			490.5	1	4	5
			472.3	---	2	2
			HiRM 8.5	---	1	1
		1998	531.0	3	5	8
		1999	531.0	5	4	9
			529.0	6	---	6
			490.5	1	---	1
			482.0	---	1	1
			472.3	---	2	2
			HIRM 8.5	1	2	3
		2000	531.0	6	15	21
			529.0	5	---	5
			490.5	---	1	1
			482.0	---	1	1
			472.3	10	2	12
			HIRM 8.5	---	1	1
		2001	531.0	3	8	11
			529.0	8	---	8
			490.5	3	3	6
			482.0	1	---	1
			472.3	---	3	3
			HIRM 8.5	2	---	2
		2002	531.0	10	18	28
			529.0	6	---	6
			490.5	2	3	5
			482.0	3	3	6
			472.3	---	1	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Flathead catfish	*Pylodictis olivaris*					
		2003	531.0	4	17	21
			529.0	5	---	5
			490.5	5	4	9
			482.0	2	3	5
			472.3	5	2	7
			HIRM 8.5	---	5	5
		2004	531.0	5	3	8
			529.0	9	---	9
			490.5	6	4	10
			482.0	---	2	2
			472.3	6	5	11
			HIRM 8.5	5	---	5
		2005	531.0	17	11	28
			529.0	17	---	17
			490.5	3	2	5
			482.0	5	8	13
			472.3	1	5	6
			HIRM 8.5	2	5	7
		2006	531.0	5	10	15
			529.0	7	---	7
			490.5	3	---	3
			482.0	2	1	3
			472.3	1	4	5
		2007	531.0	7	14	21
			529.0	28	---	28
			490.5	16	1	17
			482.0	1	4	5
			472.3	7	3	10
			HIRM 8.5	2	1	3
		2008	531.0	5	9	14
			529.0	10	---	10
			490.5	8	4	12
			482.0	---	2	2
			472.3	7	8	15
		2009	531.0	5	10	15
			529.0	5	---	5
			490.5	9	3	12
			482.0	3	---	3
			472.3	4	7	11
			HIRM 8.5	2	---	2

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Freshwater drum	*Aplodinotus grunniens*					
		1993	531.0	3	5	8
			529.0	4	---	4
			490.5	6	7	13
			472.3	1	9	10
			HIRM 8.5	4	7	11
		1994	531.0	4	1	5
			529.0	7	---	7
			490.5	4	5	9
			472.3	10	9	19
			HIRM 8.5	7	2	9
		1995	529.0	4	---	4
			490.5	4	6	10
			472.3	7	1	8
			HIRM 8.5	6	16	22
		1996	531.0	7	5	12
			529.0	9	---	9
			490.5	7	6	13
			482.0	1	8	9
		1997	529.0	6	---	6
			490.5	3	1	4
			472.3	1	8	9
			HiRM 8.5	1	19	20
		1998	531.0	1	2	3
		1999	531.0	7	22	29
			529.0	3	---	3
			490.5	7	13	20
			482.0	4	5	9
			472.3	2	12	14
			HIRM 8.5	4	13	17
		2000	531.0	5	18	23
			529.0	1	---	1
			490.5	3	1	4
			482.0	---	2	2
			472.3	1	13	14
			HIRM 8.5	3	8	11
		2001	531.0	6	11	17
			529.0	6	---	6
			490.5	2	13	15
			482.0	1	1	2
			472.3	1	6	7
			HIRM 8.5	5	18	23

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Freshwater drum	*Aplodinotus grunniens*					
		2002	531.0	4	10	14
			529.0	6	---	6
			490.5	7	3	10
			482.0	2	6	8
			472.3	1	4	5
		2003	531.0	5	1	6
			529.0	3	---	3
			490.5	5	7	12
			482.0	5	10	15
			472.3	4	5	9
			HIRM 8.5	5	10	15
		2004	531.0	10	2	12
			529.0	17	---	17
			490.5	19	5	24
			482.0	13	5	18
			472.3	19	7	26
			HIRM 8.5	4	13	17
		2005	531.0	12	3	15
			529.0	3	---	3
			490.5	2	6	8
			482.0	3	5	8
			472.3	5	9	14
			HIRM 8.5	---	4	4
		2006	531.0	1	6	7
			529.0	19	---	19
			490.5	3	6	9
			482.0	2	3	5
			472.3	6	5	11
		2007	531.0	3	5	8
			529.0	3	---	3
			490.5	9	14	23
			482.0	---	6	6
			472.3	6	6	12
			HIRM 8.5	2	4	6
		2008	531.0	2	3	5
			529.0	---	---	---
			490.5	2	6	8
			482.0	6	7	13
			472.3	10	7	17
		2009	531.0	5	6	11
			529.0	5	---	5
			490.5	16	2	18
			482.0	6	3	9
			472.3	11	4	15
			HIRM 8.5	4	---	4

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Gizzard shad	*Dorosoma cepedianum*					
		1993	531.0	388	57	445
			529.0	570	---	570
			490.5	399	45	444
			472.3	37	53	90
			HIRM 8.5	361	62	423
		1994	531.0	81	15	96
			529.0	185	---	185
			490.5	151	28	179
			472.3	61	56	117
			HIRM 8.5	64	8	72
		1995	529.0	790	---	790
			490.5	330	58	388
			472.3	31	18	49
			HIRM 8.5	829	30	859
		1996	531.0	271	46	317
			529.0	3577	---	3577
			490.5	274	36	310
			482.0	253	48	301
		1997	529.0	85	---	85
			490.5	82	16	98
			472.3	53	7	60
			HiRM 8.5	43	24	67
		1998	531.0	133	47	180
		1999	531.0	25	260	285
			529.0	46	---	46
			490.5	28	118	146
			482.0	14	76	90
			472.3	28	67	95
			HIRM 8.5	28	58	86
		2000	531.0	79	105	184
			529.0	91	---	91
			490.5	34	60	94
			482.0	135	---	135
			472.3	33	75	108
			HIRM 8.5	87	2	89
		2001	531.0	25	91	116
			529.0	44	---	44
			490.5	93	115	208
			482.0	76	83	159
			472.3	7	80	87
			HIRM 8.5	130	57	187
		2002	531.0	27	61	88
			529.0	138	---	138
			490.5	163	12	175
			482.0	170	3	173
			472.3	49	12	61

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Gizzard shad	*Dorosoma cepedianum*					
		2003	531.0	149	40	189
			529.0	178	---	178
			490.5	5	7	12
			482.0	5	10	15
			472.3	41	42	83
			HIRM 8.5	146	33	179
		2004	531.0	331	36	367
			529.0	750	---	750
			490.5	86	39	125
			482.0	147	47	194
			472.3	47	50	97
			HIRM 8.5	183	3	186
		2005	531.0	191	12	203
			529.0	307	---	307
			490.5	121	24	145
			482.0	203	87	290
			472.3	36	74	110
			HIRM 8.5	42	44	86
		2006	531.0	353	42	395
			529.0	269	---	269
			490.5	260	63	323
			482.0	188	32	220
			472.3	52	65	117
		2007	531.0	103	122	225
			529.0	111	---	111
			490.5	245	77	322
			482.0	109	72	181
			472.3	69	59	128
			HIRM 8.5	182	16	198
		2008	531.0	125	105	230
			529.0	180	---	180
			490.5	357	80	437
			482.0	108	73	181
			472.3	67	46	113
		2009	531.0	53	35	88
			529.0	131	---	131
			490.5	349	39	388
			482.0	115	35	150
			472.3	17	51	68
			HIRM 8.5	131	6	137

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Golden redhorse	*Moxostoma erythrurum*					
		1993	531.0	---	---	---
			529.0	8	---	8
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	7	---	7
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	4	4
		1995	529.0	10	---	10
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1996	531.0	---	---	---
			529.0	7	---	7
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	10	---	10
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	1	---	1
			529.0	7	---	7
			490.5	5	---	5
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	2	2
		2000	531.0	---	---	---
			529.0	4	---	4
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	1	1
			529.0	8	---	8
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2002	531.0	---	---	---
			529.0	7	---	7
			490.5	1	1	2
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Golden redhorse	*Moxostoma erythrurum*					
		2003	531.0	---	---	---
			529.0	6	---	6
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	1	2
		2004	531.0	---	1	1
			529.0	2	---	2
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2005	531.0	---	---	---
			529.0	8	---	8
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	3	3
		2006	531.0	---	---	---
			529.0	12	---	12
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	4	---	4
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	9	---	9
		2008	531.0	---	---	---
			529.0	7	---	7
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	3	---	3
			490.5	---	---	---
			482.0	---	1	1
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Golden shiner	*Notemigonus crysoleucas*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	42	1	43
			472.3	---	9	9
			HIRM 8.5	6	10	16
		1994	531.0	13	---	13
			529.0	6	---	6
			490.5	1	1	2
			472.3	---	5	5
			HIRM 8.5	43	---	43
		1995	529.0	10	---	10
			490.5	4	1	5
			472.3	---	---	---
			HIRM 8.5	10	---	10
		1996	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	3	---	3
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	3	---	3
			490.5	11	2	13
			482.0	11	8	19
			472.3	4	1	5
			HIRM 8.5	16	5	21
		2002	531.0	---	---	---
			529.0	3	---	3
			490.5	16	---	16
			482.0	1	---	1
			472.3	17	1	18

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Golden shiner	*Notemigonus crysoleucas*					
		2003	531.0	6	---	6
			529.0	3	---	3
			490.5	25	---	25
			482.0	6	1	7
			472.3	8	1	9
			HIRM 8.5	19	5	24
		2004	531.0	---	---	---
			529.0	1	---	1
			490.5	6	1	7
			482.0	3	---	15
			472.3	12	1	13
			HIRM 8.5	9	---	9
		2005	531.0	1	---	1
			529.0	3	---	3
			490.5	1	---	1
			482.0	16	---	16
			472.3	26	---	26
			HIRM 8.5	2	---	2
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	9	---	9
			482.0	4	2	6
			472.3	8	5	13
		2007	531.0	---	---	---
			529.0	1	---	1
			490.5	25	2	27
			482.0	---	1	1
			472.3	2	---	2
			HIRM 8.5	5	---	5
		2008	531.0	---	---	---
			529.0	8	---	8
			490.5	14	---	14
			482.0	11	---	11
			472.3	15	2	17
		2009	531.0	---	---	---
			529.0	14	---	14
			490.5	27	1	28
			482.0	7	6	13
			472.3	13	2	15
			HIRM 8.5	12	---	12

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Grass carp	*Ctenopharyngodon idella*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Grass carp	*Ctenopharyngodon idella*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Green sunfish	*Lepomis cyanellus*					
		1993	531.0	4	---	4
			529.0	1	---	1
			490.5	---	---	---
			472.3	3	---	3
			HIRM 8.5	---	---	---
		1994	531.0	4	---	4
			529.0	7	---	7
			490.5	1	---	1
			472.3	10	---	10
			HIRM 8.5	---	---	---
		1995	529.0	1	---	1
			490.5	1	---	1
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1996	531.0	6	---	6
			529.0	3	---	3
			490.5	---	---	---
			482.0	7	---	7
		1997	529.0	1	---	1
			490.5	---	---	---
			472.3	1	---	1
			HiRM 8.5	---	---	---
		1998	531.0	16	---	16
		1999	531.0	2	---	2
			529.0	5	---	5
			490.5	1	---	1
			482.0	1	---	1
			472.3	1	---	1
			HIRM 8.5	---	---	---
		2000	531.0	21	---	21
			529.0	4	---	4
			490.5	---	---	---
			482.0	2	---	2
			472.3	8	---	8
			HIRM 8.5	2	---	2
		2001	531.0	8	---	8
			529.0	11	---	11
			490.5	10	---	10
			482.0	1	---	1
			472.3	1	---	1
			HIRM 8.5	2	---	2

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Green sunfish	*Lepomis cyanellus*					
		2002	531.0	7	---	7
			529.0	4	---	4
			490.5	4	---	4
			482.0	---	---	---
			472.3	5	---	5
		2003	531.0	16	---	16
			529.0	3	---	3
			490.5	3	---	3
			482.0	---	---	---
			472.3	4	---	4
			HIRM 8.5	---	---	---
		2004	531.0	11	---	11
			529.0	5	---	5
			490.5	1	---	1
			482.0	---	---	---
			472.3	5	---	5
			HIRM 8.5	3	---	3
		2005	531.0	35	---	35
			529.0	30	---	30
			490.5	5	---	5
			482.0	2	---	2
			472.3	10	---	10
			HIRM 8.5	---	---	---
		2006	531.0	24	---	24
			529.0	3	---	3
			490.5	1	---	1
			482.0	1	---	1
			472.3	7	---	7
		2007	531.0	5	---	5
			529.0	3	---	3
			490.5	5	---	5
			482.0	3	---	3
			472.3	7	---	7
			HIRM 8.5	---	---	---
		2008	531.0	8	---	8
			529.0	26	---	26
			490.5	2	---	2
			482.0	---	---	---
			472.3	7	---	7
		2009	531.0	30	---	30
			529.0	11	---	11
			490.5	---	---	---
			482.0	---	---	---
			472.3	4	---	4
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Highfin carpsucker	*Carpiodes velifer*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Highfin carpsucker	*Carpiodes velifer*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Hybrid striped x white bass	*Morone saxatilis x chrysops*					
		1993	531.0	---	1	1
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	4	4
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	3	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	3	3
		1997	529.0	1	---	1
			490.5	---	1	1
			472.3	---	5	5
			HiRM 8.5	---	2	2
		1998	531.0	1	---	1
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Hybrid striped x white bass	*Morone saxatilis x chrysops*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	1	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Inland silverside	*Menidia beryllina*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Inland silverside	*Menidia beryllina*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	10	---	10
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2005	531.0	13	---	13
			529.0	---	---	---
			490.5	4	---	4
			482.0	2	---	2
			472.3	1	---	1
			HIRM 8.5	---	---	---
		2006	531.0	48	---	48
			529.0	30	---	30
			490.5	6	---	6
			482.0	38	---	38
			472.3	18	---	18
		2007	531.0	7	---	7
			529.0	---	---	---
			490.5	3	---	3
			482.0	2	---	2
			472.3	22	---	22
			HIRM 8.5	35	---	35
		2008	531.0	---	---	---
			529.0	45	---	45
			490.5	51	---	51
			482.0	23	---	23
			472.3	105	---	105
		2009	531.0	455	---	455
			529.0	---	---	---
			490.5	81	---	81
			482.0	53	---	53
			472.3	419	---	419
			HIRM 8.5	273	---	273

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Lake sturgeon	*Acipenser fulvescens*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Lake sturgeon	*Acipenser fulvescens*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Largemouth bass	*Micropterus salmoides*					
		1993	531.0	28	12	40
			529.0	120	---	120
			490.5	99	2	101
			472.3	19	2	21
			HIRM 8.5	169	---	169
		1994	531.0	42	1	43
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	118	---	118
			490.5	15	1	16
			472.3	16	2	18
			HIRM 8.5	27	---	27
		1996	531.0	25	2	27
			529.0	45	---	45
			490.5	7	3	10
			482.0	19	2	21
		1997	529.0	58	---	58
			490.5	7	---	7
			472.3	---	3	3
			HiRM 8.5	18	1	19
		1998	531.0	10	---	10
		1999	531.0	11	3	14
			529.0	8	---	8
			490.5	5	1	6
			482.0	3	3	6
			472.3	6	3	9
			HIRM 8.5	45	---	45
		2000	531.0	15	13	28
			529.0	47	---	47
			490.5	38	---	38
			482.0	31	---	31
			472.3	35	3	38
			HIRM 8.5	73	---	73
		2001	531.0	12	5	17
			529.0	17	---	17
			490.5	31	---	31
			482.0	29	3	32
			472.3	24	2	26
			HIRM 8.5	36	---	36

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Largemouth bass	*Micropterus salmoides*					
		2002	531.0	13	---	10
			529.0	39	---	39
			490.5	56	---	56
			482.0	32	---	32
			472.3	29	12	41
		2003	531.0	13	8	21
			529.0	30	---	30
			490.5	15	3	18
			482.0	22	2	24
			472.3	14	2	16
			HIRM 8.5	21	---	21
		2004	531.0	26	1	27
			529.0	65	---	65
			490.5	40	---	40
			482.0	41	4	45
			472.3	36	2	38
			HIRM 8.5	55	---	55
		2005	531.0	14	7	21
			529.0	30	---	30
			490.5	35	---	35
			482.0	20	2	22
			472.3	10	2	12
			HIRM 8.5	31	1	32
		2006	531.0	30	4	34
			529.0	16	---	16
			490.5	4	4	8
			482.0	23	1	24
			472.3	15	3	18
		2007	531.0	36	---	10
			529.0	17	---	17
			490.5	17	9	26
			482.0	20	2	22
			472.3	16	9	25
			HIRM 8.5	28	2	30
		2008	531.0	20	12	32
			529.0	15	---	15
			490.5	21	5	26
			482.0	21	4	25
			472.3	19	7	26
		2009	531.0	42	14	56
			529.0	61	---	61
			490.5	114	3	117
			482.0	66	5	71
			472.3	16	5	21
			HIRM 8.5	43	---	43

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Largescale stoneroller	*Campostoma oligolepis*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	6	---	6
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Largescale stoneroller	*Campostoma oligolepis*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Logperch	*Percina caprodes*					
		1993	531.0	1	---	1
			529.0	7	---	7
			490.5	79	---	79
			472.3	3	---	3
			HIRM 8.5	9	---	9
		1994	531.0	3	---	3
			529.0	67	---	67
			490.5	---	---	---
			472.3	25	---	25
			HIRM 8.5	1	---	1
		1995	529.0	7	---	7
			490.5	12	---	12
			472.3	12	---	12
			HIRM 8.5	4	---	4
		1996	531.0	4	---	4
			529.0	19	---	19
			490.5	10	---	10
			482.0	13	---	13
		1997	529.0	1	---	1
			490.5	1	---	1
			472.3	5	---	5
			HiRM 8.5	---	---	---
		1998	531.0	7	---	7
		1999	531.0	---	---	---
			529.0	19	---	19
			490.5	1	---	1
			482.0	9	---	9
			472.3	3	---	3
			HIRM 8.5	9	---	9
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	4	---	4
			HIRM 8.5	---	---	---
		2001	531.0	4	---	4
			529.0	3	---	3
			490.5	23	---	23
			482.0	5	---	5
			472.3	4	---	4
			HIRM 8.5	7	---	7

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Logperch	*Percina caprodes*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	2	---	2
			472.3	4	---	4
		2003	531.0	2	---	2
			529.0	1	---	1
			490.5	4	---	4
			482.0	9	---	9
			472.3	---	---	---
			HIRM 8.5	3	---	3
		2004	531.0	---	---	---
			529.0	18	---	18
			490.5	3	---	3
			482.0	1	---	1
			472.3	6	---	6
			HIRM 8.5	---	---	---
		2005	531.0	3	---	3
			529.0	4	---	4
			490.5	3	---	3
			482.0	6	---	6
			472.3	5	---	5
			HIRM 8.5	2	---	2
		2006	531.0	7	---	7
			529.0	22	---	22
			490.5	4	---	4
			482.0	15	---	15
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	5	---	5
			490.5	7	---	7
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2008	531.0	3	---	3
			529.0	4	---	4
			490.5	4	---	4
			482.0	4	---	4
			472.3	4	---	4
		2009	531.0	4	---	4
			529.0	---	---	---
			490.5	1	---	1
			482.0	---	---	---
			472.3	2	---	2
			HIRM 8.5	8	---	8

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Longear sunfish	*Lepomis megalotis*					
		1993	531.0	---	---	---
			529.0	3	---	3
			490.5	7	---	7
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	1	---	1
			490.5	1	---	1
			472.3	3	---	3
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	7	---	7
			472.3	3	---	3
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	3	---	3
			490.5	4	---	4
			482.0	12	---	12
		1997	529.0	1	---	1
			490.5	3	---	3
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	1	---	1
			529.0	---	---	---
			490.5	4	---	4
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	9	---	9
			490.5	7	---	7
			482.0	45	---	45
			472.3	16	---	16
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	2	---	2
			490.5	8	---	8
			482.0	47	2	49
			472.3	1	---	1
			HIRM 8.5	4	---	4

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Longear sunfish	*Lepomis megalotis*					
		2002	531.0	---	---	---
			529.0	8	---	8
			490.5	14	---	14
			482.0	8	---	8
			472.3	16	---	16
		2003	531.0	2	---	2
			529.0	3	---	3
			490.5	27	---	27
			482.0	29	---	29
			472.3	6	---	6
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	32	---	32
			490.5	13	---	13
			482.0	7	---	7
			472.3	4	---	4
			HIRM 8.5	3	---	3
		2005	531.0	5	---	5
			529.0	46	---	46
			490.5	12	---	12
			482.0	12	---	12
			472.3	8	---	8
			HIRM 8.5	---	---	---
		2006	531.0	6	---	6
			529.0	25	---	25
			490.5	15	---	15
			482.0	11	---	11
			472.3	10	---	10
		2007	531.0	1	---	1
			529.0	9	---	9
			490.5	13	---	13
			482.0	9	---	9
			472.3	6	---	6
			HIRM 8.5	1	---	1
		2008	531.0	8	---	8
			529.0	19	---	19
			490.5	1	---	1
			482.0	19	---	19
			472.3	19	---	19
		2009	531.0	---	---	---
			529.0	12	---	12
			490.5	33	---	33
			482.0	2	---	2
			472.3	22	---	22
			HIRM 8.5	3	---	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Longnose gar	*Lepisosteus osseus*					
		1993	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1996	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	1	---	1
		1999	531.0	---	1	1
			529.0	2	---	2
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	3	3
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	3	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Longnose gar	*Lepisosteus osseus*					
		2003	531.0	---	---	---
			529.0	3	---	3
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	1	---	1
			529.0	18	---	18
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	1	1
			472.3	1	---	1
			HIRM 8.5	---	1	1
		2006	531.0	---	---	---
			529.0	2	---	2
			490.5	---	---	---
			482.0	---	2	2
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	1	---	1
			490.5	---	1	1
			482.0	---	1	1
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	1	1
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	7	---	7
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Mooneye	*Hiodon tergisus*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	1	1
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	2	2
			482.0	---	1	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Mooneye	*Hiodon tergisus*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	1	1
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Northern hogsucker	*Hypentelium nigricans*					
		1993	531.0	1	---	1
			529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	7	---	7
			529.0	1	---	1
			490.5	---	---	---
			472.3	3	---	3
			HIRM 8.5	---	---	---
		1995	529.0	1	---	1
			490.5	---	---	---
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	2	2
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	4	---	4
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	---	1
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Northern hogsucker	*Hypentelium nigricans*					
		2002	531.0	1	---	1
			529.0	1	---	1
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	2	---	2
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Redbreast sunfish	*Lepomis auritus*					
		1993	531.0	10	---	10
			529.0	4	---	4
			490.5	15	---	15
			472.3	25	---	25
			HIRM 8.5	---	---	---
		1994	531.0	7	---	7
			529.0	45	---	45
			490.5	7	---	7
			472.3	30	---	30
			HIRM 8.5	3	---	3
		1995	529.0	1	---	1
			490.5	3	---	3
			472.3	7	---	7
			HIRM 8.5	---	---	---
		1996	531.0	4	---	4
			529.0	4	---	4
			490.5	12	3	15
			482.0	15	---	15
		1997	529.0	3	---	3
			490.5	3	---	3
			472.3	2	---	2
			HiRM 8.5	---	---	---
		1998	531.0	37	---	37
		1999	531.0	7	---	7
			529.0	6	---	6
			490.5	11	---	11
			482.0	10	---	10
			472.3	26	---	26
			HIRM 8.5	1	---	1
		2000	531.0	35	---	35
			529.0	16	---	16
			490.5	12	---	12
			482.0	30	---	30
			472.3	53	1	54
			HIRM 8.5	4	---	4
		2001	531.0	36	---	36
			529.0	15	---	15
			490.5	38	---	38
			482.0	37	2	39
			472.3	36	---	36
			HIRM 8.5	3	---	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Redbreast sunfish	*Lepomis auritus*					
		2002	531.0	14	---	14
			529.0	19	---	19
			490.5	40	---	40
			482.0	25	---	25
			472.3	70	1	71
		2003	531.0	18	---	18
			529.0	7	---	7
			490.5	58	---	58
			482.0	29	---	29
			472.3	50	---	50
			HIRM 8.5	3	---	3
		2004	531.0	57	---	57
			529.0	19	---	19
			490.5	43	---	43
			482.0	56	---	56
			472.3	68	---	68
			HIRM 8.5	2	---	2
		2005	531.0	25	---	25
			529.0	29	---	29
			490.5	65	---	65
			482.0	152	---	152
			472.3	78	---	78
			HIRM 8.5	3	---	3
		2006	531.0	83	---	83
			529.0	19	---	19
			490.5	65	---	65
			482.0	70	---	70
			472.3	215	---	215
		2007	531.0	8	---	8
			529.0	22	---	22
			490.5	94	---	94
			482.0	68	1	69
			472.3	115	---	115
			HIRM 8.5	4	---	4
		2008	531.0	38	---	38
			529.0	26	---	26
			490.5	24	---	24
			482.0	93	1	94
			472.3	179	---	179
		2009	531.0	24	---	24
			529.0	18	---	18
			490.5	88	---	88
			482.0	35	---	35
			472.3	110	---	110
			HIRM 8.5	6	---	6

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Redear sunfish	*Lepomis microlophus*					
		1993	531.0	27	2	29
			529.0	150	---	150
			490.5	66	26	92
			472.3	27	8	35
			HIRM 8.5	298	22	320
		1994	531.0	46	2	48
			529.0	274	---	274
			490.5	55	10	65
			472.3	79	2	81
			HIRM 8.5	109	8	117
		1995	529.0	124	---	124
			490.5	19	19	38
			472.3	43	10	53
			HIRM 8.5	31	17	48
		1996	531.0	34	1	35
			529.0	91	---	91
			490.5	16	15	31
			482.0	213	20	233
		1997	529.0	105	---	105
			490.5	19	17	36
			472.3	3	2	5
			HiRM 8.5	133	8	141
		1998	531.0	46	---	46
		1999	531.0	17	1	18
			529.0	63	---	63
			490.5	34	8	42
			482.0	51	6	57
			472.3	7	3	10
			HIRM 8.5	99	6	105
		2000	531.0	44	---	44
			529.0	137	---	137
			490.5	35	8	43
			482.0	60	3	63
			472.3	19	4	23
			HIRM 8.5	179	7	186
		2001	531.0	56	---	56
			529.0	139	---	139
			490.5	25	39	64
			482.0	77	20	97
			472.3	25	6	31
			HIRM 8.5	71	7	78

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Redear sunfish	*Lepomis microlophus*					
		2002	531.0	36	---	36
			529.0	221	---	221
			490.5	71	6	77
			482.0	50	2	52
			472.3	29	5	34
		2003	531.0	50	---	50
			529.0	61	---	61
			490.5	45	47	92
			482.0	96	16	115
			472.3	55	10	65
			HIRM 8.5	66	2	68
		2004	531.0	42	1	43
			529.0	64	---	64
			490.5	76	19	95
			482.0	76	8	84
			472.3	32	4	36
			HIRM 8.5	87	9	96
		2005	531.0	35	---	35
			529.0	85	---	85
			490.5	32	8	40
			482.0	81	9	90
			472.3	28	5	33
			HIRM 8.5	65	16	81
		2006	531.0	55	---	55
			529.0	83	---	83
			490.5	42	37	79
			482.0	112	7	119
			472.3	33	9	42
		2007	531.0	31	---	31
			529.0	54	---	54
			490.5	44	12	56
			482.0	40	3	43
			472.3	22	3	25
			HIRM 8.5	47	---	47
		2008	531.0	33	1	34
			529.0	93	---	93
			490.5	42	13	55
			482.0	86	---	86
			472.3	36	5	41
		2009	531.0	42	1	43
			529.0	78	---	78
			490.5	115	33	148
			482.0	82	12	94
			472.3	38	2	40
			HIRM 8.5	127	---	127

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
River carpsucker	*Carpiodes carpio*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
River carpsucker	*Carpiodes carpio*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
River redhorse	*Moxostoma carinatum*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
River redhorse	*Moxostoma carinatum*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	1	1
		2009	531.0	---	1	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Rock bass	*Ambloplites rupestris*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Rock bass	*Ambloplites rupestris*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Sauger	*Sander canadensis*					
		1993	531.0	---	1	1
			529.0	---	---	---
			490.5	---	1	1
			472.3	1	1	2
			HIRM 8.5	---	8	8
		1994	531.0	---	6	6
			529.0	1	---	1
			490.5	---	5	5
			472.3	---	2	2
			HIRM 8.5	1	15	16
		1995	529.0	4	---	4
			490.5	---	14	14
			472.3	---	12	12
			HIRM 8.5	1	7	8
		1996	531.0	---	5	5
			529.0	4	---	4
			490.5	1	10	11
			482.0	---	6	6
		1997	529.0	1	---	1
			490.5	1	25	26
			472.3	---	7	7
			HiRM 8.5	1	10	11
		1998	531.0	1	3	4
		1999	531.0	---	2	2
			529.0	1	---	1
			490.5	1	2	3
			482.0	---	4	4
			472.3	---	1	1
			HIRM 8.5	---	5	5
		2000	531.0	---	4	4
			529.0	---	---	---
			490.5	---	5	5
			482.0	---	3	3
			472.3	---	4	4
			HIRM 8.5	2	2	4
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	1	1
			HIRM 8.5	---	2	2

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Sauger	*Sander canadensis*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	1	4	5
			482.0	---	6	6
			472.3	---	1	1
		2003	531.0	---	1	1
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	2	2
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2004	531.0	---	1	1
			529.0	---	---	---
			490.5	---	2	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	1	1
			HIRM 8.5	---	2	2
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	1	1
			472.3	---	---	---
		2009	531.0	---	7	7
			529.0	1	---	1
			490.5	---	5	5
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	5	5

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Skipjack herring	*Alosa chrysochloris*					
		1993	531.0	---	13	13
			529.0	25	---	25
			490.5	---	54	54
			472.3	---	40	40
			HIRM 8.5	---	2	2
		1994	531.0	1	65	66
			529.0	10	---	10
			490.5	---	8	8
			472.3	1	17	18
			HIRM 8.5	---	---	---
		1995	529.0	1	---	1
			490.5	---	81	81
			472.3	---	34	34
			HIRM 8.5	---	10	10
		1996	531.0	---	44	44
			529.0	---	---	---
			490.5	---	43	43
			482.0	---	20	20
		1997	529.0	---	---	---
			490.5	---	25	25
			472.3	---	19	19
			HiRM 8.5	---	3	3
		1998	531.0	1	34	35
		1999	531.0	---	13	13
			529.0	---	---	---
			490.5	---	35	35
			482.0	1	19	20
			472.3	1	38	39
			HIRM 8.5	---	4	4
		2000	531.0	---	5	5
			529.0	---	---	---
			490.5	---	8	8
			482.0	---	3	3
			472.3	---	66	66
			HIRM 8.5	---	3	3
		2001	531.0	---	2	2
			529.0	---	---	---
			490.5	---	39	39
			482.0	---	6	6
			472.3	---	44	44
			HIRM 8.5	---	13	13
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	15	15
			482.0	---	3	3
			472.3	---	24	24

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Skipjack herring	*Alosa chrysochloris*					
		2003	531.0	---	2	2
			529.0	---	---	---
			490.5	---	21	21
			482.0	---	7	7
			472.3	---	33	33
			HIRM 8.5	1	---	1
		2004	531.0	---	34	34
			529.0	---	---	---
			490.5	---	28	28
			482.0	---	15	15
			472.3	---	33	33
			HIRM 8.5	---	1	1
		2005	531.0	---	9	9
			529.0	---	---	---
			490.5	---	7	7
			482.0	---	17	17
			472.3	---	82	82
			HIRM 8.5	---	10	10
		2006	531.0	---	2	2
			529.0	---	---	---
			490.5	---	31	31
			482.0	---	21	21
			472.3	---	39	39
		2007	531.0	---	4	4
			529.0	---	---	---
			490.5	---	32	32
			482.0	---	18	18
			472.3	---	24	24
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Silver redhorse	*Moxostoma anisurum*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Silver redhorse	*Moxostoma anisurum*					
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	2	2
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	5	5

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Smallmouth bass	*Micropterus dolomieu*					
		1993	531.0	19	---	19
			529.0	34	---	34
			490.5	6	1	7
			472.3	10	2	12
			HIRM 8.5	---	3	3
		1994	531.0	19	3	22
			529.0	36	---	36
			490.5	7	1	8
			472.3	16	---	16
			HIRM 8.5	---	---	---
		1995	529.0	10	---	10
			490.5	4	---	4
			472.3	15	4	19
			HIRM 8.5	---	---	---
		1996	531.0	31	---	31
			529.0	19	---	19
			490.5	10	---	10
			482.0	7	---	7
		1997	529.0	33	---	33
			490.5	9	6	15
			472.3	4	---	4
			HiRM 8.5	---	---	---
		1998	531.0	19	---	19
		1999	531.0	5	---	5
			529.0	3	---	3
			490.5	13	---	13
			482.0	1	---	1
			472.3	1	---	1
			HIRM 8.5	---	---	---
		2000	531.0	17	---	17
			529.0	19	---	19
			490.5	4	6	10
			482.0	7	1	8
			472.3	4	2	6
			HIRM 8.5	---	---	---
		2001	531.0	6	1	7
			529.0	2	---	2
			490.5	8	1	9
			482.0	4	---	4
			472.3	1	---	1
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Smallmouth bass	*Micropterus dolomieu*					
		2002	531.0	6	2	8
			529.0	16	---	16
			490.5	29	2	31
			482.0	8	2	10
			472.3	7	3	10
		2003	531.0	11	2	13
			529.0	10	---	10
			490.5	12	---	12
			482.0	2	12	14
			472.3	3	1	4
			HIRM 8.5	---	---	---
		2004	531.0	26	1	27
			529.0	25	---	25
			490.5	18	---	18
			482.0	5	---	5
			472.3	5	---	5
			HIRM 8.5	---	---	---
		2005	531.0	12	1	13
			529.0	25	---	25
			490.5	24	---	24
			482.0	1	---	1
			472.3	4	---	4
			HIRM 8.5	---	---	---
		2006	531.0	11	---	11
			529.0	10	---	10
			490.5	17	1	---
			482.0	---	---	---
			472.3	15	---	15
		2007	531.0	2	2	4
			529.0	4	---	4
			490.5	5	---	5
			482.0	1	1	2
			472.3	3	1	4
			HIRM 8.5	---	---	---
		2008	531.0	6	1	7
			529.0	2	---	2
			490.5	8	---	8
			482.0	2	---	2
			472.3	7	---	7
		2009	531.0	15	---	15
			529.0	15	---	15
			490.5	14	---	14
			482.0	13	1	14
			472.3	7	3	10
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Smallmouth buffalo	*Ictiobus bubalus*					
		1993	531.0	---	4	4
			529.0	---	---	---
			490.5	3	1	4
			472.3	1	---	1
			HIRM 8.5	---	6	6
		1994	531.0	1	---	1
			529.0	4	---	4
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		1995	529.0	---	---	---
			490.5	3	2	5
			472.3	---	1	1
			HIRM 8.5	7	6	13
		1996	531.0	1	1	2
			529.0	---	---	---
			490.5	1	---	1
			482.0	7	4	11
		1997	529.0	---	---	---
			490.5	---	1	1
			472.3	---	---	---
			HiRM 8.5	1	5	6
		1998	531.0	1	4	5
		1999	531.0	2	4	6
			529.0	---	---	---
			490.5	2	---	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	19	14	33
		2000	531.0	1	3	4
			529.0	---	---	---
			490.5	---	---	---
			482.0	9	1	10
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2001	531.0	2	1	3
			529.0	---	---	---
			490.5	3	---	3
			482.0	1	1	2
			472.3	1	---	1
			HIRM 8.5	21	3	24

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Smallmouth buffalo	*Ictiobus bubalus*					
		2002	531.0	5	3	8
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	3	9	12
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	8	3	11
		2004	531.0	9	1	10
			529.0	1	---	1
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	3	2	5
		2005	531.0	2	1	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	---	1
			HIRM 8.5	4	---	4
		2006	531.0	3	4	7
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	4	5	9
			529.0	---	---	---
			490.5	1	1	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	37	---	37
		2008	531.0	2	7	9
			529.0	1	---	1
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	1	1
		2009	531.0	1	1	2
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	4	---	4

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Smallmouth redhorse	*Moxostoma breviceps*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Smallmouth redhorse	*Moxostoma breviceps*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotfin shiner	*Cyprinella spiloptera*					
		1993	531.0	43	---	43
			529.0	13	---	13
			490.5	13	---	13
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1994	531.0	57	---	57
			529.0	12	---	12
			490.5	28	---	28
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1995	529.0	4	---	4
			490.5	52	---	52
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1996	531.0	49	---	49
			529.0	7	---	7
			490.5	4	---	4
			482.0	13	---	13
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	3	---	3
			HiRM 8.5	1	---	1
		1998	531.0	103	---	103
		1999	531.0	6	---	6
			529.0	9	---	9
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	66	---	66
			529.0	23	---	23
			490.5	---	---	---
			482.0	18	---	18
			472.3	2	---	2
			HIRM 8.5	1	---	1
		2001	531.0	92	---	92
			529.0	31	---	31
			490.5	21	---	21
			482.0	41	---	41
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2002	531.0	6	---	6
			529.0	28	---	28
			490.5	7	---	7
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotfin shiner	*Cyprinella spiloptera*					
		2003	531.0	50	---	50
			529.0	11	---	11
			490.5	19	---	19
			482.0	20	---	20
			472.3	2	---	2
			HIRM 8.5	5	---	5
		2004	531.0	16	---	16
			529.0	11	---	11
			490.5	2	---	2
			482.0	1	---	1
			472.3	3	---	3
			HIRM 8.5	1	---	1
		2005	531.0	102	---	102
			529.0	4	---	4
			490.5	1	---	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	86	---	86
			529.0	44	---	44
			490.5	6	---	6
			482.0	38	---	38
			472.3	7	---	7
		2007	531.0	16	---	16
			529.0	27	---	27
			490.5	9	---	9
			482.0	20	---	20
			472.3	4	---	4
			HIRM 8.5	2	---	2
		2008	531.0	79	---	79
			529.0	17	---	17
			490.5	6	---	6
			482.0	20	---	20
			472.3	4	---	4
		2009	531.0	101	---	101
			529.0	33	---	33
			490.5	59	---	59
			482.0	20	---	20
			472.3	10	---	10
			HIRM 8.5	20	---	20

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotted bass	*Micropterus punctulatus*					
		1993	531.0	3	1	4
			529.0	82	---	82
			490.5	82	23	105
			472.3	43	28	71
			HIRM 8.5	7	1	8
		1994	531.0	7	3	10
			529.0	52	---	52
			490.5	49	13	62
			472.3	115	2	117
			HIRM 8.5	10	5	15
		1995	529.0	9	---	9
			490.5	36	1	37
			472.3	22	15	37
			HIRM 8.5	4	4	8
		1996	531.0	1	4	5
			529.0	40	---	40
			490.5	16	10	26
			482.0	25	35	60
		1997	529.0	7	---	7
			490.5	10	15	25
			472.3	1	2	3
			HiRM 8.5	4	2	6
		1998	531.0	YOY	---	YOY
		1999	531.0	1	---	1
			529.0	11	---	11
			490.5	13	1	14
			482.0	12	5	17
			472.3	7	4	11
			HIRM 8.5	3	2	5
		2000	531.0	16	---	16
			529.0	35	---	35
			490.5	13	35	48
			482.0	47	14	61
			472.3	19	22	41
			HIRM 8.5	7	---	7
		2001	531.0	1	2	3
			529.0	16	---	16
			490.5	22	27	49
			482.0	26	70	96
			472.3	21	43	64
			HIRM 8.5	7	5	12

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotted bass	*Micropterus punctulatus*					
		2002	531.0	9	4	13
			529.0	31	---	31
			490.5	61	21	82
			482.0	35	34	69
			472.3	18	49	67
		2003	531.0	12	4	16
			529.0	24	---	24
			490.5	21	7	28
			482.0	42	8	50
			472.3	19	25	44
			HIRM 8.5	9	---	9
		2004	531.0	3	---	9
			529.0	49	---	49
			490.5	49	18	67
			482.0	29	18	47
			472.3	31	5	36
			HIRM 8.5	12	3	15
		2005	531.0	2	---	2
			529.0	56	---	56
			490.5	22	18	40
			482.0	30	21	51
			472.3	16	25	41
			HIRM 8.5	11	4	15
		2006	531.0	3	---	3
			529.0	32	---	32
			490.5	24	10	34
			482.0	30	9	39
			472.3	17	41	58
		2007	531.0	4	---	4
			529.0	30	---	30
			490.5	19	7	26
			482.0	9	12	21
			472.3	13	19	32
			HIRM 8.5	22	---	22
		2008	531.0	1	2	3
			529.0	13	---	13
			490.5	14	2	16
			482.0	20	44	64
			472.3	5	27	32
		2009	531.0	---	---	---
			529.0	35	---	35
			490.5	44	16	60
			482.0	33	17	50
			472.3	12	6	18
			HIRM 8.5	22	2	24

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotted gar	*Lepisosteus oculatus*					
		1993	531.0	1	---	1
			529.0	---	---	---
			490.5	---	1	1
			472.3	---	---	---
			HIRM 8.5	1	2	3
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	3	---	3
		1995	529.0	---	---	---
			490.5	---	1	1
			472.3	---	---	---
			HIRM 8.5	4	---	4
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	1	1
			482.0	10	4	14
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	1	---	1
		1998	531.0	1	---	1
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	2	---	2
			482.0	6	---	6
			472.3	---	---	---
			HIRM 8.5	8	2	10
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	2	---	2
			529.0	1	---	1
			490.5	4	4	8
			482.0	1	---	1
			472.3	2	---	2
			HIRM 8.5	---	---	---
		2002	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotted gar	*Lepisosteus oculatus*					
		2003	531.0	2	---	2
			529.0	---	---	---
			490.5	1	---	1
			482.0	3	---	3
			472.3	4	---	4
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	1	---	1
			490.5	8	---	8
			482.0	8	---	8
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2005	531.0	5	---	5
			529.0	---	---	---
			490.5	2	---	2
			482.0	---	---	---
			472.3	2	---	2
			HIRM 8.5	1	---	1
		2006	531.0	2	---	2
			529.0	2	---	2
			490.5	1	---	1
			482.0	2	---	2
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	25	1	26
			482.0	4	1	5
			472.3	1	1	2
			HIRM 8.5	2	---	2
		2008	531.0	2	---	2
			529.0	7	---	7
			490.5	11	---	11
			482.0	9	---	9
			472.3	5	---	5
		2009	531.0	1	---	1
			529.0	1	---	1
			490.5	10	---	10
			482.0	10	1	11
			472.3	1	---	1
			HIRM 8.5	1	---	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotted sucker	*Minytrema melanops*					
		1993	531.0	1	1	2
			529.0	16	---	16
			490.5	15	4	19
			472.3	---	---	---
			HIRM 8.5	16	5	21
		1994	531.0	1	---	1
			529.0	28	---	28
			490.5	4	5	9
			472.3	6	---	6
			HIRM 8.5	34	13	47
		1995	529.0	28	---	28
			490.5	16	1	17
			472.3	13	5	18
			HIRM 8.5	64	4	68
		1996	531.0	4	1	5
			529.0	13	---	13
			490.5	3	1	4
			482.0	4	3	7
		1997	529.0	16	---	16
			490.5	4	12	16
			472.3	---	3	3
			HiRM 8.5	---	28	28
		1998	531.0	4	4	8
		1999	531.0	---	2	2
			529.0	9	---	9
			490.5	4	---	4
			482.0	8	4	12
			472.3	1	---	1
			HIRM 8.5	56	14	70
		2000	531.0	6	10	16
			529.0	5	---	5
			490.5	5	10	15
			482.0	1	8	9
			472.3	---	9	9
			HIRM 8.5	13	26	39
		2001	531.0	7	12	19
			529.0	6	---	6
			490.5	9	1	10
			482.0	2	8	10
			472.3	3	3	6
			HIRM 8.5	64	21	85
		2002	531.0	6	7	13
			529.0	8	---	8
			490.5	4	---	4
			482.0	5	3	8
			472.3	4	8	12

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Spotted sucker	*Minytrema melanops*					
		2003	531.0	6	14	20
			529.0	4	---	4
			490.5	6	3	9
			482.0	4	5	9
			472.3	3	6	9
			HIRM 8.5	26	11	37
		2004	531.0	14	13	27
			529.0	4	---	4
			490.5	3	2	5
			482.0	6	1	7
			472.3	6	2	8
			HIRM 8.5	30	11	41
		2005	531.0	4	17	21
			529.0	8	---	8
			490.5	5	2	7
			482.0	3	1	4
			472.3	3	1	4
			HIRM 8.5	28	18	46
		2006	531.0	8	8	16
			529.0	3	---	3
			490.5	5	1	6
			482.0	2	1	3
			472.3	3	2	5
		2007	531.0	3	5	8
			529.0	5	---	5
			490.5	2	3	5
			482.0	8	---	8
			472.3	---	---	---
			HIRM 8.5	21	2	23
		2008	531.0	2	3	5
			529.0	1	---	1
			490.5	2	---	2
			482.0	5	1	6
			472.3	5	1	6
		2009	531.0	3	10	13
			529.0	2	---	2
			490.5	3	1	4
			482.0	4	---	4
			472.3	---	---	---
			HIRM 8.5	23	31	54

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Steelcolor shiner	*Cyprinella whipplei*					
		1993	531.0	48	---	48
			529.0	39	---	39
			490.5	---	---	---
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1994	531.0	34	---	34
			529.0	93	---	93
			490.5	---	---	---
			472.3	1	---	1
			HIRM 8.5	---	---	---
		1995	529.0	7	---	7
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	31	---	31
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Steelcolor shiner	*Cyprinella whipplei*					
		2003	531.0	---	---	---
			529.0	4	---	4
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
		2009	531.0	1	---	1
			529.0	4	---	4
			490.5	---	---	---
			482.0	---	---	---
			472.3	4	---	4
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Striped bass	*Morone saxatilis*					
		1993	531.0	---	---	---
			529.0	7	---	6
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	1	1	2
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	1	1
			HIRM 8.5	---	---	---
		1995	529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	4	4
			HiRM 8.5	YOY	---	YOY
		1998	531.0	---	5	5
		1999	531.0	---	3	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	4	4
		2000	531.0	---	4	4
			529.0	1	---	1
			490.5	---	5	5
			482.0	---	1	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	4	4
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	5	5
			529.0	1	---	1
			490.5	---	2	2
			482.0	---	3	3
			472.3	---	3	3

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Striped bass	*Morone saxatilis*					
		2003	531.0	1	6	7
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2004	531.0	2	1	3
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	1	1
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	1	2	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	2	---	2
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	9	9
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	7	7
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	6	6
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Striped shiner	*Luxilus chrysocephalus*					
		1993	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	1	---	1
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Striped shiner	*Luxilus chrysocephalus*					
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	2	---	2
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued) YOY= Young of year (not included in RFAI scores)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Threadfin shad	*Dorosoma petenense*					
		1993	531.0	---	6	6
			529.0	YOY	---	YOY
			490.5	YOY	---	YOY
			472.3	YOY	---	YOY
			HIRM 8.5	YOY	---	YOY
		1994	531.0	YOY	---	YOY
			529.0	YOY	---	YOY
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	YOY	---	YOY
			490.5	YOY	---	YOY
			472.3	YOY	---	YOY
			HIRM 8.5	YOY	---	YOY
		1996	531.0	YOY	---	YOY
			529.0	YOY	---	YOY
			490.5	YOY	---	YOY
			482.0	YOY	---	YOY
		1997	529.0	YOY	---	YOY
			490.5	---	1	1
			472.3	---	---	---
			HiRM 8.5	YOY	---	YOY
		1998	531.0	---	18	18
		1999	531.0	---	17	17
			529.0	261	---	261
			490.5	10	2	12
			482.0	15	5	20
			472.3	---	3	3
			HIRM 8.5	177	---	177
		2000	531.0	---	1	1
			529.0	27	---	27
			490.5	YOY	---	YOY
			482.0	YOY	---	YOY
			472.3	---	3	3
			HIRM 8.5	48	---	48
		2001	531.0	---	3	---
			529.0	YOY	---	YOY
			490.5	2	2	4
			482.0	1	2	3
			472.3	---	3	3
			HIRM 8.5	3	---	3
		2002	531.0	---	1	1
			529.0	378	---	378
			490.5	134	---	134
			482.0	---	---	---
			472.3	125	1	126

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Threadfin shad	*Dorosoma petenense*					
		2003	531.0	1	5	6
			529.0	265	---	265
			490.5	17	1	18
			482.0	---	---	---
			472.3	3	1	4
			HIRM 8.5	---	---	---
		2004	531.0	1	---	1
			529.0	196	---	196
			490.5	5	---	5
			482.0	16	---	16
			472.3	51	---	51
			HIRM 8.5	1	---	1
		2005	531.0	5	---	5
			529.0	56	---	56
			490.5	7	---	7
			482.0	26	---	26
			472.3	23	---	23
			HIRM 8.5	---	---	---
		2006	531.0	1	5	6
			529.0	1	---	1
			490.5	58	1	59
			482.0	5	---	5
			472.3	83	---	83
		2007	531.0	6	---	6
			529.0	1	---	1
			490.5	1	---	1
			482.0	2	1	3
			472.3	2	---	2
			HIRM 8.5	4	---	4
		2008	531.0	2	---	2
			529.0	---	---	---
			490.5	3	---	3
			482.0	22	1	23
			472.3	13	---	13
		2009	531.0	66	---	66
			529.0	31	---	31
			490.5	205	---	205
			482.0	3	---	3
			472.3	44	---	44
			HIRM 8.5	2	---	2

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Walleye	*Sander vitreus*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	29	29
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	15	15
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	4	4
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	10	10
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Walleye	*Sander vitreus*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	2	2
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Warmouth	*Lepomis gulosus*					
		1993	531.0	1	---	1
			529.0	16	---	16
			490.5	10	1	11
			472.3	1	---	1
			HIRM 8.5	10	---	10
		1994	531.0	---	---	---
			529.0	9	---	9
			490.5	1	---	1
			472.3	---	---	---
			HIRM 8.5	1	---	1
		1995	529.0	1	---	1
			490.5	3	---	3
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	1	---	1
			529.0	1	---	1
			490.5	1	---	1
			482.0	1	---	1
		1997	529.0	1	---	1
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	6	---	6
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	---	1
			HIRM 8.5	1	---	1
		2000	531.0	3	---	3
			529.0	9	---	9
			490.5	8	1	9
			482.0	4	1	5
			472.3	1	---	1
			HIRM 8.5	6	---	6
		2001	531.0	---	1	1
			529.0	1	---	1
			490.5	2	---	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2002	531.0	4	---	4
			529.0	5	---	5
			490.5	24	---	24
			482.0	4	1	5
			472.3	1	---	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Warmouth	*Lepomis gulosus*					
		2003	531.0	---	---	---
			529.0	1	---	1
			490.5	14	---	14
			482.0	---	---	---
			472.3	4	---	4
			HIRM 8.5	11	---	11
		2004	531.0	5	---	5
			529.0	8	2	10
			490.5	---	---	---
			482.0	---	---	---
			472.3	5	---	5
			HIRM 8.5	26	---	26
		2005	531.0	8	---	8
			529.0	---	---	---
			490.5	1	---	1
			482.0	2	---	2
			472.3	---	---	---
			HIRM 8.5	9	---	9
		2006	531.0	2	1	3
			529.0	---	---	---
			490.5	1	---	1
			482.0	---	---	---
			472.3	4	---	4
		2007	531.0	2	---	2
			529.0	6	---	6
			490.5	4	---	4
			482.0	---	---	---
			472.3	3	---	3
			HIRM 8.5	14	---	14
		2008	531.0	1	---	1
			529.0	12	---	12
			490.5	1	---	1
			482.0	1	---	1
			472.3	1	1	2
		2009	531.0	2	1	3
			529.0	11	---	11
			490.5	7	---	7
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	11	---	11

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Western mosquitofish	*Gambusia affinis*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Western mosquitofish	*Gambusia affinis*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
White bass	*Morone chrysops*					
		1993	531.0	4	16	20
			529.0	10	---	10
			490.5	---	104	104
			472.3	1	11	12
			HIRM 8.5	12	9	21
		1994	531.0	3	11	14
			529.0	6	---	6
			490.5	1	---	1
			472.3	---	---	---
			HIRM 8.5	---	3	3
		1995	529.0	61	---	61
			490.5	9	4	13
			472.3	1	7	8
			HIRM 8.5	1	2	3
		1996	531.0	1	9	10
			529.0	13	---	13
			490.5	---	2	2
			482.0	---	8	8
		1997	529.0	15	---	15
			490.5	---	2	2
			472.3	---	3	3
			HiRM 8.5	3	---	3
		1998	531.0	---	4	4
		1999	531.0	---	10	10
			529.0	3	---	3
			490.5	---	3	3
			482.0	1	1	2
			472.3	---	1	1
			HIRM 8.5	---	2	2
		2000	531.0	---	2	2
			529.0	6	---	6
			490.5	---	3	3
			482.0	---	1	1
			472.3	---	4	4
			HIRM 8.5	---	4	4
		2001	531.0	---	2	2
			529.0	6	---	6
			490.5	---	3	3
			482.0	---	1	1
			472.3	---	4	4
			HIRM 8.5	---	4	4
		2002	531.0	1	18	19
			529.0	9	---	9
			490.5	---	4	4
			482.0	1	---	1
			472.3	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
White bass	*Morone chrysops*					
		2003	531.0	2	6	8
			529.0	2	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	1	1
			HIRM 8.5	---	---	---
		2004	531.0	1	17	18
			529.0	32	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	1	1	2
			HIRM 8.5	---	---	---
		2005	531.0	4	14	18
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	3	3
			472.3	---	2	2
			HIRM 8.5	1	9	10
		2006	531.0	21	11	32
			529.0	---	8	8
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	1	3	4
			529.0	---	---	---
			490.5	---	2	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	1	6	7
			529.0	---	---	---
			490.5	---	3	3
			482.0	---	---	---
			472.3	---	1	1
		2009	531.0	---	4	4
			529.0	1	---	1
			490.5	1	1	2
			482.0	1	2	3
			472.3	---	1	1
			HIRM 8.5	1	3	4

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
White crappie	*Pomoxis annularis*					
		1993	531.0	---	5	5
			529.0	4	---	4
			490.5	1	3	4
			472.3	---	6	6
			HIRM 8.5	9	1	10
		1994	531.0	---	---	---
			529.0	1	---	1
			490.5	1	2	3
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	3	---	3
			490.5	---	1	1
			472.3	---	2	2
			HIRM 8.5	---	---	---
		1996	531.0	---	4	4
			529.0	6	---	6
			490.5	---	2	2
			482.0	---	2	2
		1997	529.0	1	---	1
			490.5	1	---	1
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	2	2
		1999	531.0	---	2	2
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	2	2
			HIRM 8.5	2	1	3
		2000	531.0	---	20	20
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	4	4
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	1	---	1
			490.5	---	10	10
			482.0	1	2	3
			472.3	---	5	5
			HIRM 8.5	1	---	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
White crappie	*Pomoxis annularis*					
		2002	531.0	---	2	2
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	2	2
			472.3	---	---	---
		2003	531.0	---	1	1
			529.0	1	---	1
			490.5	---	1	1
			482.0	---	1	1
			472.3	---	1	1
			HIRM 8.5	2	---	2
		2004	531.0	---	3	3
			529.0	6	---	6
			490.5	2	---	2
			482.0	---	2	2
			472.3	---	---	---
			HIRM 8.5	1	---	1
		2005	531.0	---	4	4
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	1	1
			HIRM 8.5	---	---	---
		2006	531.0	---	5	5
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	1	1
		2007	531.0	1	3	4
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	1	2	3
		2008	531.0	---	1	1
			529.0	---	---	---
			490.5	---	1	1
			482.0	---	1	1
			472.3	---	---	---
		2009	531.0	---	3	3
			529.0	1	---	1
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	1	1

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Yellow bass	*Morone chrysops*					
		1993	531.0	---	66	66
			529.0	79	---	79
			490.5	1	69	70
			472.3	---	33	33
			HIRM 8.5	46	24	70
		1994	531.0	---	8	8
			529.0	54	---	54
			490.5	4	62	66
			472.3	---	14	14
			HIRM 8.5	10	12	22
		1995	529.0	22	---	22
			490.5	1	83	84
			472.3	---	33	33
			HIRM 8.5	7	35	42
		1996	531.0	---	59	59
			529.0	52	---	52
			490.5	1	39	40
			482.0	1	25	26
		1997	529.0	82	---	82
			490.5	---	28	28
			472.3	---	5	5
			HiRM 8.5	34	11	45
		1998	531.0	---	8	8
		1999	531.0	---	45	45
			529.0	6	6	12
			490.5	---	50	50
			482.0	---	16	16
			472.3	1	13	14
			HIRM 8.5	21	7	28
		2000	531.0	---	108	108
			529.0	34	---	34
			490.5	4	34	38
			482.0	6	9	15
			472.3	1	40	41
			HIRM 8.5	117	28	145
		2001	531.0	---	71	71
			529.0	1	---	1
			490.5	---	124	124
			482.0	---	80	80
			472.3	1	80	81
			HIRM 8.5	2	159	161
		2002	531.0	---	42	42
			529.0	35	---	35
			490.5	18	---	46
			482.0	1	---	1
			472.3	17	---	17

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Yellow bass	*Morone chrysops*					
		2003	531.0	---	54	54
			529.0	17	---	17
			490.5	---	33	33
			482.0	2	18	20
			472.3	1	24	25
			HIRM 8.5	15	10	25
		2004	531.0	1	5	6
			529.0	26	---	26
			490.5	1	31	32
			482.0	---	17	17
			472.3	---	28	28
			HIRM 8.5	19	50	69
		2005	531.0	---	76	76
			529.0	13	---	13
			490.5	---	25	25
			482.0	2	18	20
			472.3	---	13	13
			HIRM 8.5	1	35	36
		2006	531.0	21	11	33
			529.0	8	---	8
			490.5	---	55	55
			482.0	---	9	9
			472.3	---	32	32
		2007	531.0	---	46	46
			529.0	7	---	7
			490.5	2	89	91
			482.0	---	32	32
			472.3	---	---	---
			HIRM 8.5	8	86	94
		2008	531.0	---	26	26
			529.0	1	---	1
			490.5	---	37	37
			482.0	---	14	14
			472.3	---	24	24
		2009	531.0	---	74	74
			529.0	22	---	22
			490.5	5	31	36
			482.0	---	10	10
			472.3	---	22	22
			HIRM 8.5	8	36	44

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Yellow bullhead	*Ameiurus natalis*					
		1993	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1994	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1995	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		1996	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	1	1
		1997	529.0	---	---	---
			490.5	---	---	---
			472.3	---	---	---
			HiRM 8.5	---	---	---
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	4	---	4
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2001	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Yellow bullhead	*Ameiurus natalis*					
		2002	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2004	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2005	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2006	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Yellow perch	*Perca flavescens*					
		1993	531.0	1	---	1
			529.0	1	---	1
			490.5	10	8	18
			472.3	1	1	2
			HIRM 8.5	43	---	43
		1994	531.0	4	---	4
			529.0	3	---	3
			490.5	4	---	4
			472.3	1	---	1
			HIRM 8.5	28	---	28
		1995	529.0	---	---	---
			490.5	3	3	6
			472.3	---	---	---
			HIRM 8.5	4	---	4
		1996	531.0	1	---	1
			529.0	1	---	1
			490.5	3	1	4
			482.0	1	---	1
		1997	529.0	7	---	7
			490.5	7	---	7
			472.3	---	---	---
			HiRM 8.5	19	---	19
		1998	531.0	---	---	---
		1999	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	7	---	7
			472.3	2	---	2
			HIRM 8.5	8	---	8
		2000	531.0	---	---	---
			529.0	---	---	---
			490.5	2	---	2
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	2	---	2
		2001	531.0	5	---	5
			529.0	---	---	---
			490.5	---	---	---
			482.0	1	---	1
			472.3	---	---	---
			HIRM 8.5	1	1	2

Appendix 1. (Continued)

Common Name	Scientific Name	Year	River Mile	Total Fish EF	Total Gill Net Fish	Total Fish Combined
Yellow perch	*Perca flavescens*					
		2002	531.0	---	---	---
			529.0	2	---	2
			490.5	2	---	2
			482.0	---	---	---
			472.3	---	---	---
		2003	531.0	---	---	---
			529.0	---	---	---
			490.5	1	3	4
			482.0	---	---	---
			472.3	---	1	1
			HIRM 8.5	---	---	---
		2004	531.0	5	---	5
			529.0	1	---	1
			490.5	2	---	2
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	5	---	5
		2005	531.0	1	---	1
			529.0	4	---	4
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
			HIRM 8.5	10	---	10
		2006	531.0	3	---	3
			529.0	---	---	---
			490.5	---	---	---
			482.0	---	---	---
			472.3	---	---	---
		2007	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	2	---	2
			472.3	---	---	---
			HIRM 8.5	---	---	---
		2008	531.0	---	---	---
			529.0	---	---	---
			490.5	1	---	1
			482.0	2	---	2
			472.3	1	---	1
		2009	531.0	---	---	---
			529.0	---	---	---
			490.5	9	1	10
			482.0	5	---	5
			472.3	---	---	---
			HIRM 8.5	---	---	---

Appendix 2-A. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2009.

Autumn 2009		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		31	5	28	3	23	3	26	3	29	3	28	5
2. Number of centrarchid species		8	5	6	5	5	5	7	5	7	5	7	5
3. Number of benthic invertivores		4	3	3	1	3	1	3	1	4	3	5	3
4. Number of intolerant species		5	5	4	3	4	3	5	5	3	3	5	5
5. Percent tolerant individuals	Electrofishing	33.8	3	69.3	0.5	75	0.5	34.5	1.5	56.7	1.5	54.8	1.5
	Gill Netting	---	---	29.7	1.5	37.1	0.5	17.7	1.5	8.9	2.5	23.7	1.5
6. Percent dominance by 1 species	Electrofishing	52.7	1	39.8	1.5	50.8	0.5	52.5	0.5	38.2	1.5	34.5	1.5
	Gill Netting	---	---	25.2	1.5	25	1.5	25.4	1.5	32.1	0.5	33.8	0.5
7. Percent non-native species	Electrofishing	52.8	1	4.3	1.5	5.8	0.5	53.3	0.5	23.1	0.5	34	0.5
	Gill Netting	---	---	0.6	2.5	0	2.5	1.1	2.5	2.7	2.5	3.2	2.5
8. Number of top carnivore species		11	5	10	5	8	5	8	5	9	5	9	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	7.2	1	13	2.5	14.3	2.5	6.3	1.5	7.5	1.5	4.7	0.5
	Gill Netting	---	---	43.9	1.5	33.6	1.5	69.1	2.5	51.8	1.5	66.2	2.5
10. Percent omnivores	Electrofishing	8.5	5	18.8	2.5	14.4	2.5	7.5	2.5	13.6	2.5	6.2	2.5
	Gill Netting	---	---	31	1.5	50.7	0.5	23.8	1.5	13.4	2.5	25.1	1.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	148.7	5	151.3	1.5	70.1	0.5	128.7	1.5	79.1	0.5	90.5	0.5
	Gill Netting	---	---	15.5	1.5	14	1.5	18.1	1.5	11.2	0.5	21.9	1.5
12. Percent anomalies	Electrofishing	1.7	5	2	1.5	1	2.5	2.4	1.5	1.4	2.5	0.4	2.5
	Gill Netting	---	---	0	2.5	0.7	2.5	0	2.5	0	2.5	0.9	2.5
Overall RFAI Score			**44**		**41**		**37**		**42**		**42**		**45**

Appendix 2-B. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2008.

Autumn 2008		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition											
1. Number of species		28	5	27	3	30	5	27	3	27	3
2. Number of centrarchid species		7	5	8	5	7	5	7	5	8	5
3. Number of benthic invertivores		5	3	3	1	3	1	4	3	3	1
4. Number of intolerant species		6	5	3	3	5	5	5	5	4	3
5. Percent tolerant individuals	Electrofishing	82.3	1	86.7	0.5	80.7	0.5	87.7	0.5	93.8	0.5
	Gill Netting	---	---	47.5	0.5	41.9	0.5	32.8	0.5	58.8	0.5
6. Percent dominance by 1 species	Electrofishing	63	1	53.9	0.5	58.2	0.5	71.6	0.5	72.6	0.5
	Gill Netting	---	---	44.2	0.5	38.2	0.5	24.7	1.5	49.8	0.5
7. Percent non-native species	Electrofishing	32.5	5	4	1.5	2.3	1.5	5.9	0.5	0.2	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0.5	2.5	5.2	2.5
8. Number of top carnivore species		7	5	9	5	11	5	8	5	9	5
B. Trophic composition											
9. Percent top carnivores	Electrofishing	3.7	1	5.4	0.5	4.7	0.5	2.5	0.5	2.7	0.5
	Gill Netting	---	---	40.3	1.5	47.1	1.5	52.2	2.5	33.6	1.5
10. Percent omnivores	Electrofishing	14.6	5	29	1.5	13.1	2.5	4.7	2.5	10.3	2.5
	Gill Netting	---	---	49.2	0.5	47.1	0.5	37.1	0.5	61.6	0.5
C. Fish abundance and health											
11. Average number per run	Electrofishing	94.3	3	86.3	0.5	79.7	0.5	121.5	1.5	85.8	0.5
	Gill Netting	---	---	18.1	1.5	19.1	1.5	18.6	1.5	21.1	1.5
12. Percent anomalies	Electrofishing	0.9	5	1.1	2.5	2.1	1.5	0.1	2.5	0.4	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5	0.9	2.5
Overall RFAI Score			**44**		**34**		**38**		**41**		**36**

Appendix 2-C. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2007.

Autumn 2007		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		27	3	31	5	26	3	22	3	26	3	26	3
2. Number of centrarchid species		7	5	8	5	6	5	7	5	7	5	8	5
3. Number of benthic invertivores		6	3	3	1	3	1	1	1	5	3	2	1
4. Number of intolerant species		6	5	4	3	4	3	4	3	3	3	4	3
5. Percent tolerant individuals	Electrofishing	75.6	1	76.5	0.5	75.7	0.5	86.6	0.5	70.3	0.5	85.1	0.5
	Gill Netting	---	---	29	1.5	37.7	0.5	27.1	1.5	17.1	1.5	46.8	0.5
6. Percent dominance by 1 species	Electrofishing	51.9	1	29.7	1.5	36.3	1.5	55.3	0.5	41.1	0.5	52.2	0.5
	Gill Netting	---	---	27.7	1.5	31.6	0.5	26.1	1.5	69.9	0.5	41.4	0.5
7. Percent non-native species	Electrofishing	0.3	5	1	2.5	0.7	2.5	3.2	1.5	5.2	1.5	2.6	1.5
	Gill Netting	---	---	0	2.5	0.4	2.5	0.4	2.5	0	2.5	3.4	2.5
8. Number of top carnivore species		8	5	11	5	9	5	8	5	8	5	9	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	12	3	10.7	1.5	6.4	1.5	6	1.5	10.5	1.5	9.5	1.5
	Gill Netting	---	---	62	2.5	40.4	1.5	66.8	2.5	74.8	2.5	45.8	1.5
10. Percent omnivores	Electrofishing	16.1	5	33.9	1.5	22	2.5	10.9	2.5	30.2	1.5	22.5	2.5
	Gill Netting	---	---	27.7	1.5	51.3	0.5	27.5	1.5	19.5	2.5	50.2	0.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	51.6	3	54.9	0.5	37.3	0.5	45.3	0.5	52.3	0.5	35.9	0.5
	Gill Netting	---	---	32.1	2.5	22.8	1.5	28	2.5	12.3	1.5	29.5	2.5
12. Percent anomalies	Electrofishing	3.2	3	1.6	2.5	1.4	2.5	0.6	2.5	1.5	2.5	1.3	2.5
	Gill Netting	---	---	0.6	2.5	1.3	2.5	0.4	2.5	0	2.5	4.7	1.5
Overall RFAI Score			**42**		**44**		**38**		**41**		**41**		**36**

Appendix 2-D. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2006.

Autumn 2006		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition											
1. Number of species		26	3	30	5	26	3	24	3	28	5
2. Number of centrarchid species		6	5	7	5	6	5	8	5	8	5
3. Number of benthic invertivores		5	3	4	3	3	1	2	1	3	1
4. Number of intolerant species		6	5	5	5	3	3	5	5	5	5
5. Percent tolerant individuals	Electrofishing	65.3	1	70.1	0.5	72.4	0.5	74.6	0.5	85.2	0.5
	Gill Netting	---	---	30	1.5	29.6	0.5	28.6	0.5	34.8	0.5
6. Percent dominance by 1 species	Electrofishing	29.1	3	35.3	1.5	33.6	1.5	37.4	1.5	37.9	1.5
	Gill Netting	---	---	25.2	1.5	22.5	1.5	24.4	1.5	26.1	1.5
7. Percent non-native species	Electrofishing	3.4	5	0.8	2.5	4.2	0.5	2.7	1.5	4.8	0.5
	Gill Netting	---	---	0	2.5	0	2.5	0.4	2.5	2.5	2.5
8. Number of top carnivore species		9	5	10	5	8	5	8	5	10	5
B. Trophic composition											
9. Percent top carnivores	Electrofishing	9	1	8.3	1.5	6.5	1.5	5.9	1.5	6	1.5
	Gill Netting	---	---	51.2	1.5	40.8	1.5	62.8	2.5	54	2.5
10. Percent omnivores	Electrofishing	31.5	3	37.2	1.5	24.6	1.5	8.3	2.5	30.5	1.5
	Gill Netting	---	---	27.2	1.5	47.9	0.5	30.8	1.5	32.9	1.5
C. Fish abundance and health											
11. Average number per run	Electrofishing	61.7	3	49.1	0.5	60.9	0.5	55.1	0.5	85.3	0.5
	Gill Netting	---	---	25	2.5	14.2	1.5	26.6	2.5	16.1	1.5
12. Percent anomalies	Electrofishing	1.5	5	0.3	2.5	0.4	2.5	0.7	2.5	0.2	2.5
	Gill Netting	---	---	0.4	2.5	3.5	1.5	1.9	2.5	0	2.5
Overall RFAI Score			**42**		**47**		**35**		**43**		**42**

Appendix 2-E. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2005.

Autumn 2005		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		27	3	29	3	26	3	29	5	31	5	30	5
2. Number of centrarchid species		6	5	7	5	7	5	7	5	5	5	8	5
3. Number of benthic invertivores		6	3	4	3	3	1	4	3	6	3	3	1
4. Number of intolerant species		6	5	7	5	5	5	6	5	4	3	5	5
5. Percent tolerant individuals	Electrofishing	58.6	1	76.2	0.5	70.2	0.5	71	0.5	62	1.5	81.9	0.5
	Gill Netting	---	---	23	1.5	43.4	0.5	31.2	0.5	28.7	1.5	11.9	2.5
6. Percent dominance by 1 species	Electrofishing	30.5	3	39.4	1.5	25.1	1.5	42.2	1.5	43	0.5	48.3	1.5
	Gill Netting	---	---	19.8	1.5	41	0.5	30.5	0.5	25.7	1.5	34.9	0.5
7. Percent non-native species	Electrofishing	1	5	0.8	2.5	0.5	2.5	0.2	2.5	3.4	1.5	2	1.5
	Gill Netting	---	---	0	2.5	0	2.5	0.4	2.5	0.6	2.5	2.3	2.5
8. Number of top carnivore species		7	5	9	5	9	5	12	5	11	5	10	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	16.7	3	14.2	2.5	7.3	1.5	6.4	1.5	13.8	2.5	5	1.5
	Gill Netting	---	---	45.2	1.5	34	1.5	51.7	2.5	41.5	1.5	80.7	2.5
10. Percent omnivores	Electrofishing	33.3	3	19.9	2.5	26	1.5	11.3	2.5	12.7	2.5	19.5	2.5
	Gill Netting	---	---	37.3	1.5	58	0.5	40.5	0.5	32.2	1.5	10.1	2.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	67	3	41.8	0.5	58.5	0.5	37.3	0.5	29.5	0.5	74.5	0.5
	Gill Netting	---	---	12.6	1.5	21.2	1.5	26.9	2.5	17.1	1.5	21.8	1.5
12. Percent anomalies	Electrofishing	2.2	3	0.8	2.5	0.9	2.5	0.5	2.5	0.7	2.5	0.8	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5
Overall RFAI Score			**42**		**46**		**39**		**46**		**45**		**46**

Appendix 2-F. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2004.

Autumn 2004		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		29	5	31	5	27	3	25	3	28	3	28	5
2. Number of centrarchid species		7	5	8	5	6	5	7	5	8	5	7	5
3. Number of benthic invertivores		4	3	4	3	3	1	3	1	3	1	3	1
4. Number of intolerant species		4	3	5	5	5	5	5	5	4	3	4	3
5. Percent tolerant individuals	Electrofishing	64.8	1	55.1	1.5	58.8	1.5	37.2	1.5	71.5	0.5	81.8	0.5
	Gill Netting	---	---	22.9	1.5	45.9	0.5	30.6	0.5	4.6	2.5	26.6	1.5
6. Percent dominance by 1 species	Electrofishing	50	1	29.6	1.5	30.4	1.5	33.8	1.5	45.2	0.5	36.8	1.5
	Gill Netting	---	---	20.7	1.5	29.6	0.5	27.8	1.5	45.9	0.5	23.4	1.5
7. Percent non-native species	Electrofishing	0.5	5	2.2	2.5	0.9	2.5	0.4	2.5	1.1	2.5	1.4	2.5
	Gill Netting	---	---	0.5	2.5	0.6	2.5	0	2.5	0	2.5	1.3	2.5
8. Number of top carnivore species		10	5	11	5	9	5	8	5	9	5	11	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	16.9	3	19.9	2.5	9.6	1.5	10.9	2.5	11.9	2.5	6.5	1.5
	Gill Netting	---	---	50.5	1.5	39.6	1.5	48.9	1.5	56.9	2.5	57.1	2.5
10. Percent omnivores	Electrofishing	51.2	3	15	2.5	19.4	2.5	9.5	2.5	20.5	2.5	35.1	1.5
	Gill Netting	---	---	33	1.5	48.4	0.5	42.8	0.5	11	2.5	31.8	1.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	99.9	3	49.3	0.5	60.8	0.5	51.3	0.5	66.2	0.5	66.6	0.5
	Gill Netting	---	---	18.8	1.5	15.9	1.5	18	1.5	10.9	0.5	15.4	1.5
12. Percent anomalies	Electrofishing	1.3	5	1.2	2.5	1.5	2.5	1	2.5	0.9	2.5	1.6	2.5
	Gill Netting	---	---	0.5	2.5	0	2.5	0	2.5	0	2.5	0	2.5
Overall RFAI Score			**42**		**49**		**41**		**43**		**42**		**43**

Appendix 2-G. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2003.

Autumn 2003		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		30	5	29	3	25	3	26	3	27	3	29	5
2. Number of centrarchid species		8	5	8	5	6	5	8	5	6	5	7	5
3. Number of benthic invertivores		5	3	3	1	3	1	2	1	4	3	3	1
4. Number of intolerant species		5	5	5	5	5	5	5	5	3	3	5	5
5. Percent tolerant individuals	Electrofishing	57.7	3	67	0.5	54.7	1.5	55.6	1.5	72.5	0.5	78.8	0.5
	Gill Netting	---	---	29.7	1.5	26.4	1.5	27	1.5	41.8	0.5	27.9	1.5
6. Percent dominance by 1 species	Electrofishing	34.2	3	31.2	1.5	24.8	2.5	29.9	1.5	40.2	0.5	48.5	1.5
	Gill Netting	---	---	28.1	0.5	19.6	1.5	21.4	1.5	36.3	0.5	28.4	1.5
7. Percent non-native species	Electrofishing	0.6	5	1.1	2.5	0.3	2.5	1	2.5	0.4	2.5	1	2.5
	Gill Netting	---	---	0.8	2.5	0.7	2.5	0.5	2.5	2.2	2.5	5.3	2.5
8. Number of top carnivore species		10	5	10	5	11	5	10	5	9	5	11	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	10.2	1	11.8	2.5	11.2	2.5	9.5	1.5	8.9	1.5	5.9	1.5
	Gill Netting	---	---	31.3	1.5	37.2	1.5	49.5	1.5	20.9	0.5	56.8	2.5
10. Percent omnivores	Electrofishing	18.7	5	20.8	2.5	20.4	2.5	11.2	2.5	30.9	1.5	20	2.5
	Gill Netting	---	---	44.2	1.5	39.2	0.5	35.2	0.5	51.6	0.5	32.6	1.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	69.1	3	41.3	0.5	45.7	0.5	32.1	0.5	45.1	0.5	57.6	0.5
	Gill Netting	---	---	24.9	2.5	14.8	1.5	19.6	1.5	9.1	0.5	19	1.5
12. Percent anomalies	Electrofishing	0.7	5	1	2.5	0.3	2.5	0.8	2.5	0.4	2.5	0.8	2.5
	Gill Netting	---	---	6.4	0.5	0.7	2.5	0.5	2.5	0	2.5	2.1	1.5
Overall RFAI Score			**48**		**42**		**45**		**43**		**36**		**45**

Appendix 2-H. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2002.

Autumn 2002		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition											
1. Number of species		26	3	30	5	24	3	25	3	27	3
2. Number of centrarchid species		7	5	8	5	7	5	7	5	7	5
3. Number of benthic invertivores		5	3	5	3	3	1	3	1	3	1
4. Number of intolerant species		6	5	6	5	5	5	5	5	4	3
5. Percent tolerant individuals	Electrofishing	37.5	3	57.9	1.5	70.3	0.5	52.5	1.5	78	0.5
	Gill Netting	---	---	9.8	2.5	6.2	2.5	16.6	1.5	33.9	0.5
6. Percent dominance by 1 species	Electrofishing	29.4	3	32	1.5	30.6	1.5	27.1	1.5	60	0.5
	Gill Netting	---	---	34.8	0.5	42	0.5	28	1.5	26.2	1.5
7. Percent non-native species	Electrofishing	0.8	5	0.8	2.5	0.5	2.5	0.4	2.5	1.7	2.5
	Gill Netting	---	---	2.3	2.5	3.7	2.5	2.3	2.5	4.7	2.5
8. Number of top carnivore species		7	5	10	5	10	5	8	5	10	5
B. Trophic composition											
9. Percent top carnivores	Electrofishing	12.1	3	16.3	2.5	14.3	2.5	8.1	1.5	9.7	1.5
	Gill Netting	---	---	81.1	2.5	67.9	2.5	76	2.5	56.7	2.5
10. Percent omnivores	Electrofishing	13.2	5	18	2.5	33.5	1.5	10.3	2.5	10.2	2.5
	Gill Netting	---	---	11.4	2.5	17.3	1.5	12	2.5	35.6	0.5
C. Fish abundance and health											
11. Average number per run	Electrofishing	85.7	3	75.3	0.5	38.8	0.5	45.3	0.5	28.2	0.5
	Gill Netting	---	---	13.2	1.5	8.1	0.5	17.5	1.5	23.3	1.5
12. Percent anomalies	Electrofishing	0.5	5	0.6	2.5	0.9	2.5	1	2.5	0.9	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5	0	2.5
Overall RFAI Score			**48**		**51**		**43**		**46**		**39**

Appendix 2-I. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2001.

Autumn 2001		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		29	5	31	5	29	5	28	5	32	5	27	3
2. Number of centrarchid species		7	5	8	5	7	5	7	5	8	5	6	5
3. Number of benthic invertivores		6	3	3	1	3	1	3	1	4	3	4	3
4. Number of intolerant species		6	5	5	5	5	5	5	5	5	5	4	3
5. Percent tolerant individuals	Electrofishing	51.8	3	60	1.5	67.7	0.5	54.5	1.5	62.8	0.5	75.9	0.5
	Gill Netting	---	---	34	0.5	29.5	0.5	24.6	1.5	19.9	1.5	37.5	0.5
6. Percent dominance by 1 species	Electrofishing	29.5	3	17.5	2.5	45.4	1.5	18.2	2.5	35.3	1.5	44.7	1.5
	Gill Netting	---	---	28.1	0.5	23.6	1.5	21.9	1.5	48	0.5	33.1	0.5
7. Percent non-native species	Electrofishing	0.4	5	2	2.5	0.1	2.5	0	2.5	0.3	2.5	2.2	1.5
	Gill Netting	---	---	0.2	2.5	0	2.5	0.3	2.5	0	2.5	2.5	2.5
8. Number of top carnivore species		8	5	10	5	11	5	11	5	9	5	9	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	8.4	1	13.5	2.5	7.4	1.5	25.8	2.5	8.2	1.5	4.7	0.5
	Gill Netting	---	---	49.4	1.5	56.8	2.5	60.4	2.5	61	2.5	48.4	1.5
10. Percent omnivores	Electrofishing	12.8	5	28.6	1.5	11.4	2.5	7.6	2.5	24.8	1.5	6.6	2.5
	Gill Netting	---	---	32.9	1.5	32.4	1.5	34.2	0.5	23.3	1.5	39.6	0.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	37.5	1	37	0.5	59.5	0.5	13.2	0.5	49.5	0.5	39.3	0.5
	Gill Netting	---	---	44.1	2.5	35.2	2.5	36.6	2.5	33.1	2.5	27.5	2.5
12. Percent anomalies	Electrofishing	1.2	5	2.5	1.5	1.5	2.5	2.5	1.5	1.8	2.5	0.7	2.5
	Gill Netting	---	---	0	2.5	1.7	2.5	1.9	2.5	0.6	2.5	0.4	2.5
Overall RFAI Score			**46**		**45**		**46**		**48**		**47**		**39**

Appendix 2-J. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 2000.

Autumn 2000		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		24	3	23	3	28	5	27	3	28	3	31	5
2. Number of centrarchid species		7	5	7	5	7	5	8	5	6	5	7	5
3. Number of benthic invertivores		4	3	2	1	2	1	3	1	2	1	3	1
4. Number of intolerant species		4	3	5	5	5	5	5	5	3	3	5	5
5. Percent tolerant individuals	Electrofishing	62.5	1	54.4	1.5	66.5	0.5	39.5	1.5	42.5	1.5	81	0.5
	Gill Netting	---	---	8	2.5	4.9	2.5	29.7	0.5	9.6	2.5	43.5	0.5
6. Percent dominance by 1 species	Electrofishing	38.5	3	25.1	1.5	37.5	1.5	25.2	1.5	21.9	1.5	46.7	1.5
	Gill Netting	---	---	25.5	1.5	23	1.5	26.5	1.5	26.9	1.5	31.8	0.5
7. Percent non-native species	Electrofishing	4.2	5	4.5	1.5	0.2	2.5	0	2.5	0.9	2.5	1.6	2.5
	Gill Netting	---	---	3.6	2.5	1.6	2.5	0	2.5	1.9	2.5	4.7	2.5
8. Number of top carnivore species		7	5	10	5	9	5	10	5	10	5	10	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	20.6	3	23.3	2.5	11.2	2.5	10.6	2.5	26.8	2.5	8.7	1.5
	Gill Netting	---	---	78.1	2.5	57.4	2.5	53.4	2.5	42.3	1.5	51.8	2.5
10. Percent omnivores	Electrofishing	14.7	5	20.5	2.5	21.4	2.5	5.1	2.5	14.6	2.5	15.3	2.5
	Gill Netting	---	---	4.4	2.5	14.8	2.5	35.7	0.5	12.5	2.5	39.4	0.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	61.5	3	22.1	0.5	55.3	0.5	43.3	0.5	54.5	0.5	47	0.5
	Gill Netting	---	---	13.7	1.5	6.1	0.5	28.3	2.5	10.4	0.5	34	2.5
12. Percent anomalies	Electrofishing	1.1	5	3	1.5	1.7	2.5	1.8	2.5	4.7	1.5	1.4	2.5
	Gill Netting	---	---	1.5	2.5	1.6	2.5	0.7	2.5	0	2.5	0	2.5
Overall RFAI Score			**44**		**46**		**48**		**45**		**43**		**44**

Appendix 2-K. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 1999.

Autumn 1999		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition													
1. Number of species		27	3	28	3	25	3	25	3	30	5	26	3
2. Number of centrarchid species		5	5	6	5	5	5	7	5	6	5	7	5
3. Number of benthic invertivores		7	5	4	3	3	1	4	3	6	3	3	1
4. Number of intolerant species		4	3	5	5	5	5	5	5	2	3	4	3
5. Percent tolerant individuals	Electrofishing	25.1	5	38	1.5	26.3	2.5	59.1	1.5	34.7	1.5	71	0.5
	Gill Netting	---	---	49.2	0.5	45.3	0.5	41.5	0.5	40.8	0.5	61.4	0.5
6. Percent dominance by 1 species	Electrofishing	46.9	1	16.3	2.5	21	2.5	22	2.5	25.2	1.5	29.7	1.5
	Gill Netting	---	---	48.4	0.5	42	0.5	38.1	0.5	38.2	0.5	58	0.5
7. Percent non-native species	Electrofishing	0.7	5	2.4	2.5	7.4	0.5	1.6	2.5	1.7	2.5	8.4	0.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5	3.3	2.5	2	2.5
8. Number of top carnivore species		9	5	10	5	9	5	10	5	12	5	11	5
B. Trophic composition													
9. Percent top carnivores	Electrofishing	7.9	1	17.8	2.5	9.9	1.5	13.4	2.5	12.2	2.5	14.2	2.5
	Gill Netting	---	---	38.1	1.5	27.1	1.5	38.6	1.5	22.4	0.5	19.4	0.5
10. Percent omnivores	Electrofishing	11.1	5	17.8	2.5	15.6	2.5	22	2.5	8	2.5	25.8	1.5
	Gill Netting	---	---	51.2	0.5	59.7	0.5	50.6	0.5	53.9	0.5	71	0.5
C. Fish abundance and health													
11. Average number per run	Electrofishing	37.1	1	13.9	0.5	16.2	0.5	8.5	0.5	46.9	0.5	10.3	0.5
	Gill Netting	---	---	24.4	2.5	18.1	1.5	17.6	1.5	15.2	1.5	44.8	2.5
12. Percent anomalies	Electrofishing	2.7	3	2.9	1.5	0.8	2.5	0	2.5	0.6	2.5	1.3	2.5
	Gill Netting	---	---	0	2.5	0.6	2.5	0.6	2.5	0	2.5	0	2.5
Overall RFAI Score			**42**		**45**		**41**		**45**		**43**		**36**

Appendix 2-L. Individual metric scores and overall RFAI scores for Watts Bar Reservoir forebay, Autumn 1998.

Autumn 1998		TRM 531 Watts Bar Forebay	
Metric		Obs	Score
A. Species richness and composition			
1. Number of species		28	5
2. Number of centrarchid species		7	5
3. Number of benthic invertivores		3	1
4. Number of intolerant species		4	3
5. Percent tolerant individuals	Electrofishing	29.5	2.5
	Gill Netting	37.9	0.5
6. Percent dominance by 1 species	Electrofishing	65.5	0.5
	Gill Netting	33.5	0.5
7. Percent non-native species	Electrofishing	0.8	2.5
	Gill Netting	6.8	2.5
8. Number of top carnivore species		11	5
B. Trophic composition			
9. Percent top carnivores	Electrofishing	1.7	0.5
	Gill Netting	36.6	1.5
10. Percent omnivores	Electrofishing	8	2.5
	Gill Netting	48.4	0.5
C. Fish abundance and health			
11. Average number per run	Electrofishing	144.4	1.5
	Gill Netting	16.1	1.5
12. Percent anomalies	Electrofishing	0.3	2.5
	Gill Netting	0.6	2.5
Overall RFAI Score			**41**

Appendix 2-M. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir, Autumn 1997.

Autumn 1997		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition									
1. Number of species		26	3	20	3	22	3	22	3
2. Number of centrarchid species		8	5	5	5	5	5	3	3
3. Number of benthic invertivores		6	3	3	1	4	3	2	1
4. Number of intolerant species		5	5	4	3	4	3	2	3
5. Percent tolerant individuals	Electrofishing	52.6	3	66.8	0.5	64	0.5	23.4	2.5
	Gill Netting	---	---	16.2	1.5	14.3	1.5	20.7	1.5
6. Percent dominance by 1 species	Electrofishing	25.8	3	29	1.5	53	0.5	28	1.5
	Gill Netting	---	---	18	1.5	23.8	1.5	19.8	1.5
7. Percent non-native species	Electrofishing	8.1	3	7.9	0.5	4	1.5	8.5	0.5
	Gill Netting	---	---	0.9	2.5	7.1	2.5	1.7	2.5
8. Number of top carnivore species		9	5	8	5	9	5	10	5
B. Trophic composition									
9. Percent top carnivores	Electrofishing	29.1	5	14.9	2.5	5	1.5	16.1	2.5
	Gill Netting	---	---	55	2.5	64.3	2.5	36.4	1.5
10. Percent omnivores	Electrofishing	18.5	5	35.3	1.5	57	0.5	12.4	2.5
	Gill Netting	---	---	22.5	2.5	10.7	2.5	36.4	1.5
C. Fish abundance and health									
11. Average number per run	Electrofishing	49.4	1	16.1	0.5	6.7	0.5	27.4	0.5
	Gill Netting	---	---	11.1	0.5	8.4	0.5	12.1	1.5
12. Percent anomalies	Electrofishing	2.4	3	3.3	1.5	0	2.5	0.5	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5
Overall RFAI Score			**44**		**39**		**40**		**40**

Appendix 2-N. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 1996.

Autumn 1996		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 482 Chickamauga Forebay		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition									
1. Number of species		30	5	27	3	31	5	27	3
2. Number of centrarchid species		8	5	6	5	8	5	6	5
3. Number of benthic invertivores		6	3	3	1	3	1	3	1
4. Number of intolerant species		6	5	5	5	5	5	5	5
5. Percent tolerant individuals	Electrofishing	92.9	1	52.5	1.5	38.2	1.5	85.4	0.5
	Gill Netting	---	---	23.8	1.5	24.9	1.5	25.7	1.5
6. Percent dominance by 1 species	Electrofishing	80.8	1	34.1	1.5	45.9	1.5	45.3	1.5
	Gill Netting	---	---	22.3	1.5	22.1	1.5	26.1	1.5
7. Percent non-native species	Electrofishing	0.3	5	2.2	2.5	1.1	2.5	1.3	2.5
	Gill Netting	---	---	1	2.5	1.4	2.5	4.4	2.5
8. Number of top carnivore species		10	5	10	5	11	5	9	5
B. Trophic composition									
9. Percent top carnivores	Electrofishing	4.7	1	6.7	1.5	3.7	0.5	7.3	1.5
	Gill Netting	---	---	59.6	2.5	58.1	2.5	59.3	2.5
10. Percent omnivores	Electrofishing	81.2	1	31.9	1.5	13.6	2.5	31.1	1.5
	Gill Netting	---	---	26.4	1.5	27.2	1.5	29.6	1.5
C. Fish abundance and health									
11. Average number per run	Electrofishing	295.3	5	63.6	0.5	147.5	1.5	61.3	0.5
	Gill Netting	---	---	19.3	1.5	21.7	1.5	22.6	1.5
12. Percent anomalies	Electrofishing	0	5	0	2.5	0	2.5	0.1	2.5
	Gill Netting	---	---	0	2.5	0	2.5	1.8	2.5
Overall RFAI Score			**42**		**44**		**47**		**43**

Appendix 2-O. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir, Autumn 1995.

Autumn 1995		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition									
1. Number of species		28	5	29	3	27	3	26	3
2. Number of centrarchid species		7	5	8	5	7	5	3	3
3. Number of benthic invertivores		6	3	3	1	4	3	5	3
4. Number of intolerant species		5	5	5	5	6	5	2	3
5. Percent tolerant individuals	Electrofishing	64.7	1	16.8	2.5	14.5	2.5	51.5	1.5
	Gill Netting	---	---	21.3	1.5	14.2	1.5	22.8	1.5
6. Percent dominance by 1 species	Electrofishing	40.9	3	36.3	1.5	58.3	0.5	42.7	0.5
	Gill Netting	---	---	28	1.5	18.6	1.5	23.5	1.5
7. Percent non-native species	Electrofishing	0.5	5	0.3	2.5	0.1	2.5	1.8	2.5
	Gill Netting	---	---	1	2.5	0	2.5	1.3	2.5
8. Number of top carnivore species		11	5	11	5	10	5	11	5
B. Trophic composition									
9. Percent top carnivores	Electrofishing	12.7	3	2.5	0.5	2	0.5	2.6	0.5
	Gill Netting	---	---	63.9	2.5	69.4	2.5	43	1.5
10. Percent omnivores	Electrofishing	43.3	3	10	2.5	1.7	2.5	45.2	0.5
	Gill Netting	---	---	25.7	1.5	19.7	1.5	30.2	1.5
C. Fish abundance and health									
11. Average number per run	Electrofishing	128.7	5	232.6	2.5	206	1.5	129.5	1.5
	Gill Netting	---	---	29.6	2.5	18.3	1.5	14.9	1.5
12. Percent anomalies	Electrofishing	0	5	0	2.5	0	2.5	0	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5
Overall RFAI Score			**48**		**48**		**47**		**39**

Appendix 2-P. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 1994.

Autumn 1994		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition											
1. Number of species		34	5	28	3	24	3	24	3	28	5
2. Number of centrarchid species		8	5	8	5	6	5	5	5	5	5
3. Number of benthic invertivores		6	3	2	1	4	3	4	3	4	3
4. Number of intolerant species		7	5	4	3	6	5	1	1	5	5
5. Percent tolerant individuals	Electrofishing	49.9	3	66	0.5	46.9	1.5	66.8	0.5	25.3	2.5
	Gill Netting	---	---	21.4	1.5	51.1	0.5	15.7	2.5	13.4	2.5
6. Percent dominance by 1 species	Electrofishing	27.1	3	32.1	1.5	33.8	1.5	41.6	0.5	64.6	0.5
	Gill Netting	---	---	40.3	0.5	41.5	0.5	16.9	1.5	45.8	0.5
7. Percent non-native species	Electrofishing	1	5	3.8	1.5	1.4	2.5	7.7	0.5	1.7	2.5
	Gill Netting	---	---	0	2.5	1.5	2.5	5.6	1.5	4.9	2.5
8. Number of top carnivore species		10	5	10	5	8	5	9	5	9	5
B. Trophic composition											
9. Percent top carnivores	Electrofishing	16.9	3	12.4	2.5	15	2.5	11.2	2.5	4	0.5
	Gill Netting	---	---	62.3	2.5	33.3	1.5	46.1	1.5	75.4	2.5
10. Percent omnivores	Electrofishing	13.6	5	26.2	1.5	6.9	2.5	18	2.5	5.2	2.5
	Gill Netting	---	---	24	1.5	56.3	0.5	22.5	2.5	19	1.5
C. Fish abundance and health											
11. Average number per run	Electrofishing	120.9	5	45.1	0.5	75.5	0.5	51.4	0.5	168.9	1.5
	Gill Netting	---	---	15.4	1.5	13.5	1.5	8.9	0.5	14.2	1.5
12. Percent anomalies	Electrofishing	0.1	5	0	2.5	0.2	2.5	0	2.5	0	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5	2.1	1.5
Overall RFAI Score			**52**		**40**		**44**		**39**		**48**

Appendix 2-Q. Individual metric scores and overall RFAI scores for sites sampled in Chickamauga Reservoir and Watts Bar Reservoir forebay, Autumn 1993.

Autumn 1993		TRM 529 Chickamauga Inflow		TRM 490.5 Chickamauga Transition		TRM 472.3 Chickamauga Forebay		HiRM 8.5 Hiwassee Embayment		TRM 531 Watts Bar Forebay	
Metric		Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
A. Species richness and composition											
1. Number of species		32	5	30	5	28	5	30	5	31	5
2. Number of centrarchid species		8	5	7	5	8	5	5	5	7	5
3. Number of benthic invertivores		6	3	3	1	2	1	4	3	4	3
4. Number of intolerant species		7	5	6	5	4	3	4	3	5	5
5. Percent tolerant individuals	Electrofishing	45.6	3	41.4	1.5	20.6	2.5	57.3	1.5	73.4	0.5
	Gill Netting	---	---	13.9	2.5	33.2	0.5	29.8	1.5	34.6	0.5
6. Percent dominance by 1 species	Electrofishing	34.2	3	39.7	1.5	62.1	0.5	25.6	1.5	43.4	1.5
	Gill Netting	---	---	26.2	1.5	23.3	1.5	22.2	1.5	23.4	1.5
7. Percent non-native species	Electrofishing	1.3	5	1.2	2.5	0.5	2.5	4.5	1.5	0.6	2.5
	Gill Netting	---	---	2.3	2.5	0.5	2.5	0.8	2.5	2.4	2.5
8. Number of top carnivore species		10	5	11	5	10	5	12	5	11	5
B. Trophic composition											
9. Percent top carnivores	Electrofishing	14.4	3	8.8	1.5	4.8	0.5	17.3	2.5	6.5	1.5
	Gill Netting	---	---	70	2.5	58.9	2.5	51.6	1.5	54.1	2.5
10. Percent omnivores	Electrofishing	23.5	5	20.2	2.5	3.6	2.5	27.6	1.5	46.3	1.5
	Gill Netting	---	---	16.9	2.5	31.2	1.5	31.7	1.5	37.1	0.5
C. Fish abundance and health											
11. Average number per run	Electrofishing	172.2	5	151.5	1.5	80.9	0.5	93.9	0.5	58.1	0.5
	Gill Netting	---	---	39.7	2.5	20.2	1.5	25.2	2.5	20.5	1.5
12. Percent anomalies	Electrofishing	0	5	0	2.5	0	2.5	0.1	2.5	0	2.5
	Gill Netting	---	---	0	2.5	0	2.5	0	2.5	2.4	1.5
Overall RFAI Score			**52**		**51**		**43**		**46**		**44**

ATTACHMENT 10

Analysis of Fish Species Occurrences in Chickamauga Reservoir- A Comparison of Historical and Recent Data

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October 2010

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Introduction

The Tennessee Valley Authority (TVA) has conducted an extensive amount of fish sampling in Chickamauga Reservoir spanning from 1947 to 2009. Cove rotenone sampling (consists of blocking off a cove on a reservoir and killing fish with a chemical {rotenone} to assess species occurrence and abundance) was conducted from 1947 to 1999 in Chickamauga Reservoir. Gill nets (1971 to 1994), hoop nets (1977 to 1985), trap nets (1971 to 1978), and boat electrofishing (1977 to 1985; 1991) were used during special studies conducted by TVA in Chickamauga Reservoir. Routine reservoir fisheries monitoring was initiated in 1993 using boat electrofishing and gill nets at various stations throughout Chickamauga Reservoir and has continued to present. Additional data on fish species occurrences in Chickamauga Reservoir were obtained during fish impingement mortality sampling (number of fish impinged on trash screens at power plant cooling water intakes), which was conducted during 1981 to 1985, 2001 to 2002, and 2005 to 2007 at Sequoyah Nuclear Plant; during 1974 to 1975 at Watts Bar Steam Plant, which was taken out of operation in 1982; during 1999 to 2000, and 2005 to 2007 at the Watts Bar Nuclear Plant Supplemental Condenser Cooling Water intake (the old Watts Bar Steam Plant intake at Watts Bar Dam) and during 1996 to 1997 at Watts Bar Nuclear Plant.

In addition to reservoir fish sampling, TVA conducted sampling in Chickamauga Reservoir tributary streams and rivers during 1991 to present to assess changes in water quality at a watershed level. Fish collected during these surveys provide additional information on species occurrences within the Chickamauga Reservoir watershed.

This purpose of this report is: (1) to assess differences among gear types in detecting certain fish species in Chickamauga Reservoir from 1947 to 2009 and (2) to examine temporal changes in fish species occurrences during this time period.

Methods

Data Compilation

Data included in this report were compiled from historical reports, raw data files, and TVA reservoir and stream fish databases, which represent all currently known fish species occurrence data from TVA fish collections in Chickamauga Reservoir. Table 2 compiles all species occurrence data from the historical sources. Currently accepted common and scientific names of fishes, as listed by Nelson et al. 2004, were used in this document. Only common names are used within the text of this document, while both common and scientific names are provided in tables and in the appendix.

Sampling Localities

General Description of Chickamauga Reservoir

The construction of Chickamauga Reservoir was completed in 1940. Chickamauga Dam is located at Tennessee River mile (TRM) 471 and impounds 59 miles of the Tennessee River upstream to Watts Bar Dam which is located at TRM 530 (Figure 1). Mainstem Tennessee River reservoirs, such as Chickamauga Reservoir, are typically characterized by 3 distinct zones: the inflow, transition, and forebay. The inflow zone is in the upper reaches of the reservoir and is riverine in nature; the transition zone or mid-reservoir is the area where water velocity decreases due to increased cross-sectional area; and the forebay is the lacustrine area near the dam. Chickamauga Reservoir also contains a large embayment created by the Hiwassee River inflow.

Cove Rotenone Locations

TVA began fish sampling with rotenone in Chickamauga Reservoir in 1947 to determine density of game, forage, and commercially valuable fish species. These data also provided species occurrence information and characterized the general fish community occurring in Chickamauga Reservoir. Samples were taken at various locations annually through 1959 (except during 1948 and 1953). No samples were collected from 1960 through 1969, but annual sampling resumed in 1970 and continued until 1993. Rotenone sampling continued during 1995 until 1999 on a biennial basis. Twenty-two locations were sampled with rotenone throughout Chickamauga

Reservoir; of these, five were sampled for a duration of ≥ 17 years (Table 1). Sampling locations were present within all zones of the reservoir.

Gill Net, Trap Net, Hoop Net, and Boat Electrofishing Locations

Experimental gill nets, hoop nets, and boat electrofishing were used during Watts Bar Nuclear pre-operational monitoring during 1977 to 1979 and 1982 to 1985 (TVA 1980; TVA 1986a). Experimental gill and hoop nets were set at various locations from TRM 524.2 to TRM 524.9 and from TRM 527.4 to TRM 528.4. Boat electrofishing was conducted throughout the same general sample reaches.

Standard gill nets and trap nets were set at TRM's 473, 483.6, and 495, as well as in the Hiwassee River embayment at Hiwassee River mile (HiRM) 1.0 (standard gill nets only), during Sequoyah Nuclear Plant pre-operational monitoring from 1971 to 1978 (TVA 1978). Initial Sequoyah Nuclear Plant operational monitoring was conducted using standard gill nets from 1980 to 1986 at TRM's 473, 483, and 495 (TVA 1982; TVA 1985; TVA 1986b). Experimental gill nets were used during 1986 at areas within TRM 482.7 to TRM 487.6 (TVA 1987).

A special study to evaluate population dynamics of sauger in Chickamauga Reservoir was conducted during 1986 to 1994, using both standard and experimental gill nets. In addition to sauger, data were collected on all other species captured in gill nets. Sampling was conducted in the upper 14.9 miles of Chickamauga Reservoir (TRM 515 to TRM 529.9) during 1986 and 1988 (Hevel 1987; Hickman et al. 1989). During 1989 to 1991 and 1993 to 1994, sampling was conducted at TRM's 521 and 529 (Hickman et al. 1990; Hevel and Hickman 1991; Hickman and Buchanan 1995).

During 1991, a special study was conducted to evaluate the condition of fish communities in Chickamauga Reservoir embayments (Hevel and Hickman 1992). Experimental gill nets were set in nine embayments located from TRM 477 upstream to TRM 514 and in six embayments in the Hiwassee River arm of the reservoir which were located from HiRM 7 upstream to HiRM 16. Boat electrofishing was also conducted in each embayment.

Beginning in 1993 and continued to present, annual reservoir fish monitoring was implemented in Chickamauga Reservoir utilizing Reservoir Fish Assemblage Index (RFAI) methodology to evaluate changes in the ecological health of fish communities (Simmons 2010a). RFAI has been thoroughly tested on TVA and other reservoirs and published in peer-reviewed literature (Jennings et al. 1995; Hickman and McDonough 1996; McDonough and Hickman 1999). Monitoring stations were established in the inflow, transition, and forebay zones of the reservoir, as well as in the Hiwassee River embayment. The Chickamauga Reservoir inflow sample site is located at Tennessee River mile (TRM) 529.0 below Watts Bar Dam, the transition zone sampling station is located at TRM 490.5, two sites in the forebay are located at TRM 482 and TRM 472.3, and a site on the Hiwassee River embayment of Chickamauga Reservoir is located at HiRM 8.5 (Figure 1). Boat electrofishing and experimental gill nets are the sampling gear used at each of the sampling localities with the exception of the inflow site, where only boat electrofishing is conducted.

Free-flowing Tributary Sample Locations

Of the numerous tributaries flowing into Chickamauga Reservoir, the Hiwassee River is undoubtedly the largest. For the purpose of this report, data collected in the Hiwassee River system are presented separately from those from smaller direct tributaries to Chickamauga Reservoir; faunal differences and sampling protocols differ between the two (large drainage area versus smaller drainage area). During the early 1990's, TVA began sampling free-flowing streams and rivers throughout the Tennessee River system to assess water quality conditions at a watershed level. TVA adapted Index of Biotic Integrity (IBI) methodology (Karr et al. 1986) to the Tennessee River system, which uses fish assemblage composition, abundance, and condition as an indicator of water quality. Within the Hiwassee River system in Tennessee, 56 locations were sampled from 1991 to 2010 and 37 locations were sampled in smaller direct tributaries to Chickamauga Reservoir during 1995 to 2009 (Figure 2).

Brief Synopsis of Sampling Methods

Cove Rotenone

Rotenone samples were conducted by isolating fish populations of a cove from the main body of the reservoir by stretching a block net across the cove and anchoring the bottom of the net to preclude immigration/emigration of fish in the sample area. Toxicant (rotenone) was applied

throughout the water column at a concentration of 1 mg/l and fish were collected as they floated to the surface. Potassium permanganate was applied at 1 mg/l outside the sample area to buffer the rotenone and prevent any unnecessary fish mortality. Fish collection was conducted for at least a two-day minimum after application of rotenone to pick up fish that may have floated to the surface overnight. Fish were identified to species, measured, weighed, and recorded.

Gill Netting

Gill nets are typically constructed of monofilament mesh netting and trap fish that swim into the net. Gill nets are used as an additional gear type to collect fish from deeper habitats not effectively sampled by electrofishing. Gill nets are less effective than hoop nets or electrofishing for capture of some species due to body shapes, limited movement exhibited by some species (hence less probability of encountering the net), or the affinity for cover, where gill nets cannot be effectively fished due to snagging problems. Gill nets are usually set perpendicular to the shoreline or channel. Each net is weighted with a lead line to keep the bottom of the net on the river bottom and contains a float line on the top portion of the net to keep the net standing vertical. An anchor is secured to each end of the lead line to keep the net in place and a float is secured to each end of the float line so that the nets can be retrieved. When gill nets are set in non-flowing waters, few problems are encountered other than occasional underwater obstructions that may snag a net. When nets are set in flowing waters, they are much more likely to become snagged as the current moves them along the bottom, unless sufficient weight is used to prevent any movement. They are also particularly susceptible to becoming fouled with debris, such as leaves and senescent aquatic vegetation, particularly in fall and winter months.

Both standard and experimental gill nets have been used by TVA while sampling in Chickamauga Reservoir. Standard gill nets were 30.5 m (100 ft) long by 2.4 m (8 ft) tall and contained 3.8 cm mesh (1.5 in) (TVA 1978; TVA 1982; TVA 1984; TVA 1985; Hevel 1987; Hickman et al. 1989; Hickman et al. 1990; Hickman and Buchanan 1995). Experimental gill nets employ several panels (sections) of various mesh sizes in succession rather than one mesh size throughout the length of the net. This allows for a more complete collection of various size classes of most species, as well as smaller species that may not be taken with larger mesh nets. Experimental gill nets used during Watts Bar Nuclear Plant pre-operational and initial operation monitoring were 38.1 m (125 ft) long by 2.4 m (8 ft) tall and contained five panels with mesh

ranging from 1.27 cm (0.5 in) to 6.55 cm (2.5 in) (TVA 1980; TVA 1986a). A special study to evaluate freshwater drum population in Chickamauga Reservoir used experimental gill nets which were 68.6 m (225 ft) long by 2.4 m (8 ft) tall and contained mesh panels ranging from 2.5 cm (1 in) to 12.7 cm (5 in) (TVA 1987). During special studies evaluating Chickamauga Reservoir sauger populations and embayments, experimental gill nets used were 30.5 m (100 ft) long by 2.4 m (8 ft) tall and contained five panels with mesh ranging from 2.5 cm (1 in) to 7.6 cm (3 in) (Hevel 1987; Hickman et al. 1989; Hickman et al. 1990; Hevel and Hickman 1991; Hevel and Hickman 1992; Hickman and Buchanan 1995). Routine reservoir sampling conducted from 1993 to present is conducted with experimental gill nets, 30.5 m (100 ft) long by 2.4 m (8 ft) tall, containing five panels with mesh ranging from 2.5 cm (1 in) to 12.7 cm (5 in) (Simmons 2010a). Of the five current Chickamauga Reservoir sampling stations, gill nets are used at all stations except the inflow station (TRM 529). All current reservoir stations are sampled during autumn to examine the condition of the fish community at the end of the "biological year" to evaluate how the fish community has responded to stressors (natural and anthropogenic) throughout the year. As mentioned above, gill nets set in flowing water during the fall are routinely ineffective due to clogging from organic matter. Additionally, higher water velocities reduce the integrity of the net set.

Hoop and Trap Netting

Hoop nets allow fish to enter a netted enclosure through a series of one or more funnels attached to a series of hoops. Hoop nets can be used in free-flowing rivers or in reservoir inflows where current velocities are greater. Trap nets contain a leader and two wings that lead to the net opening. The leader runs down the center to the mouth of the net and the wings are anchored at 45-degree angles to each side of the net and connect at the mouth. When fish moving along the shore encounter the net, they follow the net leader into the netted enclosure where escape is difficult. Trap nets are most applicable to transition and forebay reservoir conditions due to lack of rigidity which makes them ineffective in flowing water.

Hoop nets used during Watts Bar Nuclear Plant pre-operational monitoring contained seven hoops, two funnels, and were 7.6 m (25 ft) long (TVA 1980; TVA 1986a). Trap nets used during Sequoyah Nuclear Plant pre-operation sampling were placed along shorelines and were 3 m (9.8 ft) long (TVA 1978).

Boat Electrofishing

Electrofishing basically involves using a power source (generator) and wire leads (electrodes) to send direct electric current (dc) into the water. A control box (transformer that converts alternating current {ac} to dc) allows the operator to adjust current output based on water conductivity for maximum shocking efficiency. When the number of volts and amperes are correctly matched to the conductivity of the water, fish are temporarily stunned and collected with dip nets. Duration and length of electrofishing runs varied during historical sampling. Current boat electrofishing sampling (1993 to present) consists of 15 boat electrofishing runs near the shoreline, each 300 m long, with a duration of approximately 10 minutes each. The total near-shore area sampled is approximately 4,500 m (15,000 ft).

Impingement Sampling

Power plant cooling water intakes result in impingement of fish and debris on trash screens during operation. Numerous studies were conducted at Watts Bar Nuclear Plant, Watts Bar Steam Plant, Watts Bar Nuclear Plant Supplemental Condenser Cooling Water intake, and Sequoyah Nuclear Plant to estimate the species composition and number of adult fish that were impinged during plant operations. Traveling screens were backwashed and fish were collected as the water passed through a steel mesh basket at the end of the screen wash sluice pipe. Impinged fish were identified to species, measured, weighed, and recorded.

Free-flowing Tributaries

TVA IBI methodology is designed to deplete habitat sections in an effort to document every species present at a site. Backpack-mounted electrofishers are used to shock fish in run and riffle habitats into a 20-ft seine. Pool habitats are sampled by seine hauls. Shorelines sections (e.g. undercut banks, root wads, woody debris piles) are shocked and fish are netted as encountered. Every time a new species is encountered, three additional efforts in a particular habitat must be conducted until no new species are encountered. Streams or rivers with a drainage area of $\geq$ 100 square miles are also sampled with a small boat electrofishing unit to capture larger pool species.

Results and Discussion

Comparison of Species Records by Sampling Method

TVA fish sampling from 1947 to 2009, has resulted in collection of 88 fish species. Of these, five are questionable records (Table 2). Cove rotenone surveys have resulted in collection of 73 species, three of which are questionable records, while boat electrofishing, gill net, hoop net, and trap net sampling from 1971 to 2009 have also resulted in collection of 73 species, two of which are questionable records (Table 2). Impingement samples from Sequoyah Nuclear Plant, Watts Bar Steam Plant, Watts Bar Nuclear Plant, and Watts Bar Nuclear Plant Supplemental Condenser Cooling Water intake have resulted in collection of 50 species, one of which is a questionable record (Table 2).

Shortnose gar, mud darter, orangethroat darter, pumpkinseed, and sawfin shiner were recorded in TVA Chickamauga Reservoir samples, but were most likely misidentified and therefore are questionable species records. Shortnose gar was recorded in electrofishing, gill net, and rotenone surveys; these records were probably a misidentification of spotted gar. The currently understood distribution of shortnose gar in the Tennessee River system is restricted to the larger downstream reaches (Etnier and Starnes, 1993), which is concurrent with TVA RFAI data (Kentucky Reservoir). Some of the more upstream records in the Tennessee River system may be based on poorly marked spotted gars (D.A. Etnier, University of Tennessee, Knoxville, personal communication, 2010).

Mud darter and orangethroat darter cove rotenone records are almost certainly erroneous. In Tennessee, mud darters are distributed in direct tributaries to the Mississippi River and in tributaries to the lower Tennessee (Kentucky Reservoir) and Cumberland Rivers (Barkley Reservoir) (Etnier and Starnes 1993). Orangethroat darters are distributed in the Cumberland River system and in the lower Tennessee River system upstream to Pickwick Reservoir within Tennessee (Etnier and Starnes 1993). Both of these species can be, and probably were, confused with the rainbow darter.

Two records for pumpkinseed, one individual collected in a gill net and one individual collected in a trap net during the 1970's, are most likely invalid (TVA 1978). This species is not native to Tennessee; the only valid records are from introduced populations in east Tennessee Reservoirs (South Holston and Boone Reservoirs) (Etnier and Starnes 1993; Wallus 2008). An early record of pumpkinseed from Reelfoot Lake in western Tennessee was actually a hybrid combination of other *Lepomis* species (Etnier and Starnes 1993). Sunfish commonly hybridize which increases the probability of misidentification. Some non-native species, once introduced into a river system, are able to quickly disperse through a system. Pumpkinseeds have not demonstrated this dispersal capability where they have been introduced (Wallus 2008).

Most likely, sawfin shiners collected during 1980-1981 Sequoyah Nuclear Plant impingement samples were misidentified as mimic shiners. Mimic shiners have been able to adapt to reservoir conditions, while sawfin shiners are typically only found in free-flowing streams and rivers (Etnier and Starnes 1993). Additionally, no records of sawfin shiners exist from Chickamauga Reservoir or tributaries (Etnier and Starnes 1993).

Rotenone versus Electrofishing, Gill nets, Hoop Nets, Trap Nets

Although the same number of species has been collected in rotenone samples compared with electrofishing, gill net, hoop net, and trap net samples, there are differences in species composition relative to sampling method. In rotenone samples, 11 species, two of which are questionable records, were collected which were not encountered during Chickamauga Reservoir sampling with the other four sampling methods (blackspotted topminnow, blackstripe topminnow, fathead minnow, ghost shiner, mimic shiner, pugnose minnow, rainbow darter, stripetail darter, whitetail shiner; and questionable records, mud darter, orangethroat darter). In electrofishing, gill net, hoop net, and trap net samples, 9 species, one of which is a questionable record, were collected which were not encountered during rotenone surveys (alewife, American eel, Atlantic needlefish, brown trout, dusky darter, grass carp, inland silverside, lake sturgeon, rainbow trout; and a questionable record, pumpkinseed). No species were collected using hoop nets and trap nets that were not collected using electrofishing or gill nets.

Of the nine valid species collected in rotenone surveys that were not encountered using the other sampling gear (blackspotted topminnow, blackstripe topminnow, fathead minnow, ghost shiner,

mimic shiner, pugnose minnow, rainbow darter, stripetail darter, whitetail shiner), five are not typically found in reservoirs or occur in shallow backwater areas of reservoirs that are sampled during cove rotenone surveys but are not sampled during TVA electrofishing surveys (blackspotted topminnow, blackstripe topminnow, rainbow darter, stripetail darter, whitetail shiner). These species are too small to be collected using the other gear types (gill nets, hoop nets, trap nets). Because rotenone samples were conducted in coves in proximity to occasional stream inflows, stream fishes such as blackspotted topminnows, whitetail shiners, stripetail darters, and rainbow darters were encountered. Blackstripe topminnows are more ubiquitous in their habitat use than blackspotted topminnows; they can commonly occur in reservoirs, rivers, and streams in slackwater habitats (Etnier and Starnes 1993). Fathead minnows were collected only during a 1979 rotenone sample. This species is one of the most commercially available bait fishes used by anglers. Because they have been so widely used for bait, it is unknown if this species is even native to the Tennessee River system. There are very few reproducing populations within the state which suggests that fathead minnows may not be indigenous to this region (Etnier and Starnes 1993). Ghost shiners were collected periodically in rotenone surveys from 1974 to 1999 in Chickamauga Reservoir. A majority of these records were from coves located between TRM's 471.7 and 478, which is the forebay area of the reservoir. Ghost shiners occur in the mid-water of large streams and reservoirs, making them difficult to collect. Electrofishing runs are conducted along shorelines which would greatly reduce the probability of collecting this minnow. Pugnose minnows were collected periodically from 1975 to 1990 in rotenone samples. Chickamauga Reservoir is near the upper end of the distribution of the pugnose minnow in the Tennessee River System where it does not appear to be as common as in the lower Tennessee River system (Etnier and Starnes 1993; Boschung and Mayden 2004). Mimic shiners were collected in rotenone samples from 1976 to 1978 and during 1984 (Appendix 1). Although this species can tolerate reservoir environments, it is more common in large creeks and small rivers (Etnier and Starnes 1993).

Of the nine valid species collected in electrofishing and gill net samples which were not encountered in cove rotenone surveys (alewife, American eel, Atlantic needlefish, brown trout, dusky darter, grass carp, inland silverside, lake sturgeon, rainbow trout), six are non-native. Several of these species appeared in Chickamauga Reservoir after 1999 when cove rotenone

samples were terminated. Alewives were introduced into Watauga and Dale Hollow Reservoirs in 1976 by the Tennessee Wildlife Resources Agency (TWRA) to provide additional forage for sportfish. They have since expanded their distribution downstream in the Tennessee and Cumberland River systems. Atlantic needlefish were first collected in TVA samples in Pickwick Reservoir in 2007. They have since been collected by TVA biologists in Kentucky, Guntersville, and Chickamauga Reservoirs. It is unknown whether they entered the Tennessee River System from the Ohio River or from the Tombigbee River via the Tennessee-Tombigbee Waterway. Similarly, inland silversides have invaded the Tennessee River system from 1991 to present. This species was first collected in Kentucky Reservoir in 1991 and appeared in Chickamauga Reservoir in 2004. Grass carp is an Asian species that has been widely introduced to control aquatic vegetation. Brown and rainbow trout are stocked for recreational angling by the TWRA in the Hiwassee River, a tributary to Chickamauga Reservoir.

The three native species (American eel, lake sturgeon, dusky darter) are not commonly collected in Tennessee River reservoirs for a variety of reasons. Lake sturgeon were rare, if not extirpated, in the Tennessee River system by the mid-half of the twentieth century. Efforts, partially funded by TVA, began in 1998 to re-introduce this species to the Tennessee River. Subsequently, re-introduced individuals have been collected in recent times. Because American eels are catadromous (live in freshwater but migrate to saltwater to spawn), they are no longer common in the Tennessee River system due to the series of dams that impede their migration. The only TVA record in Chickamauga Reservoir was from the late 1970's (TVA 1980). This species presently may or may not occur naturally in the upper Tennessee River system; live individuals of this species have been seen for sale in bait shops on Fort Loudon Reservoir near Knoxville (J.W. Simmons, personal observation). Dusky darters are typically inhabitants of large creeks and rivers in areas with moderate current and woody debris (Etnier and Starnes 1993). This species' occurrence in Chickamauga Reservoir is represented by one individual collected during autumn 2009 in the Hiwassee River embayment (Simmons 2010a). Dusky darters have been collected on numerous occasions in recent years in TVA stream and river sampling in the Hiwassee River and its tributaries upstream from the impoundment (Table 4).

Impingement samples

Impingement samples have yielded four species, one of which is questionable, that were not collected with the use of rotenone, electrofishing, gill nets, hoop nets, or trap nets (banded sculpin, river chub, tangerine darter; and a questionable record, sawfin shiner). Of these, banded sculpin, river chub, and sawfin shiner were collected in impingement samples at Sequoyah Nuclear Plant and tangerine darter was collected in Watts Bar Nuclear Plant Supplemental Condenser Cooling Water intake impingement samples (Table 2) (TVA 1982; TVA 1985; TVA 2007b). All of the aforementioned species are typically inhabitants of creeks and small rivers and are rarely encountered in reservoir environments. These species may have been displaced during a high water event from their normal stream habitats into the reservoir, possibly as juveniles (e.g. Harvey 1987). Increased water velocities produced by power plant water intakes create habitats different than those typically found in impounded waters. These species adapted to free-flowing environments may have been attracted to this habitat, and consequently were impinged. Of these, none were collected in large numbers (banded sculpin, seven individuals; river chub, seven individuals; tangerine darter, one individual). The collection of a tangerine darter in Watts Bar Nuclear Plant Supplemental Condenser Cooling Water intake impingement samples was surprising; this species is still extant in many free-flowing tributaries to the Tennessee River but was presumed to be extirpated from the mainstem Tennessee River due to impoundments (Etnier and Starnes 1993). The Watts Bar Nuclear Plant Supplemental Condenser Cooling Water intake is located in Watts Bar Reservoir, just upstream of Watts Bar Dam. Tangerine darters are present in the Emory River, a tributary to Watts Bar Reservoir, and this individual could have been displaced into the reservoir during a high flow event.

Most likely, sawfin shiners were misidentified as mimic shiners. TVA (1982) lists sawfin shiners as being collected in 1980-1981 Sequoyah Nuclear Plant impingement samples with no mention of mimic shiners, while TVA (1986b) lists only mimic shiners in a summary of species collected in Sequoyah Nuclear Plant impingement samples from 1981 to 1985 with no mention of sawfin shiners.

Temporal Changes in Fish Species Occurrences

Of the 83 valid species records obtained during TVA fish sampling in Chickamauga Reservoir from 1947 to 2009, six have not been collected in Chickamauga Reservoir since the 1970's (American eel, bigmouth buffalo, brown trout *non-native*, fathead minnow *non-native*, silver chub, and whitetail shiner); four have not been collected in Chickamauga Reservoir since the 1980's (banded sculpin, blackstripe topminnow, mimic shiner, and river chub); and 16 have not been collected in Chickamauga Reservoir since the 1990's (black bullhead, blackspotted topminnow, ghost shiner, goldfish *non-native*, grass carp *non-native*, highfin carpsucker, orangespotted sunfish, paddlefish, pugnose minnow, quillback, rainbow darter, rainbow trout *non-native*, river carpsucker, smallmouth redhorse, stripetail darter, and white sucker). Five species have been collected during 2000 to 2009 that were never previously collected in TVA samples in Chickamauga Reservoir (Atlantic needlefish *non-native*, dusky darter, inland silverside *non-native*, lake sturgeon, and tangerine darter).

These temporal changes in fish species occurrence are discussed in detail below by time period:

Species not collected since the 1970's

Two of the six species that have not been collected since the 1970's are not native to the Tennessee River (brown trout and fathead minnow). Brown trout collected from Chickamauga Reservoir were presumably disoriented migrants from TWRA stocked populations in the Hiwassee River. Chickamauga Reservoir habitats would not be suitable long-term due to water temperatures that exceed the upper lethal limit for these cold water species. Fathead minnows were probably locally introduced by bait fisherman and were unable to establish a viable population. As previously discussed, natural populations of American eels have most likely been extirpated from Chickamauga Reservoir (and the majority of the Tennessee River) by the series of dams on the river system which impede downstream adult migration to reproduce and upstream migration by juveniles. Bigmouth buffalo were sporadically collected in cove rotenone samples in 1947, the 1950's, and the 1970's. During Sequoyah Nuclear Plant pre-operational sampling conducted during 1971 to 1978, 13 individuals were collected; two in gill nets and 11 in trap nets (TVA 1978). During Watts Bar Nuclear Plant pre-operational sampling conducted during 1977 to 1985, 12 individuals were collected in hoop nets (TVA 1986a). None were encountered while electrofishing or in gill nets. In the Tennessee River system, bigmouth

buffalo is the least encountered species of the three buffalo species occurring in the system, possibly due to loss of reproductive habitats from flood control (Etnier and Starnes 1993). This species spawns in response to spring floods, often in flooded fields. It is also important to note that of the 25 individuals collected, 23 were collected in hoop nets or trap nets and no individuals were collected while electrofishing. Lack of TVA records in recent times may be related to current sampling gear used (electrofishing and gill nets).

Silver chubs were collected during 1974 to 1978 in rotenone samples. The only other records from Chickamauga Reservoir were during 1977 to 1985 Watts Bar Nuclear Plant pre-operational sampling; one individual was collected while electrofishing and 32 individuals were collected in gill nets (TVA 1986a). During the past 15 years, TVA has not used gill nets in the inflow area of Chickamauga Reservoir where these individuals were collected. Therefore, the absence of this species during the past two decades may be related to the change in sampling methods.

Whitetail shiners are not typically encountered in reservoirs. The only TVA record of this species in Chickamauga Reservoir was from a 1971 cove rotenone survey (Appendix 1). This species is common in free-flowing stream and river tributaries to Chickamauga Reservoir and has been collected frequently at TVA tributary sampling sites during 1991 to 2010 (Tables 3 and 4). Whitetail shiners collected during 1971, were likely collected using cove rotenone because the sampling technique could easily include stream fish occurring near the mouth of a cove tributary.

Species not collected since the 1980's

The four species that have not been encountered in Chickamauga Reservoir since the 1980's are all primarily found in stream or river environments and are rarely encountered in reservoirs (banded sculpin, blackstripe topminnow, mimic shiner, and river chub). The only records of banded sculpins and river chubs were from Sequoyah Nuclear Plant impingement samples (each represented by seven individuals) (TVA 1982; TVA 1985). Both of these species have been collected in TVA Chickamauga Reservoir stream and river tributary samples in recent years (Tables 3 and 4). Thus, these species are present in their preferred habitats within the Chickamauga Reservoir watershed, and probably were impinged as a result of displacement from tributaries. While mimic shiners can adapt to reservoir environments, they are more common in

stream environments. Mimic shiners were collected in 1976 to1978 rotenone samples and in Sequoyah Nuclear Plant impingement samples (Appendix 1; Table 3). This species has not been encountered in Chickamauga Reservoir tributaries in TVA stream sampling (Tables 3 and 4). Etnier and Starnes (1993) indicate that mimic shiners are uncommon in this portion of the Tennessee River system. Blackstripe topminnows are represented by 3 rotenone collections from 1972 to 1981 (Appendix 1). This species is commonly confused with blackspotted topminnow (Etnier and Starnes 1993) and absence of this species from recent datasets may be due to misidentification. Backwater areas where this species occurs in reservoirs are not currently sampled during TVA electrofishing surveys. Blackspotted topminnows have been collected in recent years in Chickamauga Reservoir stream and river tributary samples, while blackstripe topminnows have not been collected since 1999 (Tables 3 and 4).

Species not collected since the 1990's

Sixteen species have not been encountered in TVA samples in Chickamauga Reservoir since the 1990's (black bullhead, blackspotted topminnow, ghost shiner, goldfish, grass carp, highfin carpsucker, orangespotted sunfish, paddlefish, pugnose minnow, quillback, rainbow darter, rainbow trout, river carpsucker, smallmouth redhorse, stripetail darter, and white sucker). Of these, three are non-native (goldfish, grass carp, and rainbow trout) and four are primarily found in stream or river environments and are rarely encountered in reservoirs (blackspotted topminnow, rainbow darter, stripetail darter, and white sucker). Rainbow darters, stripetail darters, and white suckers have all been collected in recent TVA samples in free-flowing tributaries to Chickamauga Reservoir (Tables 3 and 4).

Black bullheads have never been common in TVA Chickamauga Reservoir samples. This species was collected periodically in rotenone samples in 1972, 1979, 1981-1983, and in 1993 (Appendix 1). Only one individual was collected in gill net surveys during Sequoyah Nuclear Plant pre-operational monitoring from 1971 to 1978 and six individuals were collected in gill nets near Sequoyah Nuclear Plant during 1980 to 1985 (TVA 1978; TVA 1986b). Four individuals were collected (two in gill nets, two in hoop nets) during Watts Bar Nuclear Plant pre-operational monitoring from 1977 to 1985 (TVA 1986a). Black bullheads and brown bullheads are very difficult to distinguish without counting gill rakers (Etnier and Starnes 1993). It is possible that brown bullheads were mistaken for black bullheads, especially since brown

bullheads are much more common in reservoir habitats. Black bullheads have been collected in TVA Chickamauga Reservoir tributary stream and river fish samples from 1995 to 2007 (Table 3).

As previously discussed, ghost shiners were collected periodically in rotenone surveys from 1974 to 1999 in Chickamauga Reservoir and have not been encountered using any other sampling method. A majority of these records were from coves located between TRM's 471.7 and 478, which is the forebay area of the reservoir. Ghost shiners typically occur in the mid-water of large streams and reservoirs, making them difficult to collect. Electrofishing is conducted in shallow areas along shorelines which would greatly reduce the probability of collecting this minnow. Since 1999, electrofishing and gill nets have been the only sampling methods used in Chickamauga reservoir.

Very few highfin carpsuckers have been collected in TVA samples in Chickamauga Reservoir. The only rotenone collection was during 1949 (Appendix 1). During 1994, one individual was collected while electrofishing at TRM 490.5 (Simmons 2010a) and two individuals, one in a gill net and one in a hoop net, were collected in Watts Bar Nuclear Plant pre-operational monitoring (TVA 1986a). This species is susceptible to change by siltation and impoundment, and is much more common in large free-flowing rivers than in reservoirs. This species is not very common within the Tennessee River system; it is much more abundant in the free-flowing rivers in the Gulf Coastal Plain to the south (Etnier and Starnes 1993).

River carpsuckers were collected periodically in TVA samples throughout Chickamauga Reservoir during the 1970's, 1980's, and early 1990's[1] (Table 2). Although this species was present in samples over a 33-year period, a majority of the records were represented by one individual each. Only two individuals were collected by electrofishing (Simmons 2010a; TVA 1986a), 14 individuals were collected with gill nets (TVA 1978; TVA 1986a; Hevel 1987; Hickman et al. 1990; Hevel and Hickman 1992), eight individuals were collected with trap nets (TVA 1978), and one individual was collected with hoop nets (TVA 1986a). River carpsuckers

[1] After this report was completed, a juvenile river carpsucker was collected in a TVA electrofishing sample at Tennessee River Mile 529 (Chickamauga Reservoir inflow) on September 29, 2010.

were not collected in any free-flowing tributaries draining to Chickamauga Reservoir with the exception of the Hiwassee River (Tables 3 and 4). In the Tennessee River system, river carpsuckers are abundant in the lower Tennessee River, but less common in more upland areas in the eastern portion of the system (Etnier and Starnes 1993).

Similar to the other carpsuckers, quillbacks have rarely been encountered within Chickamauga Reservoir. In rotenone surveys, this species was collected only during 1947, 1950, 1970, and 1984 (Appendix 1). No individuals of this species have been collected in electrofishing samples, 22 individuals were collected with gill nets (TVA 1978; TVA 1986a; Hickman et al. 1990; Hevel and Hickman 1991; Hevel and Hickman 1992; Hickman and Buchanan 1995), and three individuals were collected with trap nets (TVA 1978). It is interesting to note that six of the 22 individuals collected in gill nets were during a 1991 embayment study (Hevel and Hickman 1992). Fifteen embayments within Chickamauga Reservoir were included in this study, four of which were near the upper end of impoundment of the Hiwassee River by Chickamauga Reservoir. This species was collected in three of the four Hiwassee River embayments near the upper end of the impounded portion of the Hiwassee River and were not encountered in any of the other 12 embayments sampled within Chickamauga Reservoir. This species has been consistently collected in the free-flowing section of the Hiwassee River during 1993 to 2007 (Table 4), which is consistent with its distribution throughout the Tennessee River system (affinity for un-impounded rivers) (Etnier and Starnes 1993).

Very few smallmouth redhorse have been collected in Chickamauga Reservoir. The most recent collection was during 1999, when one individual was collected in the Chickamauga Reservoir inflow and one individual was collected in the Hiwassee River embayment, both during electrofishing (Simmons 2010a). This species was collected in four rotenone samples from 1970 to 1977 (Appendix 1). Four individuals were collected in trap nets and two individuals were collected in gill nets during the 1970's and early 1980's (TVA 1978; TVA 1986a). One additional individual was collected while gill netting in 1994 (Hickman and Buchanan 1995). Smallmouth redhorse typically occur in large rivers over gravel to boulder substrates with swift flow and occasionally occur in reservoirs, especially those with large tributaries (Etnier and Starnes 1993). Chickamauga Reservoir only has one large tributary, the Hiwassee River, which

probably limits the distribution of smallmouth redhorse in the reservoir. This species has been collected frequently in the free-flowing portions of the Hiwassee River system in TVA samples collected during 1991 to 2009 (Table 4).

Orangespotted sunfish occur sporadically in mainstem Tennessee River reservoirs, but are most common in backwaters of turbid, sluggish streams in west Tennessee (Etnier and Starnes 1993). This species was collected in Chickamauga Reservoir rotenone samples from 1949 to 1990 (Appendix 1). The only other record was from a gill net sample in the early 1980's, represented by one individual (TVA 1986b). This species has not been collected in TVA samples from direct tributaries to Chickamauga Reservoir or in the Hiwassee River basin, most likely due to lack of preferred habitat (Tables 3 and 4). Since orangespotted sunfish prefer backwaters, such as those in coves of Chickamauga Reservoir, current sampling methods and sampling localities in Chickamauga Reservoir are less likely to encounter this species than the earlier rotenone sampling of coves.

Paddlefish are still widespread in mainstem Tennessee River impoundments but have not been collected in routine fish community monitoring conducted during 1993 to 2009 in Chickamauga Reservoir. A majority of paddlefish collections were in the inflow area of Chickamauga Reservoir. This species was collected in rotenone samples during 1977, 1979, and 1981 near TRM 524 (Appendix 1); 45 individuals were collected in gill nets during Watts Bar Nuclear Plant pre-operational monitoring near TRM 524 and 528; and nine were collected in gill nets near TRM 521 during 1990 and 1993 (TVA 1986a; Hevel and Hickman 1991; Hickman and Buchanan 1995). Other collections were made near Sequoyah Nuclear Plant (~TRM 484); 44 were collected in trap nets during Sequoyah Nuclear Plant preoperational monitoring during the 1970's and one was collected in a gill net in 1986 (TVA 1978; TVA 1987). It is important to note that no paddlefish were collected in electrofishing samples. Gill nets have not been used in samples from 1993 to 2009 in the inflow area of Chickamauga Reservoir which may explain the absence of this species in TVA samples during recent times.

In Chickamauga Reservoir TVA samples, pugnose minnows have been collected only with rotenone (Table 2). This species has not been encountered in any tributaries to Chickamauga

Reservoir (Tables 3 and 4). Chickamauga Reservoir is near the upper end of distribution of the pugnose minnow in the Tennessee River system where it does not appear to be as common as in the lower Tennessee River system (Etnier and Starnes 1993; Boschung and Mayden 2004). This species is too small to be collected in gill nets, hoop nets, or trap nets; thus, rotenone and electrofishing were the only other sampling methods used that may have detected this species. The presence of pugnose minnows in rotenone samples only may indicate that current electrofishing samples are not conducted in habitats used by this species within Chickamauga Reservoir.

Summary and Conclusions

The species composition of the fish assemblage of Chickamauga Reservoir has changed somewhat, but not markedly, over the decades of sampling by TVA. Although some species appear to have been lost between early and more recent sampling, and some species have appeared recently, the differences are readily explained as a result of known differences in effectiveness of various fish sampling methods and habitats they sample. A few early records appear to represent erroneous species identifications.

Of the 88 fish species records from Chickamauga Reservoir collected during 1947 to 2009, five are most likely erroneous. With the exclusion of these questionable records, 70 species were collected during rotenone sampling and 71 species were collected using electrofishing, gill nets, hoop nets, and trap nets. Impingement samples contained 49 valid species records.

Nine valid species records were collected in rotenone samples that were not collected with other sampling methods. Of these, five are not typically found in reservoirs or occur in shallow backwater areas of reservoirs that were not sampled during TVA electrofishing surveys and are too small to be captured with gill nets, hoop nets, or trap nets. Eight valid species records were collected during electrofishing, gill netting, hoop netting, and trap netting that were not encountered in rotenone samples. Of these, six are non-native, many of which were collected for the first time after rotenone sampling was terminated. The remaining three native species are not

commonly collected in Tennessee River reservoirs for a variety of reasons. All species collected in trap nets and hoop nets were also encountered in electrofishing and gill net surveys.

Three valid species records were obtained in impingement samples that were not encountered using any of the aforementioned sampling methods. These species are typically found in free-flowing streams or rivers and are rarely collected in reservoirs. Impingement, by definition, captures fish that are unable to resist the inflowing current of water intakes and become stuck on the intake screens. Impinged fish can be categorized in two groups; healthy but hapless individuals that accidently get caught and unhealthy fish that are lethargic, moribund, or dead and often out of their normal habitat. It is not unreasonable to suspect that a stream fish displaced into reservoir habitats might be lethargic, disoriented, or dead and vulnerable to drifting into the intake where it is impinged.

Of the 83 valid species records obtained during TVA fish sampling in Chickamauga Reservoir from 1947 to 2009, six have not been encountered in Chickamauga Reservoir since the 1970's, four have not been encountered since the 1980's, and 16 have not been encountered since the 1990's. Of these, five are non-native. Five additional species have been collected during 2000 to 2009 that were never previously collected in Chickamauga Reservoir, two of which are non-native. Of the 21 native species that have not been collected in recent times (2000 to 2009), nine are most adapted to stream/small river environments (whitetail shiner, banded sculpin, blackspotted topminnow, blackstripe topminnow, mimic shiner, river chub, rainbow darter, stripetail darter, white sucker, and black bullhead), five are most adapted to medium to large free-flowing rivers (bigmouth buffalo, highfin carpsucker, quillback, river carpsucker, and smallmouth redhorse), one species is catadromous (American eel) and has been severely affected by the series of dams that impede their migration, and five are not as susceptible to current collection methods or occur sporadically throughout the upper Tennessee River system (ghost shiner, pugnose minnow, silver chub, orangespotted sunfish, and paddlefish). Ten of the 21 native species that have not been collected during recent times were only collected in rotenone (eight species) or impingement samples (three species), which indicate that current sampling methods are not effective in documenting the presence of these species.

A similar analysis of recent and historical fish data was conducted for Guntersville Reservoir (two reservoirs downstream of Chickamauga Reservoir) and similar results were reported (Simmons 2010b). For example, highfin carpsucker, quillback, and smallmouth redhorse were collected only in a few historical cove rotenone samples; the only record of smallmouth redhorse was from 1959 and the only record of highfin carpsucker was from 1951. River carpsucker and bigmouth buffalo records were more numerous, but collections were sporadic; whitetail shiners were collected only by rotenone and in a creek inflow while seining; ghost shiners were collected in rotenone surveys and in a 1974 impingement sample; pugnose minnows and stripetail darters were only collected in rotenone samples; banded sculpins and river chubs were never collected; white suckers were only collected in an impingement sample; and rainbow darters were only collected in a stream inflow.

Overall, most species that have not been collected in recent times have never been collected frequently or in large numbers in Chickamauga Reservoir. Some species collected during rotenone surveys are not as susceptible to current sampling gear, thus their presence has not been detected during recent times. Impoundment of the Tennessee River, which eliminated or reduced habitats required for life history aspects such as reproduction and feeding, is the major limiting factor for many of these species. It is evident from TVA tributary stream data that a large portion of fish diversity within the Tennessee River system persists in free-flowing tributaries to reservoirs. Of the 64 species collected in direct tributaries to the Tennessee River within Chickamauga Reservoir, 35 were encountered in electrofishing and gill net sampling conducted during 1993 to 2009 within the reservoir (Table 3). Similarly, of the 91 species collected in the Tennessee portion of the Hiwassee River basin, 51 were encountered in Chickamauga Reservoir during electrofishing and gill netting from 1993 to 2009 (Table 4).

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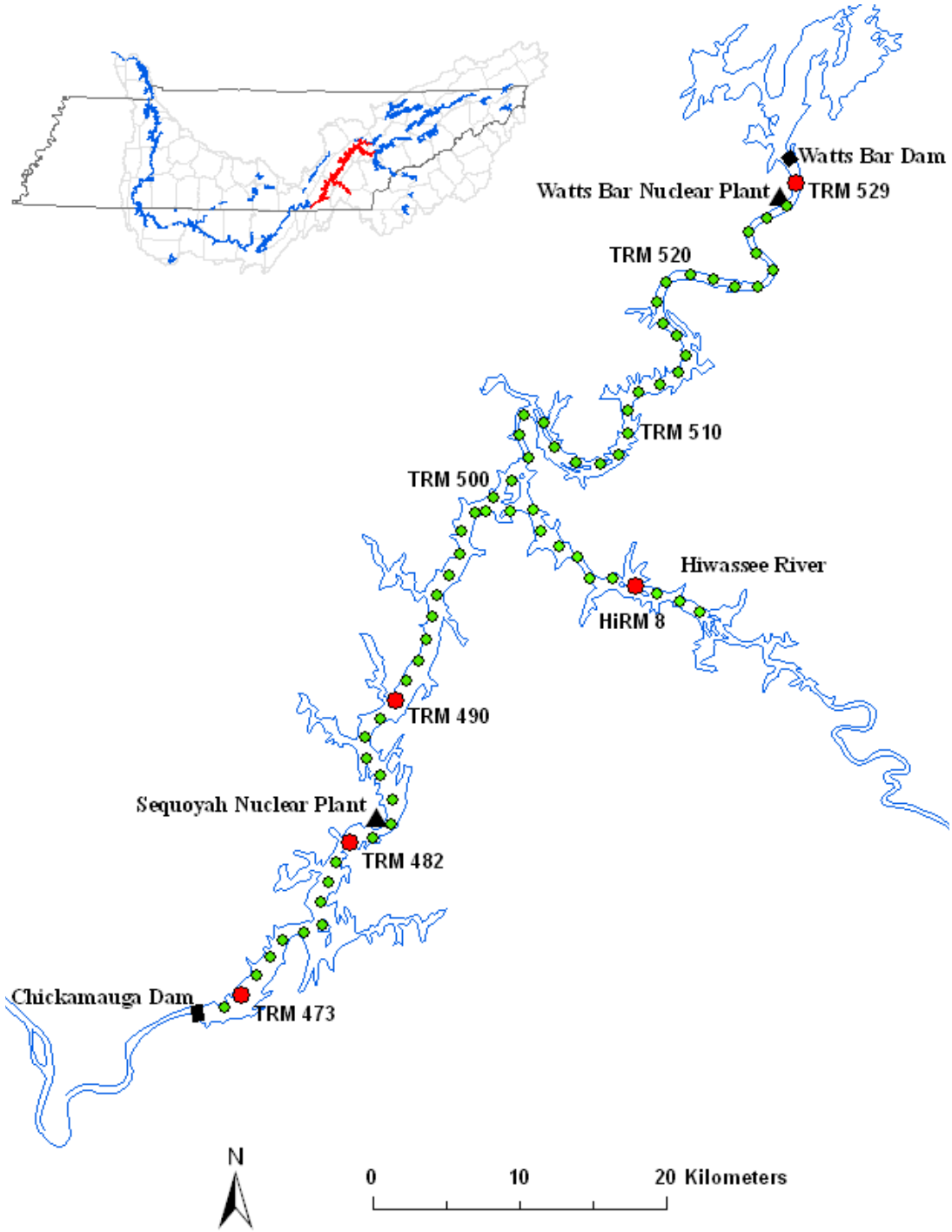

Figure 1. Chickamauga Reservoir, including the Hiwassee River embayment. Red dots indicate the approximate locations of current RFAI fish sampling stations on Chickamauga Reservoir. Green dots indicate Tennessee (TRM) or Hiwassee River Miles (HiRM) for reference and are labeled approximately every 10 river miles.

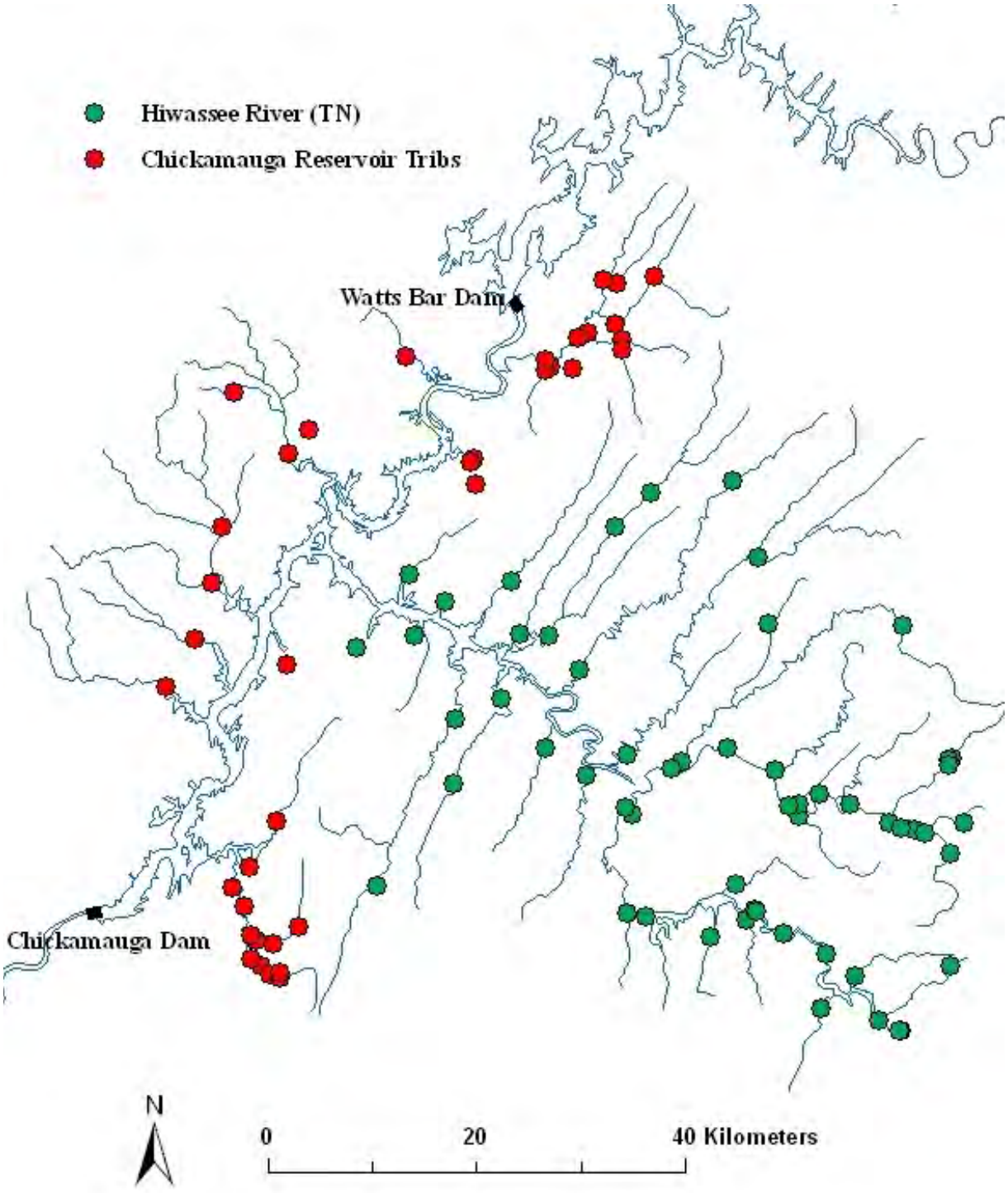

Figure 2. TVA tributary stream and river sampling locations within the Chickamauga Reservoir watershed. Red dots indicate sampling stations on direct tributaries to the Tennessee River (Chickamauga Reservoir). Green dots denote sampling stations on the Tennessee portion of the Hiwassee River and its tributaries.

Table 1. TVA cove rotenone locations and sample years in Chickamauga Reservoir
TRM-Tennessee River mile; HiRM-Hiwassee River

River Mile	Year(s) Sampled
TRM 471.7	1954
TRM 472.8	1949 - 1951
TRM 475	1947, 1950
TRM 472.2	1970
TRM 475.7	1970 - 1976
TRM 476.2	1977 – 1993; 1995, 1997, 1999
TRM 478	1950; 1955 -1957; 1970 – 1993; 1995, 1997, 1999
TRM 483.6	1971
TRM 484.7	1970
TRM 487.5	1950, 1954; 1957 - 1959
TRM 489.6	1952
TRM 492.6	1970
TRM 495	1952; 1970 - 1986
TRM 495.1	1987 – 1993; 1995, 1997, 1999
TRM 505.4	1970
TRM 506	1970
TRM 507.3	1970
TRM 508	1971 – 1993; 1995, 1997, 1999
TRM 524.6	1976 – 1993; 1995, 1997, 1999
HiRM 1.2	1970
HiRM 2.5	1956, 1970
HiRM 3.5	1970

Table 2. A comparison of overall species occurrences from current and historical TVA Chickamauga Reservoir fish collection data from electrofishing (EF), gill netting (GN), hoop netting (HN), trap netting (TN) and cove rotenone surveys, as well as data from fish impingement (impgmt) studies conducted at Sequoyah Nuclear Plant (SQN), Watts Bar Nuclear Plant (WBN), Watts Bar Supplemental Condenser Cooling Water (SCCW), and Watts Bar Steam Plant (WBSP). Records contained in parenthesis were only collected by HN or TN during the specified sampling period/locations. Species are listed alphabetically by common name. Asterisks denote questionable species records.

Data from a special Chickamauga Reservoir embayment study were from Hevel and Hickman (1992). Reservoir Fisheries Assemblage Index (RFAI) data (1993-2009) were from Simmons (2010). Cove rotenone records were taken from raw data files and from Baxter and Gardner (2000). Historic WBN EF, GN, and HN collection records were from TVA (1980) and TVA (1986a). All data included as "WBN" were collected in the vicinity of Watts Bar Nuclear Plant. Historic SQN GN collection records were from TVA (1978); TVA (1982); TVA (1985); TVA (1986b); and TVA (1987). Historic SQN TN records were from TVA (1978). All data included as "SQN" were collected in the vicinity of Sequoyah Nuclear Plant. Gill net data collected during sauger studies during 1986 to 1994 were from Hevel (1987); Hickman et al. (1989); Hickman et al. (1990); Hevel and Hickman (1991); and Hickman and Buchanan (1995). SQN impingement data collected during 1981-1985 were from TVA (1982); TVA (1983); TVA (1985); TVA (1986a). SQN impingement data collected during 2001-2002 were from Kay and Baxter (2002) and data collected during 2005-2007 were from TVA (2007a). WBSP impingement data collected during 1974-1975 were from TVA (1976). WBN impingement data collected from 1996-1997 were from TVA (1998), WBN SCCW impingement data collected from 1999-2000 were from Baxter et al. (2001), and data collected from 2005-2007 were from TVA (2007b).

Common Name	Scientific Name	1991 Embayment Study EF/GN	RFAI EF/GN 1993-2009	Cove Rotenone 1947-1999	WBN EF/GN/HN 1977-1979 1982-1985	SQN GN/TN 1971-1978 GN 1980-1986	Sauger Study GN 1986-1994	SQN Impgmt 1981-1985	SQN Impgmt 2001-2002 2005-2007	WBSP Impgmt 1974-1975	WBN/ SCCW Impgmt 1996-1997 1999-2000 2005-2007
Alewife	*Alosa pseudoherengus*	---	X	---	---	---	X	---	X	---	---
American eel	*Anguilla rostrata*	---	---	---	X	---	---	---	---	---	---
Atlantic needlefish	*Strongylura marina*	---	X	---	---	---	---	---	---	---	---
Banded sculpin	*Cottus carolinae*	---	---	---	---	---	---	X	---	---	---
Bigmouth buffalo	*Ictiobus cyprinellus*	---	---	X	(X)	X	---	---	---	---	---
Black buffalo	*Ictiobus niger*	X	X	X	---	---	---	---	---	---	---
Black bullhead	*Ameiurus melas*	---	---	X	X	X	---	---	---	---	---
Black crappie	*Pomoxis nigromaculatus*	X	X	X	X	X	X	X	X	---	X
Black redhorse	*Moxostoma duquesnei*	X	X	X	X	---	X	---	---	---	---
Blackspotted topminnow	*Fundulus olivaceus*	---	---	X	---	---	---	---	---	---	---
Blackstripe topminnow	*Fundulus notatus*	---	---	X	---	---	---	---	---	---	---
Blue catfish	*Ictalurus furcatus*	X	X	X	X	X	X	X	X	X	X
Bluegill	*Lepomis macrochirus*	X	X	X	X	X	X	X	X	X	X
Bluntnose minnow	*Pimephales notatus*	---	X	X	---	---	---	X	X	---	X
Brook silverside	*Labidesthes sicculus*	X	X	X	X	---	---	---	---	---	X
Brown bullhead	*Ameiurus nebulosus*	X	X	X	(X)	X	X	X	---	---	---
Brown trout	*Salmo trutta*	---	---	---	---	X	---	---	---	---	---
Bullhead minnow	*Pimephales vigilax*	---	X	X	X	---	---	X	X	X	X
Channel catfish	*Ictalurus punctatus*	X	X	X	X	X	X	X	X	X	X

Table 2. (Continued)

Common Name	Scientific Name	1991 Embayment Study EF/GN	RFAI EF/GN 1993-2009	Cove Rotenone 1947-1999	WBN EF/GN/HN 1977-1979 1982-1985	SQN GN/TN 1971-1978 GN 1980-1986	Sauger Study GN 1986-1994	SQN Impgmt 1981-1985	SQN Impgmt 2001-2002 2005-2007	WBSP Impgmt 1974-1975	WBN/ SCCW Impgmt 1996-1997 1999-2000 2005-2007
Chestnut lamprey	*Ichthyomyzon castaneus*	X	X	X	X	X	---	X	---	---	---
Common carp	*Cyprinus carpio*	X	X	X	X	X	X	X	---	---	---
Dusky darter	*Percina sciera*	---	X	---	---	---	---	---	---	---	---
Emerald shiner	*Notropis atherinoides*	X	X	X	X	---	---	X	X	X	---
Fathead minnow	*Pimephales promelas*	---	---	X	---	---	---	---	---	---	---
Flathead catfish	*Pylodictis olivaris*	X	X	X	X	X	X	X	X	X	X
Freshwater drum	*Aplodinotus grunniens*	X	X	X	X	X	X	X	X	X	X
Ghost shiner	*Notropis buchanani*	---	---	X	---	---	---	---	---	---	---
Gizzard shad	*Dorosoma cepedianum*	X	X	X	X	X	X	X	X	X	X
Golden redhorse	*Moxostoma erythrurum*	X	X	X	X	X	X	X	---	---	---
Golden shiner	*Notemigonus crysoleucas*	X	X	X	X	X	X	X	---	---	---
Goldfish	*Carassius auratus*	---	---	X	---	X	---	---	---	---	---
Grass carp	*Ctenopharyngodon idella*	---	X	---	---	---	---	---	---	---	---
Green sunfish	*Lepomis cyanellus*	X	X	X	X	X	---	X	---	---	---
Highfin carpsucker	*Carpiodes velifer*	---	X	X	X	---	---	---	---	---	---
Inland silverside	*Menidia beryllina*	---	X	---	---	---	---	---	---	---	---
Lake sturgeon	*Acipenser fulvescens*	---	X	---	---	---	---	---	---	---	---
Largemouth bass	*Micropterus salmoides*	X	X	X	X	X	X	X	X	---	X
Largescale stoneroller	*Campostoma oligolepis*	---	X	X	---	---	---	---	---	---	---
Logperch	*Percina caprodes*	X	X	X	X	---	---	X	X	X	X
Longear sunfish	*Lepomis megalotis*	X	X	X	X	X	---	X	---	---	X
Longnose gar	*Lepisosteus osseus*	X	X	X	X	X	X	---	---	---	---
Mimic shiner	*Notropis volucellus*	---	---	X	---	---	---	X	---	---	---
Mooneye	*Hiodon tergisus*	X	X	X	X	X	X	X		X	
Mud darter*	*Etheostoma asprigene**	---	---	X	---	---	---	---	---	---	---
Northern hogsucker	*Hypentelium nigricans*	---	X	X	X	X	X	---	---	---	---
Orangespotted sunfish	*Lepomis humilis*	---	---	X	---	X	---	---	---	---	---
Orangethroat darter*	*Etheostoma spectabile**	---	---	X	---	---	---	---	---	---	---
Paddlefish	*Polyodon spathula*	---	---	X	X	X	X	---	---	---	---
Pugnose minnow	*Opsopoeodus emiliae*	---	---	X	---	---	---	---	---	---	---
Pumpkinseed*	*Lepomis gibbosus**	---	---	---	---	X	---	---	---	---	---
Quillback	*Carpiodes cyprinus*	X	---	X	X	X	X	---	---	---	---
Rainbow darter	*Etheostoma caeruleum*	---	---	X	---	---	---	---	---	---	---
Rainbow trout	*Oncorhynchus mykiss*	---	---	---	X	---	X	X	---	---	---
Redbreast sunfish	*Lepomis auritus*	X	X	X	X	X	---	X	X	---	X

Table 2. (Continued)

Common Name	Scientific Name	1991 Embayment Study EF/GN	RFAI EF/GN 1993-2009	Cove Rotenone 1947-1999	WBN EF/GN/HN 1977-1979 1982-1985	SQN GN/TN 1971-1978 GN 1980-1986	Sauger Study GN 1986-1994	SQN Impgmt 1981-1985	SQN Impgmt 2001-2002 2005-2007	WBSP Impgmt 1974-1975	WBN/ SCCW Impgmt 1996-1997 1999-2000 2005-2007
Redear sunfish	*Lepomis microlophus*	X	X	X	X	X	X	X	X	X	X
River carpsucker	*Carpiodes carpio*	X	X	X	X	X	X	---	---	---	---
River chub	*Nocomis micropogon*	---	---	---	---	---	---	X	---	---	---
River redhorse	*Moxostoma carinatum*	X	X	X	X	X	---	---	---	---	---
Rock bass	*Ambloplites rupestris*	---	X	X	X	X	X	X	---	---	---
Sauger	*Sander canadensis*	X	X	X	X	X	X	X	X	---	---
Sawfin shiner*	*Notropis sp.** (undescribed)	---	---	---	---	---	---	X	---	---	---
Shortnose gar*	*Lepisosteus platostomus**	X	---	X	X	X	X	---	---	---	---
Silver chub	*Macrhybopsis storeriana*	---	---	X	X	---	---	X	---	---	---
Silver redhorse	*Moxostoma anisurum*	X	X	X	X	---	X	---	---	---	---
Skipjack herring	*Alosa chrysochloris*	X	X	X	X	X	X	X	X	X	X
Smallmouth bass	*Micropterus dolomieu*	X	X	X	X	X	X	---	---	X	---
Smallmouth buffalo	*Ictiobus bubalus*	X	X	X	X	X	X	---	---	X	---
Smallmouth redhorse	*Moxostoma breviceps*	---	X	X	X	(X)	X	---	---	---	---
Spotfin shiner	*Cyprinella spiloptera*	X	X	X	X	---	---	X	---	---	X
Spotted bass	*Micropterus punctulatus*	X	X	X	X	X	X	X	X	---	X
Spotted gar	*Lepisosteus oculatus*	X	X	X	X	X	X	---	---	---	---
Spotted sucker	*Minytrema melanops*	X	X	X	X	X	X	X	---	---	---
Steelcolor shiner	*Cyprinella whipplei*	X	X	X	---	---	---	---	---	X	---
Striped bass	*Morone saxatilis*	X	X	X	X	X	X	X	X	X	X
Striped shiner	*Luxilus chrysocephalus*	---	X	X	---	---	---	X	---	---	---
Stripetail darter	*Etheostoma kennicotti*	---	---	X	---	---	---	---	---	---	---
Tangerine darter	*Percina aurantiaca*	---	---	---	---	---	---	---	---	---	X
Threadfin shad	*Dorosoma petenense*	X	X	X	X	X	X	X	X	X	X
Walleye	*Sander vitreus*	---	X		X	X	X	---	---	---	---
Warmouth	*Lepomis gulosus*	X	X	X	X	X	X	X	---	---	X
Western mosquitofish	*Gambusia affinis*	---	X	X	---	---	---	X	X	---	---
White bass	*Morone chrysops*	X	X	X	X	X	X	X	X	X	X
White crappie	*Pomoxis annularis*	X	X	X	X	X	X	X	X	X	X
Whitetail shiner	*Cyprinella galactura*	---	---	X	---	---	---	---	---	---	---
White sucker	*Catostomus commersoni*	X	---	X	X	X	X	---	---	---	---
Yellow bass	*Morone mississippiensis*	X	X	X	X	X	X	X	X	X	X
Yellow bullhead	*Ameiurus natalis*	X	X	X	X	X	---	X	X	---	---
Yellow perch	*Perca flavescens*	X	X	X	X	X	X	X	---	---	X
	Total number of species:	**47**	**60**	**73**	**57**	**50**	**42**	**44**	**25**	**20**	**26**

Table 3. Fish species collected during TVA stream sampling in direct tributaries to the Tennessee River within Chickamauga Reservoir, 1995-2009. No sampling was conducted during 2010. Species are listed alphabetically by common name.

Year(s) Collected	Common Name	Scientific name	Collected in 1993-2009 RFAI Samples
1995-2007	American brook lamprey	*Lampetra appendix*	---
1995	Banded darter	*Etheostoma zonale*	---
1995-2009	Banded sculpin	*Cottus carolinae*	---
1995-2008	Bigeye chub	*Hybopsis amblops*	---
1995-2007	Black bullhead	*Ameiurus melas*	---
1995-2009	Black crappie	*Pomoxis nigromaculatus*	X
1995-2008	Black redhorse	*Moxostoma duquesnei*	X
1995-2009	Blackside snubnose darter	*Etheostoma duryi*	---
1995-2009	Blackspotted topminnow	*Fundulus olivaceus*	---
1999	Blackstripe topminnow	*Fundulus notatus*	---
1995-2009	Bluegill	*Lepomis macrochirus*	X
1995-2008	Blueside darter	*Etheostoma jessiae*	---
1995-2009	Bluntnose minnow	*Pimephales notatus*	X
1995-2005	Brook silverside	*Labidesthes sicculus*	X
1999	Bullhead minnow	*Pimephales vigilax*	X
1999-2003	Channel catfish	*Ictalurus punctatus*	X
1995	Chestnut lamprey	*Ichthyomyzon castaneus*	X
1995-2008	Creek chub	*Semotilus atromaculatus*	---
1995-1999	Dusky darter	*Percina sciera*	X
1995-2003	Emerald shiner	*Notropis atherinoides*	X
1995-2008	Fantail darter	*Etheostoma flabellare*	---
1999-2008	Fathead minnow	*Pimephales promelas*	---
1999-2009	Freshwater drum	*Aplodinotus grunniens*	X
1999-2009	Gizzard shad	*Dorosoma cepedianum*	X
1995-2009	Golden redhorse	*Moxostoma erythrurum*	X
1995-2009	Golden shiner	*Notemigonus crysoleucas*	X
1996	Goldfish	*Carassius auratus*	---
1995-2009	Green sunfish	*Lepomis cyanellus*	X
1995-2008	Greenside darter	*Etheostoma blennioides*	---
1995-2009	Largemouth bass	*Micropterus salmoides*	X
1995-2009	Largescale stoneroller	*Campostoma oligolepis*	X
1995-2009	Logperch	*Percina caprodes*	X
1995-2009	Longear sunfish	*Lepomis megalotis*	X
2007	Longnose gar	*Lepisosteus osseus*	X
1999-2004	Mottled sculpin	*Cottus bairdii*	---
1995-2005	Mountain shiner	*Lythrurus lirus*	---
1995-2008	Northern hogsucker	*Hypentelium nigricans*	X
1995-2008	Northern studfish	*Fundulus catenatus*	---

Table 3. (Continued)

Year(s) Collected	Common Name	Scientific name	Collected in 1993-2009 RFAI Samples
1995-2009	Rainbow darter	*Etheostoma caeruleum*	---
1996-2005	Rainbow trout	*Oncorhynchus mykiss*	---
1995-2009	Redbreast sunfish	*Lepomis auritus*	X
1995-2009	Redear sunfish	*Lepomis microlophus*	X
1995-2009	Redline darter	*Etheostoma rufilineatum*	---
2004	River chub	*Nocomis micropogon*	---
1995-2008	Rock bass	*Ambloplites rupestris*	X
1996	Scarlet shiner	*Lythrurus fasciolaris*	---
2008	Silver redhorse	*Moxostoma anisurum*	X
1995-2008	Smallmouth bass	*Micropterus dolomieu*	X
1995-2009	Snubnose darter	*Etheostoma simoterum*	---
1995-2009	Spotfin shiner	*Cyprinella spiloptera*	X
1995-2008	Spotted bass	*Micropterus punctulatus*	X
1995-2009	Spotted sucker	*Minytrema melanops*	X
1996-2005	Steelcolor shiner	*Cyprinella whipplei*	X
1995-2009	Striped shiner	*Luxilus chrysocephalus*	X
2002-2007	Stripetail darter	*Etheostoma kennicotti*	---
1995-2003	Telescope shiner	*Notropis telescopus*	---
1995-2009	Warmouth	*Lepomis gulosus*	X
1995-2008	Warpaint shiner	*Luxilus coccogenis*	---
1995-2008	Western blacknose dace	*Rhinichthys obtusus*	---
1995-2009	Western mosquitofish	*Gambusia affinis*	X
1995-2009	White sucker	*Catostomus commersoni*	---
1995-2008	Whitetail shiner	*Cyprinella galactura*	---
1995-2007	Yellow bullhead	*Ameiurus natalis*	X
1996-2008	Yellow perch	*Perca flavescens*	X
		Total number of species	**64**
Total number collected both in tributary streams and in RFAI samples			**35 (55%)**

Table 4. Fish species collected during TVA stream and river sampling in the Tennessee portion of the Hiwassee River and its tributaries, 1991-2010. Species are listed alphabetically by common name.

Year(s) Collected	Common Name	Scientific name	Collected in 1993-2009 RFAI Samples
1991-2009	American brook lamprey	*Lampetra appendix*	---
1991-2010	Banded darter	*Etheostoma zonale*	---
1993-2010	Banded sculpin	*Cottus carolinae*	---
1993-2010	Bigeye chub	*Hybopsis amblops*	---
1992-2009	Black buffalo	*Ictiobus niger*	X
2003, 2008	Black bullhead	*Ameiurus melas*	---
1992-2010	Black crappie	*Pomoxis nigromaculatus*	X
1991-2010	Black redhorse	*Moxostoma duquesnei*	X
1999-2007	Blackside snubnose darter	*Etheostoma duryi*	---
1993-2010	Blackspotted topminnow	*Fundulus olivaceus*	---
1993	Blackstripe topminnow	*Fundulus notatus*	---
2009	Blueback herring	*Alosa aestivalis*	---
1993-2007	Bluebreast darter	*Etheostoma camurum*	---
1991-2010	Bluegill	*Lepomis macrochirus*	X
1993-2008	Blueside darter	*Etheostoma jessiae*	---
1995-2009	Bluntnose minnow	*Pimephales notatus*	X
1993-2010	Brook silverside	*Labidesthes sicculus*	X
1994-2007	Brown bullhead	*Ameiurus nebulosus*	X
1991-2009	Brown trout	*Salmo trutta*	---
1991-2010	Central stoneroller	*Campostoma anomalum*	---
1991-2010	Channel catfish	*Ictalurus punctatus*	X
1991-2010	Chestnut lamprey	*Ichthyomyzon castaneus*	X
1992-2001	Common carp	*Cyprinus carpio*	X
1993-2010	Creek chub	*Semotilus atromaculatus*	---
1993-2010	Dusky darter	*Percina sciera*	X
1993-2007	Emerald shiner	*Notropis atherinoides*	X
1993-2008	Fathead minnow	*Pimephales promelas*	---
1995	Flame chub	*Hemitremia flammea*	---
1993-2009	Flathead catfish	*Pylodictis olivaris*	X
1991-2010	Freshwater drum	*Aplodinotus grunniens*	X
1991-2010	Gilt darter	*Percina evides*	---
1991-2010	Gizzard shad	*Dorosoma cepedianum*	X
1991-2010	Golden redhorse	*Moxostoma erythrurum*	X
1993-2008	Golden shiner	*Notemigonus crysoleucas*	X
1991-2010	Green sunfish	*Lepomis cyanellus*	X
1991-2010	Greenside darter	*Etheostoma blennioides*	---
1991-2010	Largemouth bass	*Micropterus salmoides*	X

Table 4. (Continued)

Year(s) Collected	Common Name	Scientific name	Collected in 1993-2009 RFAI Samples
2001-2009	Largescale stoneroller	*Campostoma oligolepis*	X
2006, 2008	Least brook lamprey	*Lampetra aepyptera*	---
1991-2010	Logperch	*Percina caprodes*	X
1993-2010	Longear sunfish	*Lepomis megalotis*	X
1993-2010	Longnose gar	*Lepisosteus osseus*	X
1991-2010	Mirror shiner	*Notropis spectrunculus*	---
1992-2007	Mooneye	*Hiodon tergisus*	X
1991-2010	Mottled sculpin	*Cottus bairdii*	---
1993-2010	Mountain brook lamprey	*Ichthyomyzon greeleyi*	---
1995-2006	Mountain shiner	*Lythrurus lirus*	---
1991-2010	Northern hogsucker	*Hypentelium nigricans*	X
1999-2008	Northern studfish	*Fundulus catenatus*	---
1991-2009	Ohio lamprey	*Ichthyomyzon bdellium*	---
1995-2001	Olive darter	*Percina squamata*	---
1993-2007	Quillback	*Carpiodes cyprinus*	---
1995-2008	Rainbow darter	*Etheostoma caeruleum*	---
1991-2010	Rainbow trout	*Oncorhynchus mykiss*	---
1991-2010	Redbreast sunfish	*Lepomis auritus*	X
1991-2010	Redear sunfish	*Lepomis microlophus*	X
1991-2010	Redline darter	*Etheostoma rufilineatum*	---
1999, 2005	River carpsucker	*Carpiodes carpio*	X
1991-2010	River chub	*Nocomis micropogon*	---
1991-2009	River redhorse	*Moxostoma carinatum*	X
1991-2010	Rock bass	*Ambloplites rupestris*	X
1991-2010	Sauger	*Sander canadense*	X
1992-2009	Silver redhorse	*Moxostoma anisurum*	X
1993-2009	Smallmouth bass	*Micropterus dolomieu*	X
1991-2009	Smallmouth buffalo	*Ictiobus bubalus*	X
1991-2009	Smallmouth redhorse	*Moxostoma breviceps*	X
1991-2009	Snail darter	*Percina tanasi*	---
1991-2010	Snubnose darter	*Etheostoma simoterum*	---
1993-2010	Spotfin shiner	*Cyprinella spiloptera*	X
1991-2010	Spotted bass	*Micropterus punctulatus*	X
2005	Spotted gar	*Lepisosteus oculatus*	X
1991-2010	Spotted sucker	*Minytrema melanops*	X
1993-2008	Steelcolor shiner	*Cyprinella whipplei*	X
1991-2010	Striped bass	*Morone saxatilis*	X
1991-2010	Striped shiner	*Luxilus chrysocephalus*	X
1993-2009	Tangerine darter	*Percina aurantiaca*	---

Table 4. (Continued)

Year(s) Collected	Common Name	Scientific name	Collected in 1993-2009 RFAI Samples
1991-2009	Telescope shiner	*Notropis telescopus*	---
1991-2010	Tennessee shiner	*Notropis leuciodus*	---
1993-2006	Threadfin shad	*Dorosoma petenense*	X
1999, 2001	Walleye	*Sander vitreum*	X
1993-2010	Warmouth	*Lepomis gulosus*	X
1991-2010	Warpaint shiner	*Luxilus coccogenis*	---
1993-2010	Western blacknose dace	*Rhinichthys obtusus*	---
1993-2010	Western mosquitofish	*Gambusia affinis*	X
1991-2008	White bass	*Morone chrysops*	X
1994-2010	White crappie	*Pomoxis annularis*	X
1993-2008	White sucker	*Catostomus commersoni*	---
1991-2010	Whitetail shiner	*Cyprinella galactura*	---
1991-2010	Yellow bass	*Morone mississippiensis*	X
1993-2010	Yellow bullhead	*Ameiurus natalis*	X
1991-2010	Yellow perch	*Perca flavescens*	X
		Total number of species	**91**
		Total number collected both in the Hiwassee River and its tributaries and in RFAI samples	**51 (56%)**

Appendix 1. Fish species collected, by year, from 1947 to 1999 in TVA cove rotenone surveys, Chickamauga Reservoir. Tennessee River Mile (TRM) and Hiwassee River Mile (HiRM) ranges are reservoir segments where sampling occurred in various coves throughout that particular river reach. Fish species are listed in alphabetical order by common name. *1999 Cove rotenone records are from Baxter and Gardner (2000). Exact cove locations for 1999 species records were not specified and are listed in the TRM 471.7-478 column. 1999 samples were collected in coves near TRM 476.2, 478, 495.1, 508, and 524.6. **Denotes questionable species records.

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Bigmouth buffalo	*Ictiobus cyprinellus*	1947	1950		1970		1978
		1970	1957				
		1975					
Black buffalo	*Ictiobus niger*	1955	1957			1971	1986
		1971	1970				1989
		1999*	1971				1997
Black bullhead	*Ameiurus melas*	1981		1979		1972	1983
				1983		1981	1993
						1982	
						1983	
Black crappie	*Pomoxis nigromaculatus*	1950	1959	1952	1956	1980	1986
		1954		1970		1981	1987
		1972		1977		1985	1988
		1979		1979		1988	1989
		1980		1980		1989	1990
		1981		1981		1990	1991
		1984		1985		1991	1992
		1985		1988		1992	1993
		1986		1989		1993	1995
		1987		1990		1995	1997
		1988		1991		1997	
		1989		1992			
		1990		1993			
		1991		1995			
		1992		1997			
		1993					
		1999*					
Black redhorse	*Moxostoma duquesnei*	1955		1970		1972	1979
		1956		1972		1976	

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Black redhorse (Continued)	*Moxostoma duquesnei*	1976 1999*		1976 1977 1980 1986		1982	
Blackspotted topminnow	*Fundulus olivaceus*	1973 1974 1977 1978 1993 1999*		1974 1975 1976 1977 1978 1979 1980 1982 1983 1984 1985 1986 1995 1997			
Blackstripe topminnow	*Fundulus notatus*			1976 1981		1972	
Blue catfish	*Ictalurus furcatus*	1947 1950 1951 1954 1955 1956 1957 1972 1973 1975 1980 1992 1999*	1954 1957 1958 1959 1971	1952 1978 1980	1970	1972 1978	1976 1980
Bluegill	*Lepomis macrochirus*	1947 1949 1950	1950 1954 1957	1952 1970 1971	1956 1970	1970 1971 1972	1976 1977 1978

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Bluegill (Continued)	*Lepomis macrochirus*	1951 1954 1955 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*	1958 1959 1970 1971	1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997		1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997
Bluntnose minnow	*Pimephales notatus*	1949 1972 1976 1981 1984 1997 1999*		1972 1993 1995 1997		1991 1992 1993 1995 1997	1988 1989 1990 1993 1995
Brook silverside	*Labidesthes sicculus*	1949 1950 1954	1954 1958	1971 1972 1973	1956	1971 1972 1973	1976 1977 1981

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Brook silverside (Continued)	*Labidesthes sicculus*	1956 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997		1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1982 1983 1984 1986 1987 1988 1989 1990 1991 1992 1993 1995
Brown bullhead	*Ameiurus nebulosus*	1982 1984 1985 1986 1987 1988 1989 1990 1999*		1985 1986 1987 1988 1990		1983 1986 1989 1991 1993 1995	1983 1987 1988 1989 1990 1991 1992 1993 1995 1997
Bullhead minnow	*Pimephales vigilax*	1950 1951 1957 1971	1957 1971	1971 1974 1975 1976		1971 1972 1974 1975	1976 1977 1980 1981

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Bullhead minnow (Continued)	*Pimephales vigilax*	1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1977 1978 1979 1980 1982 1984 1985 1986 1987 1990 1991 1992 1993 1995 1997		1976 1977 1978 1979 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997
Channel catfish	*Ictalurus punctatus*	1947 1949 1950 1951 1954 1955 1956 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979	1950 1954 1957 1958 1959 1971	1952 1970 1971 1972 1974 1975 1976 1977 1978 1979 1980 1981 1983 1984 1985 1988 1990 1991	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1981 1982 1983 1984 1985 1987 1988 1989	1976 1977 1978 1979 1980 1981 1982 1983 1985 1986 1987 1988 1989 1990 1991 1992 1993 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Channel catfish (Continued)	*Ictalurus punctatus*	1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1997 1999*				1990 1991 1992 1993 1997	
Chestnut lamprey	*Ichthyomyzon castaneus*	1950 1995 1999*		1981		1984	
Common carp	*Cyprinus carpio*	1947 1950 1951 1954 1956 1957 1970 1971 1972 1973 1974 1975 1976 1978 1979 1980 1981 1982 1984 1985 1986 1987	1954 1959 1970 1971	1952 1971 1972 1973 1974 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1988	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1991	1976 1977 1978 1979 1980 1981 1982 1983 1985 1986 1987 1988 1989 1990 1991 1992

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Common Carp (Continued)	*Cyprinus carpio*	1989 1990 1991 1992 1999*					
Emerald shiner	*Notropis atherinoides*	1950 1972 1973 1974 1975 1976 1977 1978 1979 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*	1971	1972 1974 1975 1976 1977 1979 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997		1972 1977 1978 1979 1980 1982 1983 1985 1986 1987 1988 1989 1991 1992 1993 1995 1997	1977 1978 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1993 1995 1997
Fathead minnow	*Pimephales promelas*			1979			
Flathead catfish	*Pylodictis olivaris*	1949 1950 1951 1954 1955 1957 1970 1971 1972	1954 1957 1958 1959 1970 1971	1952 1970 1971 1972 1973 1974 1975 1976 1977	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978	1976 1977 1991

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Flathead catfish (Continued)	*Pylodictis olivaris*	1973 1974 1975 1976 1977 1978 1979 1980 1981 1985 1986 1987 1989 1990 1991 1992 1993 1995 1997 1999*		1978 1979 1980 1981 1982 1983 1988 1989 1990 1992 1993 1995		1982 1986 1989 1990 1991 1992 1997	
Freshwater drum	*Aplodinotus grunniens*	1949 1950 1951 1954 1955 1956 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983	1950 1954 1957 1958 1959 1970 1971	1952 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Freshwater drum (Continued)	*Aplodinotus grunniens*	1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1990 1991 1992 1993 1995 1997		1991 1992 1993 1995 1997	
Ghost shiner	*Notropis buchanani*	1982 1987 1992 1995 1997 1999*		1974 1986		1988 1997	1986 1988
Gizzard shad	*Dorosoma cepedianum*	1947 1949 1950 1951 1954 1955 1956 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983	1950 1954 1957 1958 1959 1970 1971	1952 1970 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Gizzard shad (Continued)	*Dorosoma cepedianum*	1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1992 1993 1995 1997		1992 1993 1995 1997	
Golden redhorse (Continued)	*Moxostoma erythrurum*	1951 1955 1956 1957 1970 1971 1972 1973 1974 1975 1977 1978 1979 1980 1983 1991 1995 1997 1999*	1959	1970 1974 1975 1977 1979 1984 1989 1990 1995 1997	1970	1970 1971 1972 1973 1974 1976 1977 1980 1981 1985 1986 1989 1990 1992	1976 1979 1990
Golden shiner	*Notemigonus crysoleucas*	1973 1975 1976 1977 1978 1979 1980 1981 1982	1971	1976 1977 1978 1979 1980 1981 1982 1983 1984	1970	1971 1972 1973 1974 1975 1976 1977 1978 1979	1976 1977 1978 1980 1981 1982 1983 1984 1985

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Golden shiner (Continued)	*Notemigonus crysoleucas*	1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997		1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1986 1987 1988 1989 1990 1991 1992 1993 1995 1997
Goldfish	*Carassius auratus*	1954 1956 1999*		1979	1970		
Green sunfish	*Lepomis cyanellus*	1949 1950 1951 1954 1956 1957 1970 1971 1972 1973 1974 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987	1950 1957 1958 1959 1970	1952 1970 1971 1973 1977 1978 1979 1980 1981 1982 1983 1984 1986 1987 1989 1990 1991 1993 1995 1997	1970	1970 1971 1972 1973 1975 1976 1977 1979 1980 1981 1982 1983 1984 1987 1988 1989 1990 1991 1992 1993 1995 1997	1977 1979 1980 1982 1983 1984 1985 1987 1988 1989 1990 1991 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Green sunfish (Continued)	*Lepomis cyanellus*	1988 1989 1990 1991 1992 1993 1995 1997 1999*					
Highfin carpsucker	*Carpiodes velifer*	1949					
Largemouth bass	*Micropterus salmoides*	1947 1949 1950 1951 1954 1955 1956 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992	1950 1954 1957 1958 1959 1970 1971	1952 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1976 1977 1978 1979 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Largemouth bass (Continued)	*Micropterus salmoides*	1993 1995 1997 1999*					
Largescale stoneroller	*Campostoma oligolepis*	1950 1973 1976 1977 1978 1980 1997 1999*		1974 1976 1977 1978 1979 1980 1983 1984 1990 1992 1993 1997		1978 1980 1982 1995	1988
Logperch	*Percina caprodes*	1950 1954 1956 1957 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991	1954 1957 1958	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995	1956	1971 1972 1973 1976 1977 1978 1980 1984 1986 1988 1989 1990 1991 1992 1993 1995 1997	1984

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Logperch (continued)	*Percina caprodes*	1992 1993 1995 1997 1999*		1997			
Longear sunfish	*Lepomis megalotis*	1949 1951 1954 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*	1950 1954 1958 1959 1970 1971	1952 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1984 1985 1986 1987 1989 1990		1970 1972 1973 1977 1978 1980 1982 1984 1985 1986 1987 1989 1993	1983 1985 1989 1990 1991 1992 1997
Longnose gar	*Lepisosteus osseus*	1950 1970 1972 1975 1976 1978	1971	1970 1978 1980 1981 1984 1985		1978 1979 1980 1982 1983 1984	1977 1978 1979 1980 1982 1983

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Longnose gar (Continued)	*Lepisosteus osseus*	1979 1980 1982 1983 1984 1987 1988 1993 1997 1999*		1988 1990 1992 1995		1985 1988 1990 1992 1993 1997	1989 1990 1997
Mimic shiner	*Notropis volucellus*	1976 1977 1978		1976		1977	1977 1984
Mooneye	*Hiodon tergisus*	1949 1950 1955 1956 1957 1970 1976	1954 1957 1958 1959	1952 1973 1974	1970	1970 1973 1977	
Mud darter**	*Etheostoma asprigene*	1972					
Northern hogsucker	*Hypentelium nigricans*	1950 1955 1972 1973 1975 1976 1978 1979 1980 1986 1993 1999*	1954 1957	1971 1972 1976 1977			
Orangespotted sunfish	*Lepomis humilis*	1949 1950 1951 1956	1957	1971 1972 1979 1980	1970	1970 1971 1972 1973	1980

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Orangespotted sunfish (continued)	*Lepomis humilis*	1957 1971 1972 1973 1975 1979				1974 1980 1990	
Orangethroat darter**	*Etheostoma spectabile*	1975					
Paddlefish	*Polyodon spathula*						1977 1979 1981
Pugnose minnow	*Opsopoeodus emiliae*	1975 1984		1975 1979 1984 1985 1987 1990			1986
Quillback	*Carpoides cyprinus*	1947 1950	1950 1970	1970	1970		1984
Rainbow darter	*Etheostoma caeruleum*	1974 1976 1977 1980 1997		1979 1995 1997			
Redbreast sunfish	*Lepomis auritus*	1976 1980 1981 1982 1983 1984 1986 1987 1988 1989 1990 1991 1992	1958	1976 1978 1981 1982 1983 1984 1986 1987 1988 1989 1990 1991 1992		1976 1978 1979 1981 1982 1983 1984 1986 1987 1988 1990 1991 1992	1977 1983 1990 1991 1995

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
		1993		1993		1993	
Redbreast sunfish	*Lepomis auritus*	1995		1995		1995	
(Continued)		1997		1997		1997	
		1999*					
Redear sunfish	*Lepomis microlophus*	1950	1957	1952	1956	1970	1976
		1954	1958	1970	1970	1971	1979
		1955	1959	1971		1972	1980
		1956	1970	1972		1973	1981
		1957	1971	1973		1974	1982
		1970		1974		1975	1983
		1971		1975		1976	1984
		1972		1976		1977	1985
		1973		1977		1978	1986
		1974		1978		1979	1987
		1975		1979		1980	1988
		1976		1980		1981	1989
		1977		1981		1982	1990
		1978		1982		1983	1991
		1979		1983		1984	1992
		1980		1984		1985	1993
		1981		1985		1986	1995
		1982		1986		1987	1997
		1983		1987		1988	
		1984		1988		1989	
		1985		1989		1990	
		1986		1990		1991	
		1987		1991		1992	
		1988		1992		1993	
		1989		1993		1995	
		1990		1995		1997	
		1991		1997			
		1992					
		1993					
		1995					
		1997					
		1999*					
River carpsucker	*Carpiodes carpio*	1972		1988		1976	1988
		1973		1990		1984	1990
		1984					1991
River redhorse	*Moxostoma carinatum*	1956	1959	1972		1978	
		1972					
		1974					

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Rock bass	*Ambloplites rupestris*	1973	1970				
Sauger	*Sander canadensis*	1947	1954	1970	1956	1970	
		1951	1957	1972	1970	1973	
		1954	1958	1973		1974	
		1956	1959	1974		1975	
		1973		1975		1976	
		1974		1976		1977	
		1975		1977		1978	
		1976		1978		1979	
		1977		1986		1980	
		1978		1997		1990	
		1985				1991	
		1995				1997	
		1997					
		1999*					
Shortnose gar**	*Lepisosteus platostomus*	1947	1971	1987		1986	1977
		1949					1981
		1979					1982
							1983
							1988
Silver chub	*Macrhybopsis storeriana*	1974		1974		1976	
		1975		1975		1978	
		1976		1976			
				1978			
Silver redhorse	*Moxostoma anisurum*		1954				
			1957				
Skipjack herring	*Alosa chrysochloris*	1947	1950	1952	1956	1970	1976
		1950	1954	1970	1970	1972	1977
		1951	1957	1972		1973	1980
		1954	1958	1973		1974	1982
		1955	1959	1974		1975	1983
		1956	1971	1975		1976	1987
		1957		1976		1977	1989
		1972		1977		1983	1990
		1973		1980		1984	1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Skipjack herring (Continued)	*Alosa chrysochloris*	1974 1975 1977 1982 1983 1984 1985 1987 1989 1995 1999*		1982 1983 1985 1986 1989 1990 1992		1985 1987 1989 1990 1991 1992 1997	
Smallmouth bass	*Micropterus dolomieu*	1976 1977 1980 1990 1991 1992 1993 1995 1997 1999*	1950 1954 1957 1959	1991 1992 1993 1995 1997		1979	1991
Smallmouth buffalo	*Ictiobus bubalus*	1947 1950 1951 1954 1955 1956 1957 1970 1971 1972 1973 1974 1975 1976 1977 1979 1980 1981	1950 1954 1957 1958 1959 1970 1971	1952 1971 1972 1973 1974 1975 1977 1979 1981 1982 1983 1985 1986	1956 1970	1970 1971 1972 1973 1975 1976 1977 1978 1979 1983 1986	1976 1977 1980 1982 1983 1985 1986 1988 1989 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Smallmouth buffalo (Continued)	*Ictiobus bubalus*	1982 1983 1984 1985 1986 1987 1988 1989 1990 1993 1997 1999*					
Smallmouth redhorse	*Moxostoma breviceps*	1971		1970 1973 1977			
Spotfin shiner	*Cyprinella spiloptera*	1949 1973 1975 1976 1977 1978 1979 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1974 1975 1976 1977 1978 1981 1982 1983 1984 1985 1986 1987 1990 1991 1992 1993 1995 1997		1974 1977 1986 1987 1988	1978 1983 1987 1988 1992

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Spotted bass	*Micropterus punctulatus*	1947	1950	1952	1956	1970	1976
		1950	1954	1970	1970	1971	1979
		1954	1957	1971		1972	1982
		1955	1958	1972		1973	1983
		1956	1959	1973		1974	1984
		1957	1970	1974		1975	1988
		1970	1971	1975		1976	1989
		1971		1976		1977	1990
		1972		1977		1978	1991
		1973		1978		1979	
		1974		1979		1980	
		1975		1980		1982	
		1976		1982		1983	
		1977		1983		1984	
		1978		1984		1986	
		1979		1985		1987	
		1980		1986		1988	
		1981		1988		1990	
		1982		1990		1991	
		1983		1991		1992	
		1984		1992		1993	
		1985		1993		1995	
		1986		1995			
		1987		1997			
		1988					
		1989					
		1990					
		1991					
		1992					
		1993					
		1995					
		1997					
		1999*					
Spotted gar	*Lepisosteus oculatus*	1970	1958	1971		1975	1976
		1973	1971	1978		1979	1977
		1974		1981		1981	1979
		1977		1983		1983	1980
		1979		1984		1984	1983
		1981		1987		1986	1985
		1983		1989		1989	1986
		1986		1990		1991	1989

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Spotted gar (Continued)	*Lepisosteus oculatus*	1987 1988 1989 1990 1991 1995 1997 1999*		1991 1993 1997		1993 1995 1997	1990 1992 1995 1997
Spotted sucker	*Minytrema melanops*	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1986 1988 1990 1991 1992 1993 1995 1997 1999*	1959 1971	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1987 1988 1990 1991 1993	1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1976 1977 1978 1979 1980 1982 1983 1984 1986 1988 1989 1990 1991 1992 1993 1995 1997
Steelcolor shiner	*Cyprinella whipplei*	1976 1986 1987 1988 1992 1993 1995 1999*		1976 1995			

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Striped bass	*Morone saxatilis*	1997 1999*				1990	
Striped shiner	*Luxilus crysocephalus*	1977 1984 1990		1974 1975 1977 1979 1980 1983 1984 1992		1979 1982	1989 1990
Stripetail darter	*Etheostoma kennicotti*	1976 1977 1980 1985 1997 1999*					
Threadfin shad	*Dorosoma petenense*	1950 1951 1954 1955 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984	1950 1954 1957 1958 1959 1970	1952 1970 1971 1972 1973 1974 1975 1976 1979 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1979 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991	1976 1977 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Threadfin shad (Continued)	*Dorosoma petenense*	1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*		1992 1993 1995 1997		1992 1993 1995 1997	
Warmouth	*Lepomis gulosus*	1949 1950 1951 1954 1956 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989	1950 1954 1957 1958 1959 1971	1952 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1976 1977 1978 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Warmouth (Continued)	*Lepomis gulosus*	1990 1991 1992 1993 1995 1997 1999*		1997			
Western mosquitofish	*Gambusia affinis*	1976 1984 1986 1987 1989 1990 1991 1992 1993 1995 1997 1999*		1982 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997		1972 1973 1976 1980 1981 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1976 1977 1979 1980 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997
White bass	*Morone chrysops*	1949 1950 1951 1954 1955 1956 1957 1970 1972 1973 1974 1978	1954 1957 1958 1959 1970 1971	1952 1970 1973 1974 1975 1985 1986	1956 1970	1970 1971 1973 1974 1976 1977 1983 1988 1989 1990 1991	1976 1977 1979 1980 1986 1987 1989 1990 1991 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
White bass (Continued)	*Morone chrysops*	1982 1984 1986 1987 1988 1989 1990 1992 1993 1997 1999*					
White crappie	*Pomoxis annularis*	1947 1949 1950 1951 1954 1957 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990	1954 1957 1958 1959 1970 1971	1952 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1990 1992 1993 1995 1997	1956 1970	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1990 1991 1993 1995 1997	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
White crappie (Continued)	*Pomoxis annularis*	1991 1993 1997 1999*					
White sucker	*Catostomus commersonii*			1977		1977	
Whitetail shiner	*Cyprinella galactura*		1971				
Yellow bass	*Morone mississippiensis*	1971 1972 1973 1974 1975 1976 1977 1978 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*	1971	1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997		1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997
Yellow bullhead	*Ameiurus natalis*	1975 1980 1981 1984 1986 1987 1988		1978 1979 1980 1981 1982 1983 1984		1978 1979 1980 1981 1982 1983 1984	1983 1984 1985 1986 1988 1989 1990

Appendix 1. (Continued)

Common Name	Scientific Name	TRM 471.7-478	TRM 483.6-487.5	TRM 489.6-495	HiRM 1.2-3.5	TRM 505.4-508	TRM 524.6
Yellow bullhead (Continued)	*Ameiurus natalis*	1989 1990 1992 1993 1995 1999*		1985 1986 1987 1988 1989 1990 1991		1985 1986 1987 1988 1989 1990 1991 1992 1995 1997	1991 1992 1993 1995
Yellow perch	*Perca flavescens*	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997 1999*	1970 1971	1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	1970	1970 1972 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1995 1997	

ATTACHMENT 11

Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)

Prepared for
Tennessee Valley Authority

October 28, 2010
Revised November 24, 2010

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I. INTRODUCTION

The Tennessee Valley Authority (TVA) is evaluating potential environmental impacts associated with renewing the operating licenses for Units 1 and 2 at its Watts Bar Nuclear Plant (WBN). TVA began construction on WBN in 1973, but Unit 1 did not begin full operation until 1996. Due to a predicted reduction in demand for power, TVA suspended the construction of Unit 2 in 1988. In 2007, the TVA board decided to reinitiate construction of Unit 2, which is predicted to be completed by 2013.

WBN is located in Rhea County, Tennessee. It is adjacent to the Chickamauga Reservoir near Tennessee River Mile (TRM) 528 on the right descending bank, approximately two river miles below Watts Bar Dam. WBN is operated in closed cycle mode, using one of the two cooling towers for heat dissipation. Blowdown from the cooling towers is discharged through multi-port diffusers located in the main river channel at TRM 527.8. Makeup water and other raw water requirements of the facility are obtained from the intake pumping station at TRM 528. The WBN Supplemental Condenser Cooling Water (SCCW) system became operational in July 1999. The SCCW system withdraws water from the intake structure located immediately upstream of Watts Bar Dam at TRM 529.9, which formerly served Watts Bar Fossil Plant. The temperature of the water in the SCCW system reduces the temperature of the Unit 1 condenser flow when mixed within the Unit 2 Cooling Tower Basin, which enhances the performance of the steam cycle. Water from the SCCW system is discharged through the old Watts Bar Fossil Plant discharge structure located on the Tennessee River approximately TRM 529.1, which is 1.1 miles upstream of the nuclear plant intake.

The purpose of this study is to evaluate the current status of mussels (Family: Unionidae), snails, and their habitat at three long-term monitoring sites near WBN. An additional sampling location was also surveyed to determine the efficacy of an experimental boulder field for enhancing mussel habitat within areas affected by releases from Watts Bar Dam (Figure 1, page 2).

TVA contracted Third Rock Consultants, LLC (Third Rock) to conduct a survey to characterize mussels, snails, and their habitat along the project area. Third Rock coordinated with Mainstream Commercial Divers to conduct the dive effort. Dr. Monte McGregor served as malacologist.

II. SITE DESCRIPTION

A. Mollusk Sampling Sites

Three reaches of the Tennessee River in the vicinity of WBN were surveyed using semi-quantitative and quantitative sampling methods similar to those used in past monitoring efforts to facilitate collection of comparable mussel and habitat data (Figure 1, page 2) including additional characterization of the snail community. The Upstream Site (TRM 528-529L) is located on the opposite side of the river and upstream from WBN. The Middle Site (TRM 526-527R) is located on the same side of the river as WBN and immediately downstream from the mouth of Yellow Creek and WBN discharges. The Downstream Site (TRM 520-521L) is located six river miles downstream and on the opposite side of the river from WBN. All three sites are along the inside edge of the navigation channel (near the overbank) in water approximately 3 to 7 meters (approximately 10 to 20 feet) deep.

Each of the three sites consisted of four sampling locations (transects) resulting in a total of 12 transects. At each location, a 100-meter long sampling transect (lines weighted to the riverbed), marked at 10 meter intervals, was anchored perpendicular to the bank and was used as a sampling guide by divers. Semi-quantitative samples were taken along each 10-

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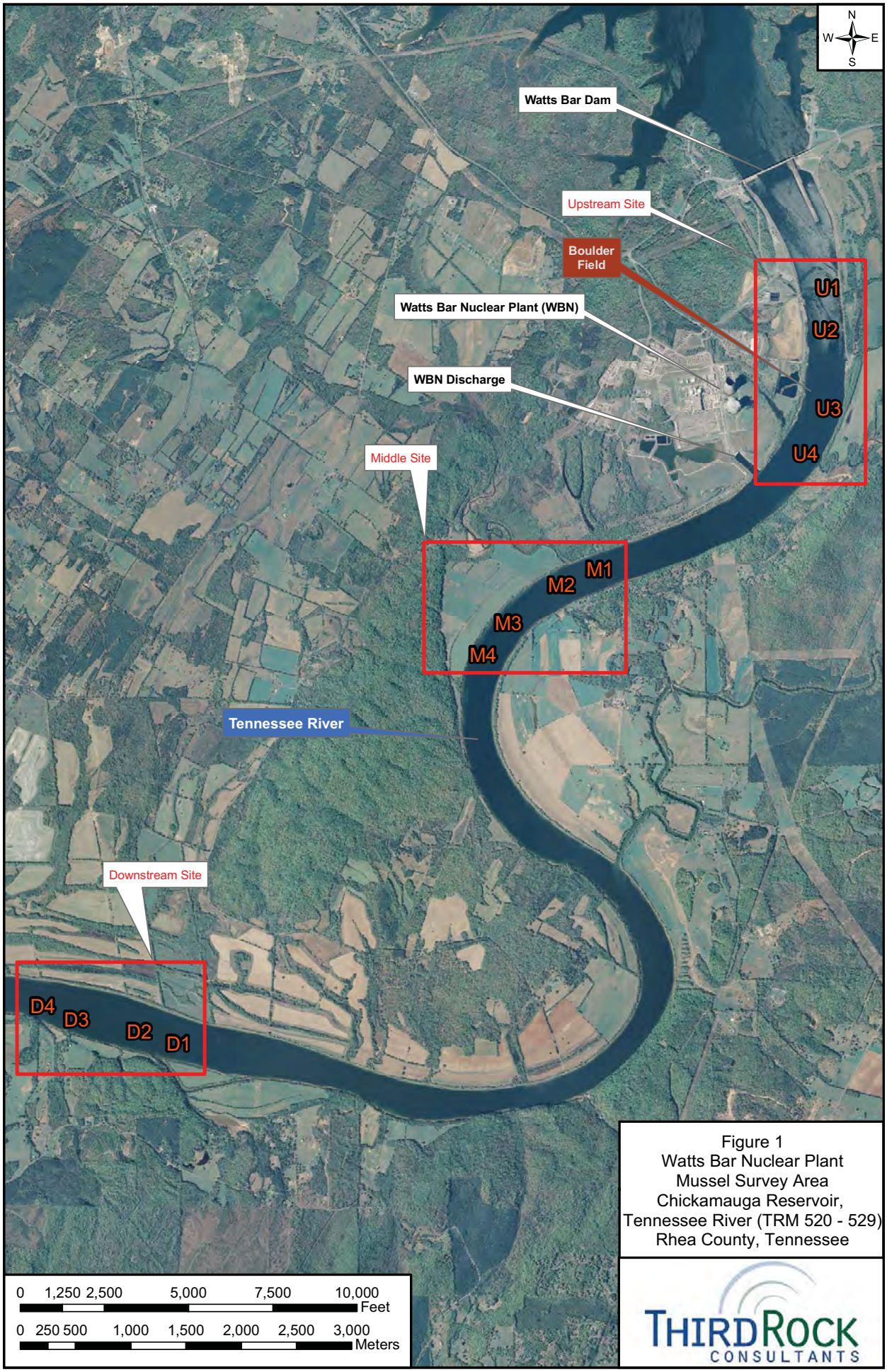

Figure 1
Watts Bar Nuclear Plant
Mussel Survey Area
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee

THIRD ROCK CONSULTANTS

meter interval and quantitative samples were taken at the end of each 10-meter interval, resulting in 120 semi-quantitative and 120 quantitative samples. GPS coordinates (Tennessee State Plane, NAD1983) of the transect endpoints and any other notable features were recorded.

B. Boulder Field Site

Additional sampling was conducted within a man-made boulder field at approximately TRM 529.5. The Boulder Site is an experimental site where boulders were placed in the river to reduce riverbed substrate movement with the anticipation of improving habitat for mussels and fostering habitat suitable for reproduction (Figure 1, page 2).

III. MUSSEL AND HABITAT SURVEY METHODS

Semi-quantitative Sampling: A total of 120 semi-quantitative samples were collected during the survey (40 per site). Four 100-meter long sampling transects were placed at historic collection locations in the three different sampling reaches (Upstream, Middle, and Downstream) (Ahlstedt 1991; Fraley *et al.* 2002). Divers collected all mussels (live and dead) and snails within 10 square-meter sample areas (1 meter wide by 10 meters long) along one side of each transect for a total sample area of 100 square meters per transect. Each 10 square meter area was exhaustively searched by the diver. A minimum of five minutes search time was spent per increment to ensure complete and thorough coverage, except where consistently poor habitat (*e.g.*, bedrock or deep silt) was encountered. Actual time spent per sample was recorded to facilitate catch per hour calculations in conjunction with estimates of mussel and snail densities. The diver used visual and tactual (disturbing the substrate by hand) search methods, placing all live and dead mussels into a mesh collection bag that was retrieved and processed in the boat. The mesh size of the collection bag was 6 millimeters. Small juveniles and snails encountered during the survey were placed in a bag with a mesh size of 3 millimeters.

Quantitative Sampling: Quantitative samples were collected at the end of each 10-meter transect, resulting in 40 quantitative samples per site. For quantitative samples, the diver excavated a whole-substrate sample from a 0.5-meter by 0.5-meter (0.25 square meter) quadrat. Samples were excavated to a depth of 10 to 15 centimeters, and material was placed into a 19-liter (5 gallon) bucket. Samples were sent to the boat for processing. Quantitative samples were processed by sieving the sample material through a series of nested sieves, with the smallest mesh size being no larger than 3 millimeters. Quantitative samples were collected at the end of each 10-meter increment on the opposite side of the transect line from where the semi-quantitative sample was collected.

Boulder Sampling Site: In 2000, an experimental effort to enhance native mussel habitat by providing refuge from high flow events resulting from dam discharges an artificial boulder field was created approximately 1 mile downstream of Watts Bar Dam. Specifically, the site was located along the right descending margin of the navigation channel between the loading facility at Watts Bar Fossil Plant and the intake structure for Watts Bar Nuclear Plant. Limestone boulders measuring at least 2 to 4 feet in any dimension were placed in six rows of 10 boulders each in an area covering approximately 70 by 100 feet (Fraley *et al.* 2002). Mussels were then stocked in three experimental plots, four corners of which were delineated with steel bars (= rebar). During the 2010 survey, an attempt was made to relocate those plots to determine the effectiveness of the boulders to enhance mussel habitat.

Sample Processing: A qualified malacologist with valid state and federal collecting permits identified and counted all live mussels and snails. Copies of current federal and state collecting permits to collect mussels were provided to the TVA Project Biologist prior to the survey (*e.g.,* with the cost estimate) and were in-hand while on site. The onsite malacologist was responsible for ensuring proper handling of mussel and snail resources, accurate and complete collection of data, and adherence to the TVA work plan. All live unionid mussels (or up to 50 individuals of each common species if densities were high) were measured (length in whole millimeters) and aged (external annuli count) to document recruitment and age/size profiles of each population. An effort was made to measure and age all individuals within quantitative samples, with individuals from qualitative samples having lower priority if some individuals were omitted. Sex of sexually dimorphic species was recorded along with reproductive state (gravid/non-gravid) of female mussels if possible. Length, height, age, and digital image (with size reference) were recorded for all live individuals of federally listed species. *Dreissena polymorpha* (zebra mussel) infestation rates (*e.g.,* percent coverage of shell) were noted for live unionid mussels. Snails collected during the survey were quantified, but not measured.

During processing, live mussels were kept wet and cool within mesh collection bags submerged in the river, and out-of-water time during processing was less than five minutes. Exposure to extreme temperature changes was avoided. All mussels from quantitative samples were processed via screening the contents of the bucket through a series of stacked sieves (12 millimeter and 6 millimeter mesh sizes). Contents were rinsed with river water and all live mussels were handpicked from the screens. Non-listed mussel species were carefully returned to the river from the water surface (boat) along each transect in the general area from which they were collected. All federally listed mussels collected were returned by hand to the location from which they were collected. No live individuals of federally listed mussels were harmed or removed from the site. Digital images of each representative species encountered during the survey were recorded. No live individuals were harmed or removed from the site.

Dead unionids (shells only) were scored as either freshly dead (with or without soft tissues, nacre lustrous, valves typically intact, periostracum worn; animal probably dead less than one year), weathered dead (no soft tissues, nacre very dull or chalky, valves may or may not be intact, periostracum worn; animal probably dead more than one year), or relic (portion of a shell and/or extremely worn and chalky, valves not intact, little or no periostracum; animal dead from many years to many decades). Only freshly dead shells were quantified to provide an estimate of recent mortality at the time of the study.

Habitat: Within the location of each quantitative sample, depth and relative proportion of each substrate particle size (Wentworth Scale) were characterized. The substrate assessment accounted for all substrate within the sample (not just the surface) and was visually estimated by the diver. Depth was measured using a pneumophathometer attached to the diver lying flat on the riverbed. Water velocity and water chemistry (temperature, dissolved oxygen, pH, conductivity, and turbidity) were measured within 0.5 meter of the water surface and near the substrate surface at the upstream and downstream end of each site. GPS coordinates of these locations were recorded. Digital images of the site were recorded. In addition, all aquatic snails collected by all sampling techniques were identified and enumerated.

IV. RESULTS

The field survey was conducted between September 28 and 30, 2010. For all sampling methods combined, a total of 907 live unionid mussels (mean density = 1.19 mussels/m^2, s^2 (variation) = 1.01; CPUE = 86.12; s^2 = 44.47) representing 17 species were recorded during the survey (Table 1, page 6). One federally endangered species, *Lampsilis abrupta*, was collected in the first transect of the Middle Site (M1). Additionally, a federal candidate species, *Plethobasus cyphyus,* was found in the second transect of the Middle Site (M2) (Exhibit 3, page 18). Both individuals were measured for length, width and thickness, photographed, and returned by hand to the same 10-meter segment from which they were collected. Fingernail clam (*Musculium transversum*) and Asian clam *(Corbicula fluminea*) were also observed during the mussel survey but were not quantified. Also encountered during the survey (all methods combined) were 503 live snails (mean density = 3.32 mussels/m^2, s^2 = 4.8; CPUE = 29.45, s^2 = 28.0) representing two species.

Semi-Quantitative Sampling: A total of 120, 10 square meter semi-quantitative samples were collected during the survey, resulting in the collection of 852 mussels. *Elliptio crassidens*, *Pleurobema cordatum*, *Cyclonaias tuberculata*, and *Quadrula pustulosa* accounted for over 90 percent of all live mussels collected over all three reaches. *E. crassidens* was the most commonly collected mussel in all three reaches. The *Pleurobema cordatum* was the second-most commonly collected mussel at the Upstream Site and Middle Site while the *Cyclonaias tuberculata* was the second-most abundant mussel in the Downstream Site.

Densities and catch per unit effort (CPUE) observed during the semi-quantitative search throughout the project area averaged 0.71 mussels/square meter. Mean CPUE was 86 mussels per hour. Semi-quantitative densities ranged from 0 to 3.7 mussels/square meter and 0 to 396 mussels per hour, respectively (Table 2, pages 7 through 11). Total mussels and mean density observed per site are as follows: Upstream Site, 175 mussels (mean density = 0.44 mussels/square meter [m^2], s^2 = 0.10); Middle Site, 341 mussels (mean density = 0.85 mussels/m^2, s^2 = 0.16); Downstream Site, 336 mussels (mean density = 0.84 mussels/m^2, s^2 = 0.28). When examining mussel abundance for each 10 meter transect across the Upstream, Middle, and Downstream Sites mussels were relatively evenly distributed along most transects, though trends were apparent along some transects (Table 2, pages 7 through 11). At Upstream Sites U2 and U3 mussels were more abundant between 5 and 55 meters, while sites M1 and M3 at the Middle Sites exhibited higher densities from 55 to 105 meters. At Downstream Site D3 abundance peaked from 35 to 74 meters and again from 95 to 105 meters, while at D4 mussel abundance was highest from 75 to 105 meters (Exhibits 1, 3, and 5, pages 16, 18, and 20; Tables 2 and 3, pages 7 through 15). A detailed spreadsheet of all survey results and GPS coordinates for all sampling locations are located in Appendices A and B, respectively. A photo log of representative mussels for each species is contained in Appendix C. A total of 312 snails representing two species – *Pleurocera canaliculata* and *Viviparus georgianus* – were collected from semi-quantitative samples. Total snails and mean density observed per site were as follows: Upstream Site, 128 snails (mean density = 0.32 snails/m^2, s^2 = 0.04), Middle Site, 173 snails (mean density = 0.43 snails/m^2, s^2 = 0.06), Downstream Site, 11 snails (mean density = 0.03 snails/m^2, s^2 = 0.0).

TABLE 1 – MUSSEL RESULTS SUMMARY

Species Name	Common Name	All Sites Combined		Upstream Site		Middle Site		Downstream Site		Boulder Field Site	
MUSSELS		**Total**	**Relative Abundance***	**Total**	**Relative Abundance***	**Total**	**Relative Abundance***	**Total**	**Relative Abundance***	**Total**	**Relative Abundance***
Elliptio crassidens	Elephant Ear	534	58.88	115	62.84	172	47.12	247	69.77	0	0.00
Pleurobema cordatum	Ohio Pigtoe	125	13.78	35	19.13	73	20.00	17	4.80	0	0.00
Cyclonaias tuberculata	Purple Wartyback	84	9.26	13	7.10	21	5.75	49	13.84	1	20.00
Quadrula pustulosa	Pimpleback	75	8.27	7	3.83	51	13.97	16	4.52	1	20.00
Potamilus alatus	Pink Heelsplitter	32	3.53	3	1.64	15	4.11	13	3.67	1	20.00
Ellipsaria lineolata	Butterfly	27	2.98	1	0.55	20	5.48	6	1.69	0	0.00
Obliquaria reflexa	Threehorn Wartyback	12	1.32	4	2.19	5	1.37	1	0.28	2	40.00
Leptodea fragilis	Fragile Papershell	5	0.55	2	1.09	1	0.27	2	0.56	0	0.00
Quadrula metanevra	Monkeyface	3	0.33	0	0.00	1	0.27	2	0.56	0	0.00
Amblema plicata	Threeridge	2	0.22	1	0.55	1	0.27	0	0.00	0	0.00
Elliptio dilatata	Spike	2	0.22	1	0.55	1	0.27	0	0.00	0	0.00
Lampsilis abrupta	Pink Mucket	1	0.11	0	0.00	1	0.27	0	0.00	0	0.00
Megalonaias nervosa	Washboard	1	0.11	0	0.00	1	0.27	0	0.00	0	0.00
Plethobasus cyphyus	Sheepnose	1	0.11	0	0.00	1	0.27	0	0.00	0	0.00
Fusconaia subrotunda	Longsolid	1	0.11	0	0.00	0	0.00	1	0.28	0	0.00
Pyganodon grandis	Giant Floater	1	0.11	1	0.55	0	0.00	0	0.00	0	0.00
Utterbackia imbecillis	Paper Pondshell	1	0.11	0	0.00	1	0.27	0	0.00	0	0.00
TOTAL MUSSELS		907		183		365		354		5	
SNAILS											
Viviparus georgianus	Banded Mysterysnail	355	70.58	96	45.71	256	93.43	2	12.50	1	33.33
Pleurocera canaliculata	Silty Hornsnail	148	29.42	114	54.29	18	6.57	14	87.50	2	66.67
TOTAL SNAILS		503		210		274		16		3	

*Percent of total mussels/snails

TABLE 2 – SEMI-QUANTITATIVE SURVEY RESULTS

Site Details				SPECIES: MUSSELS																	SPECIES: SNAILS		Totals, Densities, CPUE					
Site/ transect	Sample (distance from bank in meters)	Effort (min)	Method	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Elliptio dilitata*	*Lampsilis abrupta*	*Leptodea fragilis*	*Megalonaias nervosa*	*Obliquaria reflexa*	*Plethobasus cyphyus*	*Pleurobema cordatum*	*Fusconaia subrotunda*	*Potamilus alatus*	*Pyganodon grandis*	*Quadrula metanevra*	*Quadrula pustulosa*	*Utterbackia imbecillis*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (mussels/sq m)	CPUE (Mussels/hour)	TOTAL Snails	Density (Snails/sq m)	CPUE (Snails/hour)
U1	5-15	5	SQ													1							1	0.1	12	0	0	0
	15-25	5	SQ				2															7	2	0.2	24	7	0.7	84
	25-35	5	SQ				1					1									2	1	2	0.2	24	3	0.3	36
	35-45	8	SQ																		5	1	0	0	0	6	0.6	45
	45-55	9	SQ				1							1							2		2	0.2	13	2	0.2	13
	55-65	3	SQ											1									1	0.1	20	0	0	0
	65-75	6	SQ				1																1	0.1	10	0	0	0
	75-85	6	SQ																			2	0	0	0	2	0.2	20
	85-95	6	SQ				2															1	2	0.2	20	1	0.1	10
	95-105	7	SQ							1											2	4	1	0.1	9	6	0.6	51
U1 Total	5-105	60					7			1		1		2		1					11	16	12	0.12	12	27	0.27	27
U2	5-15	7	SQ	1			25							10					1				37	3.7	317	0	0	0
	15-25	4	SQ		1		3														2	2	4	0.4	60	4	0.4	60
	25-35	7	SQ		1		12							1							4	4	14	1.4	120	8	0.8	69
	35-45	7	SQ				2	1						1							6		4	0.4	34	6	0.6	51
	45-55	6	SQ				1							1							1	1	2	0.2	20	2	0.2	20
	55-65	6	SQ																		1	1	0	0	0	2	0.2	20
	65-75	4	SQ				1																1	0.1	15	0	0	0
	75-85	3	SQ														1						1	0.1	20	0	0	0
	85-95	7	SQ									1		1							1	4	2	0.2	17	5	0.5	43
	95-105	5	SQ													1						7	1	0.1	12	7	0.7	84
U2 Total	5-105	56		1	2		44	1				1		14		1	1		1		15	19	66	0.66	71	34	0.34	36
U3	5-15	6	SQ				13							1					1			2	15	1.5	150	2	0.2	20
	15-25	7	SQ		3		7							2		1						1	13	1.3	111	1	0.1	9
	25-35	5	SQ				7							3									10	1	120	0	0	0
	35-45	5	SQ		1	1	5							2					2				11	1.1	132	0	0	0
	45-55	6	SQ				8							2					1		2		11	1.1	110	2	0.2	20
	55-65	6	SQ		2		2							2							1	2	6	0.6	60	3	0.3	30
	65-75	3.5	SQ				2							1							1		3	0.3	51	1	0.1	17
	75-85	6	SQ				1							4							1		5	0.5	50	1	0.1	10
	85-95	5	SQ																				0	0	0	0	0	0
	95-105	4	SQ											1									1	0.1	15	0	0	0
U3 Total	5-105	54			6	1	45							18		1			4		5	5	75	0.75	84	10	0.1	11

TABLE 2 – SEMI-QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details				SPECIES: MUSSELS																		SPECIES: SNAILS		Totals, Densities, CPUE					
Site/ transect	Sample (distance from bank in meters)	Effort (min)	Method	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Elliptio dilitata*	*Lampsilis abrupta*	*Leptodea fragilis*	*Megalonaias nervosa*	*Obliquaria reflexa*	*Plethobasus cyphyus*	*Pleurobema cordatum*	*Fusconaia subrotunda*	*Potamilus alatus*	*Pyganodon grandis*	*Quadrula metanevra*	*Quadrula pustulosa*	*Utterbackia imbecillis*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (mussels/sq m)	CPUE (Mussels/hour)	TOTAL Snails	Density (Snails/sq m)	CPUE (Snails/hour)
U4	5-15	6	SQ		3		5														1	6	8	0.8	80	7	0.7	70
	15-25	5	SQ																		4	6	0	0	0	10	1	120
	25-35	6	SQ				1												1		1	1	2	0.2	20	2	0.2	20
	35-45	5.5	SQ																		1	1	0	0	0	2	0.2	22
	45-55	6	SQ				3														5	2	3	0.3	30	7	0.7	70
	55-65	6	SQ				1														1		1	0.1	10	1	0.1	10
	65-75	5	SQ				2														3	4	2	0.2	24	7	0.7	84
	75-85	5	SQ		1																10		1	0.1	12	10	1	120
	85-95	5.5	SQ				2							1							5		3	0.3	33	5	0.5	55
	95-105	6	SQ				2														4	2	2	0.2	20	6	0.6	60
U4 Total	5-105	56			4		16							1					1		35	22	22	0.22	24	57	0.57	61
M1	5-15	5	SQ																				0	0	0	0	0	0
	15-25	5	SQ																				0	0	0	0	0	0
	25-35	5	SQ		1		1												2				4	0.4	48	0	0	0
	35-45	6	SQ			1	1		1										1		1	1	4	0.4	40	2	0.2	20
	45-55	5	SQ				5																5	0.5	60	0	0	0
	55-65	4	SQ				3														1	5	3	0.3	45	6	0.6	90
	65-75	6	SQ				3									1			1			1	5	0.5	50	1	0.1	10
	75-85	5	SQ				5												1			5	6	0.6	72	5	0.5	60
	85-95	5	SQ		1		5															6	6	0.6	72	6	0.6	72
	95-105	5	SQ				2														1	7	2	0.2	24	8	0.8	96
M1 Total	5-105	51			2	1	25		1							1			5		3	25	35	0.35	41	28	0.28	33
M2	5-15	5	SQ																				0	0	0	0	0	0
	15-25	5	SQ				3				1					2						2	6	0.6	72	2	0.2	24
	25-35	6	SQ			1	5	1						8					1		1	2	16	1.6	160	3	0.3	30
	35-45	5	SQ		1		5					1		2		1			2			1	12	1.2	144	1	0.1	12
	45-55	6	SQ		1		9							3					6			7	19	1.9	190	7	0.7	70
	55-65	5	SQ				2					1		2				1	6			3	12	1.2	144	3	0.3	36
	65-75	5	SQ		2		2						1										5	0.5	60	0	0	0
	75-85	5	SQ				4												1			2	5	0.5	60	2	0.2	24
	85-95	5	SQ				1									1							2	0.2	24	0	0	0
	95-105	5	SQ																			2	0	0	0	2	0.2	24
M2 Total	5-105	52			4	1	31	1			1	2	1	15		4		1	16		1	19	77	0.77	89	20	0.2	23

TABLE 2 – SEMI-QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details				SPECIES: MUSSELS																		SPECIES: SNAILS		Totals, Densities, CPUE					
Site/ transect	Sample (distance from bank in meters)	Effort (min)	Method	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Elliptio dilitata*	*Lampsilis abrupta*	*Leptodea fragilis*	*Megalonaias nervosa*	*Obliquaria reflexa*	*Plethobasus cyphyus*	*Pleurobema cordatum*	*Fusconaia subrotunda*	*Potamilus alatus*	*Pyganodon grandis*	*Quadrula metanevra*	*Quadrula pustulosa*	*Utterbackia imbecillis*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (mussels/sq m)	CPUE (Mussels/hour)	TOTAL Snails	Density (Snails/sq m)	CPUE (Snails/hour)
M3	5-15	5	SQ				1									2						4	3	0.3	36	4	0.4	48
	15-25	5	SQ	1	1	1	6							2					2			2	13	1.3	156	2	0.2	24
	25-35	5	SQ			1	3							1		1			1			5	7	0.7	84	5	0.5	60
	35-45	5	SQ				9									1			1			1	11	1.1	132	1	0.1	12
	45-55	5	SQ		2	4	9							2		2			1			2	20	2	240	2	0.2	24
	55-65	5	SQ		4	1	22			1				5							1	9	33	3.3	396	10	1	120
	65-75	5	SQ				9							6		1			1	1		10	18	1.8	216	10	1	120
	75-85	5	SQ				3							5								7	8	0.8	96	7	0.7	84
	85-95	5	SQ		2	2	4														2	10	8	0.8	96	12	1.2	144
	95-105	5	SQ		1		5							2								23	8	0.8	96	23	2.3	276
M3 Total	5-105	50		1	10	9	71			1				23		7			6	1	3	73	129	1.29	155	76	0.76	91
M4	5-15	5	SQ				5									1			1			6	7	0.7	84	6	0.6	72
	15-25	5	SQ		1		8							3								3	12	1.2	144	3	0.3	36
	25-35	5	SQ				5							7					2			5	14	1.4	168	5	0.5	60
	35-45	5	SQ			1	2												2			1	5	0.5	60	1	0.1	12
	45-55	6	SQ				1																1	0.1	10	0	0	0
	55-65	5	SQ		1		10							4		1			3			6	19	1.9	228	6	0.6	72
	65-75	6	SQ			1								7							2	4	8	0.8	80	6	0.6	60
	75-85	5	SQ		2	3	3							3					2		2	6	13	1.3	156	8	0.8	96
	85-95	5	SQ			1	4							7								3	12	1.2	144	3	0.3	36
	95-105	5	SQ			3	2							4								11	9	0.9	108	11	1.1	132
M4 Total	5-105	52			4	9	40							35		2			10		4	45	100	1	115	49	0.49	57
D1	5-15	5	SQ		1		1					1							3				6	0.6	72	0	0	0
	15-25	5	SQ		1	2	9							1									13	1.3	156	0	0	0
	25-35	5	SQ		1		11																12	1.2	144	0	0	0
	35-45	5	SQ		1		9									1							11	1.1	132	0	0	0
	45-55	5	SQ				4							1							3		5	0.5	60	3	0.3	36
	55-65	5	SQ		2		8														1		10	1	120	1	0.1	12
	65-75	5	SQ		2		9												1				12	1.2	144	0	0	0
	75-85	5	SQ		1		10																11	1.1	132	0	0	0
	85-95	5	SQ		2		8												2				12	1.2	144	0	0	0
	95-105	5	SQ			1	10							2									13	1.3	156	0	0	0
D1 Total	5-105	50			11	3	79					1		4		1			6		4		105	1.05	126	4	0.04	5

TABLE 2 – SEMI-QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details				SPECIES: MUSSELS																		SPECIES: SNAILS		Totals, Densities, CPUE					
Site/ transect	Sample (distance from bank in meters)	Effort (min)	Method	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Elliptio dilitata*	*Lampsilis abrupta*	*Leptodea fragilis*	*Megalonaias nervosa*	*Obliquaria reflexa*	*Plethobasus cyphyus*	*Pleurobema cordatum*	*Fusconaia subrotunda*	*Potamilus alatus*	*Pyganodon grandis*	*Quadrula metanevra*	*Quadrula pustulosa*	*Utterbackia imbecillis*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (mussels/sq m)	CPUE (Mussels/hour)	TOTAL Snails	Density (Snails/sq m)	CPUE (Snails/hour)
D2	5-15	5	SQ													1							1	0.1	12	0	0	0
	15-25	5	SQ				6									1			1				8	0.8	96	0	0	0
	25-35	5	SQ		1		7								1								9	0.9	108	0	0	0
	35-45	5	SQ				1																1	0.1	12	0	0	0
	45-55	5	SQ		2	1	5							1									9	0.9	108	0	0	0
	55-65	4	SQ		2		6																8	0.8	120	0	0	0
	65-75	5	SQ				9																9	0.9	108	0	0	0
	75-85	5	SQ		1		7							2									10	1	120	0	0	0
	85-95	5	SQ		1		8																9	0.9	108	0	0	0
	95-105	5	SQ				9									1		1	1				12	1.2	144	0	0	0
D2 Total	5-105	49			7	1	58							3	1	3		1	2				76	0.76	93	0	0	0
D3	5-15	4	SQ				2																2	0.2	30	0	0	0
	15-25	4	SQ				2														3		2	0.2	30	3	0.3	45
	25-35	4	SQ		1		6							1		1							9	0.9	135	0	0	0
	35-45	4	SQ		5	1	7																13	1.3	195	0	0	0
	45-55	5	SQ		5		6							2		1			1				15	1.5	180	0	0	0
	55-65	5	SQ		4	1	7												1				13	1.3	156	0	0	0
	65-75	5	SQ		2		10																12	1.2	144	0	0	0
	75-85	5	SQ		1		4							1									6	0.6	72	0	0	0
	85-95	5	SQ		3		3																6	0.6	72	0	0	0
	95-105	5	SQ		5		20			1				1		1		1					29	2.9	348	0	0	0
D3 Total	5-105	46			26	2	67			1				5		3		1	2		3		107	1.07	140	3	0.03	4
D4	5-15	2	SQ																				0	0	0	0	0	0
	15-25	2	SQ																				0	0	0	0	0	0
	25-35	3	SQ				2																2	0.2	40	0	0	0
	35-45	3	SQ		1		1							2									4	0.4	80	0	0	0
	45-55	5	SQ				1																1	0.1	12	0	0	0
	55-65	4	SQ				3																3	0.3	45	0	0	0
	65-75	3	SQ				2														1		2	0.2	40	1	0.1	20
	75-85	4	SQ				11							1								1	12	1.2	180	1	0.1	15
	85-95	5	SQ		4		6							1							1		11	1.1	132	1	0.1	12
	95-105	4	SQ				12							1								1	13	1.3	195	1	0.1	15
D4 Total	5-105	35	SQ		5		38							5							2	2	48	0.48	82	4	0.04	7

TABLE 2 – SEMI-QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details				SPECIES																		Totals, Densities, CPUE					
				MUSSELS																SNAILS							
Site/ transect	Sample (distance from bank in meters)	Effort (min)	Method	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Elliptio dilitata*	*Lampsilis abrupta*	*Leptodea fragilis*	*Megalonaias nervosa*	*Obliquaria reflexa*	*Plethobasus cyphyus*	*Pleurobema cordatum*	*Fusconaia subrotunda*	*Potamilus alatus*	*Pyganodon grandis*	*Quadrula metanevra*	*Quadrula pustulosa*	*Utterbackia imbecillis*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (mussels/sq m)	CPUE (Mussels/hour)	TOTAL Snails	Density (Snails/sq m)	CPUE (Snails/hour)
Upstream Site				1	12	1	112	1	0	1	0	2	0	35	0	3	1	0	6	0	66	62	175	0.44 (SD 0.31)	47	128	0.32 (SD 0.19)	34
Middle Site				1	20	20	167	1	1	1	1	2	1	73	0	14	0	1	37	1	11	162	341	0.85 (SD 0.40)	100	173	0.44 (SD 0.25)	51
Downstream Site				0	49	6	242	0	0	1	0	1	0	17	1	7	0	2	10	0	9	2	336	0.84 (SD 0.28)	112	11	0.03 (SD 0.02)	4
All Sites		**2**		**81**	**27**	**521**	**2**	**1**	**3**	**1**	**5**	**1**	**125**	**1**	**24**	**1**	**3**	**53**	**1**	**86**	**226**	**852**	0.71	86	312	0.26	29

TABLE 3 – QUANTITATIVE SURVEY RESULTS

Site Details		Species											Totals, Densities			
		Mussels									Snails					
Site	Sample (distance from bank in meters)	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Leptodea fragilis*	*Obliquaria reflexa*	*Pleurobema cordatum*	*Potamilus alatus*	*Quadrula pustulosa*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (Mussels/sq m)	Total Snails	Density (Snails/sq m)
U1	15												0	0.00	0	0.00
	25											2	0	0.00	2	8.00
	35										2	1	0	0.00	3	12.00
	45										4	1	0	0.00	5	20.00
	55										2		0	0.00	2	8.00
	65												0	0.00	0	0.00
	75					1							1	4.00	0	0.00
	85											2	0	0.00	2	8.00
	95											1	0	0.00	1	4.00
	105										2	4	0	0.00	6	24.00
U1 Total		0	0	0	0	1	0	0	0	0	10	11	1	0.40	21	8.40

TABLE 3 – QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details		Species											Totals, Densities			
		Mussels									Snails					
Site	Sample (distance from bank in meters)	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Leptodea fragilis*	*Obliquaria reflexa*	*Pleurobema cordatum*	*Potamilus alatus*	*Quadrula pustulosa*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (Mussels/sq m)	Total Snails	Density (Snails/sq m)
U2	15															
	25				1		1				2	2	2	8.00	4	16.00
	35										4	4	0	0.00	8	32.00
	45										6		0	0.00	6	24.00
	55										1	1	0	0.00	2	8.00
	65										1	1	0	0.00	2	8.00
	75												0	0.00	0	0.00
	85						1						1	4.00	0	0.00
	95										1	4	0	0.00	5	20.00
	105											2	0	0.00	2	8.00
U2 Total		0	0	0	1	0	2	0	0	0	15	14	3	1.33	29	12.89
U3	15											2	0	0.00	2	8.00
	25											1	0	0.00	1	4.00
	35												0	0.00	0	0.00
	45												0	0.00	0	0.00
	55										2		0	0.00	2	8.00
	65		1								1	2	1	4.00	3	12.00
	75										1		0	0.00	1	4.00
	85										1		0	0.00	1	4.00
	95												0	0.00	0	0.00
	105												0	0.00	0	0.00
U3 Total		0	1	0	0	0	0	0	0	0	5	5	1	0.40	10	4.00
U4	15										1		0	0.00	1	4.00
	25										2		0	0.00	2	8.00
	35									1	1	1	1	4.00	2	8.00
	45										1		0	0.00	1	4.00
	55										2	2	0	0.00	4	16.00
	65												0	0.00	0	0.00
	75				2						2	1	2	8.00	3	12.00
	85										6		0	0.00	6	24.00
	95										2		0	0.00	2	8.00
	105										1		0	0.00	1	4.00
U4 Total		0	0	0	2	0	0	0	0	1	18	4	3	1.20	22	8.80

TABLE 3 – QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details		Species											Totals, Densities			
		Mussels									Snails					
Site	Sample (distance from bank in meters)	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Leptodea fragilis*	*Obliquaria reflexa*	*Pleurobema cordatum*	*Potamilus alatus*	*Quadrula pustulosa*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (Mussels/sq m)	Total Snails	Density (Snails/sq m)
M1	5										1	5	0	0.00	6	24.00
	15												0	0.00	0	0.00
	25												0	0.00	0	0.00
	35									2			2	8.00	0	0.00
	45										1		0	0.00	1	4.00
	55												0	0.00	0	0.00
	75											1	0	0.00	1	4.00
	85									1		1	1	4.00	1	4.00
	95											5	0	0.00	5	20.00
	105										1	5	0	0.00	6	24.00
M1 Total		0	0	0	0	0	0	0	0	3	3	17	3	1.20	20	8.00
M2	15												0	0.00	0	0.00
	25											1	0	0.00	1	4.00
	35								1		1	2	1	4.00	3	12.00
	45											1	0	0.00	1	4.00
	55											2	0	0.00	2	8.00
	65									1		3	1	4.00	3	12.00
	75												0	0.00	0	0.00
	85											2	0	0.00	2	8.00
	95												0	0.00	0	0.00
	105											2	0	0.00	2	8.00
M2 Total		0	0	0	0	0	0	0	1	1	1	13	2	0.80	14	5.60
M3	15									1		4	1	4.00	4	16.00
	25											2	0	0.00	2	8.00
	35									1		5	1	4.00	5	20.00
	45									1		1	1	4.00	1	4.00
	55									1		2	1	4.00	2	8.00
	65										1	8	0	0.00	9	36.00
	75											4	0	0.00	4	16.00
	85											4	0	0.00	4	16.00
	95						1			1		4	2	8.00	4	16.00
	105						1			1		3	2	8.00	3	12.00
M3 Total		0	0	0	0	0	2	0	0	6	1	37	8	3.20	38	15.20

TABLE 3 – QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details		Species											Totals, Densities			
		Mussels									Snails					
Site	Sample (distance from bank in meters)	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Leptodea fragilis*	*Obliquaria reflexa*	*Pleurobema cordatum*	*Potamilus alatus*	*Quadrula pustulosa*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (Mussels/sq m)	Total Snails	Density (Snails/sq m)
M4	15				2							5	2	8.00	5	20.00
	25									1		3	1	4.00	3	12.00
	35				1					1		5	2	8.00	5	20.00
	45									1		1	1	4.00	1	4.00
	55												0	0.00	0	0.00
	65				1					1		4	2	8.00	4	16.00
	75						1					3	1	4.00	3	12.00
	85										2	1	0	0.00	3	12.00
	95		1									3	1	4.00	3	12.00
	105				1							2	1	4.00	2	8.00
M4 Total		0	1	0	5	0	1	0	0	4	2	27	11	4.40	29	11.60
D1	20												0	0.00	0	0.00
	30									1			1	4.00	0	0.00
	40									1			1	4.00	0	0.00
	50												0	0.00	0	0.00
	60												0	0.00	0	0.00
	70										1		0	0.00	1	4.00
	80												0	0.00	0	0.00
	90												0	0.00	0	0.00
	100												0	0.00	0	0.00
	110												0	0.00	0	0.00
D1 Total		0	0	0	0	0	0	0	0	2	1	0	2	0.80	1	0.40
D2	15												0	0.00	0	0.00
	25									1			1	4.00	0	0.00
	35				1					1			2	8.00	0	0.00
	45												0	0.00	0	0.00
	55				1								1	4.00	0	0.00
	65				1					1			2	8.00	0	0.00
	75												0	0.00	0	0.00
	85								1				1	4.00	0	0.00
	95												0	0.00	0	0.00
	105												0	0.00	0	0.00
D2 Total		0	0	0	3	0	0	0	1	3	0	0	7	2.80	0	0.00

TABLE 3 – QUANTITATIVE SURVEY RESULTS, CONTINUED

Site Details		Species											Totals, Densities			
		Mussels									Snails					
Site	Sample (distance from bank in meters)	*Amblema plicata*	*Cyclonaias tuberculata*	*Ellipsaria lineolata*	*Elliptio crassidens*	*Leptodea fragilis*	*Obliquaria reflexa*	*Pleurobema cordatum*	*Potamilus alatus*	*Quadrula pustulosa*	*Pleurocera canaliculata*	*Viviparus georgianus*	TOTAL Mussels	Density (Mussels/sq m)	Total Snails	Density (Snails/sq m)
D3	15				1								1	4.00	0	0.00
	25										3		0	0.00	3	12.00
	35												0	0.00	0	0.00
	45												0	0.00	0	0.00
	55												0	0.00	0	0.00
	65												0	0.00	0	0.00
	75								1				1	4.00	0	0.00
	85								2				2	8.00	0	0.00
	95												0	0.00	0	0.00
	105												0	0.00	0	0.00
D3 Total		0	0	0	1	0	0	0	3	0	3	0	4	1.60	3	1.20
D4	15												0	0.00	0	0.00
	25												0	0.00	0	0.00
	35												0	0.00	0	0.00
	45					1							1	4.00	0	0.00
	55												0	0.00	0	0.00
	65												0	0.00	0	0.00
	75				1						1		1	4.00	1	4.00
	85								2	1			3	12.00	0	0.00
	95												0	0.00	0	0.00
	105												0	0.00	0	0.00
D4 Total		0	0	0	1	1	0	0	2	1	1	0	5	2.00	1	0.40
Upstream Site		0	1	0	3	1	2	0	0	1	48	34	8	0.8 (SD 0.50)	82	8.2 (SD 3.63)
Middle Site		0	1	0	5	0	3	0	1	14	7	94	24	2.4 (SD 1.70)	101	10.1 (SD 4.20)
Downstream Site		0	0	0	5	1	0	0	6	6	5	0	18	1.8 (SD 0.83)	5	0.5 (SD 0.50)
All Sites		0	2	0	13	2	5	0	7	21	60	128	50	1.7 (SD 0.81)	188	6.3 (SD 5.01)

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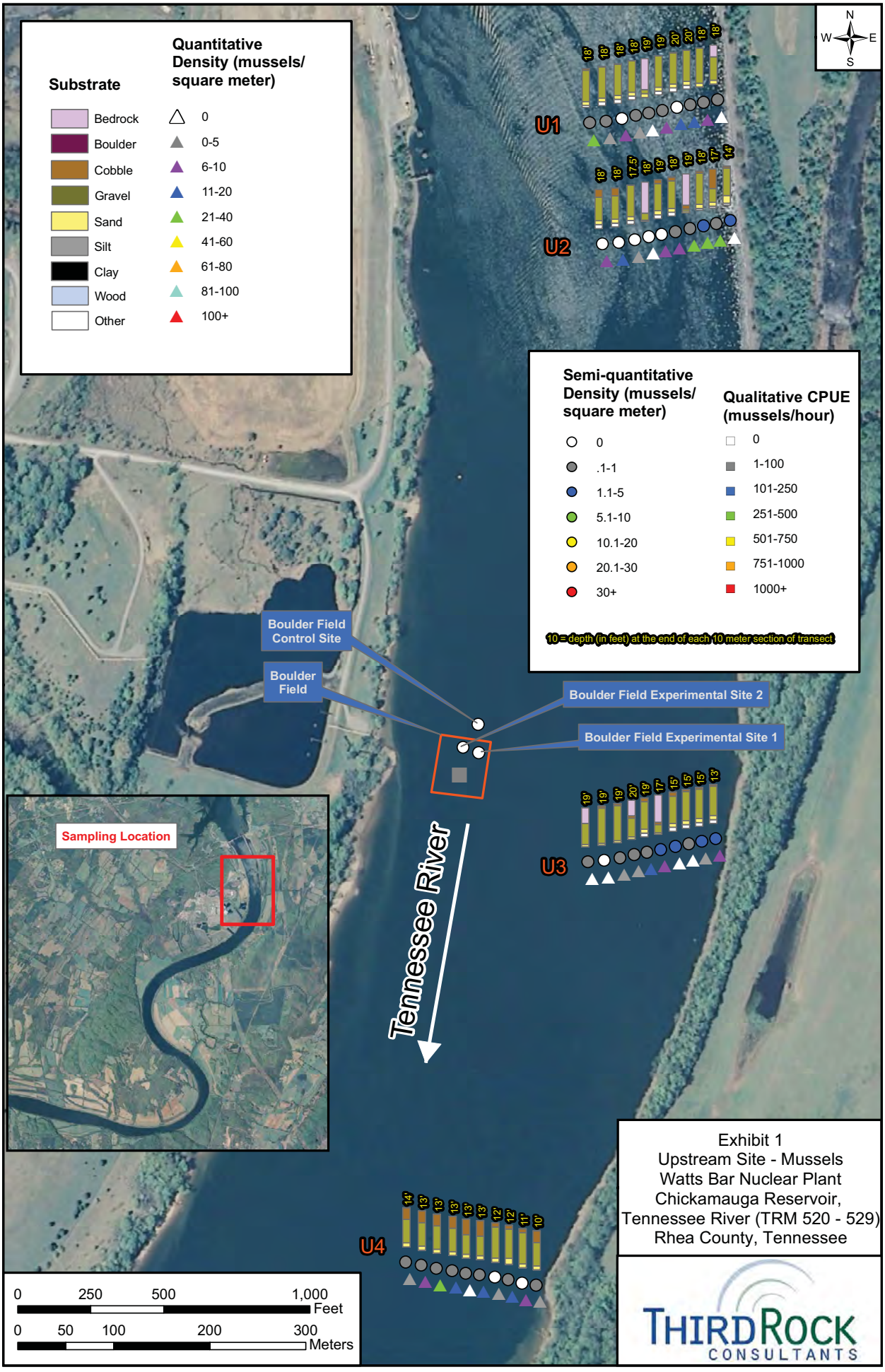

Exhibit 1
Upstream Site - Mussels
Watts Bar Nuclear Plant
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee

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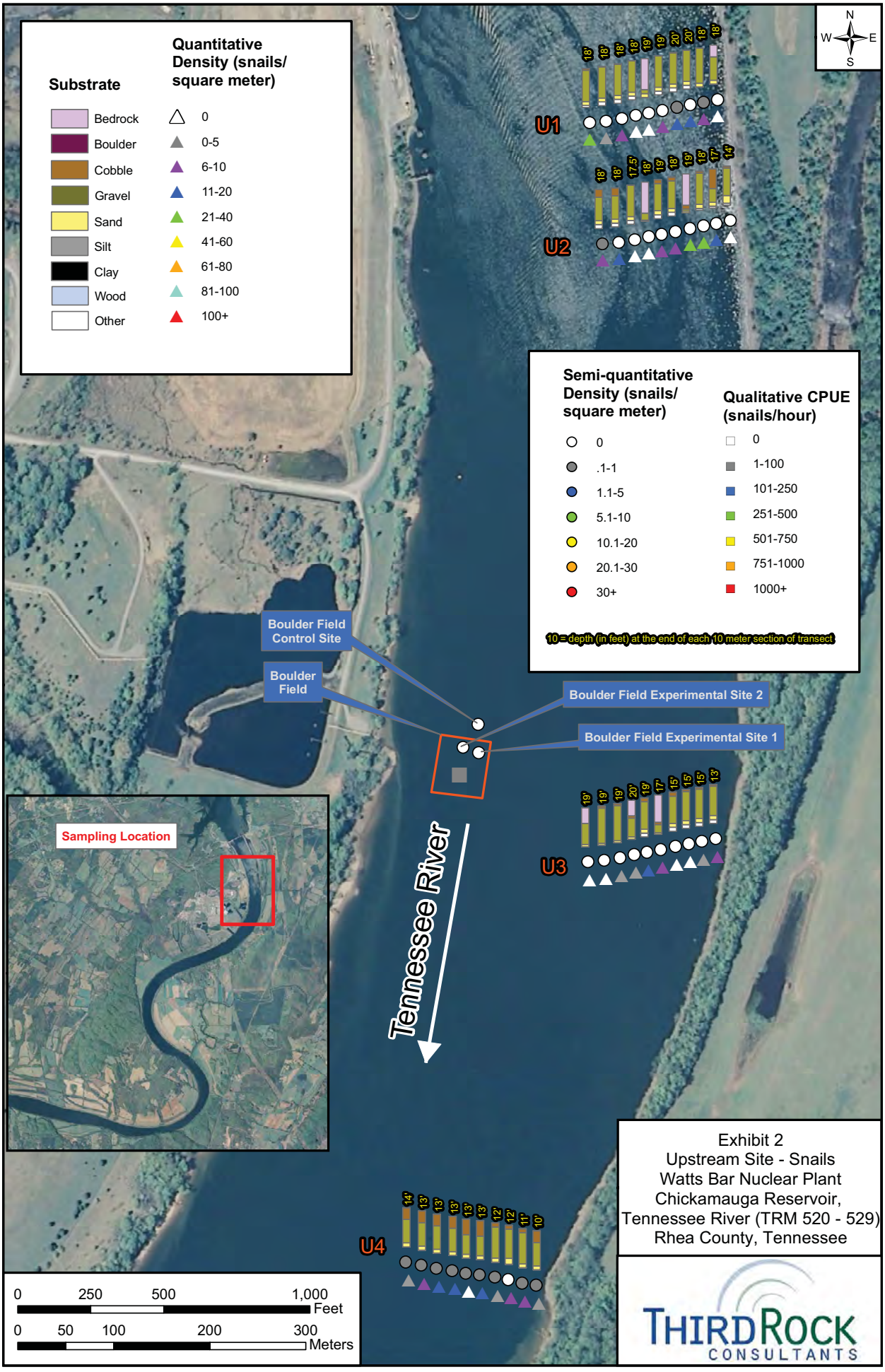
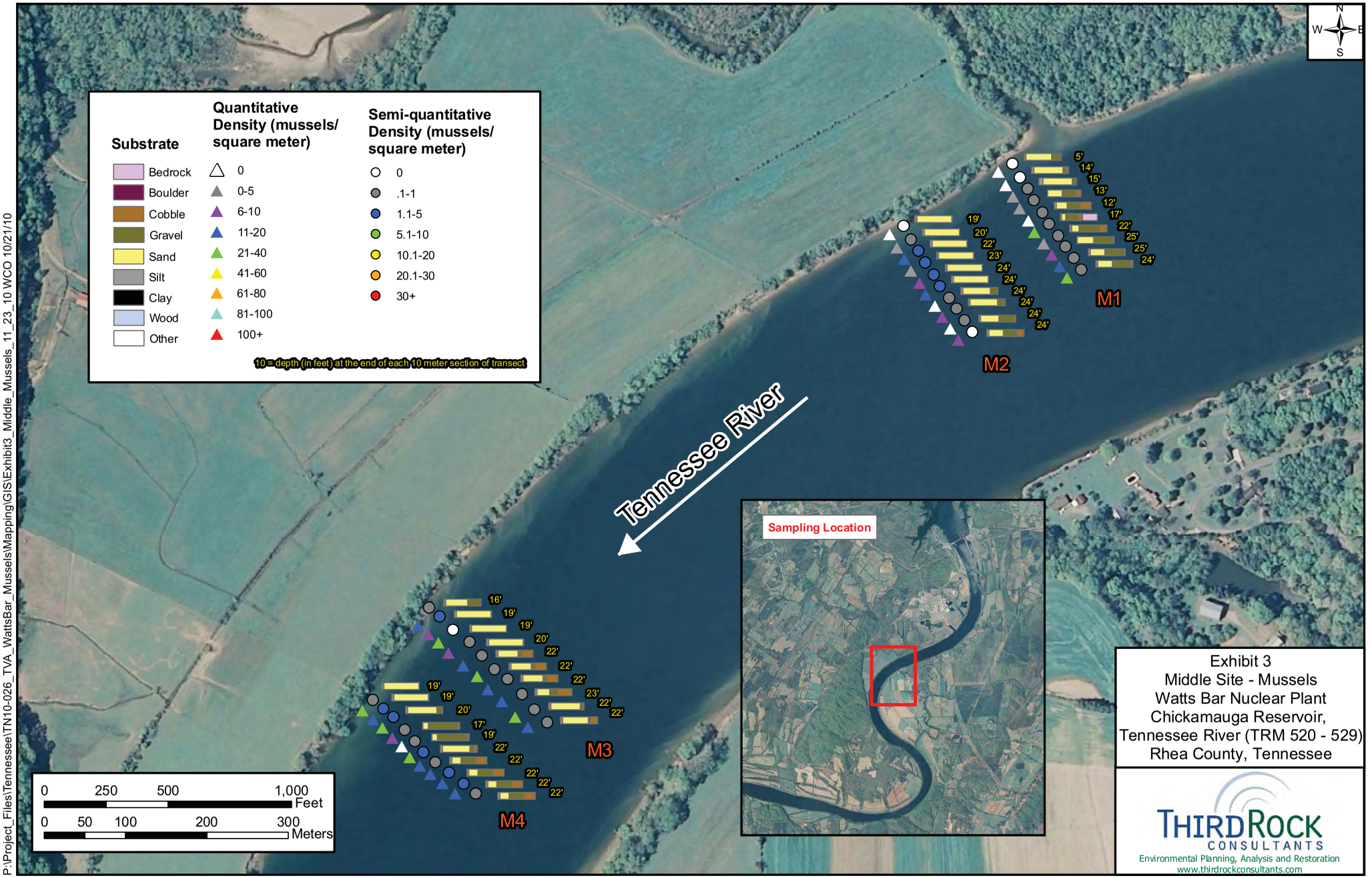


Exhibit 2
Upstream Site - Snails
Watts Bar Nuclear Plant
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee

THIRD ROCK CONSULTANTS



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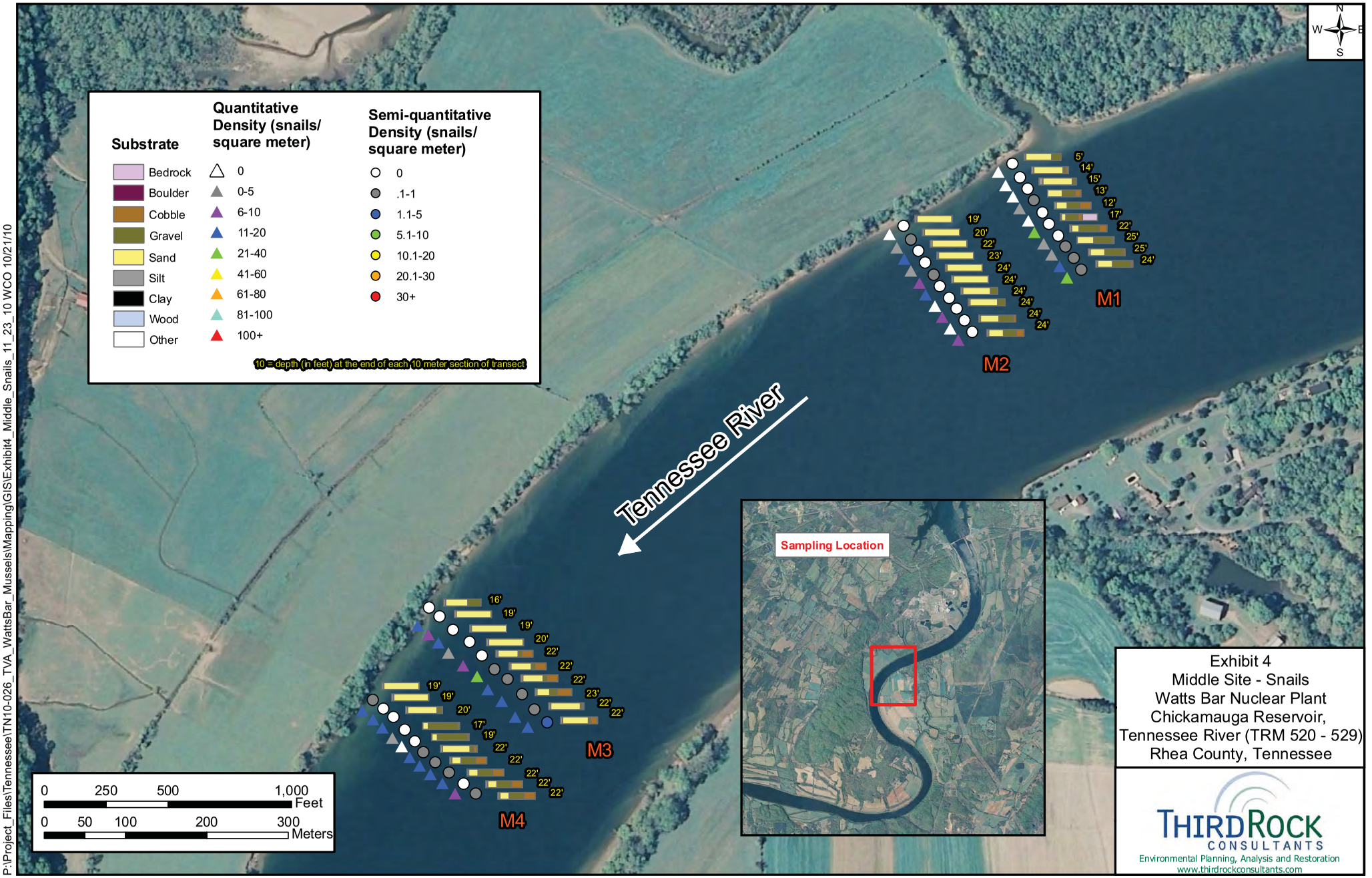

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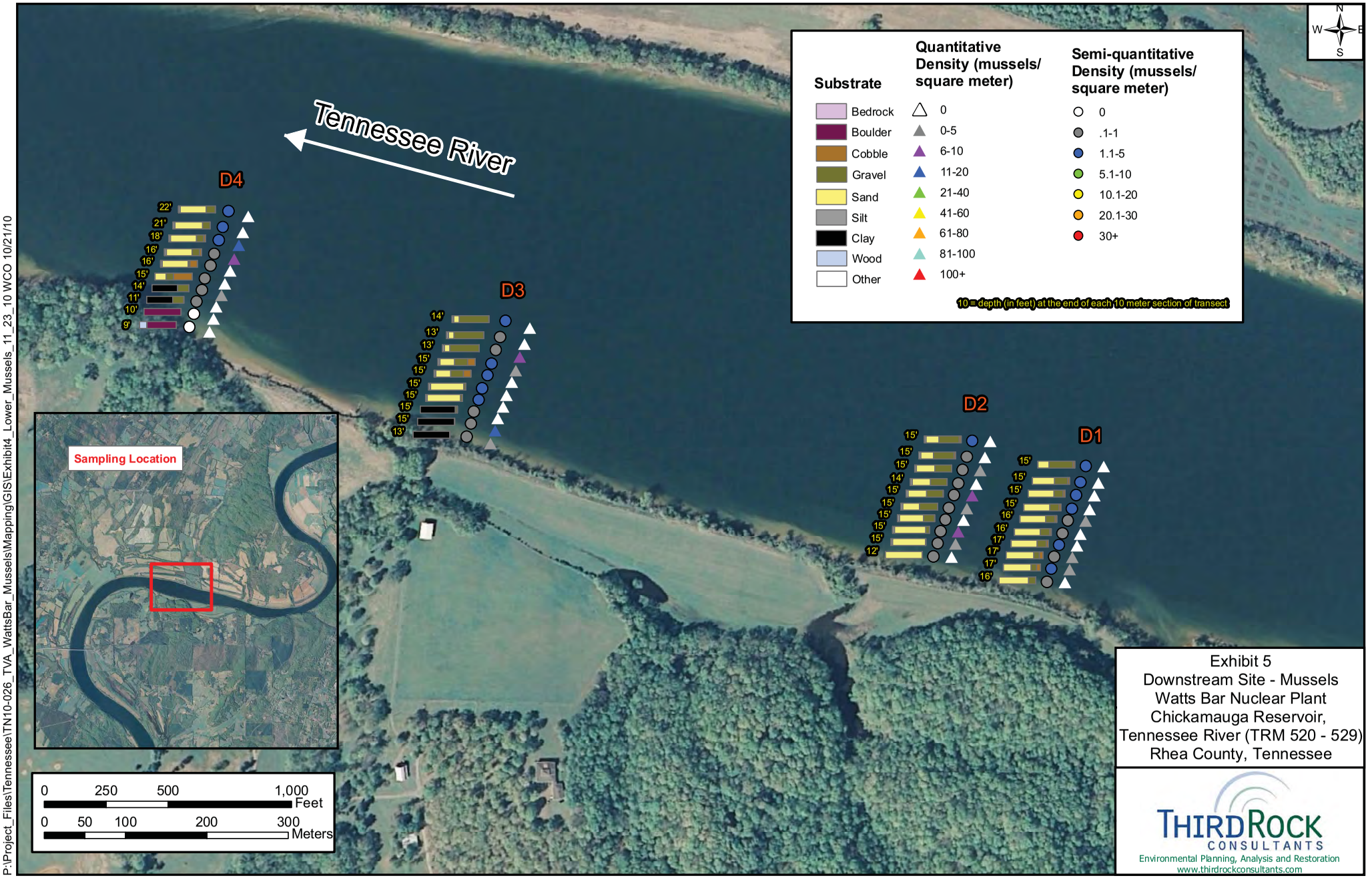

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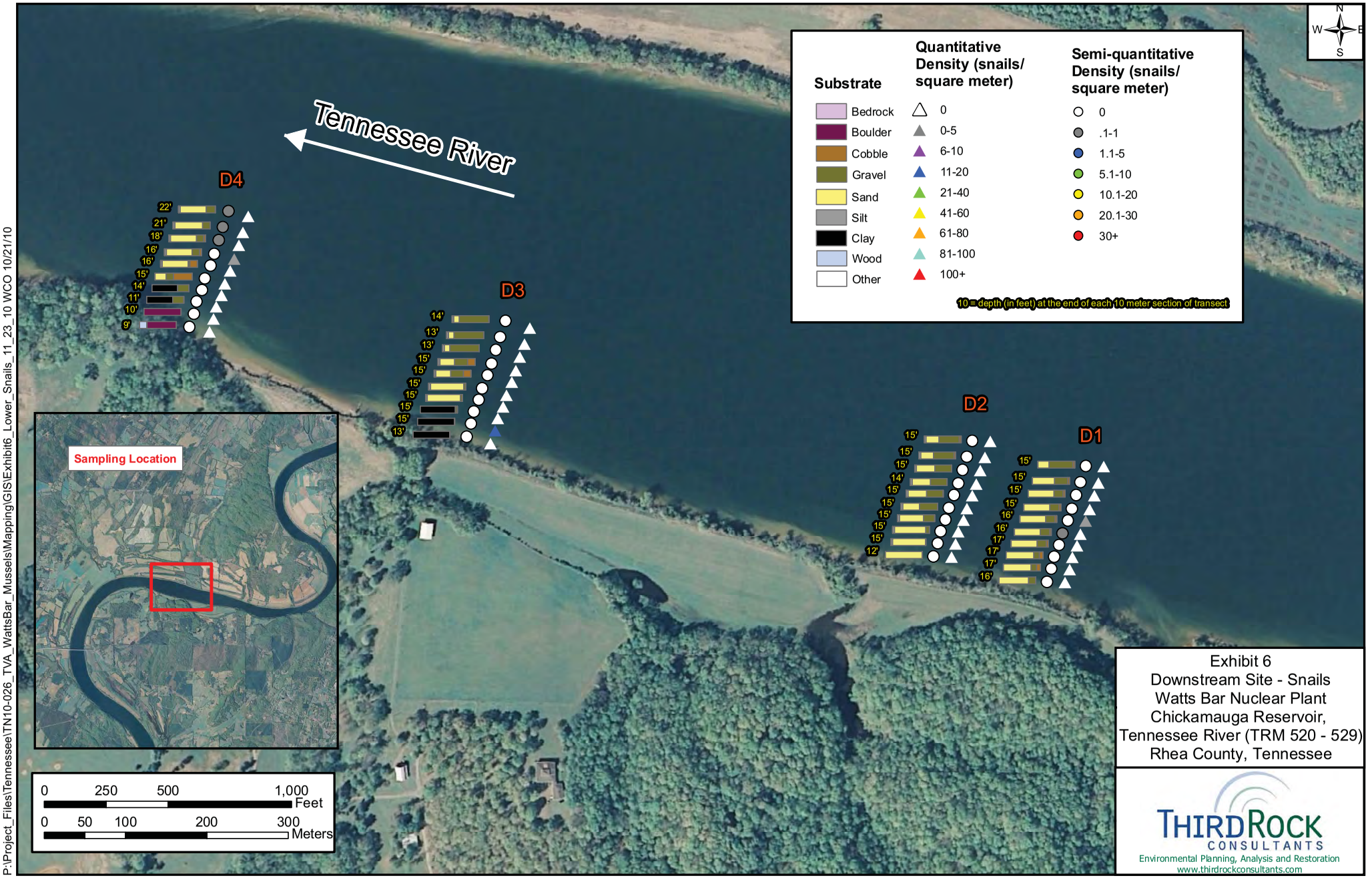
Tennessee River
D4
D3
D2
D1
Substrate
Bedrock
Boulder
Cobble
Gravel
Sand
Silt
Clay
Wood
Other
Quantitative Density (snails/ square meter)
0
0-5
6-10
11-20
21-40
41-60
61-80
81-100
100+
Semi-quantitative Density (snails/ square meter)
0
.1-1
1.1-5
5.1-10
10.1-20
20.1-30
30+
10 = depth (in feet) at the end of each 10 meter section of transect
N
W
E
S
Sampling Location
0 250 500 1,000 Feet
0 50 100 200 300 Meters
Exhibit 6
Downstream Site - Snails
Watts Bar Nuclear Plant
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee
THIRD ROCK CONSULTANTS
Environmental Planning, Analysis and Restoration
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Quantitative Sampling: A total of 120, 0.25 square meter quantitative samples were collected from the three sites. Quantitative samples resulted in the collection of 50 live mussels representing six species. The two most commonly occurring species were *Q. pustulosa* and *E. crassidens*, which is similar to the results of the semi-quantitative sampling. The average mussel densities from a 100-meter transect using quantitative sampling ranged from 0.4 to 4.4 mussels/square meter with an average of 1.7 mussels/transect (Table 3, pages 11 through 15). Total mussels and mean density observed per site were as follows: Upstream Site, 8 mussels (mean density = 0.8 mussels/m^2, s^2 = 0.21); Middle Site, 24 mussels (mean density = 2.4 mussels/m^2, s^2 = 2.88); Downstream Site, 18 mussels (mean density = 1.8 mussels/m^2, s^2 = 0.69).

Quantitative sampling resulted in the identification of 188 snails representing two species. Total snails and mean density observed per site are as follows: Upstream Site, 82 snails (mean density = 8.2 snails/m^2, s^2 = 9.87); Middle Site, 101 snails (mean density = 10.1 snails/m^2, s^2 = 17.64); Downstream Site, 18 snails (mean density = 0.5 snails/m^2, s^2 = 0.25). Sand was the most abundant substrate at the Downstream (49 percent) and Middle Site (61 percent), with gravel compromising another 28 percent and 23 percent, respectively. Gravel accounted for 64 percent of the Upstream Site. Cobble was present in varying degrees at all three sites, silt only at the Downstream and Middle Site, and bedrock only at the Middle and Upstream Site. Boulder, clay, and wood were also found at the Downstream Site. Little variation in substrate was observed at the Upstream and Middle Site; however, at the Downstream Site the abundance of sand was limited to D1 and D2. Clay (at transects D3 and D4) and boulder (at D4) accounted for an increased proportion of the substrate.

Average depth was similar at the Upstream and Downstream Sites, 16.4 feet (SD 2.9) and 15 feet (SD 2.3), respectively. At the Middle Site, average depth was 20.3 (SD 4.1). Within sites, trends were similar with depths typically gradually increasing from near the bank to the channel.

Water chemistry (as measured with a Hydrolab turbidity meter) was relatively similar at each site, though several trends were noticed (Table 4, page 24). DO gradually increased from upstream to downstream, starting at U1 with 4.49 mg/L and ending at D4 with 7.1 mg/L, while spC gradually decreased from 186.6 µS at U1 to 180.7 µS at D4. Also, pH levels were generally higher at the Middle and Downstream sites. Turbidity was 0.0 throughout the project area.

While many weathered dead and relic shells were encountered, fresh dead shells were relatively few. Of the 907 live mussels recorded during the survey only 61 fresh dead mussels were encountered, yielding an estimated recent mortality rate of 6.3 percent. The fresh dead mussels were represented by the six most commonly encountered mussels *E. crassidens, P. cordatum, C. tuberculata, Q. pustulosa, P. alatus,* and *E. lineolata*. No *Dreissena polymorpha* were encountered during the survey, though *Corbicula fluminaea* (Asian clams) were observed.

On average, the length of mussels collected in quantitative samples (47.9 millimeters) was nearly half that of mussels collected in semi-quantitative samples (98.1 millimeters), which characterizes the bias of semi-quantitative samplese to miss smaller and completely buried mussels. Recruitment does appear to be occurring within the project area for some species. A total of 28 of the 907 individuals collected were estimated to be three years of age or younger. These young individuals represented only 4 of the 17 observed species: *Leptodea fragilis*, *Obliquaria reflexa*, *Potamilus*

alatus, and *Utterbackia imbilicis*. Though snail lengths were not measured, various size classes were observed for both snail species. A summary of age and length for each species is represented in Table 5, page 24.

Experimental Boulder Field: A total of three sites (two historic, one control) were sampled in or near the experimental boulder field. During the survey, only two historic sampling stations were re-located within the boulder field. Sampling stations within the boulder field were determined by the presence of pieces of concrete embedded with steel rods (re-bar) driven into the river bottom. Divers were unable to re-locate all four pieces of re-bar that were originally placed to delineate boulder field sampling stations. Sampling was conducted in these areas since no other areas with re-bar were located. A "control" site upstream of the survey area was also surveyed (Exhibits 1 and 2, pages 16 and 17). While the last several quantitative samples were being processed on the boat, a 20-minute qualitative search was conducted through the boulder field to determine if any live mussels were present. Quantitative sampling at three locations according to the boulder field sampling protocol failed to yield any mussels (mean density = 0.0 mussels/m^2, s^2 = 0.0). The 20-minute qualitative sampling yielded a total of five live mussels (CPUE = 15 mussels/hour) and three snails (CPUE = 9 snails/hour) (Table 1, page 6; Exhibits 1 and 2, pages 16 and 17).

TABLE 4 – WATER CHEMISTRY

Date	Location	Depth	Temp (°C)	DO (mg/l)	pH	spC (µS)	Turbidity (NTU)
9/28/2010	U1	Surface	23.9	4.49	7.36	186.6	0
9/28/2010	U1	Bottom	23.9	4.5	7.54	185.8	0
9/29/2010	U4	Surface	23.87	5.59	7.43	183.7	0
9/29/2010	U4	Bottom	23.92	5.51	7.68	183.4	0
9/29/2010	M1	Surface	23.94	6.45	8.24	182.3	0
9/29/2010	M1	Bottom	23.8	5.7	8.11	182.9	0
9/29/2010	M4	Surface	24.22	6.62	8.3	184.5	0
9/29/2010	M4	Bottom	24.15	6.48	8.22	184.5	0
9/30/2010	D1	Surface	24.12	6.46	7.68	180.6	0
9/30/2010	D2	Bottom	23.96	6.11	7.89	180.4	0
9/30/2010	D3	Surface	24.57	7.09	8.86	180.7	0
9/30/2010	D4	Bottom	24.53	7.1	8.42	180.7	0

TABLE 5 – LENGTH AND AGE SUMMARY

Species	Average of Length (mm)	Min of Length (mm)	Max of Length (mm)	StdDev of Length (mm)	Average of Age (yr)	Min of Age (yr)	Max of Age (yr)	StdDev of Age (yr)	Percent of Mussels < 3 years of age	Percent of Mussels < 5 years of age
Amblema plicata	103.5	97	110	9.19	20.5	20	21	0.71		
Cyclonaias tuberculata	85.0	34	106	9.95	30.7	4	48	8.29		1.2
Ellipsaria lineolata	92.7	70	113	10.32	19.2	13	27	4.38		
Elliptio crassidens	116.1	89	140	8.28	31.0	9	46	6.31		
Elliptio dilitata	113.5	105	122	12.02	38.0	38	38			
Lampsilis abrupta	123.0	123	123		33.0	33	33			
Leptodea fragilis	77.4	46	113	25.42	3.3	1	6	2.22	40.0	60.0
Megalonaias nervosa	187.0	187	187		53.0	53	53			
Obliquaria reflexa	36.6	14	63	12.99	5.7	1	23	5.77	16.7	66.7
Plethobasus cyphyus	100.0	100	100		20.0	20	20			
Pleurobema cordatum	106.0	11	127	11.85	42.5	19	63	9.08		
Fusconaia subrotunda	68.0	68	68							
Potamilus alatus	72.3	15	180	53.64	3.3	0	15	4.49	56.3	62.5
Pyganodon grandis	163.0	163	163		12.0	12	12			
Quadrula metanevra	90.7	89	92	1.53	36.5	32	41	6.36		
Quadrula pustulosa	57.7	35	85	11.90	15.8	5	35	7.60		
Utterbackia imbecillis	45.0	45	45		3.0	3	3			100.0

APPENDICES

APPENDIX A – SURVEY RESULTS

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L1	SQ	5	1	10	20	L	*Cyclonaias tuberculata*	L	-	1	78	24	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	SQ	5	2	20	30	L	*Cyclonaias tuberculata*	L	-	1	74	27	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Cyclonaias tuberculata*	L	-	1	85	46	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Cyclonaias tuberculata*	L	-	1	82	30	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	5	50	60	L	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Cyclonaias tuberculata*	L	-	1	75	25	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Cyclonaias tuberculata*	L	-	1	78	28	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	QN	0.25	6	60	70	L	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	7	70	80	L	*Cyclonaias tuberculata*	L	-	1	90	33	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Cyclonaias tuberculata*	L	-	1	73	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Cyclonaias tuberculata*	L	-	1	82	28	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Cyclonaias tuberculata*	L	-	1	94	36	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Cyclonaias tuberculata*	L	-	1	95	37	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	SQ	5	2	20	30	L	*Ellipsaria lineolata*	L	m	1	99	13	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Ellipsaria lineolata*	L	f	1	71	13	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	gravid
L1	SQ	5	10	100	110	L	*Ellipsaria lineolata*	L	-	1	80	-	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L1	SQ	5	1	10	20	L	*Elliptio crassidens*	L	-	1	101	29	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	WD	-	4	-	-	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	118	36	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	110	32	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	108	24	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	113	32	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	112	31	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	116	32	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	120	37	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	115	36	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	2	20	30	L	*Elliptio crassidens*	L	-	1	120	32	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	124	40	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	118	35	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	120	28	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	114	35	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	109	36	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	110	39	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	120	39	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	107	37	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	1	92	18	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	3	30	40	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	109	37	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	110	36	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	109	33	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	118	32	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	126	38	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	115	36	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	116	39	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	108	30	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	4	40	50	L	*Elliptio crassidens*	L	-	1	100	34	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	5	50	60	L	*Elliptio crassidens*	L	-	1	102	27	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	5	50	60	L	*Elliptio crassidens*	L	-	1	110	36	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L1	SQ	5	5	50	60	L	*Elliptio crassidens*	L	-	1	114	38	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	5	50	60	L	*Elliptio crassidens*	L	-	1	130	32	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	5	50	60	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	108	27	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	118	31	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	110	35	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	110	27	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	110	26	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	104	29	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	120	36	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	L	-	1	110	34	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	WD	-	5	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	6	60	70	L	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	125	37	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	115	30	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	110	26	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	118	31	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	121	34	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	111	32	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	111	33	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	104	29	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	7	70	80	L	*Elliptio crassidens*	L	-	1	112	30	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	QN	0.25	7	70	80	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	L	-	1	104	30	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	L	-	1	109	28	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	L	-	1	120	35	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	L	-	1	120	39	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	L	-	1	130	34	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	L	-	5	-	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	8	80	90	L	*Elliptio crassidens*	WD	-	5	-	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Elliptio crassidens*	L	-	8	-	-	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	QN	0.25	9	90	100	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	SQ	5	10	100	110	L	*Elliptio crassidens*	WD	-	5	-	-	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L1	SQ	5	10	100	110	L	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L1	SQ	5	10	100	110	L	*Elliptio crassidens*	L	-	10	-	-	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L1	SQ	5	1	10	20	L	*Leptodea fragilis*	WD	-	1	-	-	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	SQ	5	1	10	20	L	*Obliquaria reflexa*	L	-	1	48	6	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	SQ	5	2	20	30	L	*Pleurobema cordatum*	L	-	1	102	30	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	5	50	60	L	*Pleurobema cordatum*	L	-	1	95	34	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	SQ	5	8	80	90	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	10	100	110	L	*Pleurobema cordatum*	L	-	1	104	36	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L1	SQ	5	10	100	110	L	*Pleurobema cordatum*	L	-	1	111	38	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L1	SQ	5	4	40	50	L	*Potamilus alatus*	L	-	1	29	3	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	SQ	5	1	10	20	L	*Quadrula pustulosa*	L	-	1	54	14	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	SQ	5	1	10	20	L	*Quadrula pustulosa*	L	-	1	37	6	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L1	SQ	5	1	10	20	L	*Quadrula pustulosa*	L	-	1	41	9	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	QN	0.25	2	20	30	L	*Quadrula pustulosa*	L	-	1	47	14	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	QN	0.25	3	30	40	L	*Quadrula pustulosa*	L	-	1	-	-	-	0	0	10	15	75	0	0	0	0	100.0	17	5.2	
L1	SQ	5	7	70	80	L	*Quadrula pustulosa*	L	-	1	55	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Quadrula pustulosa*	L	-	1	45	11	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L1	SQ	5	9	90	100	L	*Quadrula pustulosa*	L	-	1	48	8	-	0	0	5	35	60	0	0	0	0	100.0	15	4.6	
L2	SQ	5	3	25	35	L	*Cyclonaias tuberculata*	L	-	1	82	28	-	0	0	0	10	85	5	0	0	0	100.0	15	4.6	
L2	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	87	33	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	86	-	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	85	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	78	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	8	75	85	L	*Cyclonaias tuberculata*	L	-	1	95	32	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	8	75	85	L	*Cyclonaias tuberculata*	WD	-	2	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	95	28	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	5	45	55	L	*Ellipsaria lineolata*	L	-	1	95	22	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Ellipsaria lineolata*	FD	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	2	15	25	L	*Elliptio crassidens*	L	-	6	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L2	SQ	5	2	15	25	L	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L2	SQ	5	3	25	35	L	*Elliptio crassidens*	L	-	7	-	-	-	0	0	0	10	85	5	0	0	0	100.0	15	4.6	
L2	SQ	5	3	25	35	L	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	10	85	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	3	25	35	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	10	85	5	0	0	0	100.0	15	4.6	
L2	SQ	5	4	35	45	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	30	65	5	0	0	0	100.0	15	4.6	
L2	SQ	5	4	35	45	L	*Elliptio crassidens*	FD	-	3	-	-	-	0	0	0	30	65	5	0	0	0	100.0	15	4.6	
L2	SQ	5	4	35	45	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	30	65	5	0	0	0	100.0	15	4.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L2	SQ	5	5	45	55	L	*Elliptio crassidens*	L	-	5	-	-	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	SQ	5	5	45	55	L	*Elliptio crassidens*	WD	-	6	-	-	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	5	45	55	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Elliptio crassidens*	L	-	6	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Elliptio crassidens*	FD	-	4	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	6	55	65	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	6	55	65	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	7	65	75	L	*Elliptio crassidens*	L	-	9	-	-	-	0	0	0	45	50	5	0	0	0	100.0	14	4.3	
L2	SQ	5	7	65	75	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	14	4.3	
L2	SQ	5	8	75	85	L	*Elliptio crassidens*	L	-	7	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	8	75	85	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	9	85	95	L	*Elliptio crassidens*	L	-	8	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	9	85	95	L	*Elliptio crassidens*	WD	-	7	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	9	85	95	L	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	10	95	105	L	*Elliptio crassidens*	L	-	8	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	10	95	105	L	*Elliptio crassidens*	WD	-	4	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	10	95	105	L	*Elliptio crassidens*	L	-	1	97	12	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	2	15	25	L	Musculium transversum	L	-	1	10	1	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L2	SQ	5	5	45	55	L	*Pleurobema cordatum*	L	-	1	105	32	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	SQ	4	6	55	65	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	8	75	85	L	*Pleurobema cordatum*	L	-	1	110	39	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	8	75	85	L	*Pleurobema cordatum*	L	-	1	103	40	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	3	25	35	L	*Fusconaia subrotunda*	L	-	1	68	-	-	0	0	0	10	85	5	0	0	0	100.0	15	4.6	Orange foot,

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
																										eroded shell
L2	SQ	5	1	5	15	L	*Potamilus alatus*	FD	-	1	-	-	-	0	0	0	0	100	0	0	0	0	100.0	12	3.7	
L2	SQ	5	1	5	15	L	*Potamilus alatus*	WD	-	1	-	-	-	0	0	0	0	100	0	0	0	0	100.0	12	3.7	
L2	SQ	5	1	5	15	L	*Potamilus alatus*	L	f	1	140	12	-	0	0	0	0	100	0	0	0	0	100.0	12	3.7	
L2	SQ	5	2	15	25	L	*Potamilus alatus*	L	-	1	33	0	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	8	75	85	L	*Potamilus alatus*	L	-	1	34	0	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	10	95	105	L	*Potamilus alatus*	L	-	1	30	0	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	10	95	105	L	*Quadrula metanevra*	L	-	1	89	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	SQ	5	2	15	25	L	*Quadrula pustulosa*	L	-	1	57	13	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	2	15	25	L	*Quadrula pustulosa*	L	-	1	58	25	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	3	25	35	L	*Quadrula pustulosa*	L	-	1	35	6	-	0	0	0	10	85	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	5	45	55	L	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	0	50	45	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	6	55	65	L	*Quadrula pustulosa*	L	-	1	69	22	-	0	0	0	45	50	5	0	0	0	100.0	15	4.6	
L2	SQ	5	10	95	105	L	*Quadrula pustulosa*	L	-	1	75	28	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L3	SQ	4	3	25	35	L	*Cyclonaias tuberculata*	L	-	1	90	36	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	90	31	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	90	34	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	80	37	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	78	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	76	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	80	30	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	90	34	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	77	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	78	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L3	SQ	5	5	45	55	L	*Cyclonaias tuberculata*	L	-	1	80	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	85	29	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	86	32	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	87	27	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	79	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	7	65	75	L	*Cyclonaias tuberculata*	L	-	1	80	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	7	65	75	L	*Cyclonaias tuberculata*	L	-	1	98	39	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	8	75	85	L	*Cyclonaias tuberculata*	L	-	1	92	27	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	88	-	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	79	26	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	80	29	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	10	95	105	L	*Cyclonaias tuberculata*	L	-	1	83	27	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Cyclonaias tuberculata*	L	-	1	75	-	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Cyclonaias tuberculata*	L	-	1	81	23	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Cyclonaias tuberculata*	L	-	1	96	39	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Cyclonaias tuberculata*	L	-	1	88	42	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	4	4	35	45	L	*Ellipsaria lineolata*	L	m	1	80	16	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Ellipsaria lineolata*	L	m	1	94	19	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	4	1	5	15	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	0	0	0	0	100	0	0	100.0	13	4.0	dead mussels
L3	SQ	4	1	5	15	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	0	0	0	100	0	0	100.0	13	4.0	dead mussels
L3	QN	0.25	1	5	15	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	0	0	0	100	0	0	100.0	13	4.0	dead mussels
L3	SQ	4	2	15	25	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	0	0	0	0	100	0	0	100.0	15	4.6	dead mussels
L3	SQ	4	2	15	25	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	0	0	0	100	0	0	100.0	15	4.6	dead mussels
L3	SQ	4	3	25	35	L	*Elliptio crassidens*	L	-	1	90	9	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L3	SQ	4	3	25	35	L	*Elliptio crassidens*	L	-	5	-	-	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	
L3	SQ	4	3	25	35	L	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Elliptio crassidens*	L	-	7	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	4	4	35	45	L	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	4	35	45	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Elliptio crassidens*	L	-	6	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Elliptio crassidens*	L	-	7	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Elliptio crassidens*	WD	-	4	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	7	65	75	L	*Elliptio crassidens*	L	-	10	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	7	65	75	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	7	65	75	L	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	7	65	75	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	8	75	85	L	*Elliptio crassidens*	L	-	4	-	-	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	9	85	95	L	*Elliptio crassidens*	L	-	3	-	-	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	9	85	95	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	10	95	105	L	*Elliptio crassidens*	L	-	20	-	-	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Leptodea fragilis*	L	m	1	113	-	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	4	3	25	35	L	*Pleurobema cordatum*	L	-	1	103	41	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Pleurobema cordatum*	L	-	1	93	36	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Pleurobema cordatum*	L	-	1	95	43	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	5	45	55	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Pleurobema cordatum*	WD	-	2	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L3	SQ	5	7	65	75	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	8	75	85	L	*Pleurobema cordatum*	L	-	1	100	34	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	9	85	95	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	10	95	105	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	5	10	95	105	L	*Pleurobema cordatum*	L	-	1	110	41	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	4	3	25	35	L	*Potamilus alatus*	L	-	1	35	0	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	
L3	SQ		5	45	55	L	*Potamilus alatus*	L	-	1	38	0	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	7	65	75	L	*Potamilus alatus*	L	-	1	35	0	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	8	75	85	L	*Potamilus alatus*	L	-	1	34	0	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	QN	0.25	8	75	85	L	*Potamilus alatus*	L	-	1	35	0	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	
L3	SQ	5	10	95	105	L	*Potamilus alatus*	L	-	1	31	0	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	SQ	4	1	5	15	L	*Pyganodon grandis*	WD	-	1	-	-	-	0	0	0	0	0	0	100	0	0	100.0	13	4.0	dead mussels
L3	SQ	5	10	95	105	L	*Quadrula metanevra*	L	-	1	91	41	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L3	QN	0.25	4	35	45	L	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	5	45	55	L	*Quadrula pustulosa*	L	-	1	65	25	-	0	0	0	5	90	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	6	55	65	L	*Quadrula pustulosa*	L	-	1	70	23	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	SQ	5	7	65	75	L	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L4	SQ	3	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	83	28	-	0	0	0	30	0	0	70	0	0	100.0	14	4.3	
L4	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	85	38	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	74	-	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	SQ	5	9	85	95	L	*Cyclonaias tuberculata*	L	-	1	88	27	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	SQ	3	3	25	35	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	0	30	0	0	70	0	0	100.0	11	3.4	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L4	SQ	3	4	35	45	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	30	0	0	70	0	0	100.0	14	4.3	
L4	SQ	5	5	45	55	L	*Elliptio crassidens*	L	-	1	89	10	-	0	0	50	20	30	0	0	0	0	100.0	15	4.6	
L4	SQ	4	6	55	65	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	20	5	70	5	0	0	0	100.0	16	4.9	
L4	SQ	4	6	55	65	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	20	5	70	5	0	0	0	100.0	16	4.9	
L4	SQ	3	7	65	75	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	5	20	70	5	0	0	0	100.0	16	4.9	
L4	QN	0.25	7	65	75	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	5	20	70	5	0	0	0	100.0	16	4.9	
L4	SQ	4	8	75	85	L	*Elliptio crassidens*	L	-	8	-	-	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
L4	SQ	4	8	75	85	L	*Elliptio crassidens*	L	-	3	-	-	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
L4	SQ	5	9	85	95	L	*Elliptio crassidens*	L	-	6	-	-	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	SQ	4	10	95	105	L	*Elliptio crassidens*	L	-	10	-	-	-	0	0	0	25	70	5	0	0	0	100.0	22	6.7	
L4	SQ	4	10	95	105	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	0	25	70	5	0	0	0	100.0	22	6.7	
L4	QN	0.25	4	35	45	L	*Leptodea fragilis*	L	-	1	65	1	-	0	0	0	30	0	0	70	0	0	100.0	14	4.3	
L4	SQ	3	4	35	45	L	*Pleurobema cordatum*	WD	-	2	-	-	-	0	0	0	30	0	0	70	0	0	100.0	14	4.3	
L4	SQ	3	4	35	45	L	*Pleurobema cordatum*	L	-	1	103	27	-	0	0	0	30	0	0	70	0	0	100.0	14	4.3	
L4	SQ	3	4	35	45	L	*Pleurobema cordatum*	L	-	1	105	45	-	0	0	0	30	0	0	70	0	0	100.0	14	4.3	
L4	SQ	4	8	75	85	L	*Pleurobema cordatum*	L	-	1	91	30	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
L4	SQ	5	9	85	95	L	*Pleurobema cordatum*	L	-	1	122	56	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	SQ	4	10	95	105	L	*Pleurobema cordatum*	L	-	1	103	30	-	0	0	0	25	70	5	0	0	0	100.0	22	6.7	
L4	QN	0.25	8	75	85	L	*Potamilus alatus*	L	-	1	32	0	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
L4	QN	0.25	8	75	85	L	*Potamilus alatus*	L	-	1	28	0	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
L4	QN	0.25	8	75	85	L	*Quadrula pustulosa*	L	-	1	-	-	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
M1	QN	0.25	4	35	45	R	*Amblema plicata*	WD	-	1	-	-	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	5	3	25	35	R	*Cyclonaias tuberculata*	L	-	1	87	16	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	SQ	5	9	85	95	R	*Cyclonaias tuberculata*	L	-	1	97	29	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M1	SQ	5	9	85	95	R	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	6	4	35	45	R	*Ellipsaria lineolata*	L	m	1	91	16	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	5	3	25	35	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	SQ	5	3	25	35	R	*Elliptio crassidens*	L	-	1	114	46	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	SQ	6	4	35	45	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	6	4	35	45	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	6	4	35	45	R	*Elliptio crassidens*	L	-	1	123	24	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	5	5	45	55	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M1	SQ	5	5	45	55	R	*Elliptio crassidens*	L	-	1	120	29	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M1	SQ	5	5	45	55	R	*Elliptio crassidens*	L	-	1	114	26	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M1	SQ	5	5	45	55	R	*Elliptio crassidens*	L	-	1	122	28	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M1	SQ	5	5	45	55	R	*Elliptio crassidens*	L	-	1	119	-	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M1	SQ	5	5	45	55	R	*Elliptio crassidens*	L	-	1	133	35	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M1	SQ	4	6	55	5	R	*Elliptio crassidens*	WD	-	2	-	-	-	40	0	12	33	12	3	0	0	0	100.0	17	5.2	
M1	SQ	4	6	55	5	R	*Elliptio crassidens*	L	-	1	122	33	-	40	0	12	33	12	3	0	0	0	100.0	17	5.2	
M1	SQ	4	6	55	5	R	*Elliptio crassidens*	L	-	1	124	33	-	40	0	12	33	12	3	0	0	0	100.0	17	5.2	
M1	SQ	4	6	55	5	R	*Elliptio crassidens*	L	-	1	121	35	-	40	0	12	33	12	3	0	0	0	100.0	17	5.2	
M1	SQ	6	7	65	75	R	*Elliptio crassidens*	FD	-	3	-	-	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	6	7	65	75	R	*Elliptio crassidens*	L	-	1	115	31	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	6	7	65	75	R	*Elliptio crassidens*	L	-	1	114	35	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	6	7	65	75	R	*Elliptio crassidens*	L	-	1	115	36	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	WD	-	5	-	-	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	124	35	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	120	37	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	132	39	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	115	34	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	115	33	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	102	27	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	108	32	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	122	32	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	130	31	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	110	35	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	10	95	105	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	50	40	5	0	0	0	100.0	24	7.3	
M1	SQ	5	10	95	105	R	*Elliptio crassidens*	L	-	1	118	30	-	0	0	5	50	40	5	0	0	0	100.0	24	7.3	
M1	SQ	5	10	95	105	R	*Elliptio crassidens*	L	-	1	134	40	-	0	0	5	50	40	5	0	0	0	100.0	24	7.3	
M1	SQ	6	4	35	45	R	*Lampsilis abrupta*	L	m	1	123	33	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	5	8	75	85	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	6	7	65	75	R	*Potamilus alatus*	L	m	1	141	10	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	5	3	25	35	R	*Quadrula pustulosa*	L	-	1	52	14	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	SQ	5	3	25	35	R	*Quadrula pustulosa*	L	-	1	63	28	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	QN	0.25	3	25	35	R	*Quadrula pustulosa*	L	-	1	44	10	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	QN	0.25	3	25	35	R	*Quadrula pustulosa*	L	-	1	58	21	-	0	0	0	10	80	10	0	0	0	100.0	15	4.6	
M1	SQ	6	4	35	45	R	*Quadrula pustulosa*	L	-	1	46	8	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	QN	0.25	4	35	45	R	*Quadrula pustulosa*	FD	-	1	-	-	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	SQ	5	5	45	55	R	*Quadrula pustulosa*	FD	-	1	-	-	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M1	SQ	6	7	65	75	R	*Quadrula pustulosa*	L	-	1	58	12	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	5	8	75	85	R	*Quadrula pustulosa*	L	-	1	68	16	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	QN	0.25	8	75	85	R	*Quadrula pustulosa*	L	-	1	36	5	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Quadrula pustulosa*	FD	-	1	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M2	SQ	6	5	45	55	R	*Amblema plicata*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	4	35	45	R	*Cyclonaias tuberculata*	L	-	1	90	38	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	6	5	45	55	R	*Cyclonaias tuberculata*	L	-	1	90	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Cyclonaias tuberculata*	L	-	1	85	30	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Cyclonaias tuberculata*	L	-	1	90	22	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	6	3	25	35	R	*Ellipsaria lineolata*	L	-	1	100	22	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	4	35	45	R	*Ellipsaria lineolata*	WD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	6	5	45	55	R	*Ellipsaria lineolata*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Ellipsaria lineolata*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	2	15	25	R	*Elliptio crassidens*	L	-	1	119	36	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	SQ	5	2	15	25	R	*Elliptio crassidens*	L	-	1	115	30	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	SQ	5	2	15	25	R	*Elliptio crassidens*	L	-	1	130	45	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	SQ	5	2	15	25	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	L	-	1	130	45	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	L	-	1	124	40	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	L	-	1	108	29	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	L	-	1	114	35	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	L	-	1	116	39	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	1	120	30	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	1	130	32	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	1	126	30	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	1	123	37	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	1	130	37	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	110	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	120	30	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	116	30	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	120	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	112	35	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	140	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	115	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	115	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	130	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	5	45	55	R	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	5	45	55	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Elliptio crassidens*	L	-	1	122	30	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M2	SQ	5	6	55	65	R	*Elliptio crassidens*	L	-	1	110	26	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Elliptio crassidens*	L	-	1	105	29	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Elliptio crassidens*	L	-	1	106	33	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	115	33	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	1	123	23	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	2	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	-	-	-	0	0	5	40	50	5	0	0	0	100.0	24	7.3	
M2	SQ	5	9	85	95	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	5	40	50	5	0	0	0	100.0	24	7.3	
M2	SQ	6	3	25	35	R	*Elliptio dilitata*	L	-	1	122	38	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	7	65	75	R	*Leptodea fragilis*	WD	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	2	15	25	R	*Megalonaias nervosa*	L	-	1	187	53	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	SQ	6	3	25	35	R	*Obliquaria reflexa*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	4	35	45	R	*Obliquaria reflexa*	L	-	1	35	4	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	6	55	65	R	*Obliquaria reflexa*	L	-	1	63	23	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Obliquaria reflexa*	WD	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Plethobasus cyphyus*	L	-	1	100	20	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	109	53	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	120	58	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	112	47	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	103	46	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	110	44	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	120	53	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	102	54	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	L	-	1	102	41	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Pleurobema cordatum*	WD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	4	35	45	R	*Pleurobema cordatum*	L	-	1	104	48	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Pleurobema cordatum*	L	-	1	104	49	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	4	35	45	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	6	5	45	55	R	*Pleurobema cordatum*	L	-	1	110	41	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Pleurobema cordatum*	L	-	1	110	49	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Pleurobema cordatum*	L	-	1	105	52	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Pleurobema cordatum*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	105	37	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	125	42	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	2	15	25	R	*Potamilus alatus*	L	-	1	35	0	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	SQ	5	2	15	25	R	*Potamilus alatus*	L	f	1	100	3	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	gravid
M2	SQ	5	2	15	25	R	*Potamilus alatus*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	QN	0.25	3	25	35	R	*Potamilus alatus*	L	-	1	27	0	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	4	35	45	R	*Potamilus alatus*	L	-	1	28	0	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	5	9	85	95	R	*Potamilus alatus*	L	m	1	145	9	-	0	0	5	40	50	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula metanevra*	L	-	1	92	32	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	3	25	35	R	*Quadrula pustulosa*	L	-	1	60	13	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	6	3	25	35	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M2	SQ	5	4	35	45	R	*Quadrula pustulosa*	L	-	1	55	12	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M2	SQ	5	4	35	45	R	*Quadrula pustulosa*	L	-	1	62	17	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	L	-	1	70	20	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	L	-	1	63	15	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	L	-	1	65	17	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	L	-	1	70	30	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	L	-	1	65	24	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	L	-	1	50	9	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	6	5	45	55	R	*Quadrula pustulosa*	WD	-	3	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	70	20	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	63	22	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	59	21	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	70	22	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	58	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	75	28	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	6	55	65	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	6	55	65	R	*Quadrula pustulosa*	L	-	1	60	14	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Quadrula pustulosa*	WD	-	5	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Quadrula pustulosa*	L	-	1	70	26	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	8	75	85	R	*Quadrula pustulosa*	FD	-	2	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	SQ	5	9	85	95	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	5	40	50	5	0	0	0	100.0	24	7.3	
M2	SQ	5	10	95	105	R	*Quadrula pustulosa*	FD	-	1	-	-	-	0	0	20	35	40	5	0	0	0	100.0	24	7.3	
M2	SQ	5	7	65	75	R	*Tritogonia verrucosa*	WD	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M3	SQ	5	2	15	25	R	*Amblema plicata*	L	-	1	97	20	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M3	SQ	5	2	15	25	R	*Cyclonaias tuberculata*	L	-	1	93	27	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Cyclonaias tuberculata*	L	-	1	106	28	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Cyclonaias tuberculata*	L	-	1	86	26	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Cyclonaias tuberculata*	L	-	1	92	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Cyclonaias tuberculata*	L	-	1	98	31	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Cyclonaias tuberculata*	L	-	1	87	43	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Cyclonaias tuberculata*	L	-	1	90	35	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	9	85	95	R	*Cyclonaias tuberculata*	L	-	1	92	31	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	9	85	95	R	*Cyclonaias tuberculata*	L	-	1	96	30	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	9	85	95	R	*Cyclonaias tuberculata*	FD	-	1	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	10	95	105	R	*Cyclonaias tuberculata*	L	-	1	89	32	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	10	95	105	R	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	2	15	25	R	*Ellipsaria lineolata*	L	m	1	98	23	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	2	15	25	R	*Ellipsaria lineolata*	FD	f	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	3	25	35	R	*Ellipsaria lineolata*	L	m	1	110	26	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Ellipsaria lineolata*	L	m	1	92	17	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Ellipsaria lineolata*	L	f	1	80	18	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	gravid
M3	SQ	5	5	45	55	R	*Ellipsaria lineolata*	L	-	1	96	22	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Ellipsaria lineolata*	L	m	1	88	24	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
																										shells
M3	SQ	5	5	45	55	R	*Ellipsaria lineolata*	WD	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Ellipsaria lineolata*	L	m	1	104	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	9	85	95	R	*Ellipsaria lineolata*	L	m	1	93	16	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	9	85	95	R	*Ellipsaria lineolata*	L	f	1	70	13	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	gravid
M3	SQ	5	10	95	105	R	*Ellipsaria lineolata*	FD	-	1	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	1	5	15	R	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	35	60	5	0	0	0	100.0	16	4.9	
M3	SQ	5	2	15	25	R	*Elliptio crassidens*	L	-	6	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	2	15	25	R	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	2	15	25	R	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	QN	0.25	2	15	25	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	3	25	35	R	*Elliptio crassidens*	L	-	3	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	3	25	35	R	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	1	105	20	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells
M3	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	8	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells
M3	QN	0.25	4	35	45	R	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Elliptio crassidens*	L	-	9	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M3	QN	0.25	5	45	55	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Elliptio crassidens*	L	-	22	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Elliptio crassidens*	L	-	9	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	3	-	-	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	8	75	85	R	*Elliptio crassidens*	FD	-	2	-	-	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	3	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	1	120	11	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	9	85	95	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	9	85	95	R	*Elliptio crassidens*	FD	-	3	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	SQ	5	10	95	105	R	*Elliptio crassidens*	L	-	5	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	10	95	105	R	*Elliptio crassidens*	FD	-	1	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	QN	0.25	10	95	105	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	6	55	65	R	*Leptodea fragilis*	L	-	1	90	6	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	QN	0.25	9	85	95	R	*Obliquaria reflexa*	L	-	1	35	4	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	QN	0.25	10	95	105	R	*Obliquaria reflexa*	L	-	1	14	1	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	2	15	25	R	*Pleurobema cordatum*	L	-	1	115	32	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	2	15	25	R	*Pleurobema cordatum*	L	-	1	113	42	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	100	38	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M3	SQ	5	5	45	55	R	*Pleurobema cordatum*	L	-	1	110	25	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Pleurobema cordatum*	L	-	1	109	40	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	115	44	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	108	44	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	94	36	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	103	43	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	98	41	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	L	-	1	104	36	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	L	-	1	109	42	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	L	-	1	95	44	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	L	-	1	100	52	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	L	-	1	112	48	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	L	-	1	104	45	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	8	75	85	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	8	75	85	R	*Pleurobema cordatum*	L	-	1	112	36	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	8	75	85	R	*Pleurobema cordatum*	L	-	1	104	44	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	8	75	85	R	*Pleurobema cordatum*	L	-	1	109	42	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M3	SQ	5	8	75	85	R	*Pleurobema cordatum*	L	-	1	113	49	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	8	75	85	R	*Pleurobema cordatum*	L	-	1	120	55	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	10	95	105	R	*Pleurobema cordatum*	L	-	1	101	42	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	10	95	105	R	*Pleurobema cordatum*	L	-	1	127	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	10	95	105	R	*Pleurobema cordatum*	WD	-	2	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	1	5	15	R	*Potamilus alatus*	L	m	1	136	6	-	0	0	0	35	60	5	0	0	0	100.0	16	4.9	
M3	SQ	5	1	5	15	R	*Potamilus alatus*	L	m	1	155	10	-	0	0	0	35	60	5	0	0	0	100.0	16	4.9	
M3	SQ	5	3	25	35	R	*Potamilus alatus*	L	f	1	112	6	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	gravid
M3	SQ	5	4	35	45	R	*Potamilus alatus*	L	f	1	122	7	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	gravid
M3	SQ	5	5	45	55	R	*Potamilus alatus*	L	-	1	87	2	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Potamilus alatus*	L	-	1	15	0+	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Potamilus alatus*	L	-	1	25	0	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	QN	0.25	1	5	15	R	*Quadrula pustulosa*	L	-	1	42	6	-	0	0	0	35	60	5	0	0	0	100.0	16	4.9	
M3	SQ	5	2	15	25	R	*Quadrula pustulosa*	L	-	1	56	11	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	2	15	25	R	*Quadrula pustulosa*	L	-	1	49	10	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	2	15	25	R	*Quadrula pustulosa*	FD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	3	25	35	R	*Quadrula pustulosa*	L	-	1	65	15	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	QN	0.25	3	25	35	R	*Quadrula pustulosa*	L	-	1	40	8	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	SQ	5	4	35	45	R	*Quadrula pustulosa*	L	-	1	60	18	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells
M3	SQ	5	4	35	45	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M3	QN	0.25	4	35	45	R	*Quadrula pustulosa*	L	-	1	36	5	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Quadrula pustulosa*	L	-	1	50	8	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	5	45	55	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	QN	0.25	5	45	55	R	*Quadrula pustulosa*	L	-	1	67	30	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Quadrula pustulosa*	L	-	1	58	15	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	QN	0.25	9	85	95	R	*Quadrula pustulosa*	L	-	1	36	5	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	QN	0.25	10	95	105	R	*Quadrula pustulosa*	L	-	1	35	5	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	SQ	5	7	65	75	R	*Utterbackia imbecillis*	L	-	1	45	3	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M4	SQ	5	2	15	25	R	*Cyclonaias tuberculata*	L	-	1	85	23	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	SQ	5	6	55	65	R	*Cyclonaias tuberculata*	L	-	1	88	29	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Cyclonaias tuberculata*	L	-	1	90	33	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Cyclonaias tuberculata*	L	-	1	90	39	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	9	85	95	R	*Cyclonaias tuberculata*	L	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	2	15	25	R	*Ellipsaria lineolata*	WD	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	QN	0.25	3	25	35	R	*Ellipsaria lineolata*	WD	-	1	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	4	35	45	R	*Ellipsaria lineolata*	L	m	1	90	14	-	0	0	5	80	15	0	0	0	0	100.0	17	5.2	
M4	SQ	6	7	65	75	R	*Ellipsaria lineolata*	L	m	1	95	17	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Ellipsaria lineolata*	L	m	1	98	25	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Ellipsaria lineolata*	L	m	1	100	27	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Ellipsaria lineolata*	L	m	1	95	17	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M4	SQ	5	9	85	95	R	*Ellipsaria lineolata*	L	f	1	87	18	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Ellipsaria lineolata*	L	m	1	90	16	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Ellipsaria lineolata*	L	m	1	105	24	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Ellipsaria lineolata*	L	m	1	90	18	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	1	5	15	R	*Elliptio crassidens*	L	-	5	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	QN	0.25	1	5	15	R	*Elliptio crassidens*	L	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	SQ	5	2	15	25	R	*Elliptio crassidens*	L	-	8	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	SQ	5	3	25	35	R	*Elliptio crassidens*	L	-	5	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	QN	0.25	3	25	35	R	*Elliptio crassidens*	L	-	1	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	4	35	45	R	*Elliptio crassidens*	L	-	2	-	-	-	0	0	5	80	15	0	0	0	0	100.0	17	5.2	
M4	SQ	6	5	45	55	R	*Elliptio crassidens*	L	-	1	-	-	-	0	0	5	80	15	0	0	0	0	100.0	19	5.8	
M4	SQ	5	6	55	65	R	*Elliptio crassidens*	L	-	10	-	-	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	6	55	65	R	*Elliptio crassidens*	L	-	1	-	-	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	6	7	65	75	R	*Elliptio crassidens*	WD	-	6	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	7	65	75	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Elliptio crassidens*	L	-	3	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	9	85	95	R	*Elliptio crassidens*	L	-	4	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Elliptio crassidens*	L	-	2	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	10	95	105	R	*Elliptio crassidens*	L	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	7	65	75	R	*Obliquaria reflexa*	L	-	1	32	3	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	2	15	25	R	*Pleurobema cordatum*	L	-	1	118	50	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M4	SQ	5	2	15	25	R	*Pleurobema cordatum*	L	-	1	110	46	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	SQ	5	2	15	25	R	*Pleurobema cordatum*	L	-	1	100	30	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	114	57	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	124	48	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	100	47	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	112	43	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	114	37	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	110	58	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Pleurobema cordatum*	L	-	1	112	57	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	107	36	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	104	38	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	106	42	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	6	55	65	R	*Pleurobema cordatum*	L	-	1	107	43	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	6	55	65	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	6	7	65	75	R	*Pleurobema cordatum*	L	-	7	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Pleurobema cordatum*	L	-	3	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	9	85	95	R	*Pleurobema cordatum*	L	-	7	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	9	85	95	R	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Pleurobema cordatum*	L	-	4	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	1	5	15	R	*Potamilus alatus*	L	-	1	22	0	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	SQ	5	6	55	65	R	*Potamilus alatus*	L	m	1	135	6	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	1	5	15	R	*Quadrula pustulosa*	L	-	1	53	12	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	QN	0.25	2	15	25	R	*Quadrula pustulosa*	L	-	1	56	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M4	SQ	5	3	25	35	R	*Quadrula pustulosa*	L	-	1	61	20	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Quadrula pustulosa*	L	-	1	63	18	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	3	25	35	R	*Quadrula pustulosa*	FD	-	1	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	QN	0.25	3	25	35	R	*Quadrula pustulosa*	WD	-	1	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	QN	0.25	3	25	35	R	*Quadrula pustulosa*	L	-	1	60	23	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	SQ	5	4	35	45	R	*Quadrula pustulosa*	L	-	1	61	12	-	0	0	5	80	15	0	0	0	0	100.0	17	5.2	
M4	SQ	5	4	35	45	R	*Quadrula pustulosa*	L	-	1	44	7	-	0	0	5	80	15	0	0	0	0	100.0	17	5.2	
M4	QN	0.25	4	35	45	R	*Quadrula pustulosa*	L	-	1	43	7	-	0	0	5	80	15	0	0	0	0	100.0	17	5.2	
M4	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	77	18	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	82	18	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	6	55	65	R	*Quadrula pustulosa*	L	-	1	45	6	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	6	55	65	R	*Quadrula pustulosa*	L	-	1	74	-	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Quadrula pustulosa*	L	-	1	70	18	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Quadrula pustulosa*	L	-	1	60	18	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
U1	SQ	5	2	15	25	L	*Elliptio crassidens*	L	-	1	120	24	-	0	0	0	90	10	0	0	0	0	100.0	18	5.5	
U1	SQ	5	2	15	25	L	*Elliptio crassidens*	L	-	1	115	24	-	0	0	0	90	10	0	0	0	0	100.0	18	5.5	
U1	SQ	5	2	15	25	L	*Elliptio crassidens*	WD	-	9	-	-	-	0	0	0	90	10	0	0	0	0	100.0	18	5.5	
U1	SQ	5	3	25	35	L	*Elliptio crassidens*	L	-	1	120	30	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	SQ	5	3	25	35	L	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	SQ	8	4	35	45	L	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	SQ	9	5	45	55	L	*Elliptio crassidens*	L	-	1	115	33	-	0	0	0	80	10	0	0	0	10	100.0	19	5.8	shells
U1	SQ	6	7	65	75	L	*Elliptio crassidens*	L	-	1	-	20	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells
U1	SQ	6	9	85	95	L	*Elliptio crassidens*	L	-	1	125	26	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells
U1	SQ	6	9	85	95	L	*Elliptio crassidens*	L	-	1	120	27	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U1	SQ	9	5	45	55	L	*Leptodea fragilis*	WD	-	1	-	-	-	0	0	0	80	10	0	0	0	10	100.0	19	5.8	shells
U1	QN	0.25	7	65	75	L	*Leptodea fragilis*	L	-	1	46	2	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells
U1	SQ	7	10	95	105	L	*Leptodea fragilis*	L	m	1	73	4	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U1	SQ	5	3	25	35	L	*Obliquaria reflexa*	L	-	1	21	2	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	SQ	9	5	45	55	L	*Pleurobema cordatum*	WD	-	1	-	-	-	0	0	0	80	10	0	0	0	10	100.0	19	5.8	shells
U1	SQ	9	5	45	55	L	*Pleurobema cordatum*	L	-	1	-	35	-	0	0	0	80	10	0	0	0	10	100.0	19	5.8	shells
U1	SQ	3	6	55	65	L	*Pleurobema cordatum*	L	-	1	-	40	-	80	0	0	10	10	0	0	0	0	100.0	19	5.8	
U1	SQ	5	1	5	15	L	*Potamilus alatus*	L	m	1	180	15+	-	30	0	0	60	10	0	0	0	0	100.0	18	5.5	
U2	SQ	7	1	5	15	L	*Amblema plicata*	L	-	1	110	21	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	4	2	15	25	L	*Cyclonaias tuberculata*	L	-	1	55	8	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	SQ	7	3	25	35	L	*Cyclonaias tuberculata*	L	-	1	90	25	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	WD	-	4	-	-	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	130	26	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	130	24	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	120	28	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	112	27	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	35	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	118	32	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	27	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	125	27	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	110	25	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	120	31	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	118	25	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	32	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	118	24	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	123	37	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	120	30	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	114	27	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	37	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	118	31	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	120	34	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	29	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	121	29	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	105	22	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	21	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	100	25	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Elliptio crassidens*	L	-	1	115	31	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	QN	0.25	1	15	25	L	*Elliptio crassidens*	L	-	1	121	28	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	SQ	4	2	15	25	L	*Elliptio crassidens*	L	-	1	115	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	SQ	4	2	15	25	L	*Elliptio crassidens*	L	-	1	125	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	SQ	4	2	15	25	L	*Elliptio crassidens*	L	-	1	110	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	125	34	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	112	35	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	115	33	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	118	30	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	110	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	112	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	115	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	112	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	120	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	114	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	125	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	3	25	35	L	*Elliptio crassidens*	L	-	1	110	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	4	35	45	L	*Elliptio crassidens*	L	-	1	125	28	-	80	0	10	5	5	0	0	0	0	100.0	19	5.8	
U2	SQ	7	4	35	45	L	*Elliptio crassidens*	L	-	1	115	27	-	80	0	10	5	5	0	0	0	0	100.0	19	5.8	
U2	SQ	6	5	45	55	L	*Elliptio crassidens*	L	-	1	130	34	-	0	0	10	70	10	0	0	0	10	100.0	18	5.5	shells
U2	SQ	4	7	65	75	L	*Elliptio crassidens*	L	-	1	125	-	-	80	0	0	18	2	0	0	0	0	100.0	18	5.5	
U2	SQ	7	4	35	45	L	*Elliptio dilitata*	L	-	1	105	-	-	80	0	10	5	5	0	0	0	0	100.0	19	5.8	
U2	QN	0.25	2	15	25	L	*Obliquaria reflexa*	L	-	1	36	4	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	QN	0.25	8	75	85	L	*Obliquaria reflexa*	L	-	1	28	3	-	0	0	0	80	10	0	0	0	10	100.0	17.5	5.3	shells
U2	SQ	7	9	85	95	L	*Obliquaria reflexa*	L	-	1	37	4	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	98	19	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	110	29	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	105	31	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	100	31	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	105	31	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	115	36	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	95	29	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	110	30	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	105	30	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U2	SQ	7	1	5	15	L	*Pleurobema cordatum*	L	-	1	118	37	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U2	SQ	7	3	25	35	L	*Pleurobema cordatum*	L	-	1	100	36	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	SQ	7	4	35	45	L	*Pleurobema cordatum*	L	-	1	100	41	-	80	0	10	5	5	0	0	0	0	100.0	19	5.8	
U2	SQ	6	5	45	55	L	*Pleurobema cordatum*	L	-	1	110	-	-	0	0	10	70	10	0	0	0	10	100.0	18	5.5	shells
U2	SQ	7	9	85	95	L	*Pleurobema cordatum*	L	-	1	102	34	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells
U2	QN	0.25	2	15	25	L	*Potamilus alatus*	WD	-	1	-	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	SQ	5	10	95	105	L	*Potamilus alatus*	L	-	1	33	2	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells
U2	SQ	3	8	75	85	L	*Pyganodon grandis*	L	f	1	163	12	-	0	0	0	80	10	0	0	0	10	100.0	17.5	5.3	shells
U2	SQ	7	1	5	15	L	*Quadrula pustulosa*	L	-	1	47	6	-	0	0	5	70	20	0	0	0	5	100.0	14	4.3	shells
U3	SQ	7	2	15	25	L	*Cyclonaias tuberculata*	L	-	1	83	42	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	7	2	15	25	L	*Cyclonaias tuberculata*	L	-	1	85	44	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	7	2	15	25	L	*Cyclonaias tuberculata*	L	-	1	72	40	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	QN	0.25	2	15	25	L	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	4	35	45	L	*Cyclonaias tuberculata*	L	-	1	92	44	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	QN	0.25	4	35	45	L	*Cyclonaias tuberculata*	WD	-	1	-	-	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U3	SQ	6	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	90	48	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	SQ	6	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	95	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	QN	0.25	6	55	65	L	*Cyclonaias tuberculata*	L	-	1	97	37	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	SQ	5	4	35	45	L	*Ellipsaria lineolata*	L	m	1	113	25	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	120	30	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	120	31	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	125	29	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	120	32	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	110	-	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	125	34	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	110	35	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	110	40	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	125	33	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	110	27	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	115	31	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	108	32	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	1	123	41	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	7	2	15	25	L	*Elliptio crassidens*	L	-	6	-	-	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	7	2	15	25	L	*Elliptio crassidens*	L	-	1	102	12	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	7	2	15	25	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	3	25	35	L	*Elliptio crassidens*	L	-	7	-	-	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	4	35	45	L	*Elliptio crassidens*	L	-	5	-	-	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	6	5	45	55	L	*Elliptio crassidens*	WD	-	1	-	-	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U3	SQ	6	5	45	55	L	*Elliptio crassidens*	FD	-	1	-	-	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U3	SQ	6	5	45	55	L	*Elliptio crassidens*	L	-	8	-	-	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U3	SQ	6	6	55	65	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	SQ	3.5	7	65	75	L	*Elliptio crassidens*	L	-	2	-	-	-	40	0	6	48	6	0	0	0	0	100.0	20	6.1	
U3	SQ	6	8	75	85	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	SQ	6	1	5	15	L	*Pleurobema cordatum*	L	-	1	105	52	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	7	2	15	25	L	*Pleurobema cordatum*	L	-	1	105	35	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	7	2	15	25	L	*Pleurobema cordatum*	L	-	1	100	34	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	3	25	35	L	*Pleurobema cordatum*	L	-	1	110	41	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	3	25	35	L	*Pleurobema cordatum*	L	-	1	110	63	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	3	25	35	L	*Pleurobema cordatum*	L	-	1	108	62	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U3	SQ	5	4	35	45	L	*Pleurobema cordatum*	L	-	1	11	53	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	4	35	45	L	*Pleurobema cordatum*	L	-	1	96	47	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	6	5	45	55	L	*Pleurobema cordatum*	L	-	1	104	56	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U3	SQ	6	5	45	55	L	*Pleurobema cordatum*	L	-	1	102	50	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U3	SQ	6	6	55	65	L	*Pleurobema cordatum*	L	-	1	105	56	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	SQ	6	6	55	65	L	*Pleurobema cordatum*	L	-	1	105	52	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	SQ	3.5	7	65	75	L	*Pleurobema cordatum*	L	-	1	105	40	-	40	0	6	48	6	0	0	0	0	100.0	20	6.1	
U3	SQ	6	8	75	85	L	*Pleurobema cordatum*	L	-	1	105	51	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	SQ	6	8	75	85	L	*Pleurobema cordatum*	L	-	1	112	61	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	SQ	6	8	75	85	L	*Pleurobema cordatum*	L	-	1	107	47	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	SQ	6	8	75	85	L	*Pleurobema cordatum*	L	-	1	115	58	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	SQ	4	10	95	105	L	*Pleurobema cordatum*	L	-	1	105	47	-	40	0	0	54	6	0	0	0	0	100.0	19	5.8	
U3	SQ	7	2	15	25	L	*Potamilus alatus*	L	m	1	135	10	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	6	1	5	15	L	*Quadrula pustulosa*	L	-	1	85	25+	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	SQ	5	4	35	45	L	*Quadrula pustulosa*	L	-	1	72	-	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	4	35	45	L	*Quadrula pustulosa*	L	-	1	60	26	-	0	0	10	70	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	6	5	45	55	L	*Quadrula pustulosa*	L	-	1	65	35	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	
U4	SQ	6	1	5	15	L	*Amblema plicata*	WD	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	6	1	5	15	L	*Cyclonaias tuberculata*	L	-	1	92	-	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	6	1	5	15	L	*Cyclonaias tuberculata*	L	-	1	84	27	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	6	1	5	15	L	*Cyclonaias tuberculata*	L	-	1	60	10	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	5	8	75	85	L	*Cyclonaias tuberculata*	L	-	1	87	26	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	10	95	105	L	*Cyclonaias tuberculata*	WD	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	14	4.3	
U4	SQ	6	5	45	55	L	*Ellipsaria lineolata*	WD	-	1	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U4	SQ	6	1	5	15	L	*Elliptio crassidens*	L	-	5	-	-	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	6	1	5	15	L	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	5	2	15	25	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	10	80	10	0	0	0	0	100.0	11.0	3.4	
U4	SQ	6	3	25	35	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	10	75	15	0	0	0	0	100.0	12.0	3.7	
U4	SQ	5.5	4	35	45	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	10	80	10	0	0	0	0	100.0	12	3.7	
U4	SQ	6	5	45	55	L	*Elliptio crassidens*	L	-	3	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	5	45	55	L	*Elliptio crassidens*	WD	-	1	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	6	55	65	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5	7	65	75	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5	7	65	75	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	7	65	75	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5.5	9	85	95	L	*Elliptio crassidens*	WD	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5.5	9	85	95	L	*Elliptio crassidens*	L	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5.5	9	85	95	L	*Elliptio crassidens*	L	-	1	107	13	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	10	95	105	L	*Elliptio crassidens*	WD	-	3	-	-	-	0	0	30	60	10	0	0	0	0	100.0	14	4.3	
U4	SQ	6	10	95	105	L	*Elliptio crassidens*	L	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	14	4.3	
U4	SQ	5	8	75	85	L	*Elliptio dilitata*	WD	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5.5	9	85	95	L	*Pleurobema cordatum*	L	-	1	115	44	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	3	25	35	L	*Quadrula pustulosa*	L	-	1	62	24	-	0	0	10	75	15	0	0	0	0	100.0	12.0	3.7	
U4	QN	0.25	3	25	35	L	*Quadrula pustulosa*	L	-	1	46	11	-	0	0	10	75	15	0	0	0	0	100.0	12.0	3.7	
U4	SQ	6	6	55	65	L	*Quadrula pustulosa*	WD	-	2	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5.5	9	85	95	L	*Quadrula pustulosa*	WD	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
BF	SQ	20					*Cyclonaias tuberculata*	L	-	1	34	4	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
BF	SQ	20					*Elliptio crassidens*	WD	-	2	-	-	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
BF	SQ	20					*Elliptio crassidens*	FD	-	1	-	-	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
BF	SQ	20					*Leptodea fragilis*	WD	-	1	-	-	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
BF	SQ	20					*Obliquaria reflexa*	L	-	1	49	8	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
BF	SQ	20					*Obliquaria reflexa*	L	-	1	41	6	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
BF	SQ	20					*Potamilus alatus*	L	f	1	146	15	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
BF	SQ	20					*Quadrula pustulosa*	L	-	1	66	20+	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
U1	QN	0.25	1	5	15	L	*No Mussels*	-	-	0	-	-	-	30	0	0	60	10	0	0	0	0	100.0	18	5.5	
U1	QN	0.25	6	55	65	L	*No Mussels*	-	-	0	-	-	-	80	0	0	10	10	0	0	0	0	100.0	19	5.8	
U1	SQ	6	8	75	85	L	*No Mussels*	-	-	0	-	-	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells
U2	SQ	6	6	55	65	L	*No Mussels*	-	-	0	-	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U2	QN	0.25	7	65	75	L	*No Mussels*	-	-	0	-	-	-	80	0	0	18	2	0	0	0	0	100.0	18	5.5	
U3	QN	0.25	3	25	35	L	*No Mussels*	-	-	0	-	-	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	SQ	5	9	85	95	L	*No Mussels*	-	-	0	-	-	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	QN	0.25	9	85	95	L	*No Mussels*	-	-	0	-	-	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U3	QN	0.25	10	95	105	L	*No Mussels*	-	-	0	-	-	-	40	0	0	54	6	0	0	0	0	100.0	19	5.8	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U4	QN	0.25	6	55	65	L	*No Mussels*	-	-	0	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
M1	SQ	5	1	5	15	R	*No Mussels*	-	-	0	-	-	-	0	0	0	25	70	5	0	0	0	100.0	5	1.5	
M1	QN	0.25	1	5	15	R	*No Mussels*	-	-	0	-	-	-	0	0	0	25	70	5	0	0	0	100.0	5	1.5	
M1	SQ	5	2	15	25	R	*No Mussels*	-	-	0	-	-	-	0	0	7	7	80	6	0	0	0	100.0	14	4.3	
M1	QN	0.25	2	15	25	R	*No Mussels*	-	-	0	-	-	-	0	0	7	7	80	6	0	0	0	100.0	14	4.3	
M1	QN	0.25	5	45	55	R	*No Mussels*	-	-	0	-	-	-	0	0	30	35	30	5	0	0	0	100.0	12	3.7	
M2	SQ	5	1	5	15	R	*No Mussels*	-	-	0	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M2	QN	0.25	1	5	15	R	*No Mussels*	-	-	0	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M2	QN	0.25	7	65	75	R	*No Mussels*	-	-	0	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	9	85	95	R	*No Mussels*	-	-	0	-	-	-	0	0	5	40	50	5	0	0	0	100.0	24	7.3	
M4	QN	0.25	5	45	55	R	*No Mussels*	-	-	0	-	-	-	0	0	5	80	15	0	0	0	0	100.0	19	5.8	
L1	QN	0.25	1	10	20	L	*No Mussels*	-	-	0	-	-	-	0	0	0	20	80	0	0	0	0	100.0	16	4.9	
L1	QN	0.25	4	40	50	L	*No Mussels*	-	-	0	-	-	-	0	0	5	25	70	0	0	0	0	100.0	17	5.2	
L1	QN	0.25	5	50	60	L	*No Mussels*	-	-	0	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	QN	0.25	8	80	90	L	*No Mussels*	-	-	0	-	-	-	0	0	5	25	70	0	0	0	0	100.0	15	4.6	
L1	QN	0.25	10	100	110	L	*No Mussels*	-	-	0	-	-	-	0	0	5	65	30	0	0	0	0	100.0	15	4.6	
L2	QN	0.25	1	5	15	L	*No Mussels*	-	-	0	-	-	-	0	0	0	0	100	0	0	0	0	100.0	12	3.7	
L2	QN	0.25	4	35	45	L	*No Mussels*	-	-	0	-	-	-	0	0	0	30	65	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	7	65	75	L	*No Mussels*	-	-	0	-	-	-	0	0	0	45	50	5	0	0	0	100.0	14	4.3	
L2	QN	0.25	9	85	95	L	*No Mussels*	-	-	0	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L2	QN	0.25	10	95	105	L	*No Mussels*	-	-	0	-	-	-	0	0	5	55	35	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	3	25	35	L	*No Mussels*	-	-	0	-	-	-	0	0	0	5	0	0	95	0	0	100.0	15	4.6	
L3	QN	0.25	6	55	65	L	*No Mussels*	-	-	0	-	-	-	0	0	20	35	40	5	0	0	0	100.0	15	4.6	
L3	QN	0.25	9	85	95	L	*No Mussels*	-	-	0	-	-	-	0	0	0	80	15	5	0	0	0	100.0	13	4.0	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
L3	QN	0.25	10	95	105	L	*No Mussels*	-	-	0	-	-	-	0	0	0	80	15	5	0	0	0	100.0	14	4.3	
L4	SQ	2	1	5	15	L	*No Mussels*	-	-	0	-	-	-	0	80	0	0	0	0	0	20	0	100.0	9	2.7	riprap/wood debris
L4	QN	0.25	1	5	15	L	*No Mussels*	-	-	0	-	-	-	0	80	0	0	0	0	0	20	0	100.0	9	2.7	riprap/wood debris
L4	SQ	2	2	15	25	L	*No Mussels*	-	-	0	-	-	-	0	100	0	0	0	0	0	0	0	100.0	10	3.0	large riprap
L4	QN	0.25	2	15	25	L	*No Mussels*	-	-	0	-	-	-	0	100	0	0	0	0	0	0	0	100.0	10	3.0	large riprap
L4	QN	0.25	3	25	35	L	*No Mussels*	-	-	0	-	-	-	0	0	0	30	0	0	70	0	0	100.0	11	3.4	
L4	QN	0.25	5	45	55	L	*No Mussels*	-	-	0	-	-	-	0	0	50	20	30	0	0	0	0	100.0	15	4.6	
L4	QN	0.25	6	55	65	L	*No Mussels*	-	-	0	-	-	-	0	0	20	5	70	5	0	0	0	100.0	16	4.9	
L4	QN	0.25	9	85	95	L	*No Mussels*	-	-	0	-	-	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
L4	QN	0.25	10	95	105	L	*No Mussels*	-	-	0	-	-	-	0	0	0	25	70	5	0	0	0	100.0	22	6.7	
U1	QN	0.25	3	25	35	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	SQ	8	4	35	45	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	QN	0.25	4	35	45	L	*Pleurocera canaliculata*	L	-	4	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	QN	0.25	5	45	55	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	0	80	10	0	0	0	10	100.0	19	5.8	shells
U1	QN	0.25	10	95	105	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	QN	0.25	1	15	25	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	QN	0.25	2	15	25	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	QN	0.25	3	25	35	L	*Pleurocera canaliculata*	L	-	4	-	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	QN	0.25	4	35	45	L	*Pleurocera canaliculata*	L	-	6	-	-	-	80	0	10	5	5	0	0	0	0	100.0	19	5.8	
U2	QN	0.25	5	45	55	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	10	70	10	0	0	0	10	100.0	18	5.5	shells
U2	QN	0.25	6	55	65	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U2	QN	0.25	9	85	95	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells
U3	QN	0.25	5	45	55	L	*Pleurocera canaliculata*	L	-	2	-	-	-	70	0	6	21	4	0	0	0	0	101.0	17	5.2	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U3	QN	0.25	6	55	65	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U3	QN	0.25	7	65	75	L	*Pleurocera canaliculata*	L	-	1	-	-	-	40	0	6	48	6	0	0	0	0	100.0	20	6.1	
U3	QN	0.25	8	75	85	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	5	90	5	0	0	0	0	100.0	19	5.8	
U4	QN	0.25	1	5	15	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	5	2	15	25	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	10	80	10	0	0	0	0	100.0	11.0	3.4	
U4	QN	0.25	2	15	25	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	10	80	10	0	0	0	0	100.0	11.0	3.4	
U4	QN	0.25	3	25	35	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	10	75	15	0	0	0	0	100.0	12.0	3.7	
U4	QN	0.25	4	35	45	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	10	80	10	0	0	0	0	100.0	12	3.7	
U4	SQ	6	5	45	55	L	*Pleurocera canaliculata*	L	-	3	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	5	45	55	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	6	55	65	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5	7	65	75	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	7	65	75	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5	8	75	85	L	*Pleurocera canaliculata*	L	-	4	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	8	75	85	L	*Pleurocera canaliculata*	L	-	6	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5.5	9	85	95	L	*Pleurocera canaliculata*	L	-	3	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	9	85	95	L	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	10	95	105	L	*Pleurocera canaliculata*	L	-	3	-	-	-	0	0	30	60	10	0	0	0	0	100.0	14	4.3	
U4	QN	0.25	10	95	105	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	14	4.3	
M1	QN	0.25	4	35	45	R	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	QN	0.25	6	55	5	R	*Pleurocera canaliculata*	L	-	1	-	-	-	40	0	12	33	12	3	0	0	0	100.0	17	5.2	
M1	QN	0.25	10	95	105	R	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	5	50	40	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	3	25	35	R	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	
M3	QN	0.25	6	55	65	R	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
																										shells
M3	SQ	5	9	85	95	R	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M4	SQ	6	7	65	75	R	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	8	75	85	R	*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
BF	SQ	20					*Pleurocera canaliculata*	L	-	2	-	-	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
L1	SQ	5	5	50	60	L	*Pleurocera canaliculata*	L	-	3	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L1	QN	0.25	6	60	70	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	5	25	70	0	0	0	0	100.0	16	4.9	
L3	QN	0.25	2	15	25	L	*Pleurocera canaliculata*	L	-	3	-	-	-	0	0	0	0	0	0	100	0	0	100.0	15	4.6	dead mussels
L4	QN	0.25	7	65	75	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	5	20	70	5	0	0	0	100.0	16	4.9	
L4	SQ	5	9	85	95	L	*Pleurocera canaliculata*	L	-	1	-	-	-	0	0	0	20	75	5	0	0	0	100.0	21	6.4	
U1	SQ	5	2	15	25	L	*Viviparus georgianus*	L	-	5	-	-	-	0	0	0	90	10	0	0	0	0	100.0	18	5.5	
U1	QN	0.25	2	15	25	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	0	90	10	0	0	0	0	100.0	18	5.5	
U1	QN	0.25	3	25	35	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	QN	0.25	4	35	45	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	80	10	0	0	0	10	100.0	20	6.1	shells
U1	QN	0.25	8	75	85	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells
U1	QN	0.25	9	85	95	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	80	10	0	0	0	10	100.0	18	5.5	shells
U1	QN	0.25	10	95	105	L	*Viviparus georgianus*	L	-	4	-	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	QN	0.25	2	15	25	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	50	35	10	0	0	0	5	100.0	17	5.2	shells
U2	QN	0.25	3	25	35	L	*Viviparus georgianus*	L	-	4	-	-	-	0	0	5	80	10	0	0	0	5	100.0	18	5.5	shells
U2	QN	0.25	5	45	55	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	10	70	10	0	0	0	10	100.0	18	5.5	shells
U2	QN	0.25	6	55	65	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U2	QN	0.25	9	85	95	L	*Viviparus georgianus*	L	-	4	-	-	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells
U2	SQ	5	10	95	105	L	*Viviparus georgianus*	L	-	5	-	-	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
U2	QN	0.25	10	95	105	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	20	60	10	0	0	0	10	100.0	18	5.5	shells
U3	QN	0.25	1	5	15	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	5	75	10	0	0	0	10	100.0	13	4.0	shells
U3	QN	0.25	2	15	25	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	5	75	10	0	0	0	10	100.0	15	4.6	shells
U3	QN	0.25	6	55	65	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	10	70	10	0	0	0	10	100.0	19	5.8	shells
U4	SQ	6	1	5	15	L	*Viviparus georgianus*	L	-	6	-	-	-	0	0	30	60	10	0	0	0	0	100.0	10	3.0	
U4	SQ	5	2	15	25	L	*Viviparus georgianus*	L	-	6	-	-	-	0	0	10	80	10	0	0	0	0	100.0	11.0	3.4	
U4	QN	0.25	3	25	35	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	10	75	15	0	0	0	0	100.0	12.0	3.7	
U4	SQ	5.5	4	35	45	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	10	80	10	0	0	0	0	100.0	12	3.7	
U4	QN	0.25	5	45	55	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	40	50	10	0	0	0	0	100.0	13	4.0	
U4	SQ	5	7	65	75	L	*Viviparus georgianus*	L	-	3	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	QN	0.25	7	65	75	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	30	60	10	0	0	0	0	100.0	13	4.0	
U4	SQ	6	10	95	105	L	*Viviparus georgianus*	L	-	2	-	-	-	0	0	30	60	10	0	0	0	0	100.0	14	4.3	
M1	SQ	6	4	35	45	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	15	35	40	0	0	0	0	90.0	13	4.0	
M1	QN	0.25	6	55	5	R	*Viviparus georgianus*	L	-	5	-	-	-	40	0	12	33	12	3	0	0	0	100.0	17	5.2	
M1	QN	0.25	7	65	75	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	20	55	20	5	0	0	0	100.0	22	6.7	
M1	SQ	5	8	75	85	R	*Viviparus georgianus*	L	-	4	-	-	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	QN	0.25	8	75	85	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	5	50	45	0	0	0	0	100.0	25	7.6	
M1	SQ	5	9	85	95	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	SQ	5	10	95	105	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	5	50	40	5	0	0	0	100.0	24	7.3	
M1	QN	0.25	9	85	95	R	*Viviparus georgianus*	L	-	5	-	-	-	0	0	5	50	40	5	0	0	0	100.0	25	7.6	
M1	QN	0.25	10	95	105	R	*Viviparus georgianus*	L	-	5	-	-	-	0	0	5	50	40	5	0	0	0	100.0	24	7.3	
M2	SQ	5	2	15	25	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	QN	0.25	2	15	25	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	
M2	QN	0.25	3	25	35	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	22	6.7	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M2	QN	0.25	4	35	45	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	23	7.0	
M2	SQ	6	5	45	55	R	*Viviparus georgianus*	L	-	5	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	5	45	55	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	6	55	65	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	0	0	95	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	8	75	85	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	0	20	75	5	0	0	0	100.0	24	7.3	
M2	QN	0.25	10	95	105	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	20	35	40	5	0	0	0	100.0	24	7.3	
M3	QN	0.25	1	5	15	R	*Viviparus georgianus*	L	-	4	-	-	-	0	0	0	35	60	5	0	0	0	100.0	16	4.9	
M3	QN	0.25	2	15	25	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	QN	0.25	3	25	35	R	*Viviparus georgianus*	L	-	5	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	# of dead mussel shells
M3	QN	0.25	4	35	45	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	20	6.1	# of dead mussel shells
M3	QN	0.25	5	45	55	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	6	55	65	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	QN	0.25	6	55	65	R	*Viviparus georgianus*	L	-	8	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	7	65	75	R	*Viviparus georgianus*	L	-	6	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	QN	0.25	7	65	75	R	*Viviparus georgianus*	L	-	4	-	-	-	0	0	30	10	55	5	0	0	0	100.0	22	6.7	# of dead mussel shells
M3	SQ	5	8	75	85	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	9	85	95	R	*Viviparus georgianus*	L	-	6	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	
M3	QN	0.25	8	75	85	R	*Viviparus georgianus*	L	-	4	-	-	-	0	0	40	20	35	5	0	0	0	100.0	23	7.0	
M3	SQ	5	10	95	105	R	*Viviparus georgianus*	L	-	20	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M3	QN	0.25	9	85	95	R	*Viviparus georgianus*	L	-	4	-	-	-	0	0	5	5	80	5	0	0	0	95.0	22	6.7	

Site	Method	Effort (m2,min)	Transect/ Sample	Min Dist bank (m,ft)	Max Dist bank(m,ft)	Bank (L,R)	Species	Cond. (L/FD/WD/R)	Reprod (m,f,g,u)	Abund	Length (mm)	Age (yr)	Asian or Zebs (#,% m2 or shell)	Be	Bo	Cb	Grav	Sd	St	Cl	Wd	Othr	TOTAL	Depth (ft)	Depth (m)	Notes
M3	QN	0.25	10	95	105	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	20	5	70	5	0	0	0	100.0	22	6.7	
M4	SQ	5	1	5	15	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	QN	0.25	1	5	15	R	*Viviparus georgianus*	L	-	5	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	QN	0.25	2	15	25	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	0	0	95	5	0	0	0	100.0	19	5.8	
M4	QN	0.25	3	25	35	R	*Viviparus georgianus*	L	-	5	-	-	-	0	0	0	15	80	5	0	0	0	100.0	20	6.1	
M4	QN	0.25	4	35	45	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	5	80	15	0	0	0	0	100.0	17	5.2	
M4	SQ	5	6	55	65	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	6	55	65	R	*Viviparus georgianus*	L	-	4	-	-	-	0	0	10	10	75	5	0	0	0	100.0	22	6.7	
M4	SQ	6	7	65	75	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	7	65	75	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	8	75	85	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	8	75	85	R	*Viviparus georgianus*	L	-	1	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	9	85	95	R	*Viviparus georgianus*	L	-	3	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	SQ	5	10	95	105	R	*Viviparus georgianus*	L	-	9	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
M4	QN	0.25	10	95	105	R	*Viviparus georgianus*	L	-	2	-	-	-	0	0	30	40	25	5	0	0	0	100.0	22	6.7	
BF	SQ	20					*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	0	0	0	0	0	0	0.0		0.0	20 minute boulder field search
L4	SQ	4	8	75	85	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	5	20	70	5	0	0	0	100.0	18	5.5	
L4	SQ	4	10	95	105	L	*Viviparus georgianus*	L	-	1	-	-	-	0	0	0	25	70	5	0	0	0	100.0	22	6.7	
														1780	360	8622	31638	46208	2685	1925	40	1180			0.0	

APPENDIX B – SAMPLING LOCATIONS

Site	Latitude	Longitude
U4_End	35.59795543	-84.77822805
U4_Begin	35.59780573	-84.77702131
U3_End	35.60188838	-84.77613090
U3_Begin	35.60195829	-84.77504728
U2_End	35.60758548	-84.77584306
U2_Begin	35.60785504	-84.77478929
U1_End	35.60871804	-84.77595261
U1_Begin	35.60897126	-84.77497512
M4_End	35.58317151	-84.81005128
M4_Begin	35.58364802	-84.81101068
M3_End	35.58380384	-84.80938517
M3_Begin	35.58446123	-84.81030861
M2_End	35.58754066	-84.80369839
M2_Begin	35.58831364	-84.80435830
M1_End	35.58816922	-84.80260011
M1_Begin	35.58883717	-84.80294234
L4_End	35.55338457	-84.85512681
L4_Begin	35.55256843	-84.85559930
L3_End	35.55218806	-84.85190917
L3_Begin	35.55138130	-84.85216632
L2_End	35.55089414	-84.84619740
L2_Begin	35.55001966	-84.84637233
L1_End	35.55073002	-84.84489947
L1_Begin	35.54990022	-84.84517129
L. Abrupta	35.58752708	-84.80372479
Boulder Field Exp Site1	35.60292304	-84.77783435
Boulder Field Exp Site 2	35.60292447	-84.77788179
Boulder Field Control	35.60313829	-84.77770653
Boulder Qualitative Search	35.60329931	-84.77776361
Boulder Qualitative Search	35.60330015	-84.77774626
Boulder Qualitative Search	35.60236607	-84.77811037

APPENDIX C – PHOTO LOG

Project Area

Project Area

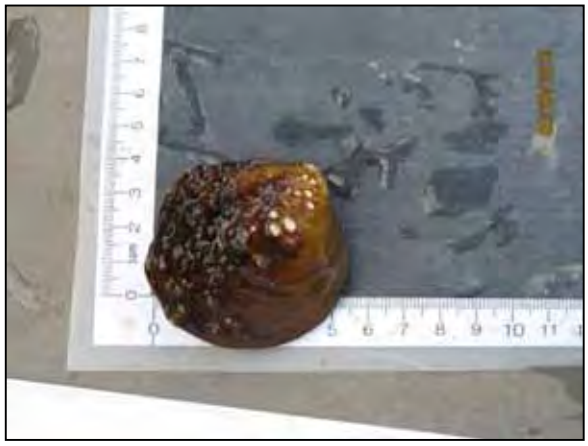
General Area of Transects 1 and 2 in the Upper Sampling Reach

Dive Boat Sampling Along Transect 3 of Upper Reach

Dive Boat Sampling Transect 1 of Middle Reach

Looking Downstream Toward Lower Reach

Amblema plicata



Cyclonaias tuberculata

Ellipsaria lineolata

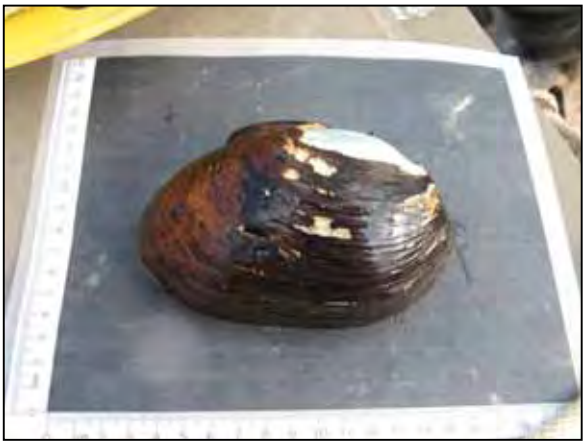
Elliptio crassidens

Elliptio dilitata

Fusconaia subrotunda

Lampsilis abrupta

Lampsilis abrupta



Lampsilis abrupta

Leptodea fragilis

Megalonaias nervosa

Obliquaria reflexa

Plethobasus cyphyus

Pleurobema cordatum

Pleurocera canaliculata

Potamilus alatus

Pyganodon grandis

Quadrula metanerva

Quadrula pustulosa

Viviparus georgianus

ATTACHMENT 12

Discussion of the results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)

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March 2011

Tennessee Valley Authority
Biological Compliance
Knoxville, Tennessee

The purpose of this document is to evaluate and compare data reported from the 2010 mussel survey conducted for Tennessee Valley Authority (TVA) by Third Rock Consultants, LLC (TRC 2010) to data collected at the three mussel beds (Figure 1) previously monitored by TVA. Specifically, the 2010 data are compared to mussel data collected by TVA for preoperational (1983 - 1994) and operational (1996 - 1997) monitoring for Unit 1 of the Watts Bar Nuclear Plant (WBN), located on the Tennessee River in Rhea County, Tennessee (TVA 1998). As described further below, these data indicate that the current mussel community adjacent to WBN is substantially similar to conditions near the end (1996-1997) of the WBN Unit 1 operational and pre-operational monitoring period. Both species composition and the number of mussels collected are similar.

1983 - 1997 Collection Methods

Between 1983 and 1985, collection was conducted by two pairs of SCUBA divers collecting mussels for 11 minutes each (for an aggregate total of approximately 45 minutes of diver search time) in four sampling sites within each of three mussel beds. Collections conducted from 1985-1997 were conducted by two divers, each collecting mussels for 22 minutes from each of the three mussel beds. This sampling was semi-quantitative in nature and was designed to maximize the number of individuals collected by each diver (TVA, 1998).

1983 - 1997 Collection Data

Examining the entire dataset from these monitoring sites (Figure 2) indicates that there was a decline in both species numbers and abundance between the 1988 and 1992 sampling efforts near WBN. A drop in the number of individual mussels collected was observed between 1988 and 1990. A similar drop in species numbers is seen between the 1990 and 1992 sampling efforts. An extreme drought period occurred across the Tennessee Valley from 1986 to 1992, with particularly extreme conditions seen from 1987 to 1988 (Riebsame et al. 1991). Sustained periods of low flow and extremely low dissolved oxygen levels (DO) were seen in Watts Bar Reservoir and the Watts Bar Dam tailwater during this time. These effects are believed to be primarily responsible for the decline in species numbers and abundance observed after the drought peaked in 1988 in the Southeast.

Changes to Watts Bar Dam releases during and following the collection of pre-operational data

In 1991, under the Lake Improvement Plan (LIP) (TVA 1990), TVA adopted efforts to increase DO concentrations in the releases from 16 dams (including Watts Bar Dam) and to provide project specific minimum flows. In 1996, TVA installed an aeration system in the forebay of Watts Bar Reservoir to reduce reservoir stratification and associated dissolved oxygen problems in the vicinity of Watts Bar Dam. This has resulted in higher dissolved oxygen levels in the dam releases and appears to have mitigated some of the effects of the more recent 2007 - 2008 drought period on aquatic communities (based on TVA Reservoir Fisheries Assemblage Index data).

TVA also established a "system minimum flow" operating scheme as a result of the Reservoir Operations Study (TVA 2004). These changes established a weekly average minimum flow at Chickamauga Dam (downstream of Watts Bar Dam) of 13,000 cfs/week from June 1 to July 31, and 25,000 cfs/week from August 1 to Labor Day. This effectively institutes a minimum flow at Watts Bar Dam, which replaces an operating scheme that previously resulted in extended periods of low flow (or essentially no flow) during summer months.

Because the observed mussel declines from 1988 to 1992 pre-date WBN Unit 1 operation in 1996 and the LIP release improvements at Watts Bar Dam, the decline cannot be attributed to operation of WBN Unit 1. It is therefore appropriate to examine the potential effects of WBN Unit 2 operation with 1992 and 1994 numbers as the environmental baseline for mussel communities near WBN.

2010 Collection Methods

Semi-quantitative and quantitative mollusk sampling was conducted September 28-30, 2010, at the three sampling areas that were part of the pre-operational (1983-1994) and operational (1996-1997) monitoring for WBN Unit 1. Details of the methodology are discussed in the full 2010 survey report (TRC 2010). A total of 120 semi-quantitative and forty quantitative samples were taken during the 2010 survey. This methodology is designed to be more repeatable than the semi-quantitative (timed search) samples taken previously. No quantitative sampling was conducted in previous years. In addition to sampling in the three mussel beds surveyed in previous sampling, a survey of the experimental boulder field placed by TVA (Fraley et al. 2002) was conducted. Very few mussels were found in the boulder field, and that sampling effort is not discussed further in this document.

2010 Collection Data

A total of 17 species (902 individuals) was collected in the semi-quantitative (17 species, 852 individuals) and quantitative (6 species, 50 individuals) sampling (TRC 2010). The data are well within the range of variation for samples collected from 1992 and 1994 (pre-operational monitoring), and 1996 and 1997 (operational monitoring) (Figure 2). One individual of the federally listed endangered pink mucket and one individual of the federal candidate sheepnose mussel were collected at transects downstream of the WBN discharge. The highest densities of mussels occurred in the two sampling sites downstream of the WBN discharge (TRC 2010).

Only the semi-quantitative data from 2010 were used in Table 1 in order to provide a reasonable comparison to previous sampling methods. As noted above, the quantitative sampling added no new species to the survey, and relatively few (50) individual mussels. There is a lack of sampling data between 1997 and 2010, and therefore it is difficult to speculate how mussel numbers may have fluctuated over this period. The expectation is that LIP and ROS improvements to Watts Bar Dam releases would have at least provided a relatively stable environment for the mussel community when compared to conditions prior to 1996.

Of note in the data is evidence that recent recruitment (individuals aged at < 5 years) has occurred in at least five mussel species (*Cyclonaias tuberculata, Leptodea fragilis, Megalonaias*

nervosa, Potamilus alatus, and Utterbackia imbecillis). Fifteen of the seventeen species collected contained individuals that were less than 40 years old (TRC 2010), indicating that reproduction in these species has occurred since closure of Watts Bar Dam. Previous data (TVA 1998) indicated "that individual mussels in the Tennessee River near WBN are continuing to grow slowly, but some species are disappearing from the communities and the some more abundant populations are demonstrating statistically significant declines. The freshwater mussels in the vicinity of WBN are quite old and most of the 30 species found may not have reproduced in the past 50 years." Data on young mussels collected in 2010 indicates that this statement may no longer be true, or that previously indicated downward trends have shown improvement.

Conclusions

The species that declined between 1992 and 1994 were present in the mussel community at extremely low densities prior to 1994 and are usually represented by the collection of only one or two individuals during any sampling effort (Table 1). These species may still be present at extremely low densities within the community and were simply not collected in subsequent sampling. A good illustration of this is the collection of a single sheepnose mussel in 2010. Prior to this collection, this species was found only in 1983 (2 individuals), 1992 (1 individual) and 1994 (1 individual). This indicates an extremely low frequency of occurrence in the population, and a corresponding low probability of detection, but does not necessarily indicate that the species is no longer present.

Since 1992, mussel species numbers and abundance appear to be relatively stable (Figure 2). The relative stability in the number of mussel species present in the samples sites, along with reasonable population sizes, indicates that operation of WBN Unit 1 has not led to any decline in the mussel community in the Tennessee River near WBN when compared to the 1992-1994 data. Evidence of reproduction in many of the mussels sampled, and evidence of very recent recruitment of five mussel species is further evidence that operation of WBN Unit 1 is not having a significant adverse effect on this resource.

Hydrothermal and water quality analyses conducted by TVA indicate that water quality conditions (particularly thermal conditions) in the Tennessee River in the vicinity of the WBN discharge would not change significantly with the addition of WBN Unit 2. No adverse impacts to mussel resources in the Tennessee River adjacent to WBN are anticipated to occur as a result of operating both WBN Unit 1 and WBN Unit 2.

References

Fraley et al. 2002. S.J. Fraley, J.J. Jenkinson, and Brennan T. Smith. Watts Bar Native Mussel Enhancement Project. Preliminary Evaluation of an Artificial Boulder Field for Enhancing Native Mussel Habitat in the Watts Bar Tailwater, Tennessee River Mile 528.5. Tennessee Valley Authority, River Systems Operation and Environment, Resource Stewardship. Norris, Tennessee.

Riebsame, W. E., S. A. Changnon, and T. R. Karl. 1991. Drought and natural resources management in the United States: impacts and implications of the 1987-89 drought. Westview Press 11-92.

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P:\Project_Files\Tennessee\TN10-026_TVA_WattsBar_Mussels\Mapping\GIS\Exhibit1_Upper_Mussels WCO 10/21/10

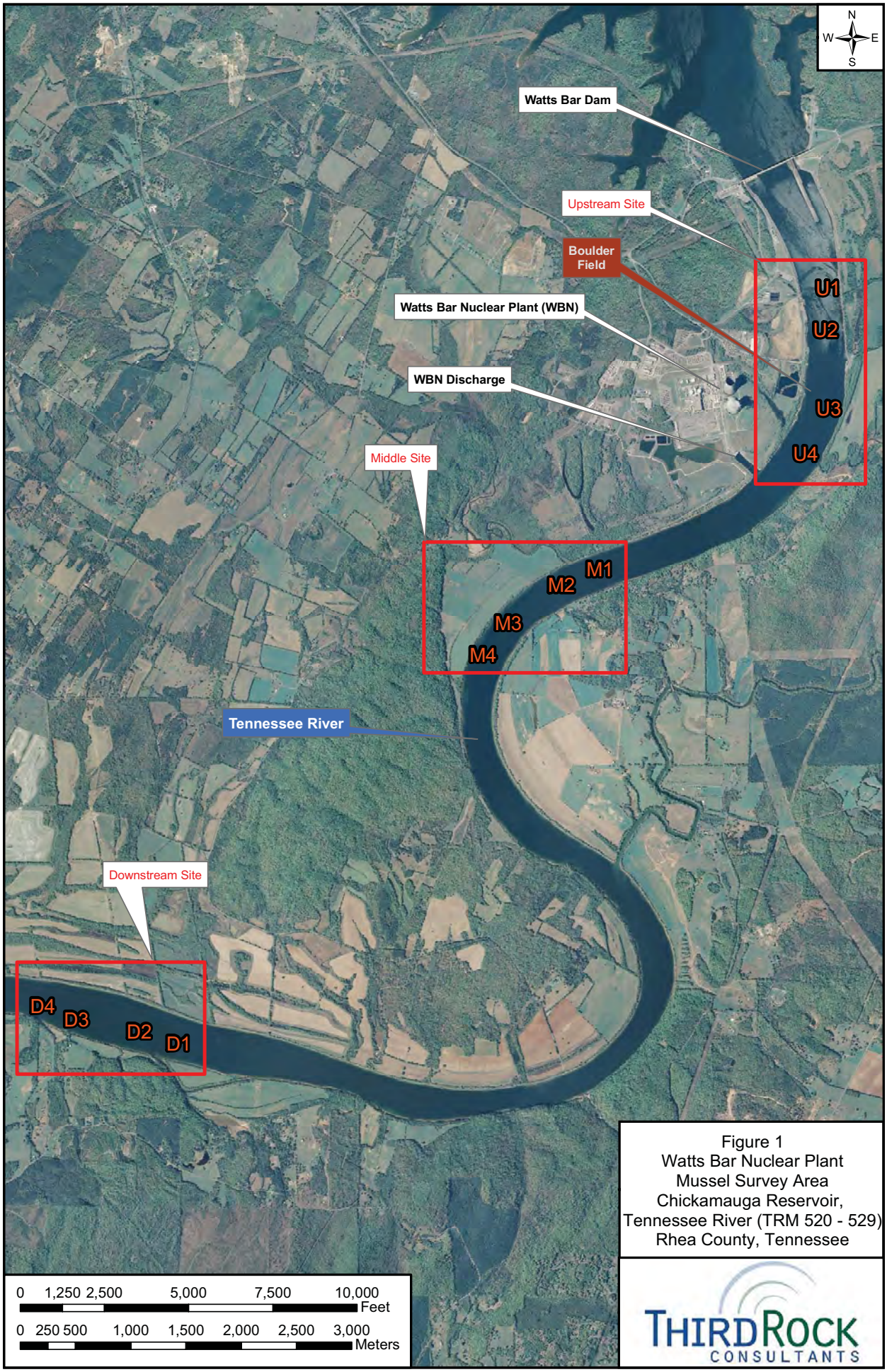

Figure 1
Watts Bar Nuclear Plant
Mussel Survey Area
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee

THIRD ROCK CONSULTANTS

Comparison of historical and current mussel species and abundances in the Tennessee River in the vicinity of Watts Bar Nuclear Plant

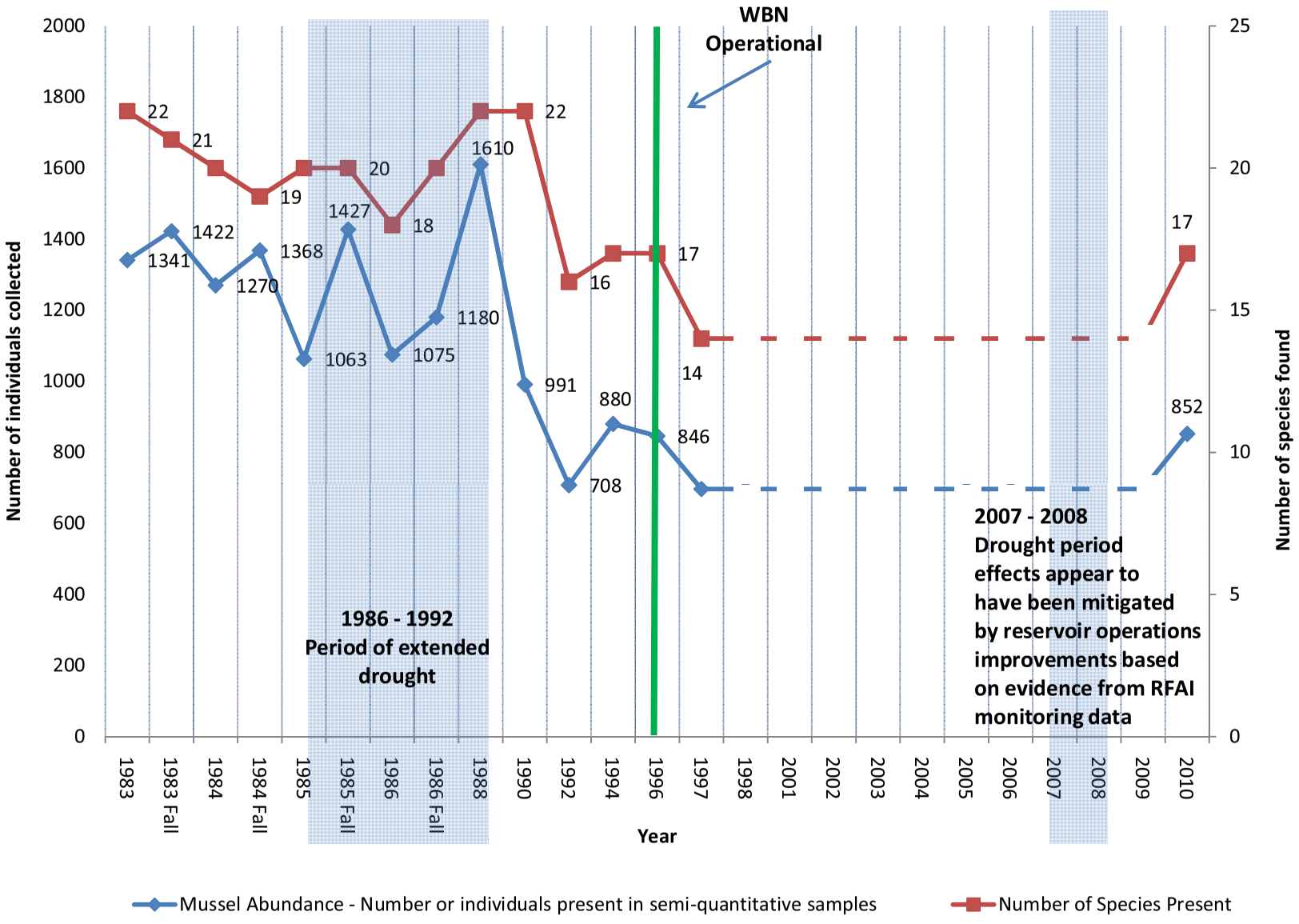

Table 1. Total numbers of each native mussel species collected during preoperational (1983-1994) and operational (1996-1997) surveys near Watts Bar Nuclear Plant.
Source: Table 3-7 from TVA SEIS (TVA, 2007) revised to include 2010 collection data (TRC, 2010).

		Preoperational												Operational						
Scientific Name	**Common Name**	**1983**	**1983 Fall**	**1984**	**1984 Fall**	**1985**	**1985 Fall**	**1986**	**1986 Fall**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Totals**	**Times Found**	**2010 Semi-Quantitative Data**	**2010 Quantitative Data**	**2010 Total - Excluding Boulder Field**
Elliptio crassidens	elephant ear	754	836	779	984	738	929	734	765	970	524	424	583	594	489	10103	14	521	13	534
Pleurobema cordatum	Ohio pigtoe	264	275	220	156	113	177	110	169	224	139	82	95	94	101	2219	14	125	0	125
Cyclonaias tuberculata	purple wartyback	88	70	73	62	60	66	55	76	93	90	68	64	38	47	950	14	81	2	83
Quadrula pustulosa	pimpleback	99	75	85	53	53	85	31	41	80	79	48	65	30	24	848	14	53	21	74
Potamilus alatus	pink heelsplitter	14	29	18	29	34	43	41	27	55	45	16	10	35	12	408	14	24	7	31
Ellipsaria lineolata	butterfly	24	29	24	25	8	27	19	18	23	28	14	11	15	8	273	14	27	0	27
Amblema plicata	threeridge	18	33	19	11	17	25	23	24	49	10	13	13	11	5	271	14	2	0	2
Pyganodon grandis	giant floater	18	10	5	4	3	7	9	7	29	20	5	7	7	1	132	14	1	0	1
Quadrula metanevra	monkeyface	14	24	11	13	6	10	7	7	8	8	8	4	2	2	124	14	3	0	3
Tritogonia verrucosa	pistogrip	6	12	5	5	4	15	8	13	18	9	9	7	4	1	116	14	0	0	0
Obliquaria reflexa	threehorn wartyback	14	6	8	3	7	5	9	3	7	11	6	11	6	3	99	14	5	5	10
Ligumia recta	black sandshell	6	3	4	10	3	8	8	10	7	2	3	1	2	1	68	14	0	0	0
Lampsilis abrupta	pink mucket	3	7	6	2	1	7	6	2	12	4	6	2	4	0	62	13	1	0	1
Leptodea fragilis	fragile papershell	1	3	4	2	3	2	6	3	12	8	0	3	1	2	50	13	3	2	5
Actinonaias ligamentina	mucket	3	2	2	0	4	7	0	8	3	5	1	0	0	0	35	9	0	0	0
Megalonaias nervosa	washboard	2	1	0	1	1	4	5	1	9	3	4	2	1	0	34	12	1	0	1
Lampsilis ovata	pocketbook	3	1	1	4	5	4	1	2	3	1	0	0	0	1	26	11	0	0	0
Elliptio dilatata	spike	4	2	1	1	0	2	2	1	3	1	0	0	1	0	18	10	2	0	2
Pleurobema oviforme	Tennessee clubshell	0	0	2	0	0	1	0	2	2	1	0	1	0	0	9	6	0	0	0
Utterbackia imbecillis	paper pondshell	0	0	0	2	0	0	0	1	1	1	0	0	0	0	5	4	1	0	1
Cyprogenia stegaria	fanshell	2	1	0	1	1	0	0	0	0	0	0	0	0	0	5	4	0	0	0
Pleurobema plenum	rough pigtoe	1	1	2	0	1	0	0	0	0	0	0	0	0	0	5	4	0	0	0
Plethobasus cyphyus	sheepnose	0	2	0	0	0	0	0	0	0	0	1	1	0	0	4	3	1	0	1
Pleurobema rubrum	pyramid pigtoe	0	0	0	0	0	3	0	0	1	0	0	0	0	0	4	2	0	0	0
Fusconaia subrotunda	longsolid	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	1
Anodonta suborbiculata	flat floater	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2	0	0	0
Lasmigona costata	flutedshell	0	0	0	0	0	0	1	0	0	0	0	0	1	0	2	2	0	0	0
Ptychobranchus fasciolaris	kidneyshell	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	2	0	0	0
Dromus dromas	dromedary pearlymussel	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Lasmigona complanata	white heelsplitter	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Total Mussels		**1341**	**1422**	**1270**	**1368**	**1063**	**1427**	**1075**	**1180**	**1610**	**991**	**708**	**880**	**846**	**697**	**15878**		**852**	**50**	**902**
Number of Species Collected		**22**	**21**	**20**	**19**	**20**	**20**	**18**	**20**	**22**	**22**	**16**	**17**	**17**	**14**	**30**		**17**	**6**	**17**

ATTACHMENT 13

TENNESSEE VALLEY AUTHORITY

RESOURCE GROUP
WATER MANAGEMENT

AQUATIC ENVIRONMENTAL CONDITIONS IN THE VICINITY OF WATTS BAR NUCLEAR PLANT DURING TWO YEARS OF OPERATION, 1996-1997

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June 1998
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TENNESSEE VALLEY AUTHORITY

Revisions (06/07/2010)

In section 2.1, Entrainment-Larval Fish (and Eggs), clerical errors were discovered that prompted a thorough review of the raw data and calculations to verify the earlier entrainment rate estimate. Fish and egg density values and CCW intake and river flow data for 1996 and 1997 used to calculate percent entrainment were re-evaluated based on the seasonality of ichthyoplankton occurrence and reservoir releases from Watts Bar Dam. Section 2.1 was revised using actual intake water demand and reservoir river flow values for each sample period. This is a more accurate method for estimating percent entrainment of fish eggs and larvae than was used in the original report, which used mean annual flow rates for plant intake and river flow past the plant. Table 2-4 in the original report ("Day and night densities (number per 1,000 m3) of larval fish collected during preoperational and operational monitoring in the vicinity of Watts Bar Nuclear Plant") was removed because diel densities were variable and no trend was apparent, and because the table did not contribute to the entrainment analysis. Tables 2-5 and 2-6 in the original report have been combined into a single table, number Table 2-4. Tables 2-7 and 2-8 have been renumbered as Tables 2-5 and 2-6. A new Table 2-7 has been added to show estimated entrainment results of fish eggs and larvae during 1996 and 1997 at Watts Bar Nuclear Plant based on intake and reservoir flow, number of days sampled, average densities, total numbers and percent entrained and total numbers transported past WBN. The remaining tables in Section 2, Tables 2-9 through 2-26, have been renumbered as Tables 2-8 through 2-25. This revision confirms that the following conclusion regarding entrainment in the original 1998 report remains valid. Overall, low entrainment percentages for fish eggs and larvae transported past WBN and minimal hydraulic entrainment by WBN, suggest no impact to the ichthyoplankton populations of Chickamauga Reservoir from the operation of WBN.

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EXECUTIVE SUMMARY

As required by the National Pollutant Discharge Elimination System (NPDES) Permit Number TN0020168 for operation of Watts Bar Nuclear Plant (WBN), this report is a composite evaluation of nonradiological preoperational and operational aquatic monitoring conducted from 1973-1979, 1982-1985, and 1996-1997. The primary objective of the WBN Nonradiological Operational Monitoring Program is to evaluate and compare specific biological and chemical parameters during the first two years of operation of WBN to those reported in the WBN Nonradiological Preoperational Assessment. Biological and chemical components monitored to detect and evaluate significant effects, if any, of WBN during the first two years of operation included: juvenile and adult fish, entrainment of fish eggs and larvae, fish impingement, tailwater fishery creel survey, benthic macroinvertebrate communities, native mussel fauna, and various water quality parameters.

In the vicinity of WBN, occurrence and abundance of ichthyoplankton (fish eggs and larvae) is primarily the result of passage through the turbines at Watts Bar Dam. This is because most fish species are reservoir and not tailwater spawners. A combination of low densities and number of taxa of ichthyoplankton passing the WBN water intake and the low volume of hydraulic entrainment required by the plant resulted in insignificant losses due to plant operation. Relative abundance and species composition of benthic macroinvertebrates and juvenile and adult fish were also primarily influenced by releases from Watts Bar Dam. Temporal analyses showed that

seasonal and yearly changes in abundance and other variables for all component populations, except freshwater mussels, were common.

It is apparent based on comparisons of species composition, relative abundance, catch per unit effort (CPUE), and Reservoir Fish Assemblage Index (RFAI) scores between preoperational and operational monitoring, WBN has not adversely impacted the tailwater fish population below Watts Bar Dam during the first two years of operation. Comparison of fish community sampling during preoperational and operational monitoring showed minimal variations comparing 12 important species. Reservoir RFAI values also remained relatively stable.

Comparisons of angling effort between preoperational and operational periods were not possible as this information was not available during the preoperational period. During the two years of tailwater creel surveys (April 1996-April 1998), a total of 392,807 fishing hours and 88,151 angler trips were estimated. Catfish, sauger, white bass, crappie, sunfish, striped bass/cherokee bass, and black bass were the most sought after species by fishermen. An estimated of 341,106 fish were caught and 165,128 fish harvested from April 1996-April 1998. Peak angling effort (30,218 hours) and number of trips (9,717) occurred in April 1996. Angling trips ranged from 9,717 in April 1996 to 1,456 trips in November 1997. Annual catch rate (number per hour) in the vicinity of WBN during operational monitoring has increased to 1.54 (fish per hour) compared to the highest catch rate during the preoperational monitoring of 1.16 (fish per hour).

The first two years of operation of WBN has not impacted the benthic macroinvertebrate community. During operational monitoring, densities of benthic macroinvertebrates collected near WBN nearly doubled from those observed during preoperational monitoring. In addition to

the increased number of taxa found during this period, zebra mussel average densities increased from 26.5/m^2 in 1996 to 41/m^2 in 1997 and were most abundant (72/m^2) at TRM 528.5 (upstream of the WBN intake channel). Freshwater mussels in the vicinity of WBN are slow growing and quite old. Many of the 30 species found below Watts Bar Dam appear to have not reproduced in the past 50 years. Declining abundance trends were noted during preoperational assessment for several communities of macroinvertebrates, plankton and periphyton. These trends are mainly due to the wide range of flow and climatic conditions that occur.

Water quality in the vicinity of WBN, while generally satisfactory, was influenced by releases from Watts Bar Dam located two miles upstream. In 1996, TVA's Water Management installed an aeration system in the forebay of Watts Bar Reservoir to reduce stratification in the vicinity of Watts Bar Dam during summer and fall. This has resulted in higher dissolved oxygen levels in hydro releases. During the first two years of operation, WBN has not impacted the water quality in Chickamauga Reservoir.

WBN operation has had no effect on the aquatic communities nor water quality in upper Chickamauga Reservoir.

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1.0 INTRODUCTION

1.1 Purpose and Objective

The Tennessee Valley Authority (TVA), in accordance with the NPDES Permit Number TN0020168, conducted a six-year (1973-1979) nonradiological preoperational aquatic monitoring program after receiving construction permits for WBN on January 23, 1973, from the Atomic Energy Commission. Due to policy changes and various construction delays, TVA conducted an additional preoperational aquatic monitoring program from March, 1982 through December, 1985 to update the data base. Information collected provided a composite analysis of biological and water quality conditions during both monitoring periods. TVA completed one reactor unit and began testing Unit 1 in March 1996 and first generated commercial power on May 27, 1996. This unit operated at 84% capacity and generated more than 8.5 billion kilowatt-hours of electricity during the first year of commercial operation (May 27, 1996 through September 5, 1997) and at or near forecast net capacity through the first quarter of 1998.

Part III, Section C.b. of the NPDES permit requires that an operational monitoring plan be implemented not later than the start of the biological year in which 100% power is predicted for Unit 1. The current operational monitoring plan was submitted to the Tennessee Department of Environmental Conservation (TDEC) on September 8, 1993 (Ref: Letter from Wilson C. McArthur to Thomas Roehm). This operational monitoring plan was revised from previous versions based on numerous aquatic biological investigations conducted in the vicinity of WBN and throughout Chickamauga Reservoir since the original operational monitoring plan was prepared in 1977. These investigations focused on selected fish species and other specific problem areas (e.g., dissolved oxygen, aquatic vegetation) identified by the State of Tennessee. The cumulative results of these investigations changed the scope and focus of concerns regarding

the potential effects of WBN operation on the ecology of Chickamauga Reservoir. In particular, results of species-specific investigations of sauger, white crappie, white bass, and channel catfish have provided information that reduced earlier concerns about the likelihood of WBN operational effects on these species.

The previously approved WBN Operational Nonradiological (Aquatic Biological) Monitoring Program contained types and frequencies of sampling that essentially duplicated those used in the preoperational monitoring program. The rationale for the preoperational monitoring program was to provide a broad base of information on all aspects of aquatic communities in the vicinity of WBN, regardless of whether or not the operation of the plant would reasonably be expected to significantly impact those communities. The rationale for the present operational monitoring program is to focus as much as possible on specific areas of concern to the State and TVA based on a realistic assessment of the likelihood of operational effects on a given community. It also provides sufficient data to indicate the presence of unexpected effects on other communities that might become the subject of more intensive studies in the future. The purpose of operational aquatic monitoring is to evaluate plant effects on the aquatic environment for at least two years after commercial operation of Unit 1 as required by the NPDES permit. This monitoring program was designed to detect and evaluate significant changes in water quality and biological communities which could be plant-induced.

Data analyzing spatial and temporal differences were compared with preoperational monitoring data when possible to detect and evaluate significant changes in water quality and biological communities. Spatial differences were determined by comparing data from stations upstream

and downstream of WBN. Temporal changes were determined by comparing operational (1996 through 1998) to preoperational monitoring data (1973-1979 and 1982-1985). Data from additional investigations conducted between 1985 and 1996 were also used to supplement preoperational data.

1.2 Plant Description

WBN is located on the west bank of upper Chickamauga Reservoir near Tennessee River Mile (TRM) 528 (Figure 1-1). This one-unit nuclear generating plant is designed for an electrical ouput of about 1270 megawatts (MWe). WBN is situated approximately two miles downstream of Watts Bar Dam (TRM 529.9) and one mile downstream of the four-unit Watts Bar Fossil Plant (WBF) that is also on the west bank of Chickamauga Reservoir (TRM 529). WBF was decommissioned on March 29, 1983, and has been off-line since 1981.

WBN is operated in closed cycle cooling mode, using one of the two cooling towers for heat dissipation. Blowdown from the cooling tower is discharged through multiport diffusers located in the main river channel at TRM 527.8. Makeup water and other water supply requirements are obtained from an intake channel and pumping station at TRM 528. These intake and discharge structures are shown in Figure 1-1.

The WBN intake channel cross-section opening is approximately 155 m^2 (1,650 ft^2) at Chickamauga Reservoir winter pool elevation of 206m (675 ft) mean sea level, and 293 m^2 (3,159 ft^2) at summer pool level of 208m (682.5 ft). Corresponding average velocities in the intake channel are 0.03 m/s (0.1 ft/s) and 0.015 m/s (0.05 ft/s). Four gates lead to the traveling

screens with a combined opening of 33 m^2 (360 ft^2), so the maximum screen velocity is approximately 0.15 m/s (0.5 ft/s). Maximum intake pumping flowrate is 4.5 m^3/s (160 cfs) or 0.6 % of the long-term average flow past WBN of 767 m^3/s (27,100 cfs).

Blowdown from the cooling tower is discharged directly to the diffuser or into a holding pond which in turn releases water through the diffuser system. During periods of no releases from Watts Bar Dam, WBN blowdown is stored in the holding pond. Releases during normal operation are approximately 2.0 m^3/s.

The diffuser system consists of two pipes extending into the main channel. The downstream pipe segment extends 90m into the channel with a 50m long, 1.35m diameter diffuser section located in the deepest (5-6 m) portion of the 400m wide channel. The upstream pipe segment extends 140m with a 25m long, 1.0m diameter diffuser section beginning where the downstream diffuser section ends. The diffuser sections are half buried in the river bottom with two rows of 2.5cm (1 in) diameter ports oriented at a 45° angle in the downstream direction. The exit jet velocity is approximately 2 m/s. The expected discharge temperature varies, depending on cooling tower performance, from 17°C in January to 35°C in July. The maximum blowdown temperature is 35°C, so the expected monthly average temperature difference between the discharge and the river varies from 10°C during winter and spring to 5°C during summer and fall. The diffuser system will result in a near-field dilution of at least 15. Far-field mixing will depend on releases from Watts Bar Dam. The permitted diffuser mixing zone at WBN is 240 feet wide and extends 240 feet downstream over the entire river depth. At the long-term average releases, maximum diffuser discharge represents 0.6 % of river flow.

2.0 JUVENILE AND ADULT FISH

2.1 Entrainment-Larval Fish (and Eggs)

Introduction

Preoperational monitoring to determine spatio-temporal concentrations of ichthyoplankton in the vicinity of WBN was conducted from 1976-1979 and from 1982-1985. Preoperational data were compared with operational data collected during 1996 and 1997 to determine and assess any effects of plant operation. This sampling provided estimates of density and relative abundance by taxon to evaluate potential losses by determining the proportion of eggs and larvae passing the plant entrained in the condenser cooling water.

Materials and Methods

Data Collection

Ichthyoplankton samples during preoperational (1976-1979, 1984 and 1985) and operational (1996 and 1997) monitoring were collected biweekly (weekly during part of preoperational monitoring) on a diel schedule (day and night), during March-August (preoperational) and April-June (operational) at TRM 528.0 (Table 2-1). This sampling provided temporal abundance of larval fish at five stations along a transect perpendicular to river flow just upstream of the plant intake channel (Figure 2-1). Samples were taken with a beam net (0.5 m square, 1.8 m long, with 505 micron "nitex" mesh netting) towed upstream at a speed of 1.0 m/s for ten minutes. The volume of water filtered through the net was measured with a large-vaned General Oceanics Inc.® flowmeter. Approximately 150 m^3 of water were filtered per ten minute sample. Water temperature was recorded using a mercury thermometer calibrated to the tenth degree.

Beginning in 1984 and during operational monitoring, additional towed samples were collected in the plant cooling water intake channel. Preoperational (1984-1985) intake channel samples consisted of four, four-minute samples taken from the plant intake pump building to the mouth of the intake channel. Each operational intake sample was a composite of four, one-minute samples taken from the trash boom to the mouth of the intake channel. Approximately 40-50 m^3 of water were filtered per intake sample.

Laboratory Analysis

Larval fish were removed from the samples, identified to the lowest possible taxon, counted and measured to the nearest millimeter total length following procedures outlined in NROPS-FO-BR-24.1 (TVA 1983). Taxonomic decisions were based on TVA's "Preliminary Guide to the Identification of Larval Fishes in the Tennessee River," (Hogue et al., 1976) and other pertinent literature.

The term "unidentifiable larvae" applies to specimens too damaged or mutilated to identify, while "unspecifiable" before a taxon implies a level of taxonomic resolution (i.e., "unspecifiable catastomids" designates larvae within the family *Catostomidae* that currently cannot be identified to a lower taxon). The category "unidentifiable eggs" applies to specimens that cannot be identified due to damage or lack of taxonomic knowledge. Taxonomic refinement is a function of specimen size and developmental stage. Throughout this report, the designation "unspecifiable clupeids" refers to clupeids less than 20 mm in total length and could include *Dorosoma cepedianum* (gizzard shad), *D. petenense* (threadfin shad), and/or *Alosa chrysochloris*

(skipjack herring), (Table 2-2). Any clupeid specimen identified to species level represents a postlarva or juvenile 20 mm or longer in total length.

Developmental stage of percichthyids also determines level of taxonomic resolution. *Morone saxatilis* (striped bass) hatch at a larger size than either *M. chrysops* (white bass) or *M. mississippiensis* (yellow bass). Although it is currently impossible to distinguish between larvae of the latter two species, *M. saxatilis* can be eliminated as a possibility based on developmental characteristics of specimens 5 mm or less in total length (hence, the taxonomic designation *Morone*, not *saxatilis*). Specimens identified as *Morone* sp. are greater than 5 mm total length.

Data Analysis

Temporal occurrence and relative abundance of eggs and larvae by taxon are presented and discussed for the entire preoperational and operational monitoring periods. Densities of fish eggs and larvae are expressed as numbers per 1,000 m^3.

Estimated entrainment of fish eggs and larvae at WBN was calculated by the following method: densities of eggs and larvae transported past the plant were estimated for each sample period by averaging densities (all stations) of eggs and larvae from TRM 528 and multiplying by the corresponding 24-hour flow past the plant.

Percentage of transported ichthyofauna entrained by the plant was estimated from the formula:

$$E = \frac{100 D_i Q_i}{D_r Q_r},$$

Where: D_i is the mean density (number/1,000 m^3) of eggs or larvae in intake samples;
D_r is the mean density (number/1,000 m^3) of eggs or larvae in the river transect at TRM 528;
Q_i is the plant intake water demand (m^3/d); and
Q_r is the river flow (m^3/d).

The annual entrainment rate is the average of the percent entrained during each of the 24-hour sampling periods.

Results and Discussion

Fish Eggs

During the two preoperational study periods, 3,005 fish eggs were collected in WBN ichthyoplankton samples. This total consisted of 65% unidentified eggs and 34% freshwater drum eggs and one *Hiodon sp*. egg (probably *Hiodon tergisus*) collected in 1985 sampling. (Table 2-3) presents total numbers and percent composition of fish eggs and larvae collected during 1976-1985 and 1996-1997. Drum eggs occurred in samples from early May to early September with peak abundance occurring from May through early July (TVA 1986).

Less than 1% of the 4534 fish eggs collected during operational monitoring were identifiable (Table 2-4). All identifiable eggs were freshwater drum, 21 in 1996, and 14 in 1997. During both operational years, drum eggs were first collected after the water temperatures reached 20°C. The planktonicity of freshwater drum eggs makes them highly vulnerable to capture by larval

fish sampling gear; therefore, low abundance at the WBN site indicates little, if any, freshwater drum spawning in the Watts Bar tailwater upstream of the WBN intake channel. The occurrence of freshwater drum eggs at WBN probably results from dam passage. It is very likely that the large number of unidentified eggs collected are freshwater drum eggs that were damaged via dam passage and thus unidentifiable. Further evidence is that freshwater drum are essentially the only abundant reservoir species which are pelagic spawners with non-adhesive, semi-buoyant eggs. Large numbers of freshwater drum larvae were collected at the Lowe Branch site above Watts Bar Dam in 1978 (TVA 1980b), indicating considerable drum spawning occurs above the dam.

Fish Larvae

Taxonomic composition of larval fish samples during preoperational and operational monitoring consisted of 20 and 18 taxa, respectively, is presented in (Table 2-3). During both years of operational monitoring (1996 and 1997) clupeid larvae represented 86 and 82 percent of the larval fish community collected, respectively, and were present eleven of thirteen sample periods (Tables 2-4). Percent composition of the remaining taxa exceeding 1% in 1996 and 1997 were freshwater drum (6.6%, 2.7%) *Morone* (4.5%, 12.3%) and sunfishes (1.9%, 1.3%), respectively. Gizzard shad (1.5%) and threadfin shad (1.0%) exceeded 1% during 1996 and crappie (1.3%) exceeded 1% during 1997. During 1996 and 1997 *Morone* (not *saxatilis*) and *Percidae* (not *Stizostedion*) occurred during the first three sample periods (Table 2-4). Six yellow perch larvae were collected during 1996, but none were collected during 1997. No sauger larvae were collected during 1996, but two were collected during the first sample period of 1997. *Morone* were present during all sample periods in 1996 and 1997 and increased in composition from

0.83% (41 larvae) during 1996 to 8.3% (820 larvae) during 1997. Percent composition of crappie larvae increased from 0.2% during 1996 (8 8 larvae) to 1.3% (125 larvae) during 1997 (Table 2-4).

During preoperational monitoring, average larval densities, measured from April-June, were highest (2,119/1,000 m^3) in 1984 and lowest (146/1,000 m^3) in 1979 (Table 2-5) with an average preoperational density of 822/1,000 m^3. The highest and lowest peak density occurred May 29, 1984 (10,485/1,000 m^3) and July 02, 1979 (522/1,000 m^3), respectively. During operational monitoring 1996 and 1997 average larval densities were 525/1,000 m^3 and 924/1,000 m^3, respectively. Peak densities of 1,387/1,000 m^3 and 1,699/1,000 m^3 occurred on June 3, 1996 and May 15, 1997, respectively (Table 2-5). Peak densities typically reflected periods of greatest larval shad abundance. During both preoperational and operational periods, seasonal larval densities were positively correlated with mean water temperatures ($r = 0.80$).

Larvae of migratory taxa (species known to have distinct spawning migrations) reported to spawn in tailwaters were not numerous in preoperational or operational monitoring samples. Specimens of *Stizostedion* sp. collected during preoperational monitoring, 1976-1978 (Table 2-3), were the result of dam passage as they were too large (10-18 mm TL) to have hatched below Watts Bar Dam in the vicinity of WBN. Priegel (1969) reported that sauger hatch at 5-7 mm total length. Neither *Stizostedion* sp. nor *S. canadense* (sauger) larvae were collected in the last five years of preoperational monitoring, nor during the first year of operational monitoring. During the second year of operational monitoring two *Stizostedion* sp. were collected during the first sampling period (Table 2-4). Both individuals were 7 mm in length (Table 2-6) indicating

these could have been walleye larvae that hatched above Watts Bar Dam or possibly incidental spawnning by sauger in the tailwater. Priegel (1970) found that walleye hatch at 6.0-6.8 mm total length. Previous investigations (Hickman et al. 1990) have determined that sauger in Chickamauga Reservoir spawn at Hunter Shoals (TRM 521), and therefore larvae hatched downstream from WBN would not be subjected to entrainment by WBN.

Temperate basses (*Morone*.), also migratory spawners, accounted for more than 1% of total larvae during five of the last six years of preoperational monitoring and during both years of operational monitoring. White and yellow bass (not striped bass), comprise the majority of this taxon. Temperate basses as a whole made up 0.06% in 1976 to 6.63% of the ichthyoplankton community in 1982 (Table 2-3). During operational monitoring (1996 and 1997), percent composition of the sum of *Morone* larvae ranged from 4.5% to 12.3%, respectively (Table 2-3). Table 2-6 illustrates a wide range of larval and postlarval *Morone* sizes in ichthyoplankton samples during the two years of operational monitoring. This suggests a combination of both *Morone* spawning in the tailwater and dam passage of larvae produced in Watts Bar Reservoir.

Perca flavescens, (yellow perch), larvae were first collected in Chickamauga Reservoir in 1978, and were subsequently collected throughout preoperational monitoring. Adult yellow perch are common in Chickamauga and Watts Bar Reservoirs. Larvae collected in the vicinity of WBN likely result from dam passage. Yellow perch made up 0.12% of larval densities during the first year of operational monitoring (1996) which was consistent with the relative abundance observed during preoperational monitoring (Table 2-3). During the second year of operational

monitoring (1997) larval yellow perch were not collected. It can be concluded that the tailwater habitat is not conducive to yellow perch spawning.

Due to their high reproductive potential, clupeids were consistently the most numerous larval fish taxon captured during both preoperational and operational periods (Table 2-3). It is unlikely that the Watts Bar Tailwater is an important spawning area for shad. Eggs of gizzard and threadfin shad are demersal and adhesive, and larvae of both species hatch at approximately 3.5 mm total length (Shelton 1972). Shelton also reported growth of both species to be 1 mm or more the first day at 23^0C. Typically, water transport time from Watts Bar Dam to the plant site would not exceed five to six hours (TVA 1986). Operational monitoring revealed that most clupeids collected were greater than 6mm (Table 2-6). This implies that larval and postlarval shad below the dam were there as a result of dam passage.

Two Centrarchids, sunfish and crappie, were collected all six years of preoperational monitoring, and during operational monitoring. Sunfish were relatively abundant in all monitoring years (Table 2-3). Preoperational data (TVA 1986) suggest that densities of sunfish larvae were greater near the shoreline and in intake samples, indicating that these two areas serve as spawning and nursery areas for sunfish.

Crappie larvae were collected during May and June for all of preoperational and operational monitoring (Tables 2-4). Size distributions of crappie larvae collected at WBN (Table 2-6) show that approximately 63% of the larvae collected were 5 or 6 mm specimens in 1996 and 84% in 1997. Crappie larvae swim up from the nest when total length is between 4.1 and 4.6 mm

(Siefert 1968 and Carlander 1977). Crappie spawning habitat has been well documented in Watts Bar Reservoir and a greater mean size of crappie larvae collected at WBN than at Lowe Branch in 1978 (TVA 1980a) suggests their occurrence at WBN is mainly via dam passage.

Freshwater drum comprised 5% of the total catch during operational monitoring and 0.3% to 18% during preoperational monitoring (Table 2-3). Mean densities of this species were the least variable of the abundant taxa and similar densities were observed during day and night samples (TVA 1986). As mentioned previously, freshwater drum were primarily spawned above Watts Bar Dam.

Estimated Entrainment of Eggs and Fish Larvae

Estimated average hydraulic entrainment by WBN (proportion of the Tennessee River flow entrained through the intake pumping station) during operation was very low (0.6%) compared to 13% by Sequoyah Nuclear Plant (SQN), (TVA 1996). These percentages are derived from measured intake volumes and river flow at each plant. Estimated percentage entrainment of fish eggs and larvae being transported past WBN during 1996 was 0.29% and 0.57%, respectively (Table 2-7), compared to 7.5% estimated entrainment of larvae at SQN during 1980-1984 (TVA 1984). During 1997, entrainment of fish eggs and larvae was estimated to be 0.02% and 0.22%, respectively. Total transport of fish eggs and larvae past WBN during six sample periods in 1996 was estimated to be 1.09×10^8 and 1.63×10^8, respectively. During the seven sample periods in 1997, the total transport of fish eggs and larvae past WBN was estimated to be 1.20×10^8 and 4.2×10^8, respectively. Corresponding numbers entrained at WBN in 1996 were 2.05×10^4 fish eggs and 1.4×10^6 larvae. During 1997, the estimated total entrainment was 1.94×10^4

eggs and 9.29 x 10^5 larvae. Due to the low hydraulic entrainment at WBN, larvae residing in the intake channel are most susceptible to entrainment. Larval shad represented 91% in 1996 and 84% in 1997 of all larvae collected in the intake channel, followed in abundance by sunfish (7.6% and 8.1%), freshwater drum (0.8% and 0. 3%), and *Morone* (0.2% and 6.4%), respectively (Table 2-8).

The higher composition of sunfish (*Lepomis*) larvae in the intake basin was likely a result of resident populations using this area as a spawning and nursery habitat. *Lepomis* was ranked fourth in combined percent composition of total larvae in reservoir and intake samples during 1996 (1.9%) and during 1997 (1.3%) (Tables 2- 3 and 2-4). Overall, low entrainment percentages for fish eggs and larvae transported past WBN and minimal hydraulic entrainment by WBN, suggest no impact to the ichthyoplankton populations of Chickamauga Reservoir from the operation of WBN.

2.2 Electrofishing

Introduction

Preoperational fish community sampling at WBN was initiated in March 1977, continued through November 1979, and resumed from March 1982 to December 1985. Additional preoperational fish community monitoring data were collected in the vicinity of WBN (TRM 526-529.9) from 1990 to 1995 in conjunction with the TVA Reservoir Vital Signs Monitoring program. Vital signs monitoring activities provide information from key physical, chemical, and biological indicators. The Reservoir Fish Assemblage Index (RFAI) provides one biological measure of the status of the environmental quality of a particular area of a reservoir (Hickman and McDonough 1996). The sampling schemes between these two data sets (older

preoperational and vital signs monitoring) were somewhat different, limiting potential comparisons.

Usefulness and validity of electrofishing data, as with other gear types, is dependent on efficiency and consistency of sample collection. Factors which influence electrofishing data can generally be broken into three categories: fish characteristics, habitat characteristics, and operating conditions (Reynolds 1983). Fish characteristics are not anticipated to influence comparisons between WBN preoperational and operational electrofishing samples as the sampling schemes were directed at the same species. Influence of habitat characteristics was minimized by both sampling schemes directed at proportionally covering all shoreline habitats available above and below WBN. Operational variations, such as seasonal differences in Watts Bar Dam water releases, were reduced by comparing only fall samples between the data sets (spring, summer and winter samples were also available for the 1977-1985 preoperational period). Another operational difference was the start-up of WBN in 1996, and this was the focus of determining plant impacts. Particularly in a tailwater habitat such as that found near WBN, numbers of species and abundance will vary seasonally.

Materials and Methods

Fish stunned by a boat electrofishing unit were captured, identified, enumerated, and recorded prior to release. During vital signs monitoring samples (1990-1997), young-of-the-year (YOY) individuals of all species were not included in counts and percent composition aspects due to their highly fluctuating densities (especially shad species), inaccurate sampling by electrofishing, and the uncertainty of their contribution to adult stocks. Earlier preoperational samples (1977-1985) did include YOY individuals. Individual lengths were not measured during these samples, therefore, determination of YOY densities was not possible. As a result, gizzard and threadfin shad were eliminated from all density and percent composition results from all data sets.

Data collected from 1977-1979 were based on timed (three minute duration) electrofishing runs, while samples collected during 1982-1985 were distance based (100 m). Five electrofishing runs were collected monthly during both of these time periods. Vital signs samples were collected once during each fall (15 electrofishing runs) and were distance-based (300 meters of shoreline/run). Species occurrence and percent composition between the two preoperational sample sets and operational results, after elimination of shad, are comparable. Since operational data are limited to two annual samples (1996 and 1997), vital signs preoperational data (1990-1995) are reported in average annual results to allow more realistic comparisons.

Catch per unit effort (CPUE) results are not comparable between 1977-1985 preoperational and 1990-1996 vital signs results due to the differences in sampling protocol. Therefore, discussions

of operational impacts of WBN on fish species CPUE will be based on comparisons between 1990-1995 (preoperational) and 1996-1997 (operational) vital signs monitoring results.

General comparisons were made between the 1977-1985 preoperational, 1990-1995 preoperational, and 1996-1997 operational data regarding species occurrence and relative composition of the resident fish population. Average CPUE results in electrofishing samples during vital signs preoperational and operational periods were compared using an univariate Analysis of Variance (ANOVA) to determine if there were significant ($P = 0.05$) differences. Only species termed "important" (those occurring in 50% or more of the samples and comprising at least 1% of the total catch) are discussed in detail. RFAI scores between vital signs preoperational and operational years were compared to determine if the overall fish community had been impacted by the initial two years of WBN operation.

Results and Discussion

Table 2-9 compares species occurrence and percent composition between preoperational electrofishing (1977-1979 and 1982-1985), preoperational vital signs monitoring data (1990-1995), and operational monitoring (1996-1997) electrofishing data. During the 1977-1985 preoperational monitoring period at WBN, monthly electrofishing yielded 43 species from 12 families (Table 2-9). Fall vital signs electrofishing preoperational monitoring resulted in the collection of 39 species from 10 families while 34 species (9 families) were captured during fall operational monitoring. The higher diversity found during 1977-1985 preoperational monitoring was likely due to samples occurring on a monthly basis instead of only one fall sample taken per year during vital signs monitoring activities. Operational monitoring consisted of a total of two samples, fall 1996 and 1997 however; species occurrence was just slightly lower than 1990-1995 preoperational results, which included a total of six fall samples.

Percent composition of the various preoperational and operational electrofishing samples (excluding gizzard and threadfin shad) revealed minimal differences in the fish community make-up from 1977-1997 (Table 2-9). Only emerald shiners appear to have declined substantially in numerical importance over the course of the sample periods; making up 58.6% of the community during 1977-1985, 17.1% from 1990-1995, and only 1.5% during 1996-1997. This decline began prior to WBN startup, therefore plant operation is not considered responsible. Bluegill, redear sunfish, yellow bass, and largemouth bass have consistently dominated the overall catch. Bluegill and smallmouth bass increased in importance throughout the sampling period. Additional species of fish generally meeting the important species criteria (comprising more than 1% of the population) included; white bass, common carp, spotted sucker, golden

redhorse, freshwater drum, brook silversides, logperch, smallmouth bass, spotted bass, and black crappie. Brook silversides were not collected during either year of operational monitoring, while golden redhorse, freshwater drum, and black crappie increased somewhat in importance to the community after WBN became operational.

Comparisons of CPUE (catch per electrofishing run) results between vital signs preoperational (1990-1995) and operational (1996-1997) monitoring are listed in Table 2-10. Mean CPUE for all species during preoperational and operational monitoring was 76 and 53 fish per shocking run, respectively. Threadfin shad were not included due to extreme variability of results caused by the schooling nature of these species. If a large school of shad is encountered during a particular electrofishing run, the catch rates are skewed out of proportion. Bluegill, redear sunfish, largemouth bass, yellow bass, spotted bass, and smallmouth bass dominated the catch during both periods. Only emerald shiners revealed any major change in abundance, and, as noted earlier, this decline began prior to WBN becoming operational. None of the differences between preoperational and operational sample results for 12 species meeting the criteria to be considered "important" were significant, P=0.05 level (Table 2-11).

RFAI values for the vicinity of WBN remained relatively stable with an average annual score of 44 during the 1991-1995 preoperational period and an average score of 45 in the operational period (1996-1997). Scores ranged from a maximum score of 56 in 1993 to a minimum of 33 in 1991 (Figure 2-2). The maximum RFAI score of 56 obtained in 1993 was followed by a gradual decline to 38 by 1996. This decline began two years before WBN became operational and

rebounded to a score of 52 during the second year of operation. Reasons for the 1993-1996 decline are unknown, but it is apparent WBN operation was not responsible.

Conclusions

Fish community sampling results revealed only minor differences in species occurrence and percent composition between preoperational and operational samples. These differences were attributed to variations in sampling design with 1977-1985 data collected on a monthly basis throughout each year and 1990-1996 data collected only once during fall of each year. Operational data included only two samples.

Comparison of catch per electrofishing run (CPUE) during 1990-1995 preoperational and 1996-1997 operational monitoring also showed minimal variation (76 and 53 fish per shocking run, respectively). Only emerald shiners revealed any major change in abundance, and this decline began prior to WBN becoming operational. None of the differences between preoperational and operational CPUE for 12 species meeting the criteria to be considered “important” were significant.

Reservoir Fish Assemblage Index (RFAI) values for the vicinity of WBN remained relatively stable with an average annual score of 44 during the 1991-1995 preoperational period and an average score of 45 in 1996-1997.

Based on comparisons of species composition, relative abundance, CPUE, and RFAI scores between preoperational and operational monitoring, WBN has not adversely impacted the tailwater fish population below Watts Bar Dam during the initial two years of operation.

2.3 Impingement

Introduction

Monitoring for impingement of fish on the WBN cooling water intake traveling screens began March 15, 1996, before Unit 1 became commercially operational. WBN operates in closed cycle cooling mode, with blowdown from the cooling tower being discharged through the multiport diffusers located in the main channel at TRM 527.8. Makeup water is pumped from the intake channel located at TRM 528.0 with a maximum flow rate of 4.5 m^3/s (160cfs), which represents 0.6% of the long-term average flow of 767 m^3/s (27,100 cfs) past WBN (TVA 1996). Results from the first and second year (partial) of fish impingement monitoring at WBN are compared with standing stocks of fish in Chickamauga Reservoir and previous impingement estimates from SQN. The Tennessee Department of Environment and Conservation (TDEC) Division of Water Pollution Control approved TVA's request in the first annual report (Baxter et.al 1997) to discontinue impingement sampling due to extremely low numbers of fish impinged. Sampling was suspended October 7, 1997.

Material and Methods

Total numbers and species of fish impinged on the screens were estimated from weekly screen washings during December-May and biweekly during June-November. Protocol for impingement sampling at the WBN intake pumping station consisted of four screens rotating and backwashing simultaneously to remove all fish and debris. Screens were left stationary for 24 hours to collect the sample and all four screens were rotated and backwashed again to remove impinged fish. These fish were collected from the screen backwash water as the water passed through a steel mesh basket at the end of the screen wash sluice pipe. Impinged fish were identified to species, measured, weighed and recorded. Thirty-six samples were collected between March 15, 1996, through February 28, 1997 and 21 samples were obtained from March 4, 1997 through September 30, 1997. Estimates of total annual impingement were calculated by multiplying average number of fish impinged per sample by the number of days in each month and year.

Results and Discussion

Fifty-five impingement samples, collected between March 15, 1996 and September 30, 1997, yielded only 20 fish representing nine species (Table 2-12). Numbers of impinged fish were consistently low due to the low volume of water withdrawn through the intake channel. Total annual estimated number of fish impinged during 1996 and 1997 was 162.2 and 40.8, respectively (Table 2-12). This rate was extremely low compared to 70,022, 40,944 and 14,960 fish estimated impinged at SQN during 1981-1983, respectively (Table 2-13). None of the species were impinged at WBN in sufficient numbers to impact Chickamauga Reservoir

populations. None of the species impinged are listed as threatened, endangered or of special concern by the State of Tennessee or the U. S. Fish and Wildlife Service.

2.4 Fishery Creel Survey

Introduction

The specific objectives of the creel survey were to determine recreational angler catch, harvest, and effort and provide insight into population characteristics of largemouth bass, smallmouth bass, spotted bass, channel catfish, blue catfish, black crappie, white crappie, sauger, striped bass, and white bass.

Due to the limited scope of the preoperational WBN vicinity creel survey (1982-1985), only annual catch rates could be compared with data obtained during the more intensive operational survey. Therefore, results of the operational monitoring creel survey are reported as a "baseline". Creel results (collected by Tennessee Wildlife Resources Agency) from subsequent years could be used to further determine impacts of WBN on the Watts Bar Tailwater fishery.

Materials and Methods

Recreational fishing data in the vicinity of WBN (TRM 523.2 to TRM 529.9) were collected during preoperational and operational monitoring using access point angler creel surveys. Preoperational creel survey results are limited to catch rate estimates, average weight of each species and percent composition. Fishing pressure was not estimated due to a limited sampling schedule. A modified bus stop angler survey was used during operational monitoring to assess

harvest, catch, and effort data. Only catch rates between preoperational and operational creel results are used for comparison.

Study Area

The Tennessee River from Watts Bar Dam (TRM 529.9) downstream to Yellow Creek (TRM 526.8) served as the study area during preoperational monitoring, April 1982 to December 1985. During operational monitoring (April 1996-April 1998), the study area was extended an additional 3.6 miles, increasing the creel area to include accesses at Sewee Creek and Eaves Ferry boat ramp (TRM 523.2). Six access points are available to anglers in the study area (Table 2-15). Anglers can bank fish from all six locations and launch a boat from four of these locations.

Survey Technique

A modified bus stop creel technique was employed. Anglers utilizing six access points were surveyed. Proportion of time surveyed at each access point is provided in Table 2-14. Creel surveys during preoperational monitoring used the same technique employing a creel clerk one day per week. During operational monitoring, a creel clerk surveyed three days per week (one weekend and two weekdays) within the study area. The clerk was stationed onsite either in the morning, afternoon, or evening (May-July). All schedule times were randomly assigned. The clerk was instructed to seek out anglers on the bank and to encounter any boat anglers as they either came ashore or as they fished near shore. The clerk interviewed anglers during the assigned period, and when completed, traveled to the next location.

Instantaneous counts were made once per day from April 1996 through June 1997 and three times per day from July 1997 through April 1998 at randomly assigned periods. The clerk counted all fisherman at Watts Bar Dam, including those boat and bank anglers visible with the aid of binoculars. Directly following that count, the clerk traveled to the Eaves Ferry Boat Ramp and counted all visible boat and bank anglers, providing a complete count of all anglers within a 15 minute period. In addition, all vehicles with boat trailers were counted at each access ramp at the beginning of each sample period. To validate instantaneous counts, the clerk traversed the entire three mile reach via boat on one out of five of the survey days to count all anglers.

Creel Data Analysis

Creel data analysis followed standard techniques reported by TVA (1986) for preoperational monitoring and by Pollock et al. (1994) for operational monitoring. Monthly catch and harvest rates were determined for generalist anglers fishing for any species group, and for anglers directing their efforts toward a particular species group (i.e., black bass, crappie, catfish, etc.) during operational monitoring. To analyze catch and harvest rates for individual species (i.e., largemouth bass in the black bass group), only angler data from those indicating they were targeting largemouth bass were included.

Estimated effort (hours) was determined using instantaneous count data and using a standard expansion approach based on day of week, time of day probabilities, and an 8.5 hour sample period (Pollock et al. 1994). Estimated effort for a specific directed species group was determined by partitioning the annual effort estimate by the proportion of effort accounted for by

each directed species group. Similarly, effort was determined by location, and boat or bank anglers. Estimated angling trips were determined by dividing the mean length of completed trips for a selected group (i.e., sauger anglers) into the estimated effort (hours) for that group. All estimated values are reported with a standard error of the mean as a measurement of variation.

Length and weight were obtained from individuals of selected species. Length frequency analysis was conducted, and an age-length key developed following the methods of Ricker (1975).

Results

During preoperational monitoring, April 1982-December 1985, 4,745 individual fishermen were interviewed. Interviews were taken from 3,555 angling parties during operational monitoring (April 1996-April 1998). Monthly interviews exceeded 100 except during December 1996, and September, November and December of 1997 (Table 2-15).

Boat versus bank angler information was not collected during preoperational monitoring. During the WBN operational creel, 69% of angling parties interviewed were fishing from the bank. A majority of both bank (60%) and boat (75%) anglers were fishing for a specific group of species. Bank anglers primarily sought catfish (13%), sauger (11%) and white bass (10%). Boat anglers primarily sought catfish (27%), sauger (13%), white bass (11%), and black bass (10%). (Table 2-16).

Of the six locations selected as potential access points to the fishery, three were used primarily by bank anglers and three by boat anglers (Table 2-17). The majority of bank anglers utilized the two access points at the dam (Table 2-17). Bank anglers used the Sewee Creek boat ramp primarily during the spring white bass spawning period. All anglers used the public use areas below Watts Bar Dam greater than 95% of the time to gain access to the fishery.

Angling Effort

No comparison of angler use patterns prior to WBN becoming operational could be made as fishing pressure information was not collected during the preoperational phase. Anglers expended an estimated 392,807 hours during the WBN operational period (April 1996-April 1998). Mean length of an angling trip was 4.62 hours. Daily effort was 386.9 hours on weekdays and 865.5 hours on weekend days. An estimated 88,151 angling trips were conducted during the 25-month period.

Monthly angling effort varied from 30,218 hours in April 1996 to 7,395 hours in November 1997 (Table 2-18). Angling trips ranged from 9,717 in April 1996 to 1,456 trips in November1997 (Table 2-18). Mean length of angling trip ranged from 5.85 hours in April 1997 to 3.11 hours in April 1996.

Anglers seeking any species expended an estimated 129,313 hours or 29,116 trips (Table 2-19). Directed species groups expending greater than 40,000 hours included catfish (89,707 hours), white bass (42,473 hours) and sauger (40,670 hours).

Monthly angling effort by directed species group showed seasonal trends (Figures 2-3 and 2-4). Any species angler percent effort exceeded 20% of the total for each month except December 1997. Catfish angler effort peaked during the summer months. Sauger angler effort was greatest in November-January. Bank anglers expended an estimated 271,037 hours or 60,824 angling trips, as compared to 121,770 hours or 27,327 angling trips for boat anglers. Mean length of angling trips for bank anglers was 2.90 hours and 5.09 hours for boat anglers. An estimated 57,783 angling trips were taken at the two access points located at the dam.

Catch and Harvest

Overall annual catch rates (number of fish caught per hour) in the vicinity of WBN during preoperational monitoring from 1982-1985 were 0.73, 0.83, 1.00, and 1.16, respectively (TVA 1996). By comparison, annual catch rate during operational monitoring (1996-1997) was 0.61 (fish/hour).

Annual mean catch and harvest rates (Tables 2-20 and 2-22) and estimated numbers caught and harvested (Tables 2-21 and 2-23) were determined for both directed species group anglers and any species group anglers. In addition, the total number of fish caught and harvested for the fishery was estimated (Table 2-24). An estimated 41,331 sauger were caught from April 1996 through April 1998 of which 20% were harvested. Estimated number of blue catfish caught was 50,825 representing the largest portion of any catfish species. Bluegill represented the greatest single species caught with 140,764 caught and 63,502 harvested.

The greater catch and harvest rates for directed species group anglers allowed for a greater annual catch and harvest by this group. Interestingly, yellow bass was the only species for which a greater portion of the catch and harvest was attributed to the any species group (Figure 2-5).

Monthly catch and harvest rates for directed species group anglers varied with season for sauger, blue catfish, and white bass during operational monitoring (Figure 2-6 and 2-7). Sauger catch and harvest rates peaked in April 1996 and was lowest during summer months. The peak in April 1996 for sauger was not achieved in spring of 1997, nor 1998. Blue catfish catch and harvest rates were fairly consistent except during winter months. White bass catch and harvest rates peaked in the spring of 1996 and 1997, but did reach similar levels in 1998. The poor angling success in spring of 1998 was attributed to low water in the early spring followed by record flooding in April.

Catch rate comparisons for each species collected between preoperational and operational monitoring are listed in Table 2-25. During operational monitoring, harvest rates exceeded those for the preoperational survey for all species compared.

Length and age frequency trends for largemouth bass, smallmouth bass, spotted bass, blue catfish, channel catfish, black crappie, white crappie, sauger, white bass, and striped bass were examined during the WBN operational, but not during preoperational survey.

Length frequency of the three black bass species harvested were similar. Anglers harvested mostly individuals from 275-300, 300-325, and 325-350 mm (Figure 2-8). Few large largemouth

or smallmouth bass were harvested. Largemouth bass were primarily age-3 and-4 as were smallmouth bass (Figure 2-9). Spotted bass were dominated by age 2-4 individuals.

Length frequency of both blue catfish and channel catfish were similar. Anglers harvested more individuals from 350-450 mm (Figure 2-10). Larger blue catfish (> 500 mm) were caught more frequently than channel catfish.

Angler harvested black crappie and white crappie were primarily from 250-275 mm (Figure 2-11). This corresponds to the newly enacted statewide size limit on crappie 250 mm or 10 inches. Age frequency of harvested crappie indicated that most were either age 3 or 4 (Figure 2-12), but black crappie as old as age 8 were harvested.

The length frequency of harvested sauger was dominated by individuals from 375 -425 mm (Figure 2-13). Age frequency of harvested sauger was dominated by 3-5 year old individuals (Figure 2-14). Harvested white bass were mainly from 275-350 mm (Figure 2-15). The age frequency of white bass was dominated by 3 and 4 year olds (Figure 2-16). Striped bass harvested were generally greater than 650 mm, but some as small as 250 mm were harvested (Figure 2-17). Age frequency displayed a wide range of ages (2-11) with most harvested striped bass being between the ages of 4 and 8 (Figure 2-18).

Fishing effort, catch rates and total harvest data indicate a viable and popular tailwater fishery below Watts Bar Dam. It is apparent, during the first two years of operational monitoring, that WBN did not impact the tailwater fishery in the vicinity of the plant.

3.0 AQUATIC MACROINVERTEBRATES

3.1 Hess Sampling

Introduction

Benthic aquatic macroinvertebrates are animals that live part or all of their life cycles on or near the bottom of streams or reservoirs. These organisms serve as an important food resource for other forms of aquatic life, especially fish, and studies of their abundance and distribution are useful for detecting major environmental perturbations. Because many have an attached, or sessile, mode of life in the aquatic environment and are neither subject to rapid migrations nor severe translocation by water mass displacement (except under flood conditions), these organisms reflect exposure history and serve as natural monitors of environmental conditions. Additionally, many species are sensitive to pollution and some have a relatively long and complex life cycle of a year or more; hence, their presence or absence and abundance patterns help describe environmental conditions over a period of time.

Hynes (1970) reports that evaluation of power plant effects on benthic macroinvertebrate communities requires good preoperational monitoring assessment of "natural" abundance and distribution patterns. Macroinvertebrate species composition and population levels respond readily to not only power plant effects but also naturally occurring factors such as availability of food, nature of benthic sediments, flow, floods, proximity of suitable habitats, temperature, and dissolved substances. The most obvious influential factors in the vicinity of WBN are flow and substrate composition. Traveling downstream from WBN, there is a lessening of current velocity which is accompanied by a transition from hard rock and sand to softer, more silty

substrates (TVA 1986). These factors strongly influence spatial distribution of macroinvertebrate populations.

Materials and Methods

To measure abundance and species composition, Hess® samplers were used to collect benthic macroinvertebrates during summer (July-September) and fall (October-December) quarters from TRM 521.0, 526.3, 527.4, 528.0, and 528.5 in upper Chickamauga Reservoir (Figure 3-1). Samples were collected during both preoperational (1983-1985) and operational (1996-1997) periods.

Divers collected ten Hess samples at each station. The Hess sampler was pushed into the riverbed to a depth of 2.5 to 5.0 cm and the substrate within the confines (0.0856 m^2) of the sampler disturbed by hand or with a hand rake to a depth of approximately 15 cm. Dislodged organisms and detritus were carried by the current into a catch cup located on the down stream side of the sampler. All large rocks, mussels, clams, etc., encountered in a sample were placed in an attached mesh bag. The Hess sampler's mesh net and collection cup were tied closed after the sample was collected to keep material from being back flushed out of the catch cup and net. Collected material was pulled to the surface via a tether line connected to the sampler, transferred to plastic containers, and preserved with 10% formalin.

Laboratory Analysis

Samples were sorted and identified using standard operating procedures (Pennington and Associates, Inc. 1992). Benthic samples were washed in a 270 micron mesh screen, organisms

removed from the detritus and preserved in 85% ethanol. Organisms were then identified to the lowest practical taxonomic level.

Data Analysis

Results of summer and fall operational monitoring Hess samples (1996-1997) were compared with those collected during preoperational monitoring (1983-1985). Sorensen's Quotient of Similarity (McCain 1975) and Percentage Similarity (Pielou 1975) used to evaluate similarity among stations were inconsistent during preoperational and the first year of operational monitoring. Baxter et al. 1997 suggested that comparisons between preoperational and operational results must be made on an individual station to station basis. Therefore community diversity (D-Bar, diversity index) (Patten 1962), one-way ANOVA and Duncan's Multiple Range Test (Steel and Torrie 1960) were used to evaluate station differences (number of taxa present and abundance/m^2) in summer and fall quarters. Abundance data were transformed (log_{10}) prior to the analysis.

Results and Discussion

Table 3-1 compared occurrence of 59 macroinvertebrate taxa were collected during preoperational (1973-1985) monitoring in the vicinity of WBN. During operational monitoring (1996 and 1997), Hess samples collected a total of 104 taxa.

Densities of benthic macroinvertebrates also increased considerably at all five stations (Table 3-2) after WBN became operational. These increases are likely due to aforementioned

improvements in dissolved oxygen levels in water released through Watts Bar Dam as a result of the aeration system in the forebay of Watts Bar Reservoir beginning in early summer, 1996.

Three of the 59 taxa collected during preoperational monitoring, *Corbicula fluminea*, Asiatic clam (formerly *C. manilensis*), *Crynellus fraternus*, and Oligochaeta, comprised approximately 85% of the total community (Table 3-2). During operational monitoring, four of 104 taxa collected, *Corbicula fluminea*, *Dugesia tigrina*, *Gammarus minus* and Oligochaeta, comprised 87.5% of the total community. *Corbicula fluminea* was consistently the most abundant taxon during preoperational monitoring, but was less dominant during operational monitoring (Table 3-2). *Dugesia tigrina* was the most abundant taxon during operational monitoring, especially in fall samples (Table 3-2) (Appendix A). *C. fraternus* (caddisfly) met the dominant taxon criterion (Table 3-2) during preoperational monitoring and comprised 5% of the total community and was found at each station during fall 1997 operational monitoring (Appendix A). *Hydra americana* also was dominant during the summer of operational monitoring but did not exceed 5% of the total community during the fall samples (Appendix A).

Average number of taxa collected in preoperational summer and fall Hess samples (1983, 1984 and 1985) was 11.5, 17.4, and 16.1, respectively (Table 3-3). Greatest number of taxa collected at a single station during preoperational monitoring was 24 in summer of 1985 at TRM 521.0. Community diversity was low (<2.5) at all stations during preoperational monitoring and frequently below 1.00, especially downstream of TRM 528.0 (Table 3-3). Low diversities generally reflected complete dominance by *Corbicula fluminea* at most stations. The greatest

diversity value (2.20) was recorded at TRM 527.4 during fall 1985 when only 53% of the community was composed of *Corbicula fluminea* (TVA 1986).

During operational monitoring, an average of 28.3 (summer and fall combined) taxa were collected per station, which was significantly greater ($\alpha = 0.001$) than average of 15 collected during preoperational monitoring. The greatest number of taxa collected at a single station in summer 1997 was 35 at TRM 528.0. Community diversity during operational monitoring, as during preoperational monitoring, was low (≤ 2.5) at all stations (Table 3-3). However, the number of taxa found at each station increased during operational monitoring. The number of taxa found at TRM's 527.4, 528.0 and 528.5 nearly doubled during operational monitoring, yet the diversity index stayed relatively the same (Table 3-3). These results indicate negative no impacts on the benthic community of upper Chickamauga Reservoir due to operation of WBN.

Analysis of variance and Duncan's Multiple Range Test of total benthic macroinvertebrate standing crop were used to compare stations (Table 3-4). Stations in summer 1983 were alike except for a highly significant difference ($P>F = 0.0002$) at TRM 527.4, where a greater than 50% reduction in the dominant organism, *Corbicula fluminea*, occurred. Stations differences were more pronounced in summer 1984, with densities again strongly influenced by abundance of *Corbicula fluminea*. In summer, 1985, abundance of macroinvertebrates again changed, with abundance much higher at TRM 526.3 than at other stations (Table 3-5). This station contained exceptionally large numbers (540 per m^2) of the silt tolerant midge, *Chironomus* sp., and other silt-tolerant organisms such as *Branchiura sowerbyi*, Tubificidae, *Hexagenia*, and Chironomidae, which were not present or abundant at other stations (TVA 1986). Sediment core samples

collected during preoperational monitoring contained an average of 18.5 grams (dry weight) of silt/clay at this site.

During both summer and fall quarters of operational monitoring, stations that had similar benthic communities varied with preoperational results (Table 3-4). Benthic community standing crops at stations adjacent to WBN and upstream (528.0 and 528.5) were significantly higher than stations below the plant during fall of 1996 but not during fall of 1997. These annual differences are likely caused by fluctuating discharges from Watts Bar Dam and not related to the operation of WBN. Station similarities in total benthic macroinvertebrate densities were primarily due to abundance of *Corbicula fluminea*, *Dugesia tigrina*, *Gammarus minus* and Oligochaeta, (Table 3-2).

Silt-tolerant organisms such as *Branchiura sowerbyi*, Tubificidae, and *Limnodrilus hoffmeisteri*, were also somewhat abundant at TRM's 521.0, 526.3, and 527.4, (Appendix A). The substrate of the five benthic macroinvertebrate stations, during operational monitoring, consisted primarily of cobble/gravel mix with dead mollusk shell deposits, very little silt was present.

During fall preoperational monitoring, no significant differences were identified among stations in 1983 and 1985 (Table 3-4). In 1984, total abundance in fall was greater upstream of TRM 526.3, resulting from a large increase in the caddisfly, *Cyrnellus fraternus*, and amphipod, *Crangonyx*. During operational monitoring (1996 and 1997), densities (no/m^2) of benthic macroinvertebrates collected at five stations near WBN nearly doubled from those observed during preoperational monitoring, 1983-1985, (Table 3-2).

In addition to the increased number of taxa found during operational monitoring, Hess sampling collected Zebra Mussels (*Dreissena polymorpha*) at each station (Appendix A). Zebra mussels were most abundant (72 /m^2) in the fall of 1997 at TRM 528.5 upstream of the WBN intake channel (Appendix A). Zebra mussels were first found near WBN on June 1, 1995, at TRM 528.0 (adjacent to the WBN intake channel). Samples collected on that date indicated a density of 4.8/m^2 (TVA 1995). During operational monitoring (1996 and 1997), average densities of zebra mussels increased to 26.5/m^2 and 41/m^2, respectively.

Based on comparisons of species composition, occurrence, and densities of aquatic macroinvertebrates between preoperational and operational monitoring periods, WBN has not impacted the tailwater benthic macroinvertebrate community during the first two years of operation.

3.2 Native Mussel Fauna

Introduction

Preoperational monitoring of freshwater mussels in the vicinity of WBN was conducted 12 times during the years 1983 through 1994. On each occasion, the same sites on each of three mussel beds were examined by divers. Results of the preoperational surveys of these beds have been presented in various reports (TVA 1986; Ahlstedt 1989, 1991; Ahlstedt and McDonough 1996). The first year of WBN operational monitoring of the mussel fauna was conducted during 1996 at the same sites following the same techniques used during the preoperational period. Results of that study were presented in the WBN first annual operational monitoring report (Baxter, et al., 1997).

In July1997, a second operational monitoring survey of the native mussel fauna was conducted in the Watts Bar Tailwater. This report also includes an evaluation of the long-term population trends on these three mussel beds throughout the 15-year period they have been monitored. The purposes of this evaluation are to identify how the mussel resources on these beds have changed and to determine if operation of WBN has had any obvious effect on the mussel resources in this part of the Tennessee River.

Study Area Description

In 1983, mussel monitoring sites were established in three known concentrations of mussels (mussel beds) in the reach of the Tennessee River downstream from Watts Bar Dam near WBN: TRM 520-521L (left descending bank), TRM 526-527R (right descending bank), and TRM 528-529L (Figure 3-2). The most upstream of these beds (TRM 528-529L) is located on the opposite side of the river from WBN and upstream from its discharges. The middle bed (TRM 526-527R) is on the same side of the river as WBN and is just downstream from the confluence of Yellow Creek and all WBN discharges. The downstream bed (TRM 520-521L) is six river miles downstream from WBN and is located on the opposite side of the river. All three beds exist on submerged gravel and cobble bars in water approximately three to seven meters deep.

Four sampling sites were established along the length of each bed (Figure 3-2). Initially, each site was located as precisely as possible using river mile markers, navigation buoys, and bankside landmarks. During the 1996 survey, original notes and the original field crew leader assisted in adding global positioning system coordinates to these site locations.

Methods

Between 1983 and 1985, the examination of each site was conducted by two pairs of SCUBA divers collecting mussels for 11 minutes each (for an aggregate total of approximately 45 minutes of diver search time). Over the years, improvements in communications and diver equipment have allowed this search commitment to be met using two independent divers, each collecting mussels for 22 minutes of bottom time.

During the 1997 survey, two divers collected all of the live native mussels (thus excluding the Asiatic clam, *Corbicula manilensis*) they encountered during 22 minutes of bottom time at each of the 12 sampling sites. All of the mussels found at each site were brought to the surface where they were sorted by species, identified, and counted. Up to 50 live animals of each species from each bed were then measured in three dimensions (length, height, and thickness). All mussels were returned to the river in the vicinity of the site from which they were collected. The numbers of each species found at each site and the measurement data from each bed were recorded on field sheets and, later, added to the existing WBN mussel database.

Summary results for the 1997 survey were prepared from the database using the same format included in previous reports. A variety of statistical analyses were used to examine the combined sets of survey results, and the 5 percent significance level ($\propto = 0.05$) was used as a decision point in all analyses. Prior to any analysis, the abundance data were transformed to approximate a normal distribution using a $\log_{10}(x + 1)$ transformation.

For both the abundance and measurement data sets, regression analyses were used initially to test if the results on each mussel bed differed among the sampling sites or between years. If the slopes of all sites on a bed were not different from zero, then analysis of variance and Fishers Least Significant Difference Test were used to test for differences between sites. If the slopes were different from zero, and found to be parallel in a homogeneity of slopes test, covariance analysis and Fishers Least Significant Difference Test were used to identify differences between the sites. When appropriate, the nature of long-term trends was identified by plotting pertinent yearly mean values.

Results and Discussion

1997 Survey Results

Results during the 1997 survey of these three mussel beds (Table 3-6) indicate that 697 live mussels, representing 14 native species, were collected. Of this total, 199 mussels (28.5 percent) were found on the downstream bed (TRM 520-521), 154 (22.1 percent) were found on the middle bed (TRM 526-527), and 344 (49.4 percent) were found on the upstream bed (TRM 528-529). Six of the 14 species were found on all three beds, and five species each were found on only one of the beds.

With regard to individual species, the most abundant species on each bed was the elephantear, *Elliptio crassidens* (70.2 percent of the combined total). On the upstream and middle beds, the second most abundant species was the Ohio pigtoe, *Pleurobema cordatum* (14.5 percent of the

combined total); however, the purple wartyback, *Cyclonaias tuberculata*, occupied second place on the downstream bed (15.6 percent on this bed, 6.7 percent overall) and *Pleurobema cordatum* was a close third (14.1 percent). No specimens of the pink mucket, *Lampsilis abrupta*, or any other federal endangered species were encountered on any of the three beds during this survey (however, TVA divers did encounter live pink muckets in the Watts Bar tailwater in 1997 during other survey activities).

In the way of a short-term comparison, 846 live mussels representing 17 native species were encountered on these three mussel beds during the survey conducted in 1996 (Appendix A, Table 3-7). That total is approximately 20 percent higher than the number found during the 1997 survey. Numerical results from each of the three beds indicate that substantially more live mussels were found on the downstream and middle beds in 1996 than in 1997 (35 and 34 percent, respectively, more than in 1997). On the upstream bed, the 1996 survey yielded only slightly more (8 percent) live mussels than were found there in 1997.

With regard to individual species, even though three more species were found during the 1996 survey than in 1997, relative abundance of the common species changed very little between these two most recent surveys. As in 1997, the elephantear was the most abundant species encountered during the 1996 survey (70.2 percent of the combined total in both years), followed by the Ohio pigtoe (11.1 percent in 1996; 14.5 percent in 1997) and the purple wartyback (4.5 percent in 1996; 6.7 percent in 1997). In 1996, the pink heelsplitter, *Potamilus alatus*, was fourth in overall abundance (4.1 percent of the total) and the pimpleback, *Quadrula pustulosa*, was fifth (3.6 percent). Results from the 1997 survey show that the pink heelsplitter dropped to

fifth place (1.7 percent of the total) while the pimpleback moved up to fourth place (3.4 percent of the total).

Long-term Evaluation

For reference purposes both in this report and during any future studies, results from all 14 surveys at the 12 sites on these three mussel beds are presented in Appendix A. The information presented in that appendix and the following analyses are both divided into sections discussing separately the abundance and measurement data from these surveys.

Abundance Analysis

As an initial step in evaluating abundance data, Table 3-7 presents the total numbers of each mussel species found on all three beds during each of the 14 surveys. The greatest number of species collected in a year was 22 during 1983, 1988 and 1990. A total of 30 native mussel species was found during all of the surveys combined, ranging in abundance from over 10,000 specimens of the most common species (*Elliptio crassidens*, 63.6 percent of the overall total) to single specimens of two species (*Dromus dromus* and *Lasmigona complanata*). The species totals presented in this table showed that the five most abundant species made up 91.5 percent of the overall total, and the next five most abundant species raise that percentage to 97.3 percent of the total. All of the 20 other species encountered during these surveys represent just 2.7 percent of the total number of mussels found.

With regard to species occurrence patterns, Table 3-7 indicates that 12 species have been encountered during all of the 14 surveys, and six more have been found on at least half of the

surveys. Each of the 12 species encountered in seven or fewer of the surveys is represented by fewer than ten animals. Three of the extremely uncommon species on these beds (*Elliptio dilatata*, *Pleurobema oviforme*, and *Plethobasus cyphyus*) were seen last in 1996 and 1994, four of them (*Anodonta imbecillis*, *Pleurobema rubrum*, *Anodonta suborbiculata*, and *Ptychobranchus fasciolaris*) were encountered last in 1990 or 1988, three (*Cyprogenia stegaria*, *Pleurobema plenum*, and *Lasmigona complanata*) were last found on these beds in summer 1985 (Table 3-7), and the final two (*Fusconaia subrotunda* and *Dromus dromas*) were encountered only during the first survey in Summer 1983. Of these 12 rarely-encountered species, those found several times throughout this series of surveys may be simply extremely rare members of these mussel beds. Others of these species (perhaps those represented by one or two animals encountered only once or twice) appear to be the last survivors of populations nearly extirpated from this part of the river.

Table 3-8 presents rank order information for the 12 species that were found during all 14 surveys of these mussel beds. These rank order numbers were nearly always assigned based on how many members of a species were encountered during a given survey; however, when two or more species were represented by equal numbers of animals, alphabetical order of the scientific names was used to avoid assigning some sort of tie ranks.

The survey-by-survey rankings presented in Table 3-8 demonstrate considerable consistency in the relative abundance of these routinely-encountered species. During each of the 14 surveys, *Elliptio crassidens* was the most abundant species and *Pleurobema cordatum* was second in abundance. In all but one survey, third and fourth places were occupied by *Cyclonaias*

tuberculata and *Quadrula pustulosa* (mean ranks 3.4 and 3.7, respectively), even though five times out of the 14 surveys, their order was reversed. Similarly, rank order places five through seven typically were occupied by *Potamilus alatus*, *Ellipsaria lineolata*, and *Amblema plicata* (mean ranks of 5.7, 6.2, and 6.5, respectively). While these three species swapped rank order places during several surveys, other species occupied one of these three places only on six out of the possible 42 opportunities. The other five species found during every survey (mean ranks of 9.3 through 11.0) also routinely swapped rank order places among themselves; however, one of them occupied some other rank order spot only on five out of the 70 possible opportunities. The consistency of these rank order relationships suggests that the data sets from the 14 surveys are, at least, all valid representations of the mussel abundance patterns on these three beds.

Statistical analysis of the mussel abundance information from the 15-year study period was performed only on the data collected during the first (summer) survey conducted each year. Exclusion of the four second (fall) surveys conducted during a given year (in years 1983 through 1986) removed much of the early-year weighting in the data set and simplified the identification of long-term trends. Table 3-9 presents a summary of data used in the statistical analyses of mussel abundance. As indicated in the first section of this table, the divers encountered a total of 10,481 live native mussels on the three beds during these 10 surveys (66.0 percent of the 14-survey total). Overall, 33.0 percent of the mussels were found on the downstream bed, 21.0 percent were found on the middle bed, and 46.0 percent occurred on the upstream bed. The standard deviation information presented in Table 3-9 indicates that variations in the survey results on the middle and upstream beds were relatively similar (SDEV values are 31.9 and 38.6

percent of the means, respectively) but results on the downstream bed were nearly twice as variable (62.4 percent of that mean).

Statistical analysis of the all-species abundance data is presented in the first row of Table 3-10. The initial regression analysis indicated that a statistically significant trend was present in the data for the downstream bed (TRM 520-521, $p = 0.004$) but no trend was present in the data for the middle or upstream beds (TRM 526-527 and TRM 528-529). On the beds where no trend was present, analysis of variance indicated statistically significant differences among the sites on both beds, and Fishers Least Significant Distance tests indicated the relationships in abundance at those sites. In Table 3-10, these relationships are indicated by the order and underlining of the site locations. For example, the underline linking the site on the middle bed (TRM 526-527) with the lowest mean number of mussels present (TRM 526.3) with the next lowest mean (TRM 526.5) indicates these two values are not statistically different from each other. Similarly, the line linking TRM 526.5 and both of the other sites on that bed indicates that all three of those mean values are not statistically different from each other; however, the means for both TRM 526.8 and TRM 526.0 are statistically different from the mean for TRM 526.3.

For the downstream bed where the all-species analysis indicated a trend was present, covariance analysis indicated that the slopes of the abundance lines for each site mean were not different from each other ($p = 0.48$) and there was no significant difference between the sites ($p = 0.31$), but there was a significant relationship among the years ($p = 0.002$). The yearly mean values are listed in Table 3-9 and the general (downward) trend in these overall abundance values is illustrated on Figure 3-3.

Table 3-10 also presents the results of similar analyses for the five most abundant species encountered during these surveys. Similar analyses were not conducted for less-abundant species because of the large number of zeros present in the site-by-site survey data for those species. The analysis results presented in Table 3-10 indicate that the three most abundant species (*Elliptio crassidens*, *Pleurobema cordatum*, and *Quadrula pustulosa*) all showed statistically significant year trends on the downstream bed (TRM 520-521). For *Pleurobema cordatum* and *Quadrula pustulosa*, these trends included all four sites; however, the trend for *Elliptio crassidens* at TRM 520.0 was parallel, but different from the trend at the other three sites ($p = 0.02$). These trends, which are all downward, are illustrated on Figures 3-4, 3-5, and 3-6.

On the middle bed (TRM 526-527), only *Quadrula pustulosa* exhibited a significant year-related trend ($p = 0.05$), a downward trend illustrated on Figure 3-7. Like *Elliptio crassidens* on the downstream bed, the *Quadrula pustulosa* trend at TRM 526.0 was parallel but different from the other three sites on the middle bed ($p = 0.0007$).

On the upstream bed (TRM 528-529), none of these three species exhibited any year-related trends. For *Elliptio crassidens* and *Pleurobema cordatum*, however, the downstream site (TRM 528.2) was substantially different from the others ($p = 0.0001$ and 0.03, respectively)(Table 3-10).

Data for the fourth most abundant species (*Cyclonaias tuberculata*) indicated that trends were present on the downstream bed; however, the covariance analysis indicated that the lines for the

four sites were not parallel ($p = 0.009$). Figure 3-7 illustrates the complex patterns produced by the abundance of this species at each of the four sites on this bed.

Abundance information for the fifth most abundant species (*Potamilus alatus*), did not indicate that any trend was present in the abundance data or any difference in its abundance among sites on any of the three beds.

Considered together, this analysis indicates that the abundance of the three most common species and, probably because of the dominance of these species, the all-species totals demonstrated statistically significant declines over the years on the downstream bed (TRM 520-521). In contrast to this, only the third most abundant species (*Quadrula pustulosa*) showed a similar decline on the middle bed (TRM 526-527), and none of the five showed a statistically significant decline on the upstream bed (TRM 528-529). All other statistically significant analysis results on these beds were associated with variations in abundance between individual sampling sites. Where statistically significant declines did occur, plots of the mean values illustrate that those declines were gradual throughout the 15 year period, with no sharp breaks that might indicate a response to some specific adverse impact.

The statistically significant (declining) abundance trends among the three most abundant mussel species on the downstream bed and, for one of those species, on the middle bed, differ from the general impression presented by Ahlstedt and McDonough (1997). That report included data from the years 1983 through 1992 and was prepared before the 1994, 1996, and 1997 surveys were conducted. While some significant trends were present in the results of that earlier

analysis, the general pattern was not particularly apparent and was overshadowed by the substantial variations among the survey results.

The statistically significant trends present on the downstream and middle beds probably account for some of the survey-to-survey variations included in this data set. The amount of year-to-year variations in abundance represented on Figures 3-3 through 3-8, however, seems unusually large for these beds of sedentary, long-lived animals living in a managed river reach. Some of the variations present in these survey results might be related to differences in diver harvest speed and the relatively short time (22 minutes) involved in each timed dive. Other possible sources of the observed variations in abundance could be related to the fact that these 14 surveys were focused on examining the exact same sites on these mussel beds, but no concerted effort was always made to return the animals to the precise location where they had been found.

Measurement Analysis

As indicated in Methods, analysis of the measurement data followed the same format used for the abundance data. Like both earlier evaluations of the measurement data from these three beds (TVA 1986, Ahlstedt and McDonough 1997), these analyses were conducted only on the lengths of the mussel shells. Length, alone, was analyzed largely because that measurement appeared to be less affected by the extensive amount of shell erosion and other damage exhibited by the mussels living on these beds.

Results of the measurement component of each survey of these three mussel beds, including the 1997 survey, are presented in Appendix A. As a partial summary of these data, Table 3-11

presents the mean lengths of each mussel species measured during each year in which one or more surveys were conducted. It is important to note that each mean value in this summary table is based on a different number of measured mussels, and includes measurements from all three beds. The chief value of Table 3-11 is that it provides a concise indication of the range of length measurements for each species and the relationship of those measurements to an overall mean for the survey period. The general impression presented in this table is that virtually all of the mean values are relatively large for each species, and relatively little variation exists for nearly all of the routinely-encountered species.

Table 3-12 presents the results of the statistical analyses of the length data for the five most abundant species, the same species included in the abundance analysis. As indicated in the table, regression analysis indicated statistically significant trends were present for three of these species. The most abundant species (*Elliptio crassidens*) showed statistically significant year trends on both the downstream (TRM 520-521, $p = 0.002$) and middle beds (TRM 526-527, $p = 0.0004$). These trends, both of which are illustrated on Figure 3-9, indicate very similar, gradual increases in length over the 15-year period. Mean length on the middle bed is rather consistently 8 to 10 millimeters larger than on the downstream bed.

The second most abundant species (*Pleurobema cordatum*) exhibited statistically significant trends on two of the three mussel beds (TRM 526-527, $p = 0.0002$; and TRM 528-529, $p = 0.002$); however, Fishers Least Significant Difference Tests indicated that sites on the upstream bed represented statistically different length groupings. Figure 3-10 includes the mean length plots for *Pleurobema cordatum* on both of these beds (with all sites included). Both of these

plots include somewhat more year-to-year variation than was present in the *Elliptio crassidens* data, but still illustrate slight increases in shell length over the study period.

The only other statistically significant trend for the fourth most abundant species (*Cyclonaias tuberculata*) was on the downstream bed (TRM 520-521, $p = 0.003$). The plot of the yearly mean lengths for this species (presented on Figure 3-8) indicates a very slight increase (approximately 2 millimeters) over the 15-year survey period.

Neither of the other two common species (*Quadrula pustulosa* and *Potamilus alatus*) demonstrated statistically significant year-related trends on any of the three beds. *Quadrula pustulosa* did not yield any type of statistically significant relationships on any of the beds, but *Potamilus alatus* produced significant differences between sites on both the downstream and middle beds.

As a whole, this analysis of length data for the five most abundant species indicates that, when statistically significant trends were present, each species exhibited a very slow, steady increase in shell length over the 15-year period. Overall, this data set also appears to include considerably less variation than is present in the abundance data collected during these surveys.

Summary and Conclusions

This study has examined the native mussel resources in the Tennessee River near WBN during the second year the plant was operating (1997) following the same techniques used in 1996 and

during the preoperational monitoring period. In 1997, the three mussel beds involved in this survey program (TRM 520-521, TRM 526-527, and TRM 528-529) yielded 697 live mussels, representing 14 native species. In the way of a short-term comparison, approximately 20 percent more mussels were found on these beds during the 1996 survey (846 animals), and three more species were found on these beds in 1996 than in 1997. Substantially more live mussels were found on the downstream and middle beds in 1996 than in 1997 (35 and 34 percent, respectively, more than in 1997), but only slightly more (8 percent) live mussels than were found on the upstream bed in 1996 than in 1997.

One part of the long-term evaluation of this 14-survey, 15-year monitoring program was the analysis of the mussel abundance data. Over the years, 30 native mussel species have been encountered on these three mussel beds. Twelve of these species have been found on all of the surveys, and six more have been found on at least half of them. Five of the 12 rarely-encountered species have not been found on these beds since 1985 or 1983. Relative abundance ranks of the 12 most abundant species have changed very little over the 15-year monitoring period.

Statistical analysis of the mussel abundance data indicates that the three most common species and, probably because of the dominance of those species, the all-species totals demonstrated statistically significant declines in abundance over the years on the downstream bed (TRM 520-521). In contrast to this, only the third most abundant species (*Quadrula pustulosa*) showed a similar statistically significant decline on the middle bed (TRM 526-527), and none of the five showed a statistically significant decline on the upstream bed (TRM 528-529). Where the

statistically significant declines did occur, the data indicate those declines were gradual throughout the 15 year period, with no sharp breaks that might indicate a response to some specific adverse impact.

An analysis of length data for the five most abundant species demonstrated some very slow, steady increases in shell lengths throughout the survey period. The length data also indicated that virtually all of the animals are relatively large for each species.

In general, these results and analyses indicate that individual mussels in the Tennessee River near WBN are continuing to grow slowly, but some species are disappearing from the communities and the some more abundant populations are demonstrating statistically significant declines. The freshwater mussels in the vicinity of WBN are quite old and most of the 30 species found may not have reproduced in the past 50 years. The data also indicate that these population declines are gradual, and have been occurring throughout the 15-year monitoring period. There is no indication that operation of WBN during the last two years has had any effect on mussel resources in the river.

4.0 INSTREAM WATER QUALITY MONITORING

4.1 Water Quality Analysis

Introduction

Preoperational instream water quality monitoring data collected during the period 1982-1991 were compared to 1996 and 1997 operational monitoring data to determine if any significant changes have occurred to the nonradiological water quality of Watts Bar Tailwater since WBN became operational. Data obtained prior to 1982 were not included in the comparative analysis because improvements in the analytical detection limits since then could bias results.

Materials and Methods

Water samples for chemical analysis were collected monthly from April to September during 1996 and 1997 at four locations in the vicinity of WBN. The locations sampled correspond to the preoperational sampling locations at TRMs 529.9 (Watts Bar Forebay), 529.5 (upstream of WBN), 527.4, and 518.0 (downstream of WBN) (Figure 4-1).

Samples were collected during May, June, and July of 1996 and 1997 and analyzed for pH, turbidity, total solids, dissolved solids, ammonia, nitrogen, nitrate-nitrite nitrogen, organic nitrogen, total phosphorous, dissolved phosphorous, total organic carbon, chemical oxygen demand, and total alkalinity. Samples were also collected during April, May, June, and July of 1996 and 1997 for chlorophyll-a analysis. Samples for pH, turbidity, and total solids were collected at a depth of 1 meter. All other samples were collected from multiple depths down to 5 meters at each location and the data averaged for analysis purposes. During April, August, and September 1996 and 1997, one mid-depth grab sample was collected from the four stations for

metals analysis, including: calcium, magnesium, arsenic, boron, cadmium, chromium, copper, iron, lead, nickel, zinc, aluminum, selenium, mercury, and hardness.

Results and Discussion

In Tables 4-1 and 4-2, average values are presented for the preoperational and operational nonmetals data for each of the four sampling locations. All monthly values for preoperational and operational data were averaged for analysis. The individual concentrations measured for each parameter during preoperational and operational monitoring were also plotted for each sampling location over time (see Appendices B1 through B4). The plots of the preoperational nonmetals data exhibit high variability for all parameters at all locations. The operational (nonmetals) data tended to be less variable than the preoperational data. Dissolved phosphorous and chlorophyll-a were exceptions by being highly variable, which could be an artifact of the sample size. The reason for the difference in the preoperational and operational variability is not known, but the limited number of operational data points is probably a major factor. The significant observation regarding the data plots is that the range of operational data points fall well within the range of the preoperational data.

A statistical comparative analysis of the preoperational and operational nonmetals water quality data was performed using the Analysis of Variance (ANOVA) with Duncan's Multiple Range Test. The results of these analyses are shown in Tables 4-3, 4-4, and 4-5. In Table 4-3, the 1996 data are compared to the preoperational data; Table 4-4 compares the 1997 data, and Table 4-5 compares the combined 1996-1997 data to the preoperational data. The analysis indicates that, for most parameters, no significant differences (α=0.05) exist between preoperational and

operational data. The only constituent with a consistent significant difference is chlorophyll-a, which shows an increase during the operational period at all sampling locations. Chlorophyll-a concentrations (a measure of plankton biomass) below Watts Bar Dam and in the vicinity of the WBN are a function of chlorophyll-a concentrations above Watts Bar Dam in the forebay of Watts Bar Reservoir. The increase in operational chlorophyll-a concentrations at TRM 529.9 (Watts Bar Forebay) could result from many factors, none of which are related to WBN.

The preoperational and operational concentrations of metals were plotted over time and are shown in Appendices B5 through B7. Concentrations of arsenic, boron, cadmium, chromium, copper, lead, nickel, zinc, selenium, and mercury were less than detectable in nearly all samples. The plots show that all measurable values of operational metals data were well within the variability of the preoperational data, and no changes or trends of any magnitude were indicated. A statistical summary of the preoperational and operational metals data is presented in Tables 4-6 and 4-7.

Although operational data sample size limits the extent of data analysis, it is apparent that during the first two years of operation, WBN has not adversely impacted the nonradiological water quality of the Watts Bar tailwater.

5.0 SUMMARY AND CONCLUSIONS

WBN Unit 1 began commercial generation May 27, 1996, and operated at an 84% capacity factor during the first year of operation. Trends and similarities noted during preoperational

monitoring, in addition to comparisons with operational data, were used to provide insight into potential plant-induced effects to aquatic communities and water quality.

Evaluation of entrainment of ichthyoplankton (fish eggs and larvae) by WBN revealed the presence of few taxa and relatively low densities. Eggs and larvae passing WBN were primarily spawned in Watts Bar Reservoir and exposed to passage through the turbines at Watts Bar Dam. Larval samples were dominated by clupeids (shad). Freshwater drum, sunfish, and the temperate basses were the only additional taxa to exceed one percent composition of total larvae collected throughout the study. Very few eggs or larvae of species known to spawn in tailwaters were collected, indicating most spawning in Chickamauga Reservoir occurred downstream of WBN. Sunfish (*Lepomis*) spawning in the littoral zone near WBN (including plant intake and shoreline stations) was indicated by significantly higher larval densities of this taxon. The proportion of the Tennessee River flow entrained by WBN (0.6%) is very low compared to SQN (13%). Percentage entrainment of fish larvae passing WBN was estimated to be 0.1% compared to 7.5% at SQN, 1981-1984. Total entrainment of larval fish and eggs at WBN during the period sampled was estimated to be 449 and 267 in 1996, and 1911 and 120,000 in 1997. Larval shad represented 91% of the sample in 1996 and 85% in 1997. These represent extremely low numbers and would constitute no impact to the ichthyoplankton passing WBN or the fish community of Chickamauga Reservoir.

Fish community sampling results revealed only minor differences in species occurrence and percent composition between preoperational and operational samples. These differences were attributed to variations in sampling design with 1977-1985 data collected on a monthly basis

throughout each year and 1990-1996 data collected only once during fall of each year. Operational data included only two samples.

Comparison of catch per electrofishing run (CPUE) during 1990-1995 preoperational and 1996-1997 operational monitoring also showed minimal variation (76 and 53 fish per shocking run, respectively). Only emerald shiners revealed any major change in abundance, and this decline began prior to WBN becoming operational. None of the differences between preoperational and operational CPUE for 12 species meeting the criteria to be considered "important" were significant, P=0.05 level.

Reservoir Fish Assemblage Index (RFAI) values for the vicinity of WBN remained relatively stable with an average annual score of 44 during the 1991-1995 preoperational period and an average score of 45 in 1996-1997. A gradual decline in RFAI values occurred from 1993-1996. Since this decline began prior to WBN becoming operational, and as a result of the 1997 RFAI rebounding to a score of 52, the plant is not considered responsible.

It is apparent based on comparisons of species composition, relative abundance, CPUE, and RFAI scores between preoperational and operational monitoring, WBN has not adversely impacted the tailwater fish population below Watts Bar Dam during the initial two years of operation.

Fish impingement on the WBN cooling water intake traveling screens was virtually nonexistent. A total of 203 fish was estimated to be impinged during the first two years of operation.

Impingement at WBN has obviously not affected the fish community in Chickamauga Reservoir. This monitoring activity was suspended October 7, 1997 by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

The operation of WBN has had no impact on the Watts Bar Tailwater fishery. Total tailwater fishing pressure in the Watts Bar tailwater has increased dramatically during the past 24 years. A total of 392,807 fishing hours and 88,151 angler trips were estimated during the first two years of WBN operation. Catfish, sauger, white bass, crappie, sunfish, striped bass/Cherokee bass, and black bass were the most sought after species by anglers. An estimate of 341,106 fish were caught and an estimated 165,128 fish were harvested from April 1996-April 1998. Peak angling effort (hours) and trips occurred both in April 1996 with 30,218 and 9,717, respectively. Angling trips ranged from 9,717 in April 1996 to 1,456 trips in November 1997. The increased fishing pressure and potential overharvest of popular species are likely to have greater impact on the fishery than operation of WBN.

Total number of benthic macroinvertebrate taxa collected in Watts Bar Tailwater has increased from 59 recorded during preoperational monitoring to 104 collected during operational monitoring. The average number of taxa per station during operational monitoring was 29.8 which almost doubled the average number (15) collected during preoperational monitoring. Based upon organism abundance and taxonomic occurrence, stations upstream and adjacent to the plant (TRM's 528.0 and 528.5) and below the plant (TRM's 526.3 and 527.4) were similar in the summer and fall samples. In addition to the increased number of taxa found during operational monitoring, zebra mussels were found at each station at an average density of

28.6/m^2 in 1996 and 41/m^2 in 1997. Zebra mussels were most abundant (72/m^2) in the fall of 1997 at TRM 528.5 (upstream to the WBN intake channel). Temporal analyses showed that seasonal and yearly changes in abundance and other variables for benthic macroinvertebrate populations, except freshwater mussels, were common.

The freshwater mussels in the vicinity of WBN are quite old and most of the 30 species found may not have reproduced in the past 50 years. A total of 15,878 live mussels were encountered during the 15-year monitoring program. On each mussel bed, the most abundant species was the elephantear, *Elliptio crassidens* (70.2 percent of the combined total). Each bed contributed to a total of four specimens of the pink mucket, *Lampsilis abrupta*, the only species encountered which is on the federal endangered species list. The numerical and relative abundance results comparing preoperational and operational monitoring were similar and changed very little over the 15-year monitoring period. These results indicate the two years of operation of WBN has not impacted the aquatic macroinvertebrate resources below Watts Bar Dam.

Water quality in the vicinity of WBN, while generally satisfactory, is influenced by releases from Watts Bar Dam, located two miles upstream. In 1996, TVA's Water Management installed an aeration device in the forebay of Watts Bar Reservoir. This could reduce stratification of the forebay during the summer and fall and provide higher dissolved oxygen levels in the hydro releases. Concentrations of selected metals were less than detectable in nearly all samples. Measurable water quality data values during operational monitoring were well within the variability of the preoperational data. The first two years of operation of WBN has not impacted the nonradiological water quality in upper Chickamauga Reservoir.

Overall, it was concluded that WBN had no effect on either the aquatic communities or the water quality in upper Chickamauga Reservoir from the first two years of operation.

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Table 2-1. Sample periods, dates, number of samples, and mean temperatures for larval fish collections near Watts Bar Nuclear Plant during preoperational monitoring 1976 through 1979, 1982 through 1985 and operational monitoring 1996 and 1997.

PREOPERATIONAL MONITORING			
Sample period	Date	Number of Samples	Mean Water Temperature (^{o}C)
1976			
1	03/24/76	7	12.3
2	04/07/76	20	14.3
3	04/21/76	20	15.4
4	05/05/76	21	18.1
5	05/18/76	25	19.1
6	06/03/76	28	20.1
7	06/17/76	27	22.4
8	06/29/76	19	23.6
9	07/14/76	25	24.3
10	07/28/76	28	25.3
11	08/09/76	28	24.1
12	08/25/76	28	25.3
13	09/09/76	21	24.6
	Total	**297**	
1977			
1	03/16/77	10	10.9
2	03/23/77	10	12.2
3	03/29/77	10	13.6
4	04/12/77	10	15.1
5	04/19/77	10	16.5
6	04/26/77	10	17.2
7	05/04/77	10	17.7
8	05/10/77	10	18.4
9	05/16/77	10	19.0
10	05/24/77	10	19.7
11	06/02/77	10	21.3
12	06/08/77	10	21.9
13	06/15/77	10	23.0
14	06/21/77	10	23.0
15	07/07/77	10	26.1
16	07/19/77	16	26.5
17	08/01/77	10	26.8
18	08/16/77	10	24.8
	Total	**186**	

Table 2-1. (Continued)

PREOPERATIONAL MONITORING			
Sample period	Date	Number of Samples	Mean Water Temperature (^{o}C)
1978			
1	03/28/78	10	10.1
2	04/11/78	10	14.4
3	04/25/77	10	16.8
4	05/09/78	10	16.6
5	05/23/78	10	17.9
6	06/06/78	10	20.9
7	06/20/78	10	23.1
8	07/05/78	10	25.6
9	07/18/78	10	25.4
10	08/01/78	10	25.5
11	08/15/78	10	N/A
12	08/29/78	10	26.2
13	09/12/78	10	26.4
	Total	**130**	
1979			
1	03/13/79	10	9.0
2	03/28/79	10	11.6
3	04/10/79	10	13.3
4	04/23/79	10	15.4
5	05/10/79	10	18.3
6	05/22/79	10	N/A
7	06/06/79	10	19.1
8	06/18/79	10	22.2
9	07/02/79	10	23.0
10	07/17/79	10	24.2
11	07/30/79	10	22.9
12	08/13/79	10	24.2
13	08/28/79	10	24.6
	Total	**130**	

Table 2-1. (Continued)

PREOPERATIONAL MONITORING			
Sample period	Date	Number of Samples	Mean Water Temperature (^{o}C)
1982			
1	03/15/82	10	10.5
2	03/29/82	10	12.8
3	04/12/82	10	13.1
4	04/26/82	10	15.2
5	05/10/82	10	16.5
6	05/24/82	10	18.5
7	06/07/82	10	23.9
8	06/21/82	10	26.6
9	07/06/82	10	24.9
10	07/19/82	10	27.8
11	08/02/82	10	28.0
12	08/16/82	10	27.3
	Total	**120**	
1983			
1	03/07/83	20	10.6
3	04/04/83	10	11.5
4	04/18/83	10	11.7
5	05/03/83	10	16.0
6	05/17/83	10	20.0
7	05/31/83	10	21.8
8	06/14/83	10	23.0
9	06/27/83	10	N/A
10	07/11/83	10	28.0
11	07/25/83	10	25.5
12	08/08/83	10	25.9
13	08/23/83	10	28.0
	Total	**130**	

Table 2-1. (Continued)

PREOPERATIONAL MONITORING			
Sample period	Date	Number of Samples	Mean Water Temperature (^{o}C)
1984			
1	03/06/84	10	7.8
2	03/20/84	10	9.1
3	04/03/84	18	11.1
4	04/16/84	10	N/A
5	04/30/84	10	14.3
6	05/29/84	18	18.8
7	06/11/84	18	20.8
8	06/25/84	18	23.6
9	07/09/84	18	23.1
10	07/23/84	18	26.7
11	08/06/84	18	24.4
12	08/20/84	18	25.7
	Total	**184**	
1985			
1	03/14/85	18	9.7
2	03/27/85	18	11.5
3	04/10/85	16	13.9
4	04/24/85	18	15.1
5	05/08/85	18	16.8
6	05/22/85	18	19.2
7	06/04/85	18	22.6
8	06/18/85	18	23.5
9	07/02/85	18	25.3
10	07/16/85	18	26.0
11	08/01/85	18	26.1
12	08/13/85	18	25.7
13	08/28/85	18	25.0
	Total	**232**	

Table 2-1. (Continued)

OPERATIONAL MONITORING			
Sample period	Date	Number of Samples	Mean Water Temperature (^{o}C)
1996			
1	04/08/96	20	10.7
2	04/02/96	16	15.1
3	05/06/96	18	17.3
4	05/20/96	18	21.3
5	06/03/96	18	23.3
6	06/17/96	18	22.6
	Total	**108**	
Sample period	Date	Number of Samples	Mean Water Temperatures (^{o}C)
1997			
1	03/31/97	18	15.0
2	04/14/97	18	17.0
3	04/28/97	18	17.1
4	05/15/97	18	19.5
5	05/27/97	18	20.4
6	06/09/97	18	20.5
7	06/23/97	18	22.4
	Total	**126**	

Table 2-2. List of scientific and common names for fish egg and larval taxa collected near Watts Bar Nuclear Plant during 1976 through 1979, 1982 through 1985, and 1996 and 1997.

Scientific Name	Common Name
Eggs	
Unidentifiable fish eggs	
Hiodon spp. eggs	Unidentifiable mooneye or goldeye eggs
Aplodinotus grunniens eggs	Freshwater drum eggs
Larvae	
Unidentified fish larvae*	
Clupeidae	
Unspecifiable clupeids	Unspecified shad and/or herring
Alosa chrysochloris	Skipjack herring
Dorosoma sp.	Unidentified shad
Dorosoma cepedianum	Gizzard shad
Dorosoma petenense	Threadfin shad
Hiodontidae	
Hiodon tergisus	Mooneye
Cyprinidae	
Unspecifiable cyprinids	Unspecified minnow or carp
Cyprinus carpio	Common carp
Macrhybopsis storeriana	Silver chub
Notropis sp.	Unidentified shiner
Notropis atherinoides	Emerald shiner
Notropis volucellus	Mimic shiner
Catostomidae	
Unspecifiable catostomids	Unspecified suckers
Ictiobinae	Unspecified Ictiobines**
Minytrema melanops	Spotted sucker
Ictaluridae	
Ictalurus furcatus	Blue catfish
Ictalurus punctatus	Channel catfish
Pylodictis olivaris	Flathead catfish
Percichthyidae	
Morone sp.	Unspecified temperate bass
Morone chrysops	White bass
Morone mississippiensis	Yellow bass
Morone (not saxatilis)	Unspecified temperate bass(not striped bass)

Table 2-2. (Continued)

Scientific Name	Common Name
Centrarchidae	
Lepomis or pomoxis	Unspecified crappie or sunfish
Lepomis sp.	Unspecified sunfish
Micropterus sp.	Unspecifies bass
Micropterus dolomieu	Smallmouth bass
Pomoxis sp.	Unspecified crappie
Pomoxis annularis	White crappie
Percidae	
Unspecifiable darter	Unspecified darter
Perca flavescens	Yellow perch
Stizostedion sp.	Walleye or sauger
Stizostedion canadense	Sauger
Sciaenidae	
Aplodinotus grunniens	Freshwater drum
Atherinidae	
Labidesthes sicculus	Brook silverside

* Damaged specimens.

** Members of the subfamily Ictiobinae (buffalo, carpsuckers).

Table 2-3. Total numbers and percent composition of fish eggs and larvae collected during 1976-1982 1985 and 1996-1997 in the vicinity of Watts Bar Nuclear Plant.

	1976		1977		1978		1979		1982	
Taxon	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**
EGGS										
Unidentifiable fish eggs	5	2.00%	40	23.39%	722	81.67%	4	5.63%	8	4.17%
Hiodon spp. eggs	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Aplodinotus grunniens eggs	245	98.00%	131	76.61%	162	18.33%	67	94.37%	184	95.83%
Total	250		171		884		71		192	
LARVAE										
Unidentified fish	1	0.01%	8	0.02%	7	0.19%	0	0.00%	0	0.00%
Clupeidae										
Unspecifiable clupeids	9913	91.17%	31679	92.94%	1569	42.44%	1976	77.04%	1259	38.86%
Alosa chrysochloris	0	0.00%	6	0.02%	0	0.00%	0	0.00%	0	0.00%
Dorosoma sp.	0	0.00%	68	0.20%	73	1.97%	0	0.00%	0	0.00%
Dorosoma cepedianum	2	0.02%	637	1.87%	334	9.03%	0	0.00%	324	10.00%
Dorosoma petenense	32	0.29%	1	0.00%	0	0.00%	0	0.00%	20	0.62%
Hiodontidae										
Hiodon tergisus	0	0.00%	4	0.01%	0	0.00%	1	0.04%	0	0.00%
Cyprinidae										
Cyprinidae	8	0.07%	14	0.04%	28	0.76%	5	0.19%	5	0.15%
Cyprinus carpio	27	0.25%	16	0.05%	0	0.00%	8	0.31%	1	0.03%
*Macrhybopsis storeriana***	0	0.00%	1	0.00%	0	0.00%	0	0.00%	0	0.00%
Notropis sp.	0	0.00%	1	0.00%	0	0.00%	0	0.00%	0	0.00%
Notropis atherinoides	0	0.00%	4	0.01%	5	0.14%	0	0.00%	0	0.00%
Catostomidae										
Unspecifiable catostomids	0	0.00%	0	0.00%	1	0.03%	1	0.04%	0	0.00%
Ictiobinae***	0	0.00%	82	0.24%	0	0.00%	0	0.00%	0	0.00%
Minytrema melanops	2	0.02%	1	0.00%	0	0.00%	0	0.00%	0	0.00%
Ictaluridae										
Ictalurus furcatus	1	0.01%	0	0.00%	1	0.03%	1	0.04%	1	0.03%
Ictalurus punctatus	45	0.41%	27	0.08%	38	1.03%	8	0.31%	9	0.28%
Pylodictis olivaris	1	0.01%	2	0.01%	0	0.00%	0	0.00%	0	0.00%
Percichthyidae										
Morone sp.	1	0.01%	62	0.18%	73	1.97%	13	0.51%	16	0.49%
Morone chrysops	0	0.00%	0	0.00%	1	0.03%	0	0.00%	0	0.00%
Morone mississippiensis	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
*Morone (*not *saxatilis)*	5	0.05%	50	0.15%	7	0.19%	31	1.21%	199	6.14%
Centrarchidae										
Lepomis or Pomoxis	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Lepomis sp.	209	1.92%	428	1.26%	873	23.61%	57	2.22%	857	26.45%
Micropterus dolomieu	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	0.03%
Pomoxis sp.	24	0.22%	281	0.82%	334	9.03%	9	0.35%	328	10.12%
Pomoxis annularis	0	0.00%	1	0.00%	0	0.00%	0	0.00%	0	0.00%
Percidae										
Unidentifiable darter	0	0.00%	4	0.01%	5	0.14%	1	0.04%	4	0.12%
Perca flavescens	0	0.00%	0	0.00%	5	0.14%	0	0.00%	3	0.09%
Stizostedion sp.	1	0.01%	5	0.01%		0.00%		0.00%		0.00%
Stizostedion canadense	0	0.00%	0	0.00%	1	0.03%	0	0.00%	0	0.00%
Sciaenidae										
Aplodinotus grunniens	601	5.53%	704	2.07%	310	8.39%	454	17.70%	205	6.33%
Atherinidae										
Labidesthes sicculus	0	0.00%	0	0.00%	32	0.87%	0	0.00%	8	0.25%
Total	10873		34086		3697		2565		3240	

T = Less than 0.01 percent composition.* Number collected changed or was previously missing. ** Scientific name changed.

Table 2-3. (Continued)

	1983		1984		1985		1996		1997	
Taxon	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**	**Total Collected**	**% Comp**
EGGS										
Unidentifiable fish eggs	1143	87.12%	26	27.66%	16	51.61%	2908	99.28%	1591	99.13%
*Hiodon spp.*eggs	0	0.00%	0	0.00%	1	3.23%	0	0.00%	0	0.00%
Aplodinotus grunniens eggs	169	12.88%	68	72.34%	14	45.16%	21	0.72%	14	0.87%
Total	1312		94		31		2929		1605	
LARVAE										
Unidentified fish	38	0.49%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Clupeidae										
Unspecifiable clupeids	5658	73.01%	22435	93.33%	5890	68.63%	4132	83.88%	8083	82.07%
Alosa chrysochloris	0	0.00%	0	0.00%	0	0.00%	0	0.00%	8	0.08%
Dorosoma sp.	0	0.00%	1	0.00%	0	0.00%	0	0.00%	0	0.00%
Dorosoma cepedianum	1	0.01%	114	0.47%	0	0.00%	74	1.50%	1	0.01%
Dorosoma petenense	2	0.03%	0	0.00%	8	0.09%	50	1.02%	2	0.02%
Hiodontidae										
Hiodon tergisus	0	0.00%	7	0.03%	0	0.00%	0	0.00%	0	0.00%
Cyprinidae										
Unspecifiable cyprinids	110	1.42%	1	0.00%	9	0.10%	2	0.04%	6	0.06%
Cyprinus carpio	15	0.19%	7	0.03%	0	0.00%	2	0.04%	2	0.02%
*Macrhybopsis storeriana***	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Notropis sp.	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Notropis atherinoides	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Notropis volucellus	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	0.02%
Catostomidae										
Unspecifiable catostomids	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Ictiobinae	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Minytrema melanops	0	0.00%	0	0.00%	0	0.00%	3	0.06%	0	0.00%
Ictaluridae										
Ictalurus furcatus	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Ictalurus punctatus	11	0.14%	0	0.00%	2	0.02%	2	0.04%	0	0.00%
Pylodictis olivaris	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Percichthyidae										
Morone sp.	50	0.65%	108	0.45%	24	0.28%	41	0.83%	820	8.33%
Morone chrysops	0	0.00%	0	0.00%	0	0.00%	5	0.10%	2	0.02%
Morone mississippiensis	0	0.00%	0	0.00%	0	0.00%	16	0.32%	6	0.06%
*Morone (*not *saxatilis)*	244	3.15%	283	1.18%	29	0.34%	161	3.27%	382	3.88%
Centrarchidae										
Lepomis or Pomoxis	20	0.26%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Lepomis sp.	309	3.99%	247	1.03%	2427	28.28%	95	1.93%	130	1.32%
Micropterus sp.	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	0.03%
Micropterus dolomieu	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Pomoxis sp.	220	2.84%	90	0.37%	158	1.84%	8	0.16%	125	1.27%
Pomoxis annularis	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Percidae										
Unidentifiable darter	4	0.05%	0	0.00%	0	0.00%	5	0.10%	8	0.08%
Perca flavescens	12	0.15%	9	0.04%	9	0.10%	6	0.12%	0	0.00%
Stizostedion sp.	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	0.02%
Stizostedion canadense	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Sciaenidae										
Aplodinotus grunniens	1056	13.63%	737	3.07%	25	0.29%	324	6.58%	267	2.71%
Atherinidae										
Labidesthes sicculus	0	0.00%	0	0.00%	1	0.01%	0	0.00%	0	0.00%
Total	7750		24039		8582		4926		9849	

T = Less than 0.01 percent composition.* Number collected changed or was previously missing. ** Scientific name changed.

Table 2-4. Species list, total number collected, percent composition and occurrence spans of fish eggs and larvae collected during operational monitoring at Watts Bar Nuclear Plant, 1996 and 1997.

1996									
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	SAMPLING PERIODS						
FISH EGGS			1	2	3	4	5	6	
Unidentifiable fish eggs	2908	99.28	x	x	x	x	x		
Aplodinotus grunniens eggs	21	0.72				x	x	x	
Total	2929	100							
FISH LARVAE									
Clupeidae	4132	83.88			x	x	x	x	
Dorosoma cepedianum	74	1.50					x	x	
Dorosoma petenense	50	1.02					x	x	
Cyprinidae	2	0.04						x	
Cyprinus carpio	2	0.04				x	x		
Minytrema melanops	3	0.06			x				
Ictalurus punctatus	2	0.04						x	
Morone sp.	41	0.83				x	x	x	
Morone chrysops	5	0.10					x		
Morone mississippiensis	16	0.32					x		
Morone (not saxatilis)	161	3.27	x	x	x				
Lepomis sp.	95	1.93					x	x	
Pomoxis sp.	8	0.16			x	x	x		
Percidae (not stizostedion)	5	0.10	x	x	x				
Perca flavescens	6	0.12		x	x				
Aplodinotus grunniens	324	6.58				x	x	x	
TOTAL	4926	100							

1997									
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	SAMPLING PERIODS						
FISH EGGS			1	2	3	4	5	6	7
Unidentifiable fish eggs	1591	99.13	x	x	x	x			x
Aplodinotus grunniens eggs	14	0.87					x		x
Total	1605	100							
FISH LARVAE									
Clupeidae	8083	82.07	x	x	x	x	x	x	x
Alosa chrysochloris	8	0.08					x	x	
Dorosoma cepedianum	1	0.01							x
Dorosoma petenense	2	0.02						x	x
Cyprinidae	6	0.06						x	x
Cyprinus carpio	2	0.02						x	
Notropis volucellus	2	0.02		x	x				
Morone sp.	820	8.33		x	x	x	x	x	x
Morone chrysops	2	0.02				x	x		
Morone mississippiensis	6	0.06					x	x	x
Morone (not saxatilis)	382	3.88	x	x	x	x		x	
Lepomis sp.	130	1.32					x	x	x
Micropterus sp.	3	0.03					x		x
Pomoxis sp.	125	1.27			x	x	x	x	x
Percidae (not stizostedion)	8	0.08	x	x	x				
Stizostedion sp.	2	0.02	x						
Aplodinotus grunniens	267	2.71				x	x	x	x
TOTAL	9849	100							

Table 2-5. Average and peak density (number per 1,000 m^3) of larval fish with mean water temperatures collected in the vicinity of Watts Bar Nuclear Plant during preoperational and operational monitoring.

	PREOPERATIONAL								OPERATIONAL	
	1976	**1977**	**1978**	**1979**	**1982**	**1983**	**1984**	**1985**	**1996**	**1997**
Average Density	444	1,960	358	146	365	835	2,119	347	525	924
Mean Water Temperature (°C)	19.1	19.3	18.3	17.7	19.0	17.3	23.9	18.5	18.4	22.4
Peak Density	1,334	4,559	624	522	731	3,011	10,485	1,007	1387	1699
Date of Peak Density	5/19	4/26	6/6	7/2	6/7	6/14	5/29	6/4	6/3	5/15

Table 2-6. Distribution of larval fishes by size group (mm) collected at Watts Bar Nuclear Plant, during 1996 and 1997.

1996	Size Group (mm)															
TAXON	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16-19**	**20-30**	**>30**
Clupeidae		10	172	345	365	496	561	527	460	367	253	119	111	346		
Dorosoma cepedianum															73	1
Dorosoma petenense															50	
Cyprinidae			1	1												
Cyprinus carpio					2											
Minytrema melanops									3							
Ictalurus punctatus														1	1	
Morone sp.			4	2	5	10	5	6	5	4						
Morone chrysops									2			1		2		
Morone mississippienis									1	5	9	1				
Morone (not saxatilis)	119	42														
Lepomis sp.		1	6	64	13	6	3	1		1						
Pomoxis sp.			4	1		1		1	1							
Unidentified Darter				1	2	2										
Perca flavescens				2	1	1	1	1								
Aplodinotus grunniens	1	4	164	81	19	22	25	5	2					1		

NOTE: These numbers represent expanded subsample measurements.

Table 2-6 (Continued)

1997	Size Group (mm)																
TAXON	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16-19**	**20-30**	**>30**
Clupeidae			6	247	1014	1104	1575	1663	1205	597	300	123	79	52	45		
Alosa chrysochloris																8	
Dorosoma cepedianum																1	
Dorosoma petenense																2	
Cyprinidae					2	3					1						
Cyprinus carpio							1										
Notropis volucellus																	2
Morone sp.				2	349	245	115	42	20	34	8	2		1			
Morone chrysops											1	1					
Morone mississippienis												5				1	
Morone (not saxatilis)		133	57	169													
Lepomis sp.			1	55	55	15	1	1									
Micropterus sp.					2	1											
Pomoxis sp.	2			65	40	8	5	3	2								
Unidentified Darter							1	2		3	1	1					
Stizostedion sp.						2											
Aplodinotus grunniens			2	176	81	4	4	2									

NOTE: These numbers represent expanded subsample measurements

.

Table 2-7. Estimated entrainment results of fish eggs and larvae during 1996 and 1997 at Watts Bar Nuclear Plant including intake and reservoir flow, number of days sampled, average densities, and total numbers and percent entrained and transported past WBN.

1996-Eggs									
		Intake			Reservoir				
Date	Sample Period	Density 1000 m3	Water Demand m3/d	Estimated Number Entrained	Density 1000 m3	River Flow m3/d	Estimated Number Transported		Percent Entrained
		D_i	Q_i		D_r	Q_r			
April 8	1	17.1	1.27E+05	2.18E+03	382.2	2.04E+07	7.80E+06		0.03%
Aprill 22	2	108.9	7.10E+04	7.73E+03	1527.5	6.29E+07	9.61E+07		0.01%
May 6	3	58.8	1.62E+05	9.54E+03	25.7	2.41E+07	6.17E+05		1.55%
May 20	4	0.0	1.54E+05	0.00E+00	83.6	4.36E+07	3.64E+06		T
June 3	5	8.8	1.17E+05	1.03E+03	9.5	8.20E+07	7.80E+05		0.13%
June 17	6	0.0	2.26E+05	0.00E+00	7.0	6.94E+07	4.84E+05		0.00%
			Total:	2.05E+04		**Total:**	1.09E+08		0.29%
1996-Larvae									
		Intake			Reservoir				
Date	Sample Period	Density 1000 m3	Water Demand m3/d	Estimated Number Entrained	Density 1000 m3	River Flow m3/d	Estimated Number Transported		Percent Entrained
		D_i	Q_i		D_r	Q_r			
April 8	1	0.0	1.27E+05	0.00E+00	1.4	2.04E+07	2.93E+04		T
Aprill 22	2	0.0	7.10E+04	0.00E+00	22.1	6.29E+07	1.39E+06		T
May 6	3	294.1	1.62E+05	4.77E+04	426.2	2.41E+07	1.03E+07		0.47%
May 20	4	1348.2	1.54E+05	2.08E+05	594.2	4.36E+07	2.59E+07		0.80%
June 3	5	5575.2	1.17E+05	6.51E+05	1065.3	8.20E+07	8.73E+07		0.75%
June 17	6	2354.0	2.26E+05	5.32E+05	550.6	6.94E+07	3.82E+07		1.39%
			Total:	1.44E+06		**Total:**	1.63E+08		0.57%
1997-Eggs									
		Intake			Reservoir				
Date	Sample Period	Density 1000 m3	Water Demand m3/d	Estimated Number Entrained	Density 1000 m3	River Flow m3/d	Estimated Number Transported		Percent Entrained
		D_i	Q_i		D_r	Q_r			
March 21	1	177.0	1.03E+05	1.82E+04	1069.8	1.09E+08	1.17E+08		0.02%
April 14	2	0.0	1.24E+05	0.00E+00	16.0	2.38E+07	3.80E+05		T
April 28	3	0.0	1.01E+05	0.00E+00	10.5	5.43E+07	5.72E+05		T
May 15	4	0.0	1.04E+05	0.00E+00	0.7	4.96E+07	3.35E+04		T
May 27	5	0.0	1.10E+05	0.00E+00	2.7	4.63E+07	1.25E+05		T
June 9	6	0.0	1.19E+05	0.00E+00	0.0	7.49E+07	0.00E+00		T%
June 23	7	9.1	1.23E+05	1.12E+03	18.1	9.99E+07	1.81E+06		0.06%
			Total:	1.94E+04		**Total:**	1.20E+08		0.02%
1997-Larvae									
		Intake			Reservoir				
Date	Sample Period	Density 1000 m3	Water Demand m3/d	Estimated Number Entrained	Density 1000 m3	River Flow m3/d	Estimated Number Transported		Percent Entrained
		D_i	Q_i		D_r	Q_r			
March 21	1	35.4	1.03E+05	3.65E+03	52.1	1.09E+08	5.70E+06		0.06%
April 14	2	232.1	1.24E+05	2.89E+04	318.5	2.38E+07	7.59E+06		0.38%
April 28	3	427.4	1.01E+05	4.30E+04	1115.3	5.43E+07	6.05E+07		0.07%
May 15	4	1822.0	1.04E+05	1.89E+05	1688.9	4.96E+07	8.37E+07		0.23%
May 27	5	625.0	1.10E+05	6.88E+04	550.0	4.63E+07	2.55E+07		0.27%
June 9	6	2260.4	1.19E+05	2.70E+05	1032.2	7.49E+07	7.74E+07		0.35%
June 23	7	2645.5	1.23E+05	3.25E+05	1600.0	9.99E+07	1.60E+08		0.20%
			Total:	9.29E+05		**Total:**	4.20E+08		0.22%

T=less than 0.01 percent composition

Table 2-8. Percent composition of dominant larval fish taxa collected in the cooling water intake channel at the Watts Bar Nuclear Plant Site, 1984 through 1985, and 1996 through 1997.

	Preoperational		Operational	
TAXON	Year	Percent Composition	Year	Percent Composition
A. grunniens	1984	0.1	1996	0.8
	1985	0.2	1997	0.3
Centrachidae	1984	0.9	1996	7.6
	1985	12.5	1997	8.1
Clupeidae	1984	97.8	1996	90.5
	1985	86.4	1997	83.7
Dorosoma sp.	1984	0.09	1996	0.8
	1985	--------	1997	0.2
Morone (not saxatilis)	1984	0.6	1996	0.1
	1985	0.5	1997	1.0
Morone sp.	1984	0.5	1996	0.1
	1985	0.5	1997	5.4

Table 2-9. Comparison of percent composition of the catch from preoperational (1977-1985 and 1990-1995) and operational (1996-1997) monitoring periods.

Common Name	1977-1985 Preoperational	1990-1995 Preoperational	1996-1997 Operational
Chestnut lamprey			0.1%
Spotted gar	0.1%	--	--
Longnose gar	0.5%	0.0%	0.1%
Mooneye	0.2%	--	0.1%
American eel	0.0%	--	--
Skipjack herring	1.5%	0.7%	--
Gizzard shad	*	*	*
Threadfin shad	*	*	*
Spotfin shiner	0.1%	1.8%	0.4%
Steelcolor shiner	--	2.5%	--
Common carp	1.2%	1.0%	3.8%
Striped shiner	--	0.0%	--
Silver chub	0.0%	--	--
Golden shiner	0.2%	0.4%	0.1%
Emerald shiner	58.6%	17.1%	1.5%
Bluntnose minnow	--	0.1%	0.1%
Bullhead minnow	0.0%	0.1%	--
River carpsucker	0.0%	--	--
Northern hogsucker	0.1%	0.1%	0.1%
Smallmouth buffalo	0.0%	0.1%	--
Spotted sucker	1.2%	1.3%	2.0%
River redhorse	0.0%	--	0.1%
Black redhorse	--	0.2%	0.3%
Golden redhorse	0.5%	0.5%	1.2%
Blue catfish	0.0%	0.1%	--
Channel catfish	0.0%	1.6%	0.6%
Flathead catfish	0.0%	0.6%	0.9%
Brook silversides	5.4%	1.1%	--
White bass	1.3%	1.7%	1.8%
Yellow bass	4.1%	4.3%	8.5%
Striped bass	0.1%	0.2%	0.2%
Rock bass	0.0%	--	--
Redbreast sunfish	0.9%	1.3%	0.4%
Green sunfish	0.0%	0.4%	0.3%
Warmouth	0.1%	0.7%	0.2%
Bluegill	10.0%	32.4%	45.1%
Longear sunfish	0.2%	0.1%	0.3%
Redear sunfish	7.2%	13.4%	12.5%
Hybrid sunfish	--	0.0%	0.2%
Smallmouth bass	0.3%	1.8%	3.5%
Spotted bass	1.0%	3.1%	3.2%
Largemouth bass	3.4%	7.8%	6.9%
White crappie	0.8%	0.2%	0.4%
Black crappie	0.0%	0.8%	1.8%
Yellow perch	0.4%	0.4%	0.6%
Logperch	0.1%	1.5%	1.3%
Sauger	0.1%	0.1%	0.4%
Walleye	0.0%	--	--
Freshwater drum	0.2%	0.6%	1.0%

* Numbers not included.

Table 2-10. Comparison by species of average catch per electrofishing run (CPUE) and percent composition of the catch from vital signs preoperational (1990-1995) and operational (1996-1997) results.

	1990-1995 Preoperational		1996-1997 Operational	
Common Name	Average CPUE	Percentage of CPUE	CPUE	Percentage of CPUE
Chestnut lamprey	--	--	0.03	0.06%
Longnose gar	0.03	0.04%	0.07	0.13%
Mooneye	--	--	0.07	0.13%
Skipjack herring	0.51	0.67%	--	--
Gizzard shad	*		*	
Threadfin shad	*		*	
Spotfin shiner	1.41	1.85%	0.23	0.44%
Steelcolor shiner	1.91	2.51%	--	--
Common carp	0.76	1.00%	2.00	3.82%
Striped shiner	0.03	0.04%	--	--
Golden shiner	0.28	0.37%	0.07	0.13%
Emerald shiner	13.03	17.13%	0.80	1.53%
Bluntnose minnow	0.04	0.05%	0.07	0.13%
Bullhead minnow	0.04	0.05%	--	--
Northern hogsucker	0.07	0.09%	0.07	0.13%
Smallmouth buffalo	0.07	0.09%	--	--
Spotted sucker	0.97	1.27%	1.03	1.97%
River redhorse	--	--	0.03	0.06%
Black redhorse	0.18	0.24%	0.17	0.32%
Golden redhorse	0.41	0.54%	0.63	1.20%
Blue catfish	0.05	0.07%	--	--
Channel catfish	1.19	1.56%	0.30	0.57%
Flathead catfish	0.49	0.64%	0.47	0.90%
Brook silverside	0.82	1.08%	--	--
White bass	1.26	1.66%	0.93	1.78%
Yellow bass	3.26	4.28%	4.47	8.54%
Striped bass	0.18	0.24%	0.10	0.19%
Redbreast sunfish	0.97	1.27%	0.23	0.44%
Green sunfish	0.30	0.39%	0.13	0.25%
Warmouth	0.50	0.66%	0.10	0.19%
Bluegill	24.68	32.44%	23.60	45.10%
Longear sunfish	0.08	0.11%	0.13	0.25%
Redear sunfish	10.20	13.41%	6.57	12.55%
Hybrid sunfish	0.03	0.04%	0.10	0.19%
Smallmouth bass	1.36	1.79%	1.83	3.50%
Spotted bass	2.35	3.09%	1.67	3.19%
Largemouth bass	5.92	7.78%	3.60	6.88%
White crappie	0.12	0.16%	0.23	0.44%
Black crappie	0.61	0.80%	0.93	1.78%
Yellow perch	0.28	0.37%	0.30	0.57%
Logperch	1.16	1.52%	0.67	1.28%
Sauger	0.11	0.14%	0.20	0.38%
Freshwater drum	0.42	0.55%	0.53	1.01%
Total	**76**	**100%**	**52**	**100%**
Average RFAI score	**44**		**45**	

* Densities not included.

Table 2-11. Summary of one-way univariate ANOVA testing of effects of 1990-1995 preoperational compared to 1996-1997 operational monitoring results and interactions of these for variables on CPUE of each important species collected by electrofishing near Watts Bar Nuclear Plant.

Species	P-Value	Preoperational CPUE 1990-1995	Operational CPUE 1996-1997
Largemouth Bass	0.0711	5.9	3.6
Redear Sunfish	0.1183	10.2	6.6
Emerald Shiner	0.2441	13.0	0.8
Brook Silversides	0.3676	0.8	0
Bluegill	0.5120	24.7	23.6
Spotted Sucker	0.6556	1.3	1
Spotted Bass	0.7367	2.4	1.7
White Bass	0.7498	1.3	0.9
Common Carp	0.8137	0.8	2
Logperch	0.8761	1.2	0.7
Smallmouth Bass	0.9359	1.4	1.8
Yellow Bass	0.9379	3.3	4.5

Table 2-12. Actual and estimated numbers of fish impinged at Watts Bar Nuclear Plant during two sample periods, March 1996 through March 1997 and March 1997 through September 30, 1997.

Common Name	Total Number of Fish Impinged		Estimated Number of Fish Impinged		Percentage Composition	
	Sample Period		Sample Period		Sample Period	
	1	**2**	**1**	**2**	**1**	**2**
Gizzard shad	4	0	40.6	0	25.0	0
Threadfin shad	2	0	20.3	0	12.5	0
Freshwater drum	3	3	30.4	30.6	18.7	75.0
Channel catfish	1	0	10.1	0	6.3	0
Flathead catfish	1	0	10.1	0	6.3	0
Bluegill	2	0	20.3	0	12.5	0
Redear sunfish	1	0	10.1	0	6.2	0
White crappie	2	0	20.3	0	12.5	0
Log Perch	0	1	0	10.2	0	25.0
Total	**16**	**4**	**162.2**	**40.8**	**100.3**	**100.0**

Table 2-13. Estimated total impingement of fishes at Sequoyah Nuclear Plant (1981 through 1983).

COMMMON NAME	1981	1982	1983
Unidentified Fish	0	7	0
Lamprey	0	0	37
Chestnut lamprey	29	0	0
Unidentified shad	0	0	183
Skipjack herring	73	149	270
Gizzard shad	453	9,967	2,365
Threadfin shad	56,582	15,829	4,687
Mooneye	37	60	15
Minnow, carp	0	7	0
Carp	0	0	7
Silver chub	102	30	0
River chub	7	0	0
Golden shiner	153	15	15
Emerald shinner	22	7	22
Mimic shiner	0	0	15
Bluntnose minnow	22	238	37
Bullhead minnow	110	350	241
Spotted sucker	7	0	0
Golden redhorse	0	0	7
Blue catfish	102	127	146
Black bullhead	0	7	0
Yellow bullhead	7	7	7
Channel catfish	387	179	387
Flathead catfish	58	97	22
Mosquitofish	7	0	0
White bass	51	782	95
Yellow bass	212	1,862	350
Unidentified sunfish	0	37	0
Warmouth	153	45	37
Redbreast sunfish	51	97	7
Green sunfish	2,759	74	22
Bluegill	4,672	3,553	2,613
Longear sunfish	110	0	7
Redear sunfish	256	216	73
Spotted bass	117	670	22
Largemouth bass	44	67	29
White crappie	190	97	139
Yellow perch	445	387	190
Logperch	22	268	15
Sauger	22	7	7
Freshwater drum	2,759	5,706	2,891
Total	70,022	40,944	14,960

Table 2-14. Location of access points, percent of clerk time allotted for interviews, and angler type encountered for the Watts Bar Tailwater creel survey.

Access Point Location	Percent of Time Allotted	Type of Anglers Intercepted
Bank @ Lock	30	Bank
Bank @ Power Plant	40	Bank
TVA Ramp	20	Boat/Bank
Unimproved Ramp	5	Bank
TWRA Sewee Creek Ramp	10	Boat/Bank
Eaves Ferry Ramp	5	Boat

Table 2-15. Number of days surveyed and number of interviews for the Watts Bar Tailwater creel survey, April 1996 through April 1998.

Month	Number of Days Surveyed	Number of Interviews
1996		
April	14	152
May	15	208
June	13	168
July	14	144
August	12	120
September	12	115
October	12	128
November	13	128
December	8	80
1997		
January	16	182
February	16	211
March	16	228
April	12	143
May	15	172
June	14	188
July	10	111
August	14	145
September	12	98
October	15	118
November	12	64
December	9	57
1998		
January	13	148
February	11	146
March	14	157
April	13	144

Table 2-16. Directed species effort for bank and boat fishermen during the Watts Bar Tailwater creel survey, April 1996 through April 1998.

Directed Species Group	Percent Participation		
	Bank	Boat	Overall
Any Species	40	25	35
Black Bass	1	10	4
Catfish	13	27	18
Crappie	7	4	6
Sauger	11	13	11
Striped Bass/Cherokee Bass	9	6	8
Sunfish	9	4	7
White Bass	10	11	11

Table 2-17. Number of interviews and percent angler use at six access points within the Watts Bar Tailwater survey, April 1996 through April 1998.

Access Point	Number of Interviews	Percent Participation
Bank Anglers		
Bank@Lock	1315	52
Bank@Power Plant	1051	43
TVA Ramp	49	2
TWRA Sewee Creek Ramp	39	2
Eaves Ferry Ramp	13	1
Boat Anglers		
TVA Ramp	1047	96
Unimproved Ramp	2	< 1
TWRA Sewee Creek Ramp	10	1
Eaves Ferry Ramp	29	3

Table 2-18. Monthly estimated effort, percent effort, and estimated number of angling trips for the Watts Bar Tailwater survey, April 1996 through April 1998.

Month	Estimated Effort (hrs)	Standard Error	Percent Effort	Estimated Trips	Standard Error
1996					
April	30,218	1,362	8	9,717	438
May	20,526	826	5	4,970	200
June	24,157	694	6	6,178	178
July	21,758	687	6	5,193	164
August	15,190	700	4	3,714	171
September	10,002	357	3	2,037	73
October	16,951	409	4	3,229	78
November	11,884	569	3	2,285	109
December	15,641	795	4	3,724	189
1997					
January	12,204	660	3	2,885	156
February	16,365	610	4	2,976	111
March	20,781	921	5	3,906	173
April	19,988	749	5	3,417	128
May	17,014	626	4	3,389	125
June	24,481	674	6	5,165	142
July	15,456	285	4	3,816	70
August	9,333	230	2	2,333	57
September	11,052	341	3	2,303	71
October	10,814	338	3	1,975	62
November	7,395	127	2	1,456	25
December	8,718	273	2	1,851	58
1998					
January	9,636	120	2	2,190	27
February	9,894	466	3	2,401	113
March	14,542	699	4	3,438	165
April	18,780	621	5	3,603	113

Table 2-19. Estimated effort, number, and length of trips for selected species groups by fishermen in the Watts Bar Tailwater fishery, April 1996 through April 1998.

Directed Species Group	Percent Effort	Estimated Effort (hrs)	Estimated Trips	Mean Length of Trip (hrs)	Standard Error	Number of Trips Creeled
Any Species	33	129,313	29,116	4.5	0.1	1251
Black Bass	5	20,024	4,451	5.1	0.2	140
Catfish	23	89,707	20,409	4.8	0.1	618
Crappie	4	15,789	3,679	3.7	0.3	224
Sauger	10	40,670	9,163	4.6	0.2	406
Striped Bass/Cherokee Bass	8	31,363	6,550	4.5	0.3	279
Sunfish	6	23,467	5,085	4.4	0.3	262
White Bass	11	42,473	9,695	4.8	0.2	375

Table 2-20. Mean catch and harvest rate with standard errors, and percent harvested for directed species group anglers in the Watts Bar Tailwater fishery, April 1996 through April 1998.

Species	Mean Catch Rate (No/hr)	Standard Error	Mean Harvest Rate (No/hr)	Standard Error	Percent Harvested
Largemouth Bass	0.56	0.06	0.08	0.03	15
Smallmouth Bass	0.26	0.05	0.02	0.01	9
Spotted Bass	0.18	0.04	0.03	0.01	14
Blue Catfish	0.55	0.06	0.36	0.07	67
Channel Catfish	0.43	0.10	0.34	0.09	79
Black Crappie	0.51	0.13	0.31	0.07	61
White Crappie	1.17	0.26	0.68	0.15	58
Sauger	0.88	0.14	0.15	0.03	18
Striped Bass	0.18	0.02	0.08	0.02	42
Bluegill	4.98	0.63	2.34	0.29	47
White Bass	1.60	0.21	0.80	0.14	50
Yellow Bass	0.56	0.16	0.25	0.11	45

Table 2-21. Estimated number of fish caught and harvested with standard errors for directed species group anglers in the Watts Bar Tailwater fishery, April 1996 through April 1998.

Species	Estimated Number Caught	Standard Error	Estimated Number Harvested	Standard Error
Largemouth Bass	9,072	6,628	1,236	1,959
Smallmouth Bass	1,684	550	198	306
Spotted Bass	1,726	1,653	290	436
Blue Catfish	46,650	46,558	26,622	23,953
Channel Catfish	26,831	19,522	18,349	13,219
Black Crappie	5,522	6,141	3,917	4,863
White Crappie	11,141	8,962	6,758	5,898
Sauger	33,390	51,382	7,426	11,511
Striped Bass	3,104	2,136	1,543	1,482
Bluegill	123,391	128,857	56,832	59,715
White Bass	67,976	79,450	38,046	51,109
Yellow Bass	10,619	10,798	3,911	5,538

Table 2-22. Mean catch and harvest rate with standard errors, and percent harvested for any species anglers in the Watts Bar Tailwater fishery, April 1996 through April 1998.

Species	Mean Catch Rate (No./hr)	Standard Error	Mean Harvest Rate (No./hr)	Standard Error	Percent Harvested
Largemouth Bass	0.02	< 0.01	< 0.01	< 0.01	21
Smallmouth Bass	0.02	< 0.01	< 0.01	< 0.01	15
Blue Catfish	0.04	0.01	0.02	< 0.01	47
Channel Catfish	0.02	< 0.01	0.01	< 0.01	36
Black Crappie	0.03	< 0.01	0.02	< 0.01	61
White Crappie	0.04	0.01	0.02	< 0.01	46
Sauger	0.05	0.01	0.01	< 0.01	16
Bluegill	0.16	0.04	0.06	0.02	39
White Bass	0.12	0.02	0.04	0.01	34
Yellow Bass	0.11	0.02	0.03	0.01	25

Table 2-23. Estimated number of fish caught and harvested with standard errors for any species anglers in the Watts Bar Tailwater fishery, April 1996 through April 1998.

Species	Estimated Number Caught	Standard Error	Estimated Number Harvested	Standard Error
Largemouth Bass	2,564	1,155	554	466
Smallmouth Bass	3,017	3,038	460	464
Blue Catfish	4,175	2,554	1,942	1,721
Channel Catfish	2,666	1,161	979	659
Black Crappie	4,189	2,795	2,467	2,000
White Crappie	4,772	3,287	2,365	2,333
Sauger	7,942	6.250	1,075	1,353
Bluegill	17,373	13,474	6,670	6,214
White Bass	15,814	12,771	5,893	7,755
Yellow Bass	15,540	19,741	4,604	9,372

Table 2-24. Estimated number of fish caught and harvested with standard errors by all anglers in the Watts Bar Tailwater fishery, April 1996 through April 1998.

Species	Estimated Number Caught	Standard Error	Estimated Number Harvested	Standard Error
Largemouth Bass	11,635	6,728	1,790	2,014
Smallmouth Bass	4,701	3,087	657	556
Spotted Bass	1,726	1,653	290	435
Blue Catfish	50,825	46,628	28,564	24,015
Channel Catfish	29,496	19,557	19,328	13,236
Black Crappie	9,710	6,748	6,383	5,258
White Crappie	15,914	9,546	9,122	5,343
Sauger	41,331	51,762	8,501	11,591
Striped Bass	3,104	2,136	1,542	1,482
Bluegill	140,764	42,918	63,502	60,038
White Bass	83,791	79,450	43,938	51,695
Yellow Bass	26,158	22,501	8,515	10,869

Table 2-25. A comparison of harvest rates from preoperational and operational creel surveys conducted in the Watts Bar Tailwater.

Species	Operational 1982-1985		Preoperational 1996-1998
	Harvest Rate	Standard Error	Harvest Rate
Largemouth Bass	0.08	0.03	0.03
Smallmouth Bass	0.02	0.01	0.01
Spotted Bass	0.03	0.01	< 0.01
Blue Catfish	0.36	0.05	0.04
Channel Catfish	0.34	0.09	0.08
Black Crappie	0.36	0.05	< 0.01
White Crappie	0.68	0.15	0.11
Sauger	0.15	0.03	0.11
Striped Bass	0.08	0.02	-
Bluegill	2.34	0.29	0.34
White Bass	0.80	0.14	0.10
Yellow Bass	0.25	0.11	0.06

Table 3-1. Benthic macroinvertebrate taxa collected during preoperational (1973 through 1985) and operational (1996 and 1997) monitoring at Watts Bar Nuclear Plant.

	Preoperational	Operational
Nematoda		X
Coelenterata		X
Hydrozoa		
Hydroida		
Clavidae		
Cordylophora lacustris		X
Hydridae		
Hydra americana		X
Turbellaria		
Tricladida		
Planariidae	X	
Dugesia tigrina	X	X
Oligochaeta	X	
Haplotaxida		
Lumbricidae		X
Naididae	X	X
Dero sp.		X
Nais sp.		X
Nais communis		X
Nais simplex		X
Pristina sp.		X
Pristina leidyi		
Slavina appendiculata		X
Tubificidae	X	X
Branchiura sowerbyi	X	X
Limnodrilus sp.	X	
Limnodrilus hoffmeisteri		X
Lumbriculida		
Lumbriculidae		X
Lumbriculus sp.		X
Hirudinea	X	X
Rhynchobdellida		
Glossiphoniidae	X	
Helobdella sp.		X
Helobdella triserialis		X
Pharyngobdellida		
Erpobdellidae	X	
Erpobdella sp.		X
Erpobdella punctata		X

Table 3-1 (Continued)

	Preoperational	Operational
Crustacea		
Isopoda		
Asellidae		
Caecidotea sp.	X	X
Lirceus sp.	X	
Amphipoda		
Crangonyctidae		
Crangonyx sp.	X	
Gammaridae		
Gammarus sp.	X	
Gammarus minus		X
Decapoda		
Cambaridae		
Orconectes sp.	X	X
Cladocera		
Daphnidae		
Daphnia lumholtzi		X
Sididae		
Sida crystallina		X
Podocopa		X
Candoniidae		
Candona sp.		X
Insecta		
Plecoptera		
Perlidae		X
Odonata		
Coenagrionidae	X	
Argia sp.		X
Enallagma sp.	X	
Ischnura sp.	X	
Corduliidae		
Neurocordlia molesta		X
Gomphidae		
Dromogomphus sp.	X	
Gomphus sp.	X	
Ephemeroptera		
Baetidae		X
Baetis amplus		X
Caenidae		

Table 3-1 (Continued)

	Preoperational	Operational
Caenis sp.	X	
Ephemeridae		
Hexagenia sp.	X	
Heptageniidae		X
Stenacron sp.	X	X
Stenacron interpunctatum		X
Stenonema sp.		X
Leptophlebiidae		
Paraleptophlebia sp.		X
Tricorythidae		
Tricorythodes sp.	X	
Heteroptera		
Corixidae		X
Trichoptera		
Hydropsychidae		
Cheumatopsyche sp.	X	X
Hydropsyche sp.	X	
Hydroptilidae		
Hydroptila sp.		X
Leptoceridae		
Ceraclea sp.	X	X
Oecetis sp.		X
Polycentropodidae		
Cyrnellus fraternus	X	X
Megaloptera		
Corydalidae		
Nigronia sp.		X
Sialidae		
Sialis sp.	X	X
Diptera		
Chaoboridae		
Chaoborus sp.	X	
Chironomidae	X	X
Ablabesmyia sp.	X	X
Ablabesmyia annulata		X
Ablabesmyia mallochi		X
Ablabesmyia parajanta		X
Chironomus sp.	X	X
Cladotanytarsus sp.		X

Table 3-1 (Continued)

	Preoperational	Operational
Clinotanypus pinguis		X
Coelotanypus sp.	X	
Coelotanypus tricolor		X
Conchapelopia sp.	X	
Cricotopus bicinctus		X
Cryptochironomus sp.	X	
Cryptochironomus fulvus		X
Dicrotendipes sp.	X	X
Glyptotendipes sp.	X	X
Harnischia sp.		X
Microtendipes sp.		X
Nanocladius sp.		X
Parachironomus sp.	X	X
Paratanytarsus sp.		
Paratendipes sp.		
Phaenopsectra obediens		X
Polypedilum sp.		X
Polypedilum convictum		X
Polypedilum halterale		X
Polypedilum illinoense		
Procladius sp.	X	
Pseudochironomus sp.		X
Rheotanytarsus sp.		X
Stenochironomus sp.		X
Stictochironomus sp.		X
Synorthocladius semivirens		X
Tanytarsus sp.		X
Thienemanniella xena		X
Thienemannimyia sp.		X
Tvetenia discoloripes sp. gp.		X
Coleoptera		
Elmidae		
Dubiraphia sp.		X
Macronychus sp.	X	
Stenelmis sp.		X
Arachnoidea		
Hydrachnellae		
Hydrachnidae	X	
Gastropoda		

Table 3-1. (Continued)

Mesogastropoda		
Hydrobiidae		X
Amnicola sp.	X	X
Somatogyrus sp.		X
Pleuroceridae		
Leptoxis praerosa		X
Pleurocera sp.	X	X
Pleurocera canaliculata		X
Viviparidae		
Campeloma sp.	X	
Campeloma decisum		X
Basommatophora		
Ancylidae		
Ferrissia rivularis		X
Physidae		
Physa sp.	X	
Physella sp.		X
Planorbidae		X
Gyraulus sp.	X	
Gyraulus parvus		X
Menetus sp.		X
Micromenetus dilatatus		X
Bivalvia		
Unionoida		
Unionidae		
Actinonaias ligamentina		X
Amblema plicata	X	
Anodonta imbecillis	X	X
Cyclonaias tuberculata	X	
Ellipsaria lineolata	X	
Elliptio crassidens	X	X
Fusconaia ebena	X	
Lampsilis abrupta		X
Obliquaria reflexa	X	X
Pleurobema cordatum	X	
Pleurobema pyramidatum	X	
Potamilus alatus		X
Quadrula pustulosa pustulosa	X	X

Table 3-1. (Continued)

Veneroida		
Corbiculidae		
Corbicula fluminea	X	X
Dreissenidae		
Dreissena polymorpha		X
Sphaeriidae		X
Musculium transversum		X
Sphaerium sp.	X	
TOTAL	**59**	**104**

Table 3-2. Average densities (number/m^2) of dominant* macroinvertebrates collected with Hess samples near Watts Bar Nuclear Plant, during summer and fall 1983 through 1985 (preoperational) and 1996 and 1997 (operational).

Season	Organism	Tennessee River Mile 521.0	526.3	527.4	528.0	528.5
1983-1985 (Preoperational)						
Summer	Chironomus	5.2	180.0	5.6	0.0	1.2
	Corbicula fluminea	681.6	901.2	616.0	552.4	796.8
	Cyrnellus fraternus	12.4	14.4	31.6	53.2	55.2
	Oligochaeta	45.6	114.0	65.2	47.6	61.2
	Total	853.6	1283.2	791.6	770.4	1008.4
Fall	Corbicula fluminea	640.4	704.4	676.0	509.6	511.6
	Crangonyx	13.6	3.2	13.6	79.6	38.0
	Cyrnellus fraternus	59.6	106.0	219.2	426.0	415.6
	Oligochaeta❖	43.6	88.8	61.2	9.2	31.2
	Total	883.2	965.6	1064.0	1212.0	1148.4
1996-1997 (Operational)						
Summer*	Corbicula fluminea	594	725	867	1604	886
	Dugesia tigrina	622	675	1468	1226	855
	Gammarus minus	829	441	1002	1014	1122
	Oligochaeta	285	164	159	60	38
	Hydra americana	153	66	13	48	709
	Total	2636	2157	3596	3978	3612
*90% of Total Benthic Community						
Fall*	Corbicula fluminea	350	318	739	1042	597
	Dugesia tigrina	1294	1085	1118	1189	1678
	Gammarus minus	386	58	126	126	347
	Oligochaeta❖	352	75	54	133	282
	Cyrnellus fraternus	14	39	414	647	409
	Total	2396	1716	2471	3190	3313
*85% of Total Benthic Community						

❖Includes Branchiura sowerbyi and Tubificidae

Table 3-3. Number of taxa and diversity index ($\overline{d}$) values of benthic macroinvertebrates from Hess samples collected during preoperational monitoring (1983 through 1985), and operational monitoring (1996 and 1997) at Watts Bar Nuclear Plant.

		Tennessee River Mile									
		521.0		526.3		527.4		528.0		528.5	
Year	Quarter	No. taxa	$\overline{d}$	No. taxa	$\overline{d}$	No. taxa	$\overline{d}$	No. taxa	$\overline{d}$	No. taxa	$\overline{d}$
Preoperational											
1983	**Summer**	12	0.77	8	0.60	14	1.76	12	1.30	14	1.21*
	Fall	10	0.93	13	0.99	12	0.97	9	1.47	11	1.55
1984	**Summer**	19	1.03	20	0.66	15	0.84	18	1.27	17	0.75
	Fall	16	1.95	14	1.59	17	1.65	20	2.10	18	2.02
1985	**Summer**	24	2.11	19	2.12	13	1.88	18	2.18	12	2.11
	Fall	18	2.02	16	1.87	14	2.20	13	2.05	14	2.16
Operational											
1996	**Summer**	31	2.13	27	2.03	31	2.20	24	2.10	26	1.89
	Fall	29	2.15	25	1.97	27	2.12	29	2.34	32	2.46
1997	**Summer**	28	2.23	32	2.13	28	2.25	35	2.35	29	2.50
	Fall	31	2.27	24	2.02	25	2.19	26	2.26	27	2.29

*Data collected from TRM 528.8 in summer 1983.

Table 3-4. Results of one-way analysis of variance and Duncan's new multiple range test on total benthic macroinvertebrate standing crop (number/m^2) estimated from Hess samples during preoperational (1983 through 1985) and operational (1996 through 1997) monitoring, Watts Bar Nuclear Plant, Chickamauga Reservoir.

				Tennessee River Mile				
Year	Quarter	F-Ratio	P>F	Low $\overline{x}$				High $\overline{x}$
Preoperational								
1983	Summer	7.1	0.0002	527.4	521.0	526.3	528.0	528.8
	Fall	1.3	0.2818	N.S.D.*				
1984	Summer	5.5	0.0011	528.0	521.0	528.5	526.3	527.4
	Fall	11.2	0.0001	521.0	526.3	527.4	528.5	528.0
1985	Summer	27.2	0.0001	527.4	528.5	528.0	521.0	526.3
	Fall	0.8	0.5663	N.S.D.*				
Operational								
1996	Summer	4.7	0.0030	528.5	526.3	521.0	528.0	527.4
	Fall	7.6	0.0001	526.3	527.4	521.0	528.0	528.5
1997	Summer	4.13	0.0062	528.5	528.0	527.4	521.0	526.3
	Fall	5.9	0.0007	528.5	521.0	528.0	527.4	526.3

*No significant difference.

Table 3-5. Total densities of benthic macroinvertebrates (number/m^2) collected in Hess samples near Watts Bar Nuclear Plant, summer and fall, 1983 through 1985 (preoperational) and 1996 and 1997 (operational).

		Tennessee River Mile				
Season	**Year**	**521.0**	**526.3**	**527.4**	**528.0**	**528.5**
Preoperational						
Summer	1983	793	790	514	863	1,082*
	1984	766	1,172	1,194	654	1,162
	1985	1,002	1,888	667	794	781
Fall	1983	881	826	834	866	752
	1984	901	1,130	1,392	1,754	1,654
	1985	868	941	966	1,015	1,039
Operational						
Summer	1996	2,963	2,156	3,705	3,001	1,775
Fall	1996	2,603	2,222	2,552	3,920	4,558
Summer	1997	3014	2926	4207	5596	6226
Fall	1997	3335	2835	2981	3321	3649

*Collected at TRM 528.8

Table 3-6. Results of the 1997survey of native mussels in three monitored beds near the Watts Bar Nuclear Plant.

	Tennessee River Mile 520					Tennessee River Mile 526					Tennessee River Mile 528					Grand	
Native Mussel Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	%
Elliptio crassidens	24	13	51	35	123	45	33	17	14	109	20	66	126	45	257	489	70.16
Pleurobema cordatum	4	4	9	11	28	2	16	0	0	18	3	33	7	12	55	101	14.49
Cyclonaias tuberculata	1	16	9	5	31	1	2	0	0	3	2	7	4	0	13	47	6.74
Quadrula pustulosa	0	5	2	2	9	1	0	2	3	6	1	7	1	0	9	24	3.44
Potamilus alatus	0	0	1	1	2	0	1	4	1	6	4	0	0	0	4	12	1.72
Ellipsaria lineolata	1	0	2	2	5	0	0	0	1	1	1	0	1	0	2	8	1.15
Amblema plicata	0	0	0	0	0	0	0	3	1	4	0	0	1	0	1	5	0.72
Obliquaria reflexa	0	0	0	1	1	0	0	0	2	2	0	0	0	0	0	3	0.43
Leptodea fragilis	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0.29
Quadrula metanevra	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	2	0.29
Anodonta grandis	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0.14
Lampsilis ovata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0.14
Ligumia recta	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.14
Tritogonia verrucosa	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0.14
Grand Total	30	38	74	57	199	49	53	26	26	154	32	114	141	57	344	697	100.00
Number of Species Collected	4	4	6	7	7	4	5	4	9	12	7	5	7	2	10	14	

Table 3-7. Total numbers of each native mussel species collected during preoperational (1983-1994) and operational (1996-1997) surveys near Watts Bar Nuclear Plant.

	Preoperational												Operational			
	1983	1983 Fall	1984	1984 Fall	1985	1985 Fall	1986	1986 Fall	1988	1990	1992	1994	1996	1997	Totals	Times Found
Elliptio crassidens	754	836	779	984	738	929	734	765	970	524	424	583	594	489	10103	14
Pleurobema cordatum	264	275	220	156	113	177	110	169	224	139	82	95	94	101	2219	14
Cyclonaias tuberculata	88	70	73	62	60	66	55	76	93	90	68	64	38	47	950	14
Quadrula pustulosa	99	75	85	53	53	85	31	41	80	79	48	65	30	24	848	14
Potamilus alatus	14	29	18	29	34	43	41	27	55	45	16	10	35	12	408	14
Ellipsaria lineolata	24	29	24	25	8	27	19	18	23	28	14	11	15	8	273	14
Amblema plicata	18	33	19	11	17	25	23	24	49	10	13	13	11	5	271	14
Anodonta grandis	18	10	5	4	3	7	9	7	29	20	5	7	7	1	132	14
Quadrula metanevra	14	24	11	13	6	10	7	7	8	8	8	4	2	2	124	14
Tritogonia verrucosa	6	12	5	5	4	15	8	13	18	9	9	7	4	1	116	14
Obliquaria reflexa	14	6	8	3	7	5	9	3	7	11	6	11	6	3	99	14
Ligumia recta	6	3	4	10	3	8	8	10	7	2	3	1	2	1	68	14
Lampsilis abrupta	3	7	6	2	1	7	6	2	12	4	6	2	4	-	62	13
Leptodea fragilis	1	3	4	2	3	2	6	3	12	8	-	3	1	2	50	13
Actinonaias ligamentina	3	2	2	-	4	7	-	8	3	5	1	-	-	-	35	9
Megalonaias nervosa	2	1	-	1	1	4	5	1	9	3	4	2	1	-	34	12
Lampsilis ovata	3	1	1	4	5	4	1	2	3	1	-	-	-	1	26	11
Elliptio dilatata	4	2	1	1	-	2	2	1	3	1	-	-	1	-	18	10
Pleurobema oviforme	-	-	2	-	-	1	-	2	2	1	-	1	-	-	9	6
Anodonta imbecillis	-	-	-	2	-	-	-	1	1	1	-	-	-	-	5	4
Cyprogenia stegaria	2	1	-	1	1	-	-	-	-	-	-	-	-	-	5	4
Pleurobema plenum	1	1	2	-	1	-	-	-	-	-	-	-	-	-	5	4
Plethobasus cyphyus	-	2	-	-	-	-	-	-	-	-	1	1	-	-	4	3
Pleurobema rubrum	-	-	-	-	-	3	-	-	1	-	-	-	-	-	4	2
Anodonta suborbiculata	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	2
Fusconaia subrotunda	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1
Lasmigona costata	-	-	-	-	-	-	1	-	-	-	-	-	1	-	2	2
Ptychobranchus fasciolaris	-	-	1	-	-	-	-	-	-	1	-	-	-	-	2	2
Dromus dromas	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Lasmigona complanata	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1
Total Mussels	1341	1422	1270	1368	1063	1427	1075	1180	1610	991	708	880	846	697	15878	
Number of Species Collected	22	21	20	19	20	20	18	20	22	22	16	17	17	14	30	

Table 3-8. Rank order relationships among the 12 mussel species encountered during all 14 surveys of three mussel beds near Watts Bar Nuclear Plant. Most rank order assignments were based on the total number of a species found during each survey; however, alphabetical order of scientific names was used to avoid ties when two or more species were represented by the same number of animals.

	1983	1983 Fall	1984	1984 Fall	1985	1985 Fall	1986	1986 Fall	1988	1990	1992	1994	1996	1997	Mean Rank	Overall Totals
Elliptio crassidens	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	10103
Pleurobema cordatum	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.0	2219
Cyclonaias tuberculata	4	4	4	3	3	4	3	3	3	3	3	4	3	3	3.4	848
Quadrula pustulosa	3	3	3	4	4	3	4	4	4	4	4	3	5	4	3.7	950
Potamilus alatus	9	7	7	5	5	5	5	5	5	5	5	8	4	5	5.7	124
Ellipsaria lineolata	5	6	5	6	7	6	7	7	8	6	6	6	6	6	6.2	408
Amblema plicata	6	5	6	8	6	7	6	6	6	9	7	5	7	7	6.5	273
Anodonta grandis	7	10	10	11	11	11	8	10	7	7	11	9	8	10	9.3	271
Obliquaria reflexa	8	11	9	12	8	12	9	12	12	8	10	7	9	8	9.6	132
Quadrula metanevra	10	8	8	7	9	9	12	11	10	11	9	11	12	9	9.7	116
Tritogonia verrucosa	12	9	11	10	10	8	11	8	9	10	8	10	10	12	9.9	68
Ligumia recta	11	12	12	9	12	10	10	9	11	12	12	12	11	11	11.0	99

Table 3-9. Numbers of all native mussel species and each of the five most abundant species encountered on each of the three mussel beds near Watts Bar Nuclear Plant during the 10 summer surveys used in the statistical analyses.

All Species	**1983**	**1984**	**1985**	**1986**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Mean**	**SDEV**
TRM 520-521	625	467	296	331	418	364	220	299	268	199	348.7	127.5
TRM 526-527	375	161	193	244	271	216	135	212	207	154	216.8	69.2
TRM 528-529	341	642	574	500	921	411	353	369	371	344	482.6	186.4
Totals	**1341**	**1270**	**1063**	**1075**	**1610**	**991**	**708**	**880**	**846**	**697**	**1048.1**	**291.2**
Percent @ TRM 520-521	46.6	36.8	27.8	30.8	26.0	36.7	31.1	34.0	31.7	28.6	33.3	6.0
Percent @ TRM 526-527	28.0	12.7	18.2	22.7	16.8	21.8	19.1	24.1	24.5	22.1	20.7	4.4
Percent @ TRM 528-529	25.4	50.6	54.0	46.5	57.2	41.5	49.9	41.9	43.9	49.4	46.0	8.8
Elliptio crassidens	**1983**	**1984**	**1985**	**1986**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Mean**	**SDEV**
TRM 520-521	414	232	203	224	236	195	110	197	212	123	214.6	82.2
TRM 526-527	132	81	95	142	87	85	42	110	114	109	99.7	28.5
TRM 528-529	208	466	440	368	647	244	272	276	268	257	344.6	136.7
Totals	**754**	**779**	**738**	**734**	**970**	**524**	**424**	**583**	**594**	**489**	**658.9**	**164.8**
Percent @ TRM 520-521	54.9	29.8	27.5	30.5	24.3	37.2	25.9	33.8	35.7	25.2	32.6	9.0
Percent @ TRM 526-527	17.5	10.4	12.9	19.3	9.0	16.2	9.9	18.9	19.2	22.3	15.1	4.7
Percent @ TRM 528-529	27.6	59.8	59.6	50.1	66.7	46.6	64.2	47.3	45.1	52.6	52.3	11.5
Pleurobema cordatum	**1983**	**1984**	**1985**	**1986**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Mean**	**SDEV**
TRM 520-521	90	107	36	55	68	34	26	35	27	28	50.6	28.8
TRM 526-527	109	12	23	8	44	24	27	19	20	18	30.4	29.3
TRM 528-529	65	101	54	47	112	81	29	41	47	55	63.2	26.8
Totals	**264**	**220**	**113**	**110**	**224**	**139**	**82**	**95**	**94**	**101**	**144.2**	**66.1**
Percent @ TRM 520-521	34.1	48.6	31.9	50.0	30.4	24.5	31.7	36.8	28.7	27.7	35.1	8.5
Percent @ TRM 526-527	41.3	5.5	20.4	7.3	19.6	17.3	32.9	20.0	21.3	17.8	21.1	10.6
Percent @ TRM 528-529	24.6	45.9	47.8	42.7	50.0	58.3	35.4	43.2	50.0	54.5	43.8	9.7

Table 3-9. (Continued)

Quadrula pustulosa	**1983**	**1984**	**1985**	**1986**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Mean**	**SDEV**
TRM 520-521	32	27	7	3	5	17	14	6	1	9	12.1	10.4
TRM 526-527	45	20	18	12	21	26	16	30	9	6	20.3	11.4
TRM 528-529	22	38	28	16	54	36	18	29	20	9	27.0	13.1
Totals	**99**	**85**	**53**	**31**	**80**	**79**	**48**	**65**	**30**	**24**	**59.4**	**26.2**
Percent @ TRM 520-521	32.3	31.8	13.2	9.7	6.3	21.5	29.2	9.2	3.3	37.5	20.4	12.5
Percent @ TRM 526-527	45.5	23.5	34.0	38.7	26.3	32.9	33.3	46.2	30.0	25.0	34.2	7.9
Percent @ TRM 528-529	22.2	44.7	52.8	51.6	67.5	45.6	37.5	44.6	66.7	37.5	45.5	13.6
Cyclonaias tuberculata	**1983**	**1984**	**1985**	**1986**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Mean**	**SDEV**
TRM 520-521	45	62	34	23	56	71	44	46	18	31	43.0	16.9
TRM 526-527	18	2	7	8	8	5	12	8	7	3	7.8	4.6
TRM 528-529	25	9	19	24	29	14	12	10	13	13	16.8	7.0
Totals	**88**	**73**	**60**	**55**	**93**	**90**	**68**	**64**	**38**	**47**	**67.6**	**18.6**
Percent @ TRM 520-521	51.1	84.9	56.7	41.8	60.2	78.9	64.7	71.9	47.4	66.0	63.6	13.7
Percent @ TRM 526-527	20.5	2.7	11.7	14.5	8.6	5.6	17.6	12.5	18.4	6.4	11.5	6.0
Percent @ TRM 528-529	28.4	12.3	31.7	43.6	31.2	15.6	17.6	15.6	34.2	27.7	24.9	10.1
Potamilus alatus	**1983**	**1984**	**1985**	**1986**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Mean**	**SDEV**
TRM 520-521	6	7	3	4	10	13	6	2	3	2	5.6	3.6
TRM 526-527	7	9	25	23	30	28	5	5	28	6	16.6	11.0
TRM 528-529	1	2	6	14	15	4	5	3	4	4	5.8	4.8
Totals	**14**	**18**	**34**	**41**	**55**	**45**	**16**	**10**	**35**	**12**	**28.0**	**16.0**
Percent @ TRM 520-521	42.9	38.9	8.8	9.8	18.2	28.9	37.5	20.0	8.6	16.7	20.0	13.1
Percent @ TRM 526-527	50.0	50.0	73.5	56.1	54.5	62.2	31.3	50.0	80.0	50.0	59.3	13.7
Percent @ TRM 528-529	7.1	11.1	17.6	34.1	27.3	8.9	31.3	30.0	11.4	33.3	20.7	11.0

Table 3-10. Results of statistical analyses of native mussel abundance on three beds monitored near Watts Bar Nuclear Plant during 1983 through 1997. Only the summer sample data were used in these analyses to equalize the weight associated with each year. The significance level used in these analyses was ∝ = 0.05.

Test Subject	Trend Present	Trend not Significant (ANOVA) Site	Trend not Significant (ANOVA) Multiple Range Results	Significant Trend Present (Covariance) Parallel	Site	Year	Multiple Range Results
All Species							
TRM 520-521	0.004			0.477	0.312	0.002	
TRM 526-527	0.381	0.034	526.3 526.5 526.8 526.0				
TRM 528-529	0.427	0.002	528.8 528.9 528.5 528.2				
Elliptio crassidens							
TRM 520-521	0.02			0.17	0.02	0.01	520.0 520.8 520.6 520.3
TRM 526-527	0.79	0.30					
TRM 528-529	0.50	0.0001	528.9 528.8 528.5 528.2				
Pleurobema cordatum							
TRM 520-521	0.004			0.13	0.72	0.001	?
TRM 526-527	0.42	0.0002	526.3 526.5 526.0 526.8				
TRM 528-529	0.31	0.03	528.9 528.5 528.8 528.2				
Quadrula pustulosa							
TRM 520-521	0.05			0.13	0.16	0.05	
TRM 526-527	0.04			0.18	0.0007	0.02	526.6 526.8 526.3 526.0
TRM 528-529	0.10	0.50					
Cyclonaias tuberculata							
TRM 520-521	0.02			0.009			Trends at sites not parallel
TRM 526-527	0.77	0.0009	526.5 526.3 526.0 526.8				
TRM 528-529	0.47	0.04	528.5 528.8 528.2 528.9				
Potamilus alatus							
TRM 520-521	0.75	0.27					
TRM 526-527	0.32	0.07					
TRM 528-529	0.58	0.78					

Table 3-11. Mean lengths (in millimeters) of each native mussel species encountered during surveys conducted near Watts Bar Nuclear Plant during 1983-1997. As a general rule, no more than 50 members of each species were measured from each bed during any given survey.

Species	1983	1984	1985	1986	1988	1990	1992	1994	1996	1997	Number Measured	Overall Mean
Actinonaias ligamentina	104.00	109.55	104.72	99.23	97.87	110.38	94.80				35	103.57
Amblema plicata	96.86	98.18	103.37	103.36	102.47	102.16	105.46	106.79	104.90	96.00	272	101.52
Anodonta grandis	121.88	124.58	123.14	122.18	126.85	135.42	130.06	135.29	141.10	147.00	132	127.57
Anodonta imbecillis		53.60		39.20	54.00	52.00					5	50.48
Anodonta suborbiculata					107.80	126.20					2	117.00
Cyclonaias tuberculata	79.14	76.09	78.39	76.16	79.12	79.65	80.10	78.52	83.00	81.50	897	79.30
Cyprogenia stegaria	54.83	52.90	57.70								5	55.02
Dromus dromas	60.10										1	60.10
Ellipsaria lineolata	85.29	82.92	87.83	84.30	87.22	85.42	90.49	87.68	92.20	81.80	265	85.90
Elliptio crassidens	107.96	109.58	110.22	110.53	110.06	115.21	112.26	113.88	112.90	113.10	2182	111.08
Elliptio dilatata	103.32	96.35	98.80	109.23	101.10	94.60			95.40		17	101.64
Fusconaia subrotunda	66.09										1	66.09
Lampsilis abrupta	94.39	96.66	101.94	100.44	100.78	105.95	108.85	105.05	110.20		62	101.18
Lampsilis ovata	124.93	127.98	127.36	141.40	130.37	121.70	157.27			115.30	26	128.39
Lasmigona complanata			180.20								1	180.20
Lasmigona costata				122.10					118.40		2	120.25
Leptodea fragilis	84.13	111.33	100.28	96.87	99.81	110.46		117.67	126.20	92.20	50	102.46
Ligumia recta	155.34	157.96	165.39	147.23	160.27	172.60		161.40	157.50	160.00	67	156.70
Megalonaias nervosa	13.83	180.00	173.70	152.35	160.61	166.60	173.35	174.45	180.00		34	166.23
Obliquaria reflexa	53.80	53.63	55.72	55.11	54.84	55.06	57.17	57.30	56.10	54.10	99	55.12
Plethobasus cyphyus	91.80						91.40	88.60			4	90.90
Pleurobema cordatum	95.39	95.08	96.42	92.87	96.57	97.37	98.53	97.71	99.40	98.20	1628	96.06
Pleurobema oviforme		69.80	72.90	68.90	72.20	72.80		71.90			9	71.04
Pleurobema plenum	58.10	60.10	84.60								4	65.73
Pleurobema rubrum			87.97		88.30						4	88.05
Potamilus alatus	135.39	142.73	139.79	139.66	142.76	142.78	142.99	149.92	145.90	146.40	407	141.46
Ptychobranchus fasciolaris		94.40				116.80					2	105.60
Quadrula metanevra	76.52	78.68	78.07	74.75	83.34	84.28	78.61	74.18	81.90	88.00	122	78.24
Quadrula pustulosa	55.91	56.75	57.98	54.97	58.73	57.56	56.37	58.02	60.80	59.00	827	57.18
Tritogonia verrucosa	110.06	110.44	124.66	110.36	112.68	107.59	106.24	115.60	109.70	109.60	116	112.77

Table 3-12. Statistical analyses of mean lengths of native mussels collected near Watts Bar Nuclear Plant during the period 1983 through 1997. Only the summer sample data were used in these analyses to equalize the weight associated with each year. The significance level used in these analyses was $\propto = 0.05$.

	Trend	Trend not Significant (ANOVA)		Significant Trend Present (Covariance)			
Test Subject	Present	Site	Multiple Range Results	Parallel	Site	Year	Multiple Range Results
Elliptio crassidens							
TRM 520-521	0.02			0.45	0.65	0.002	
TRM 526-527	0.002			0.18	0.12	0.0004	
TRM 528-529	0.10	0.52					
Pleurobema cordatum							
TRM 520-521	0.02			0.05	0.001	0.06	520.0 520.3 520.8 520.6
TRM 526-527	0.002			0.36	0.10	0.0002	
TRM 528-529	0.02			0.42	0.03	0.002	528.5 528.8 528.2 528.9
Quadrula pustulosa							
TRM 520-521	0.14	0.98					
TRM 526-527	0.65	0.09					
TRM 528-529	0.13	0.42					
Cyclonaias tuberculata							
TRM 520-521	0.01			0.22	0.11	0.003	
TRM 526-527	0.82	0.46					
TRM 528-529	0.21	0.15					
Potamilus alatus							
TRM 520-521	0.23	0.01	520.3 520.0 520.6 520.8				
TRM 526-527	0.34	0.02	526.5 526.3 526.8 526.0				
TRM 528-529	0.18	0.18					

Table 4-1. Preoperational water quality monitoring summary statistics for parameters measured during 1982-1987 at WBN

Tennessee River Mile 518.0					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	459	7.55	0.36	6.8	8.7
Turbidity (NTU)	115	5.40	2.98	1.1	16.0
Total Solids (mg/L)	0	-	-	-	-
Suspended Solids (mg/L)	79	4.6	2.3	1	9
Volatile Suspended Solids (mg/L)	52	2.4	1.0	1	5
Dissolved Solids (mg/L)	19	96.8	23.6	40	130
Ammonia Nitrogen (mg/L)	140	0.047	0.032	0.01	0.28
Nitrate+Nitrate Nitrogen (mg/L)	140	0.291	0.081	0.17	0.48
Organic Nitrogen (mg/L)	140	0.209	0.099	0.04	0.63
Total Phosphorus (mg/L)	116	0.0341	0.0162	0.010	0.110
Dissolved Phosphorus (mg/L)	125	0.0139	0.0058	0.010	0.030
Total Organic Carbon (mg/L)	139	2.50	0.86	1.1	5.8
COD (mg/L)	19	7.9	3.4	2	15
Total Alkalinity (mg/L)	133	63.0	8.4	46	78
Chlorophyll a (ug/L)	85	4.7	3.9	1	19.1
Tennessee River Mile 527.4					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	553	7.48	0.39	6.5	9.0
Turbidity (NTU)	105	5.01	2.40	0.8	12.0
Total Solids (mg/L)	0	-	-	-	-
Suspended Solids (mg/L)	69	3.4	1.3	1	6
Volatile Suspended Solids (mg/L)	0	-	-	-	-
Dissolved Solids (mg/L)	69	98.1	18.3	50	150
Ammonia Nitrogen (mg/L)	114	0.042	0.027	0.01	0.21
Nitrate+Nitrate Nitrogen (mg/L)	114	0.333	0.338	0.02	3.50
Organic Nitrogen (mg/L)	114	0.196	0.102	0.04	0.62
Total Phosphorus (mg/L)	79	0.0284	0.0126	0.010	0.060
Dissolved Phosphorus (mg/L)	109	0.0114	0.0037	0.010	0.030
Total Organic Carbon (mg/L)	114	3.00	2.58	1.2	26.0
COD (mg/L)	69	6.9	3.0	1	22
Total Alkalinity (mg/L)	103	62.5	8.6	46	76
Chlorophyll a (ug/L)	76	5.8	3.3	2.3	17.8

Table 4-1. (Continued)

Tennessee River Mile 529.5					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	163	7.50	0.45	6.4	9.1
Turbidity (NTU)	78	5.40	2.82	1.2	14.0
Total Solids (mg/L)	0	-	-	-	-
Suspended Solids (mg/L)	43	3.6	1.4	1	6
Volatile Suspended Solids (mg/L)	0	-	-	-	-
Dissolved Solids (mg/L)	43	99.1	20.9	70	180
Ammonia Nitrogen (mg/L)	104	0.038	0.023	0.01	0.13
Nitrate+Nitrate Nitrogen (mg/L)	104	0.301	0.118	0.02	0.85
Organic Nitrogen (mg/L)	104	0.191	0.091	0.01	0.48
Total Phosphorus (mg/L)	80	0.0285	0.0120	0.010	0.050
Dissolved Phosphorus (mg/L)	95	0.0118	0.0041	0.010	0.030
Total Organic Carbon (mg/L)	103	2.71	1.02	1.3	10.0
COD (mg/L)	45	7.3	2.8	2	14
Total Alkalinity (mg/L)	91	63.1	8.8	46	76
Chlorophyll a (ug/L)	76	5.7	3.7	2.2	19.3
Tennessee River Mile 529.9					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	195	7.61	0.40	5.8	8.8
Turbidity (NTU)	42	5.38	2.79	1.5	13.0
Total Solids (mg/L)	0	-	-	-	-
Suspended Solids (mg/L)	31	4.9	1.9	1	9
Volatile Suspended Solids (mg/L)	22	2.5	0.8	1	4
Dissolved Solids (mg/L)	1	100.0	.	100	100
Ammonia Nitrogen (mg/L)	42	0.034	0.021	0.01	0.11
Nitrate+Nitrate Nitrogen (mg/L)	51	0.262	0.098	0.07	0.61
Organic Nitrogen (mg/L)	42	0.203	0.078	0.03	0.42
Total Phosphorus (mg/L)	51	0.0320	0.0165	0.010	0.100
Dissolved Phosphorus (mg/L)	33	0.0142	0.0144	0.010	0.090
Total Organic Carbon (mg/L)	42	2.28	0.67	1.2	4.1
COD (mg/L)	1	9.0	.	9	9
Total Alkalinity (mg/L)	38	64.7	9.8	41	82
Chlorophyll a (ug/L)	17	5.4	2.6	2	12

Table 4-2. Operational water quality monitoring summary statistics for parameters measured during 1996-1997 at WBN

Tennessee River Mile 518.0					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	12	7.47	0.14	7.2	7.7
Turbidity (NTU)	11	3.36	1.21	2.0	6.0
Total Solids (mg/L)	11	107.3	15.6	80	130
Suspended Solids (mg/L)	0	-	-	-	-
Volatile Suspended Solids (mg/L)	0	-	-	-	-
Dissolved Solids (mg/L)	11	90.0	14.8	70	110
Ammonia Nitrogen (mg/L)	38	0.039	0.015	0.01	0.06
Nitrate+Nitrate Nitrogen (mg/L)	38	0.284	0.076	0.18	0.43
Organic Nitrogen (mg/L)	38	0.165	0.063	0.07	0.27
Total Phosphorus (mg/L)	38	0.0311	0.0118	0.008	0.070
Dissolved Phosphorus (mg/L)	38	0.0155	0.0060	0.002	0.030
Total Organic Carbon (mg/L)	38	1.68	0.17	1.4	2.0
COD (mg/L)	11	5.5	1.5	5	10
Total Alkalinity (mg/L)	12	65.1	6.8	54	74
Chlorophyll a (ug/L)	80	5.8	2.9	2	18
Tennessee River Mile 527.4					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	12	7.63	0.22	7.3	8.0
Turbidity (NTU)	11	3.55	0.69	3.0	5.0
Total Solids (mg/L)	12	104.2	16.2	80	130
Suspended Solids (mg/L)	0	-	-	-	-
Volatile Suspended Solids (mg/L)	0	-	-	-	-
Dissolved Solids (mg/L)	12	90.8	13.8	80	120
Ammonia Nitrogen (mg/L)	41	0.030	0.014	0.01	0.05
Nitrate+Nitrate Nitrogen (mg/L)	41	0.272	0.075	0.19	0.42
Organic Nitrogen (mg/L)	41	0.176	0.055	0.02	0.26
Total Phosphorus (mg/L)	41	0.0273	0.0059	0.020	0.040
Dissolved Phosphorus (mg/L)	41	0.0127	0.0045	0.008	0.020
Total Organic Carbon (mg/L)	41	1.71	0.18	1.5	2.2
COD (mg/L)	12	5.8	1.7	5	10
Total Alkalinity (mg/L)	12	63.9	8.0	52	74
Chlorophyll a (ug/L)	80	7.7	3.2	4	18

Table 4-2. (Continued)

Tennessee River Mile 529.5					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	10	7.61	0.22	7.1	7.9
Turbidity (NTU)	10	3.50	0.97	2.0	5.0
Total Solids (mg/L)	11	102.7	14.2	90	130
Suspended Solids (mg/L)	0	-	-	-	-
Volatile Suspended Solids (mg/L)	0	-	-	-	-
Dissolved Solids (mg/L)	11	92.7	11.0	80	120
Ammonia Nitrogen (mg/L)	33	0.029	0.014	0.01	0.06
Nitrate+Nitrate Nitrogen (mg/L)	33	0.267	0.077	0.16	0.41
Organic Nitrogen (mg/L)	33	0.189	0.067	0.07	0.29
Total Phosphorus (mg/L)	33	0.0252	0.0083	0.020	0.060
Dissolved Phosphorus (mg/L)	33	0.0091	0.0029	0.002	0.010
Total Organic Carbon (mg/L)	33	1.74	0.20	1.5	2.1
COD (mg/L)	11	5.8	1.3	5	8
Total Alkalinity (mg/L)	10	63.0	6.8	55	73
Chlorophyll a (ug/L)	69	8.0	3.0	3	15
Tennessee River Mile 529.9					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
pH (standard units)	11	8.55	0.56	7.3	9.2
Turbidity (NTU)	11	1.73	0.79	1.0	3.0
Total Solids (mg/L)	11	101.8	14.0	80	130
Suspended Solids (mg/L)	0	-	-	-	-
Volatile Suspended Solids (mg/L)	0	-	-	-	-
Dissolved Solids (mg/L)	11	90.9	14.5	70	110
Ammonia Nitrogen (mg/L)	42	0.014	0.007	0.01	0.03
Nitrate+Nitrate Nitrogen (mg/L)	42	0.189	0.107	0.03	0.42
Organic Nitrogen (mg/L)	42	0.242	0.201	0.08	1.40
Total Phosphorus (mg/L)	42	0.0212	0.0055	0.010	0.030
Dissolved Phosphorus (mg/L)	42	0.0100	0.0022	0.005	0.020
Total Organic Carbon (mg/L)	42	1.92	0.38	1.5	3.1
COD (mg/L)	11	9.0	6.2	5	26
Total Alkalinity (mg/L)	11	65.8	5.5	56	74
Chlorophyll a (ug/L)	81	11.3	5.1	1	28

Table 4-3. Statistical Comparison of WBN 1996 Operational Water Quality Data to Pre-operational Data using Anova w/Duncan's Multiple Range Test

1996 Compared to Pre-Op Period		TRM 518.0	TRM 527.4	TRM 529.5	TRM 529.9	All
	pH	-	-	-	Up	Up
	Turbidity	-	-	-	Down	Down
	Dissolved Solids	-	-	-	-	-
	Ammonia Nitrogen	-	-	-	Down	-
	Nitrite+Nitrate Nitrogen	-	-	-	Down	-
	Organic Nitrogen	Down	-	-	-	-
	Total Phosphorus	-	-	-	Down	Down
	Dissolved Phosphorus	-	-	Down	-	-
	Total Organic Carbon	Down	-	Down	-	Down
	Chemical Oxygen Demand	-	-	-	-	-
	Total Alkalinity	-	-	-	-	-
	Chlorophyll a	Up	Up	Up	Up	Up

Table 4-4. Statistical Comparison of WBN 1997 Operational Water Quality Data to Pre-operational Data using Anova w/Duncan's Multiple Range Test

1997 Compared to Pre-Op Period		TRM 518.0	TRM 527.4	TRM 529.5	TRM 529.9	All
	pH	-	-	-	Up	Up
	Turbidity	Down	-	-	Down	Down
	Dissolved Solids	-	-	-	-	Down
	Ammonia Nitrogen	Down	Down	Down	Down	Down
	Nitrite+Nitrate Nitrogen	-	-	Down	Down	Down
	Organic Nitrogen	-	-	-	-	-
	Total Phosphorus	-	-	-	Down	Down
	Dissolved Phosphorus	-	Up	Down	-	-
	Total Organic Carbon	Down	Down	Down	Down	Down
	Chemical Oxygen Demand	Down	-	-	-	-
	Total Alkalinity	-	-	-	-	-
	Chlorophyll a	-	Up	Up	Up	Up

Table 4-5. Statistical Comparison of WBN Combined 1996-97 Operational Water Quality Data to Pre-operational Data using Anova w/Duncan's Multiple Range Test

1996-97 Compared to Pre-Op Period		TRM 518.0	TRM 527.4	TRM 529.5	TRM 529.9	All
	pH	-	-	-	Up	Up
	Turbidity	Down	Down	Down	Down	Down
	Dissolved Solids	-	-	-	-	Down
	Ammonia Nitrogen	-	Down	Down	Down	Down
	Nitrite+Nitrate Nitrogen	-	-	-	Down	Down
	Organic Nitrogen	Down	-	-	-	-
	Total Phosphorus	-	-	-	Down	Down
	Dissolved Phosphorus	-	-	Down	Down	Down
	Total Organic Carbon	Down	Down	Down	Down	Down
	Chemical Oxygen Demand	Down	-	-	-	-
	Total Alkalinity	-	-	-	-	-
	Chlorophyll a	Up	Up	Up	Up	Up

Table 4-3. Statistical Comparison of WBN 1996 Operational Water Quality Data to Pre-operational Data using Anova w/Duncan's Multiple Range Test

1996 Compared to Pre-Op Period		TRM 518.0	TRM 527.4	TRM 529.5	TRM 529.9	All
	pH	-	-	-	Up	Up
	Turbidity	-	-	-	Down	Down
	Dissolved Solids	-	-	-	-	-
	Ammonia Nitrogen	-	-	-	Down	-
	Nitrite+Nitrate Nitrogen	-	-	-	Down	-
	Organic Nitrogen	Down	-	-	-	-
	Total Phosphorus	-	-	-	Down	Down

Shaded boxes indicate differences from those identified in 1996 comparisons in top table. "-" indicates no significant (p=>.05) difference between pre-operational and post-operational periods. "Up" indicates a statistically significant increase in the indicated parameter. "Down" indicates a statistical decrease in the indicated parameter

Table 4-6. Preoperational (1982-1991) water quality monitoring summary values for metals at WBN

Tennessee River Mile 518.0					
Parameter	N	Mean	Std Dev	Minimum	Maximum
Total Calcium (mg/L)	25	21.8	3.2	11.0	25.7
Total Magnesium (mg/L)	25	5.6	1.2	2.3	7.3
Total Arsenic (ug/L)	25	1.2	0.5	1.0	3.0
Total Boron (ug/L)	25	50.0	0.0	50.0	50.0
Total Cadmium (ug/L)	25	0.1	0.1	0.1	0.8
Total Chromium (ug/L)	25	1.4	0.7	1.0	4.0
Total Copper (ug/L)	25	11.0	9.0	5.0	50.0
Total Iron (ug/L)	25	189.2	139.2	50.0	590.0
Total Lead (ug/L)	25	2.8	3.9	1.0	20.0
Total Manganese (ug/L)	25	57.1	33.4	10.0	134.0
Total Nickel (ug/L)	25	2.2	2.0	1.0	9.0
Total Zinc (ug/L)	25	10.5	7.6	1.0	36.0
Total Aluminum (ug/L)	25	189.2	118.9	50.0	410.0
Total Selenium (ug/L)	25	1.1	0.6	1.0	4.0
Total Mercury (ug/L)	25	0.2	0.1	0.2	0.5
Ca/Mg Hardness (mg/L)	25	77.6	12.7	37.0	92.0
Tennessee River Mile 527.4					
Parameter	N	Mean	Std Dev	Minimum	Maximum
Total Calcium (mg/L)	78	22.5	3.6	16.0	38.0
Total Magnesium (mg/L)	78	5.4	0.9	3.7	8.4
Total Arsenic (ug/L)	79	1.3	0.6	1.0	3.0
Total Boron (ug/L)	79	45.3	16.7	6.0	130.0
Total Cadmium (ug/L)	79	0.3	0.5	0.1	2.0
Total Chromium (ug/L)	79	1.4	0.9	1.0	4.0
Total Copper (ug/L)	79	12.6	13.6	5.0	90.0
Total Iron (ug/L)	79	177.0	120.3	10.0	610.0
Total Lead (ug/L)	75	3.9	5.7	1.0	40.0
Total Manganese (ug/L)	75	64.9	34.5	12.0	180.0
Total Nickel (ug/L)	79	2.0	1.8	1.0	10.0
Total Zinc (ug/L)	79	18.8	43.4	5.0	330.0
Total Aluminum (ug/L)	79	148.4	95.0	50.0	480.0
Total Selenium (ug/L)	79	1.1	0.4	1.0	3.0
Total Mercury (ug/L)	79	0.2	0.0	0.2	0.3

Ca/Mg Hardness (mg/L)	79	78.2	12.0	56.0	130.0

Table 4-6 (Continued)

Tennessee River Mile 529.5					
Parameter	N	Mean	Std Dev	Minimum	Maximum
Total Calcium (mg/L)	53	22.9	4.9	17.0	40.0
Total Magnesium (mg/L)	53	5.7	1.3	3.9	8.7
Total Arsenic (ug/L)	53	1.3	1.1	1.0	8.0
Total Boron (ug/L)	53	71.1	125.7	50.0	940.0
Total Cadmium (ug/L)	53	0.1	0.1	0.1	0.6
Total Chromium (ug/L)	53	1.7	1.7	1.0	12.0
Total Copper (ug/L)	53	11.2	10.2	5.0	59.0
Total Iron (ug/L)	53	201.5	163.3	10.0	700.0
Total Lead (ug/L)	53	2.0	2.2	1.0	14.0
Total Manganese (ug/L)	53	63.1	35.4	5.0	174.0
Total Nickel (ug/L)	53	1.7	1.5	1.0	9.0
Total Zinc (ug/L)	53	15.7	29.5	2.0	220.0
Total Aluminum (ug/L)	53	166.2	102.7	50.0	390.0
Total Selenium (ug/L)	53	1.3	0.9	1.0	6.0
Total Mercury (ug/L)	53	0.2	0.0	0.2	0.3
Ca/Mg Hardness (mg/L)	53	80.6	17.3	58.0	130.0
Tennessee River Mile 529.9					
Parameter	N	Mean	Std Dev	Minimum	Maximum
Total Calcium (mg/L)	1	22.0	.	22.0	22.0
Total Magnesium (mg/L)	1	5.5	.	5.5	5.5
Total Arsenic (ug/L)	1	1.0	.	1.0	1.0
Total Boron (ug/L)	1	8.0	.	8.0	8.0
Total Cadmium (ug/L)	1	0.1	.	0.1	0.1
Total Chromium (ug/L)	1	2.0	.	2.0	2.0
Total Copper (ug/L)	1	40.0	.	40.0	40.0
Total Iron (ug/L)	1	130.0	.	130.0	130.0
Total Lead (ug/L)	0	.	.	.	.
Total Manganese (ug/L)	0	.	.	.	.
Total Nickel (ug/L)	1	1.0	.	1.0	1.0
Total Zinc (ug/L)	1	10.0	.	10.0	10.0
Total Aluminum (ug/L)	1	100.0	.	100.0	100.0
Total Selenium (ug/L)	1	1.0	.	1.0	1.0
Total Mercury (ug/L)	1	0.2	.	0.2	0.2
Ca/Mg Hardness (mg/L)	1	78.0	.	78.0	78.0

Table 4-7. Operational (1996-1997) water quality monitoring summary values for metals at WBN

Tennessee River Mile 518.0					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
Total Calcium (mg/L)	13	19.5	4.0	12.0	23.0
Total Magnesium (mg/L)	13	5.6	0.6	4.4	6.2
Total Arsenic (ug/L)	13	1.0	0.0	1.0	1.0
Total Boron (ug/L)	13	500.0	0.0	500.0	500.0
Total Cadmium (ug/L)	13	0.1	0.0	0.1	0.2
Total Chromium (ug/L)	13	1.0	0.0	1.0	1.0
Total Copper (ug/L)	13	10.0	0.0	10.0	10.0
Total Iron (ug/L)	13	490.8	583.0	150.0	1800.0
Total Lead (ug/L)	13	1.0	0.0	1.0	1.0
Total Manganese (ug/L)	13	63.7	24.9	30.0	110.0
Total Nickel (ug/L)	13	1.0	0.0	1.0	1.0
Total Zinc (ug/L)	13	10.0	0.0	10.0	10.0
Total Aluminum (ug/L)	13	170.0	76.9	50.0	280.0
Total Selenium (ug/L)	13	1.0	0.0	1.0	1.0
Total Mercury (ug/L)	13	0.2	0.0	0.2	0.2
Ca/Mg Hardness (mg/L)	13	71.6	10.7	55.5	82.5
Tennessee River Mile 527.4					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
Total Calcium (mg/L)	14	21.1	2.3	16.0	23.0
Total Magnesium (mg/L)	14	5.5	0.6	4.4	6.1
Total Arsenic (ug/L)	14	1.1	0.3	1.0	2.0
Total Boron (ug/L)	14	500.0	0.0	500.0	500.0
Total Cadmium (ug/L)	14	0.1	0.0	0.1	0.1
Total Chromium (ug/L)	14	1.0	0.0	1.0	1.0
Total Copper (ug/L)	14	10.0	0.0	10.0	10.0
Total Iron (ug/L)	14	237.1	43.6	180.0	320.0
Total Lead (ug/L)	14	1.0	0.0	1.0	1.0
Total Manganese (ug/L)	14	60.1	20.4	20.0	85.0
Total Nickel (ug/L)	14	1.1	0.3	1.0	2.0
Total Zinc (ug/L)	14	10.7	2.7	10.0	20.0
Total Aluminum (ug/L)	14	175.0	44.3	120.0	280.0
Total Selenium (ug/L)	14	1.0	0.0	1.0	1.0
Total Mercury (ug/L)	14	0.2	0.0	0.2	0.2
Ca/Mg Hardness (mg/L)	14	75.4	8.1	58.1	82.5

Table 4-7 (Continued)

Tennessee River Mile 529.5					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
Total Calcium (mg/L)	12	21.5	2.8	16.0	25.0
Total Magnesium (mg/L)	12	5.5	0.6	4.4	6.4
Total Arsenic (ug/L)	12	1.0	0.0	1.0	1.0
Total Boron (ug/L)	12	500.0	0.0	500.0	500.0
Total Cadmium (ug/L)	12	0.1	0.0	0.1	0.1
Total Chromium (ug/L)	12	1.0	0.0	1.0	1.0
Total Copper (ug/L)	12	10.0	0.0	10.0	10.0
Total Iron (ug/L)	12	215.8	49.4	140.0	300.0
Total Lead (ug/L)	12	1.0	0.0	1.0	1.0
Total Manganese (ug/L)	12	60.9	21.1	25.0	91.0
Total Nickel (ug/L)	12	1.0	0.0	1.0	1.0
Total Zinc (ug/L)	12	10.0	0.0	10.0	10.0
Total Aluminum (ug/L)	12	170.8	36.3	110.0	220.0
Total Selenium (ug/L)	12	1.0	0.0	1.0	1.0
Total Mercury (ug/L)	12	0.2	0.0	0.2	0.3
Ca/Mg Hardness (mg/L)	12	76.4	9.5	58.1	88.8
Tennessee River Mile 529.9					
Parameter	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
Total Calcium (mg/L)	15	21.1	2.8	16.0	24.0
Total Magnesium (mg/L)	15	5.4	0.6	4.4	6.0
Total Arsenic (ug/L)	15	1.0	0.0	1.0	1.0
Total Boron (ug/L)	15	500.0	0.0	500.0	500.0
Total Cadmium (ug/L)	15	0.1	0.0	0.1	0.1
Total Chromium (ug/L)	15	1.0	0.0	1.0	1.0
Total Copper (ug/L)	15	10.0	0.0	10.0	10.0
Total Iron (ug/L)	15	184.0	57.4	100.0	300.0
Total Lead (ug/L)	15	1.0	0.0	1.0	1.0
Total Manganese (ug/L)	15	41.5	9.9	24.0	52.0
Total Nickel (ug/L)	15	1.0	0.0	1.0	1.0
Total Zinc (ug/L)	15	10.0	0.0	10.0	10.0
Total Aluminum (ug/L)	15	127.3	64.2	50.0	270.0
Total Selenium (ug/L)	15	1.0	0.0	1.0	1.0
Total Mercury (ug/L)	15	0.2	0.0	0.2	0.2
Ca/Mg Hardness (mg/L)	15	75.1	9.2	58.1	83.8

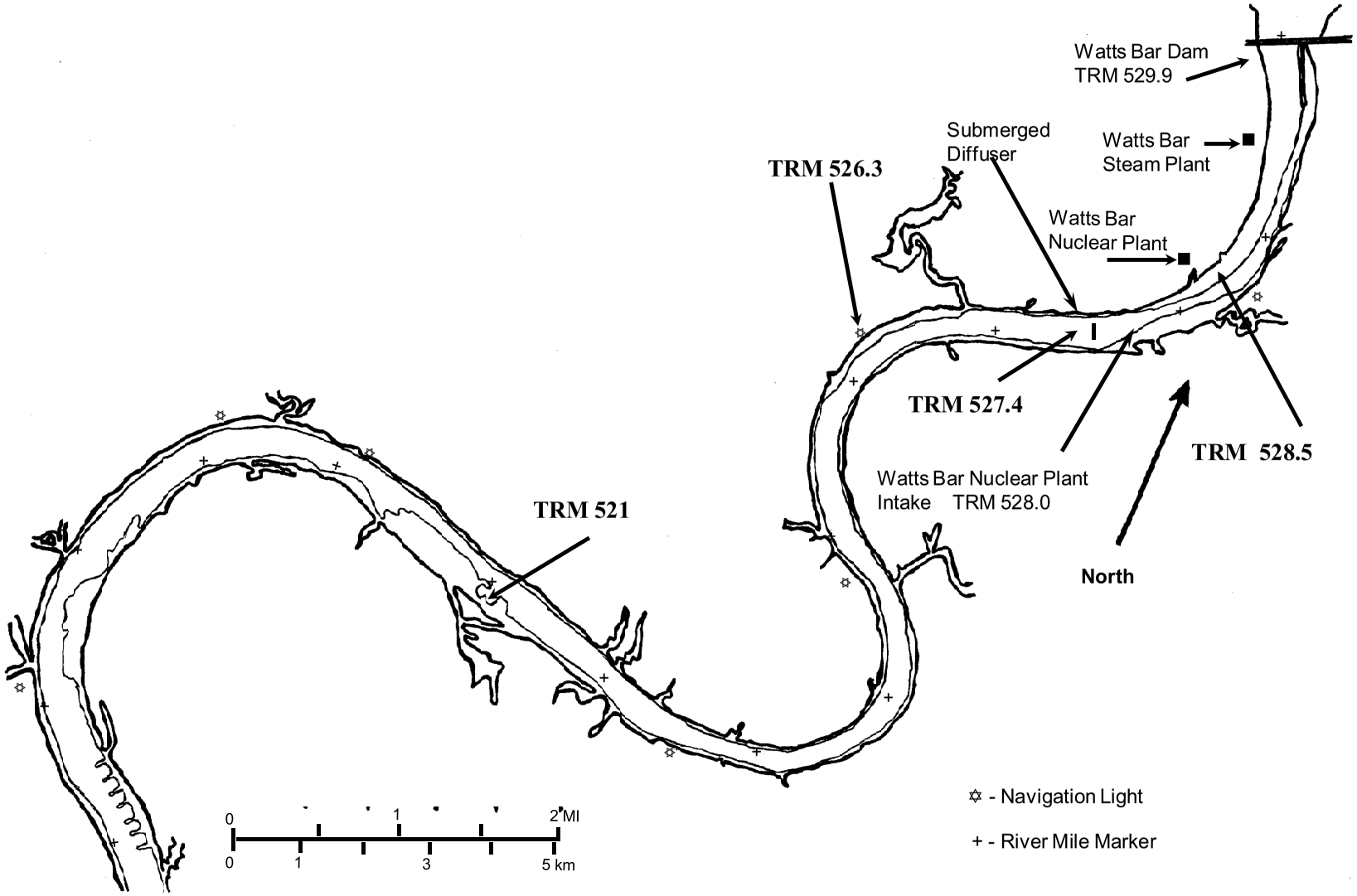


Figure 1-1. Location of Watts Bar Nuclear Plant on Chickamauga Reservoir.

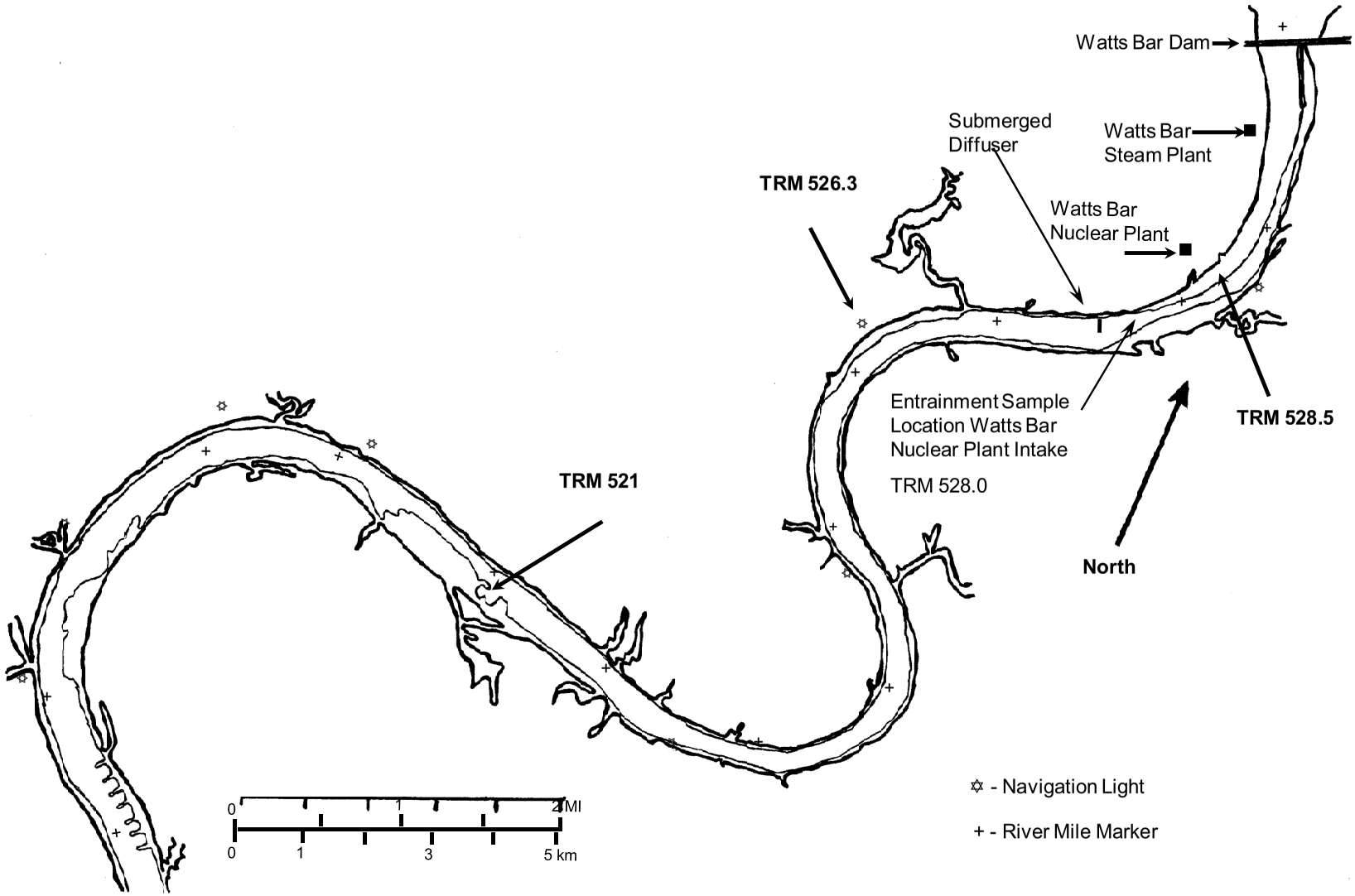


Figure 2-1. Sample Locations for Entrainment Samples in the vicinity of Watts Bar Nuclear Plant, 1996-1997.

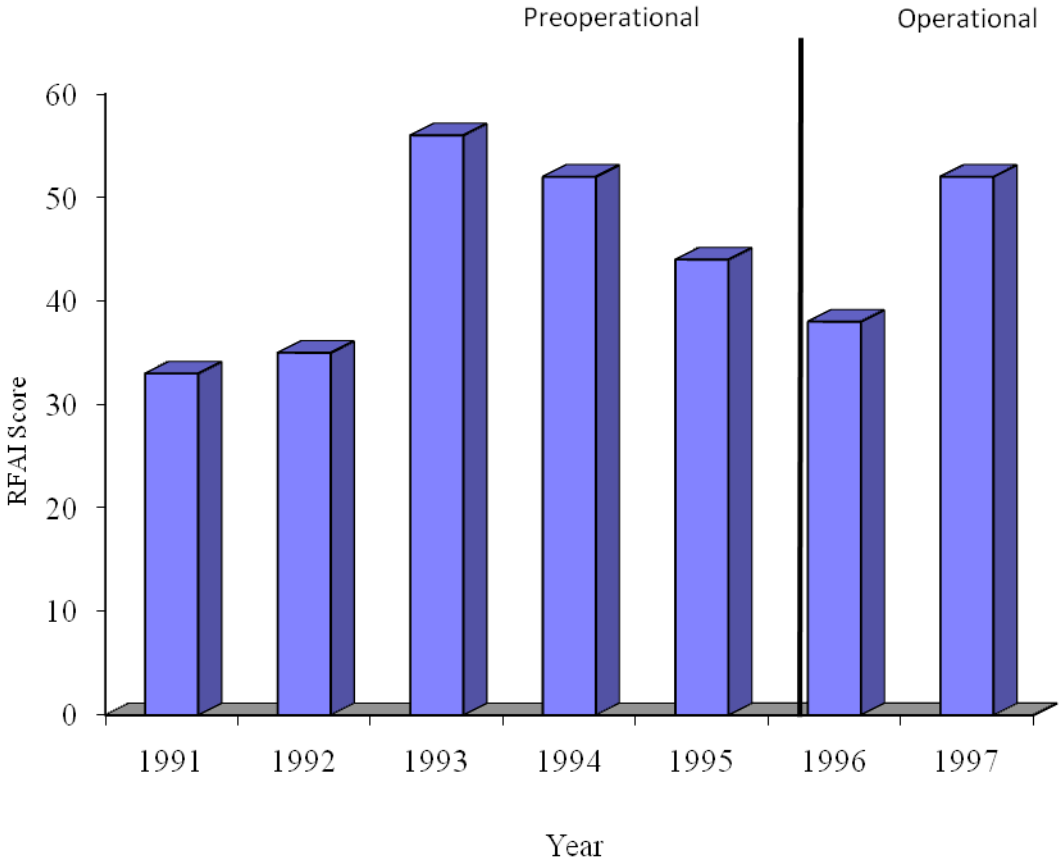


Figure 2-2. Reservoir Fish Assemblage Index (RFAI) scores from preoperational (1991-1995) and operational (1996-1997) periods on Chickamauga Reservoir in the vicinity of Watts Bar Nuclear Plan

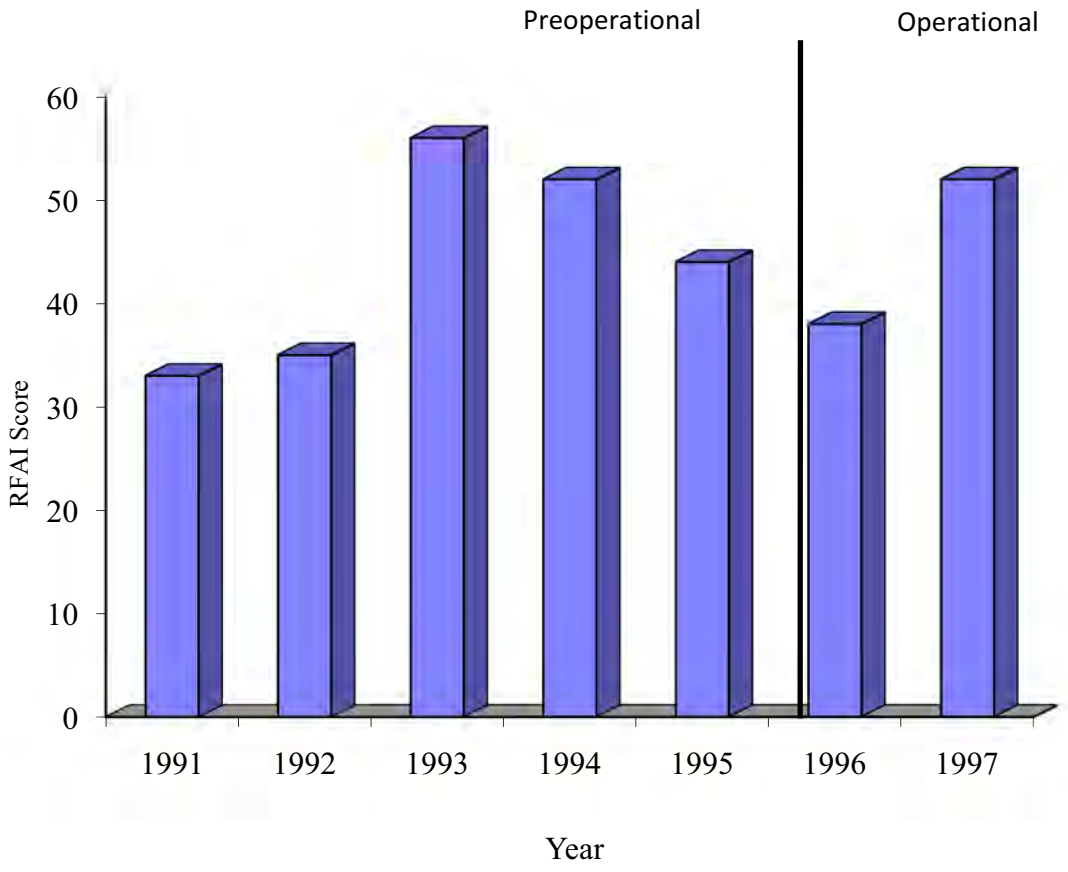


Figure 2-2. Reservoir Fish Assemblage Index (RFAI) scores from preoperational (1991-1995) and operational (1996-1997) periods on Chickamauga Reservoir in the vicinity of Watts Bar Nuclear Plan

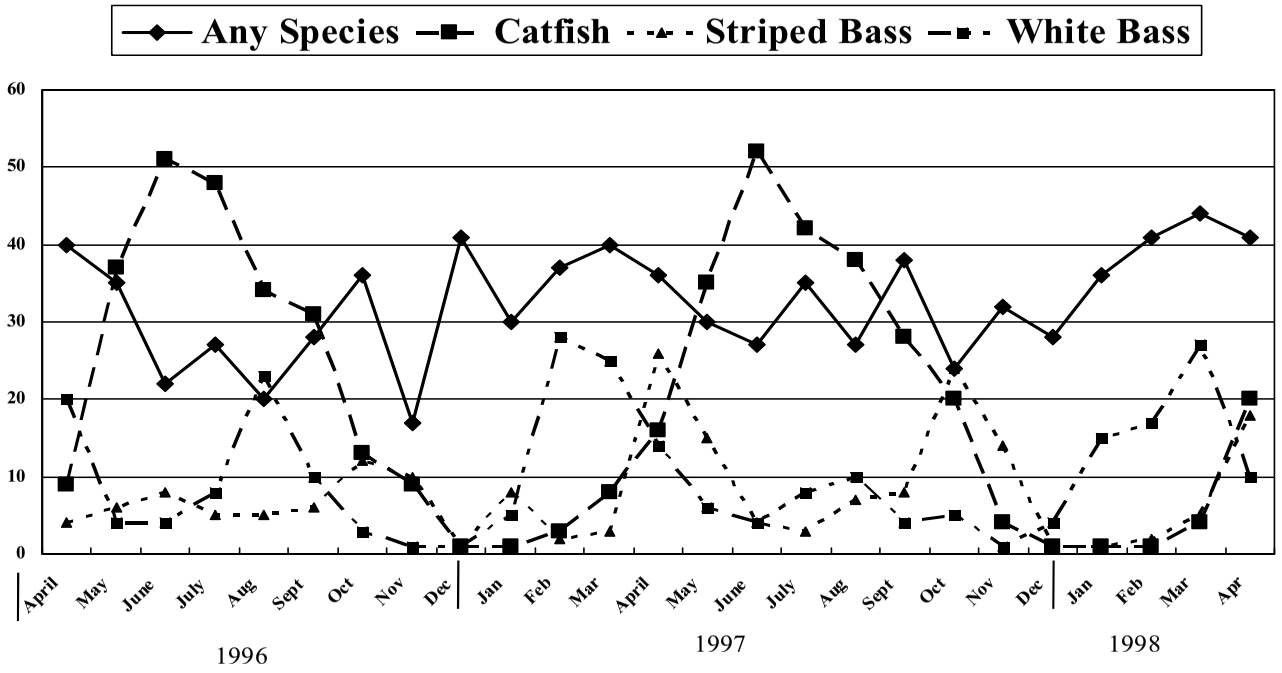


Figure 2-3. Percent of angler effort for selected directed species groups from the Watts Bar tailwater fishery. April 1996 through April 1998.

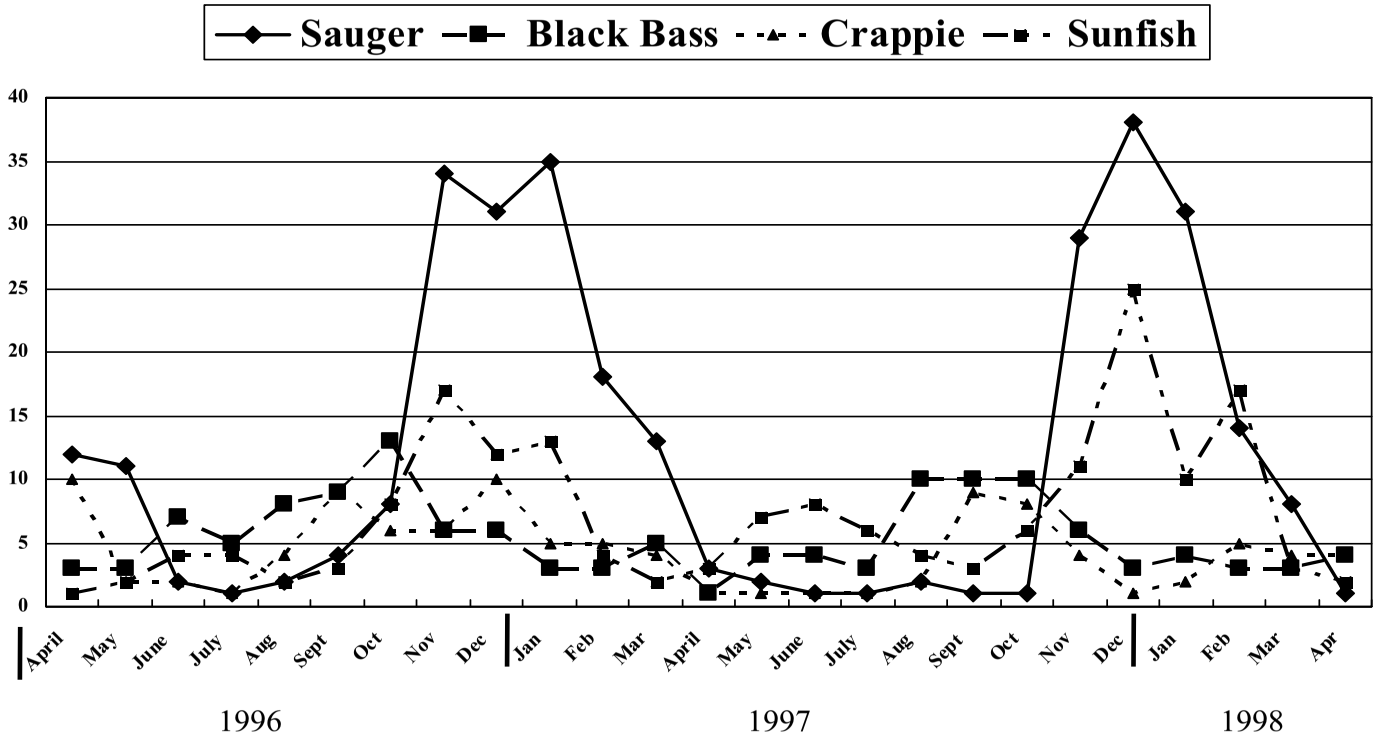


Figure 2-4. Percent of angler effort for selected directed species groups from the Watts Bar tailwater fishery. April 1996 through April 1998.

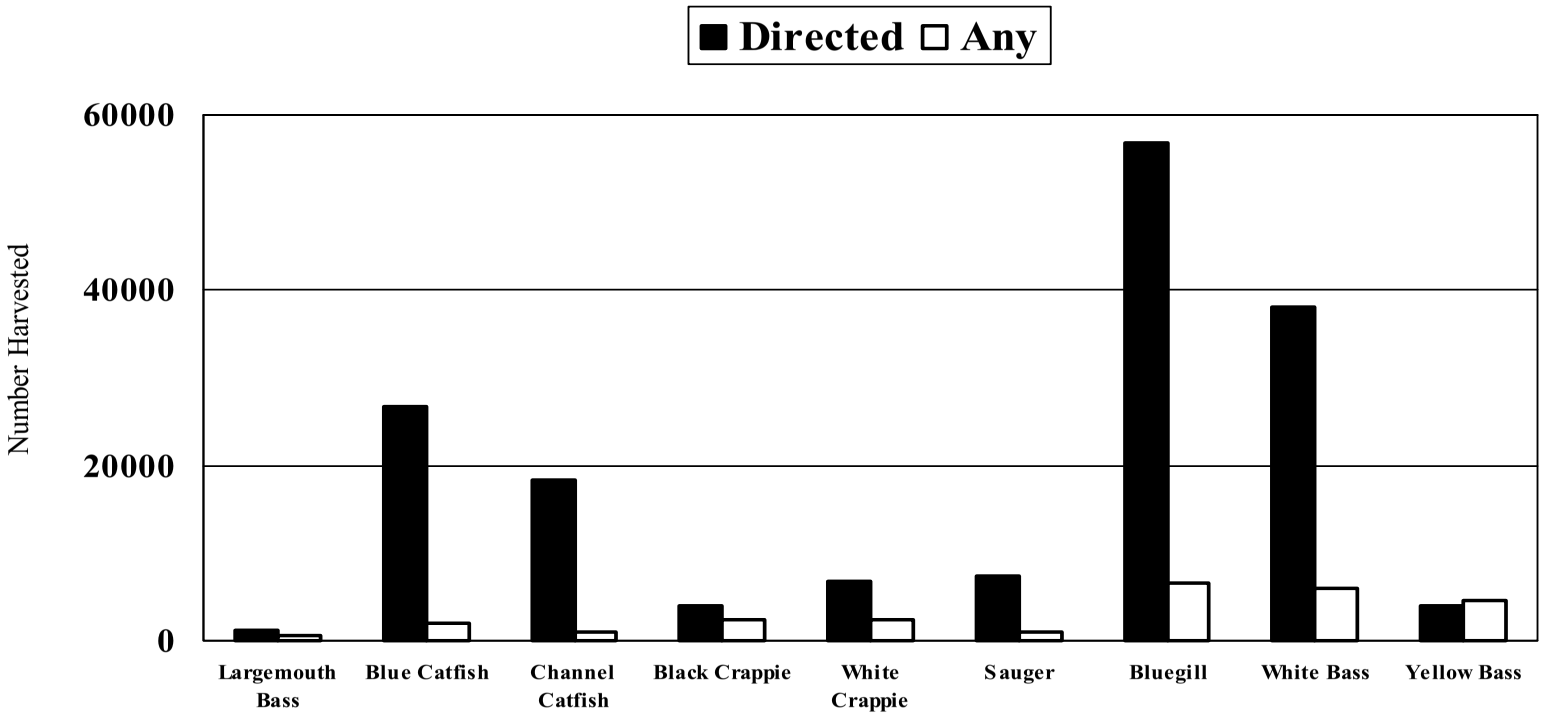


Figure 2-5. Estimated number of fish harvested in Watts Bar Tailwater by directed and any species groups, April 1996 through April 1998.

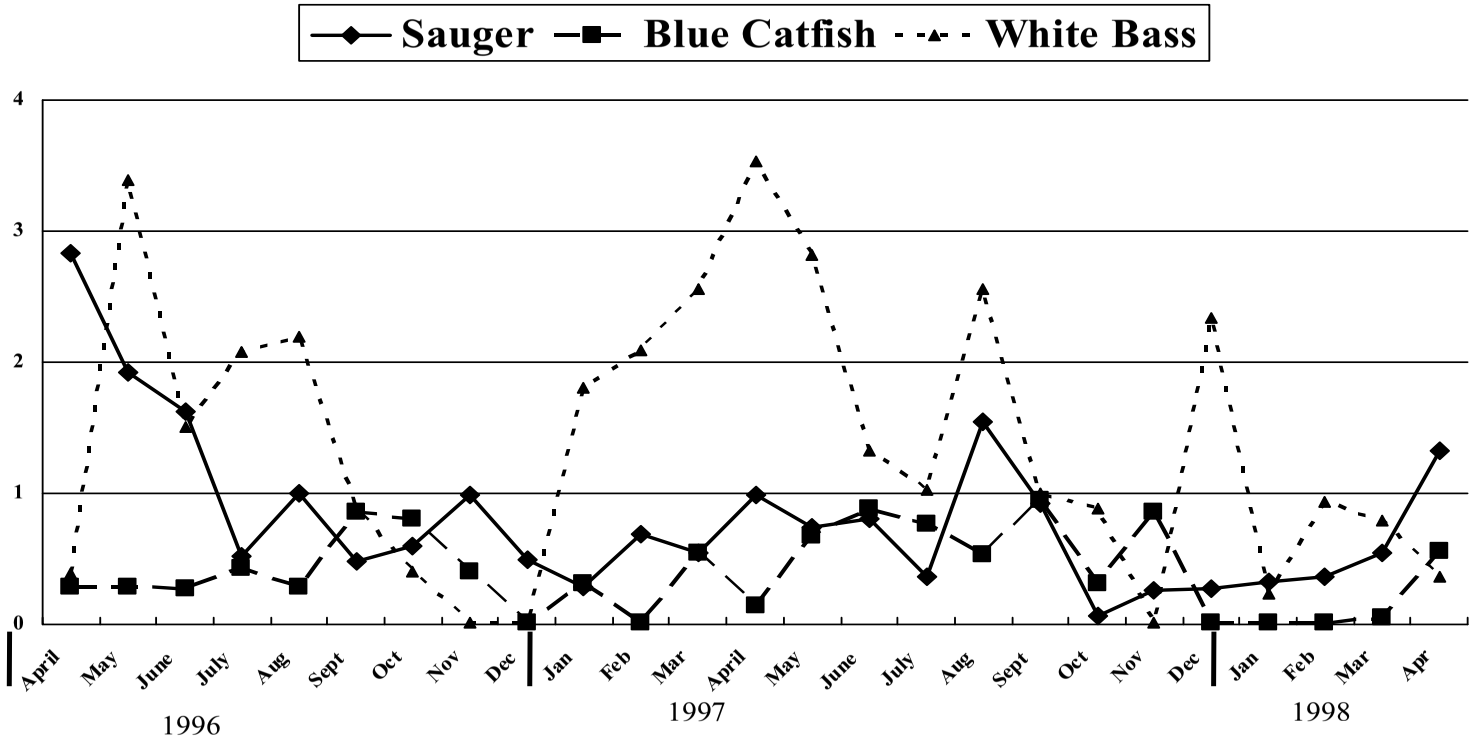


Figure 2-6. Monthly catch rate for selected species from the Watts Bar tailwater fishery. April 1996 through April 1998.

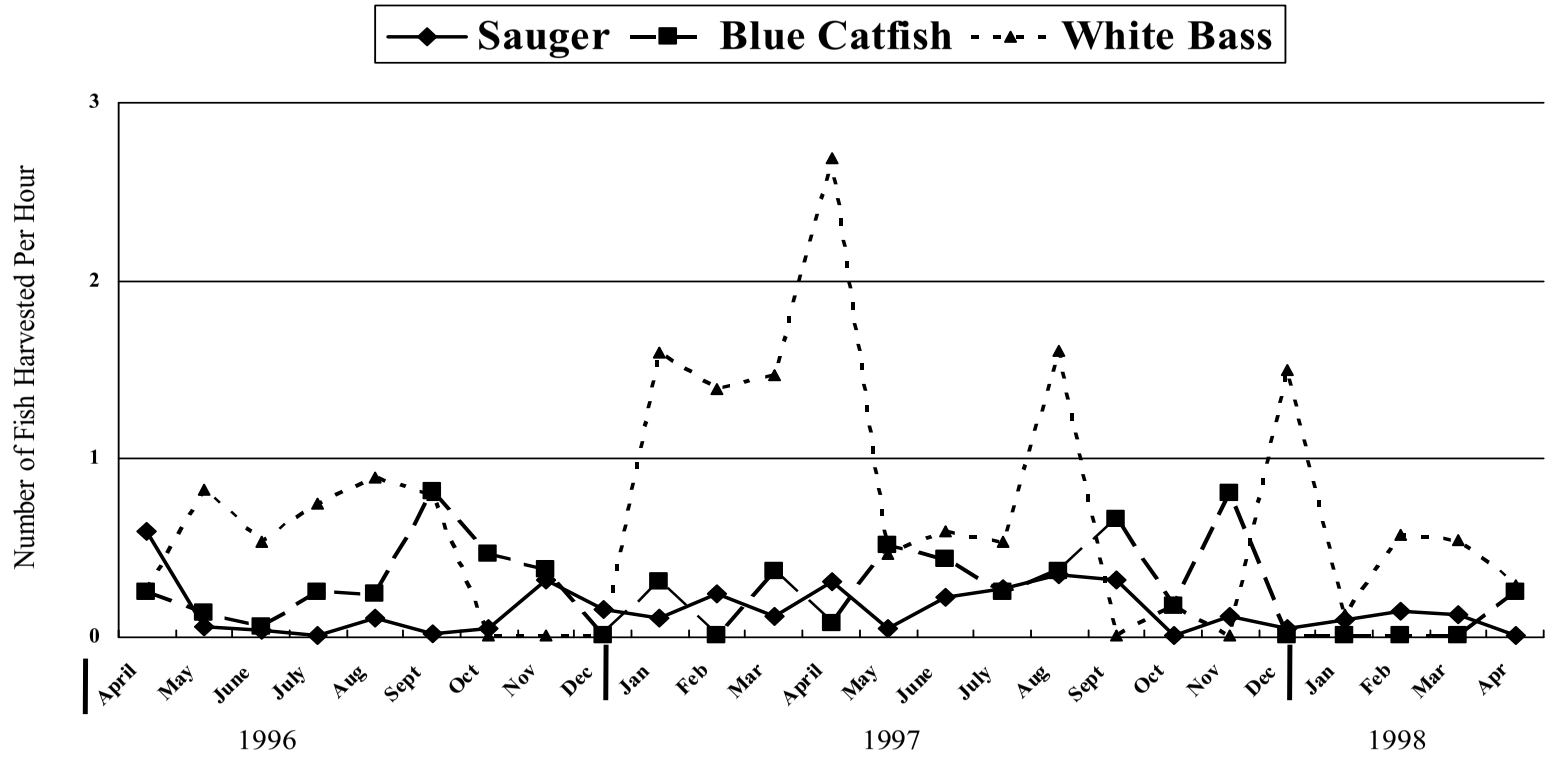


Figure 2-7. Monthly harvest rate for selected species from the Watts Bar tailwater fishery. April 1996 through April 1998.

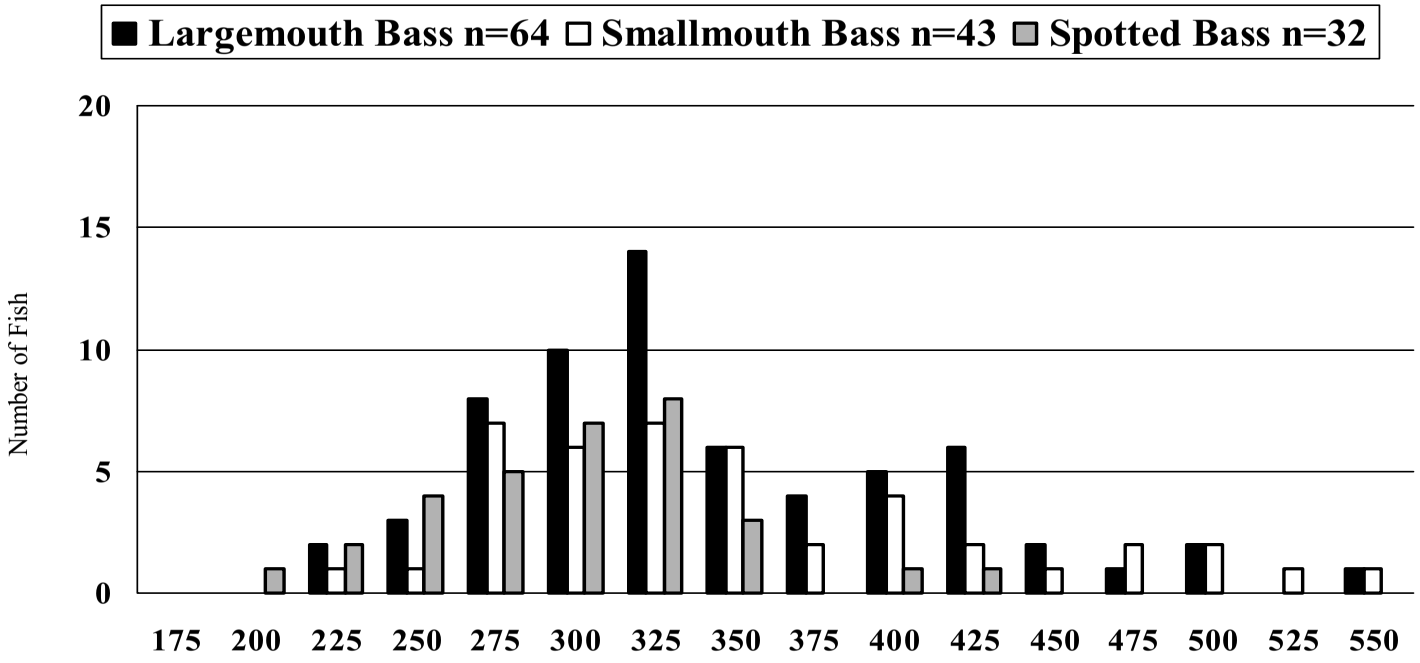
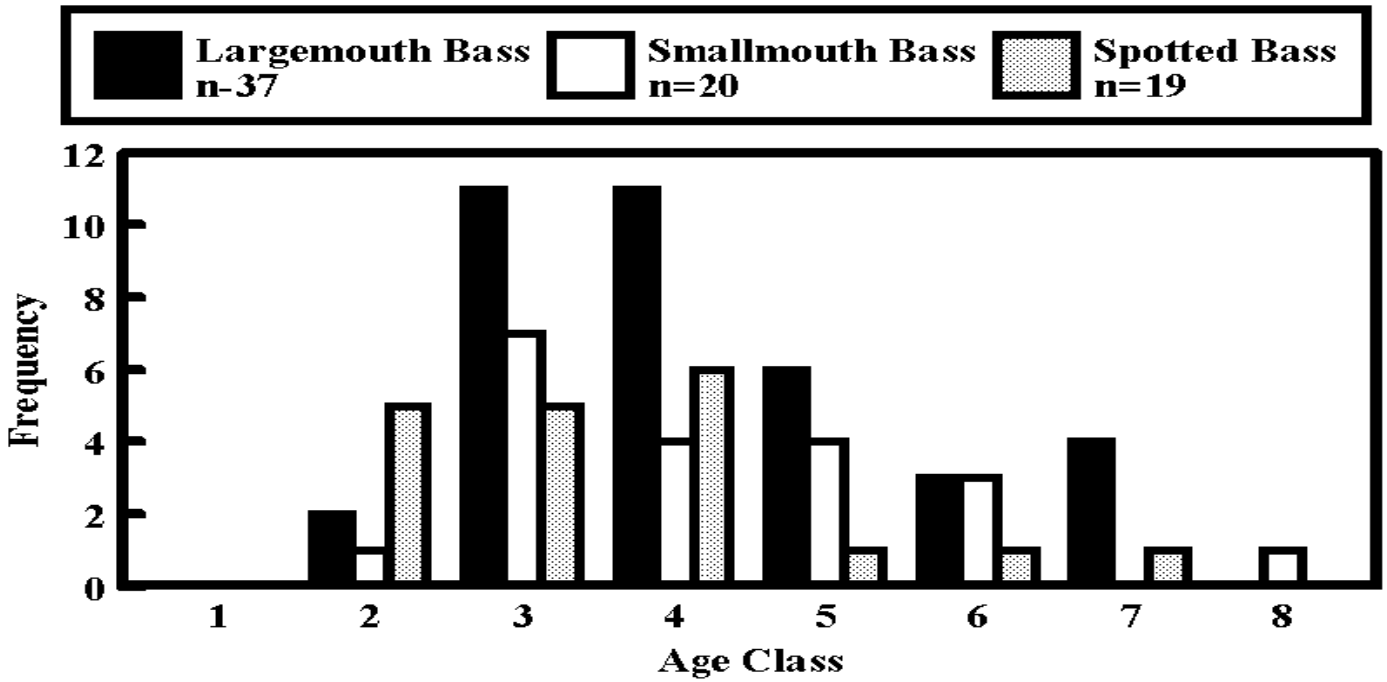


Figure 2-8. Length frequency of angler –harvested black basses sampled during creel surveys in Watts Bar Tailwater, April 1996 through April 1998.


Largemouth Bass
n-37
Smallmouth Bass
n=20
Spotted Bass
n=19
Frequency
0
2
4
6
8
10
12
1
2
3
4
5
6
7
8
Age Class

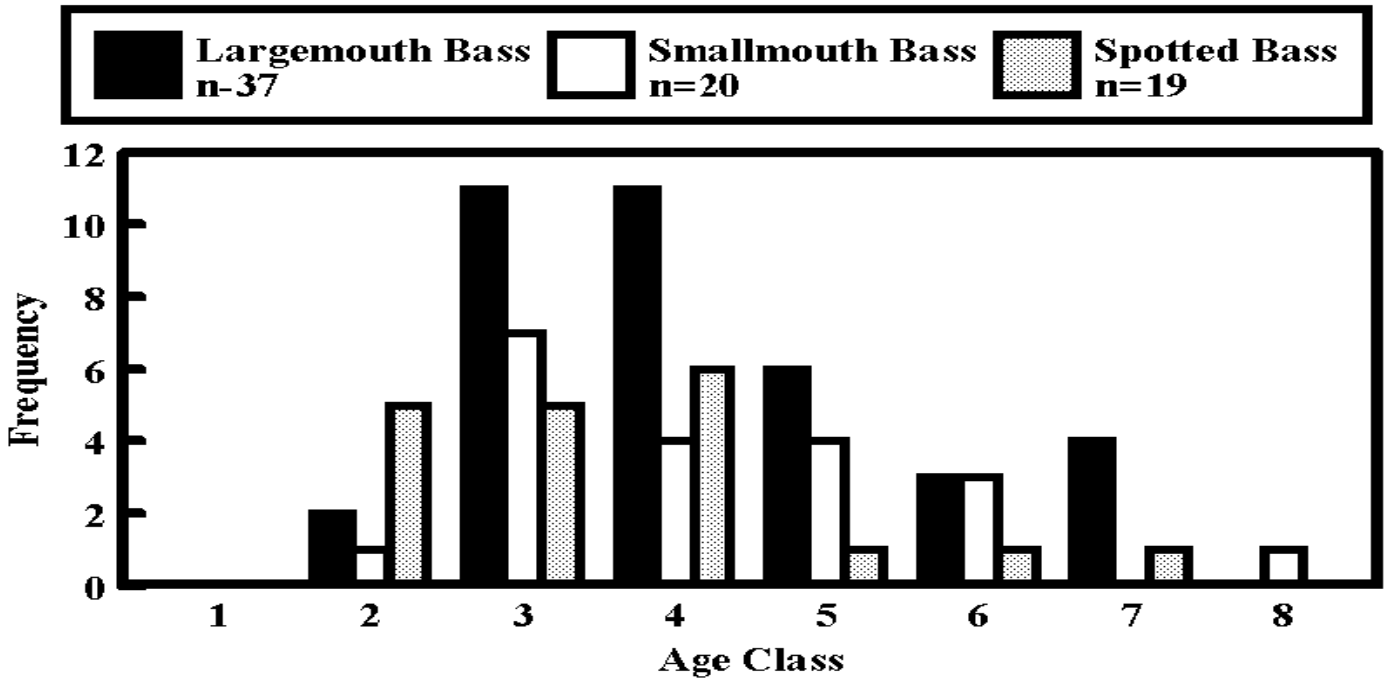


Figure 2-9. Age frequency of harvested largemouth bass, smallmouth bass, and spotted bass from the Watts Bar Tailwater. April 1996 though March 1997.

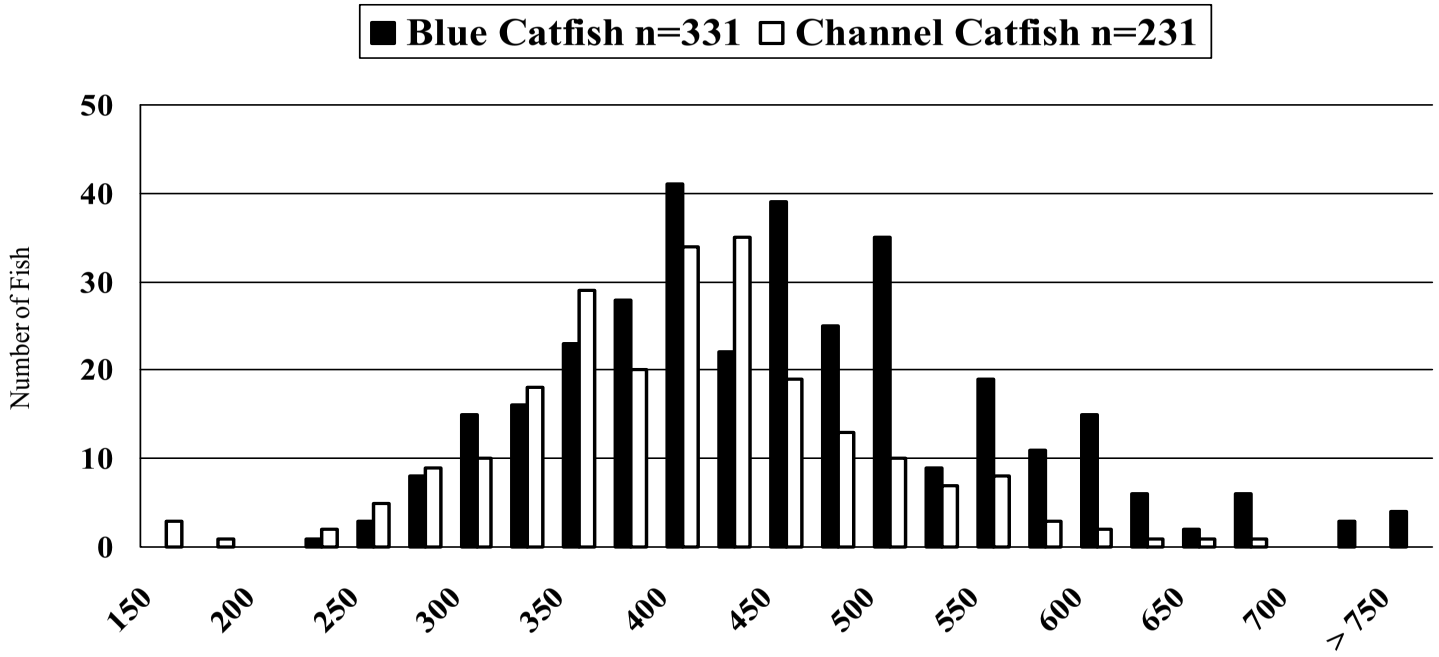


Figure 2-10. Length frequency of angler-harvested blue catfish and channel catfish from Watts Bar Tailwater, April 1996 through April 1998.

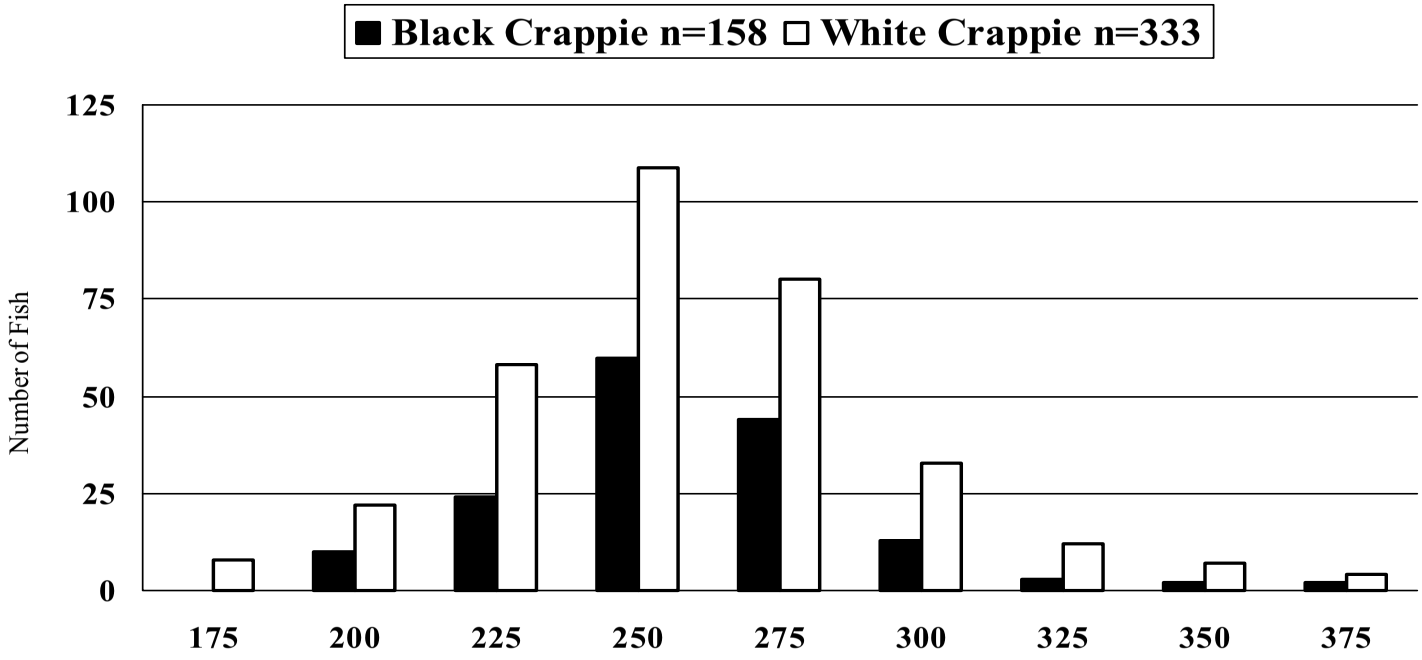


Figure 2-11. Length frequency of angler-harvested black and white crappie from Watts Bar Tailwater, April 1996 through April 1998.

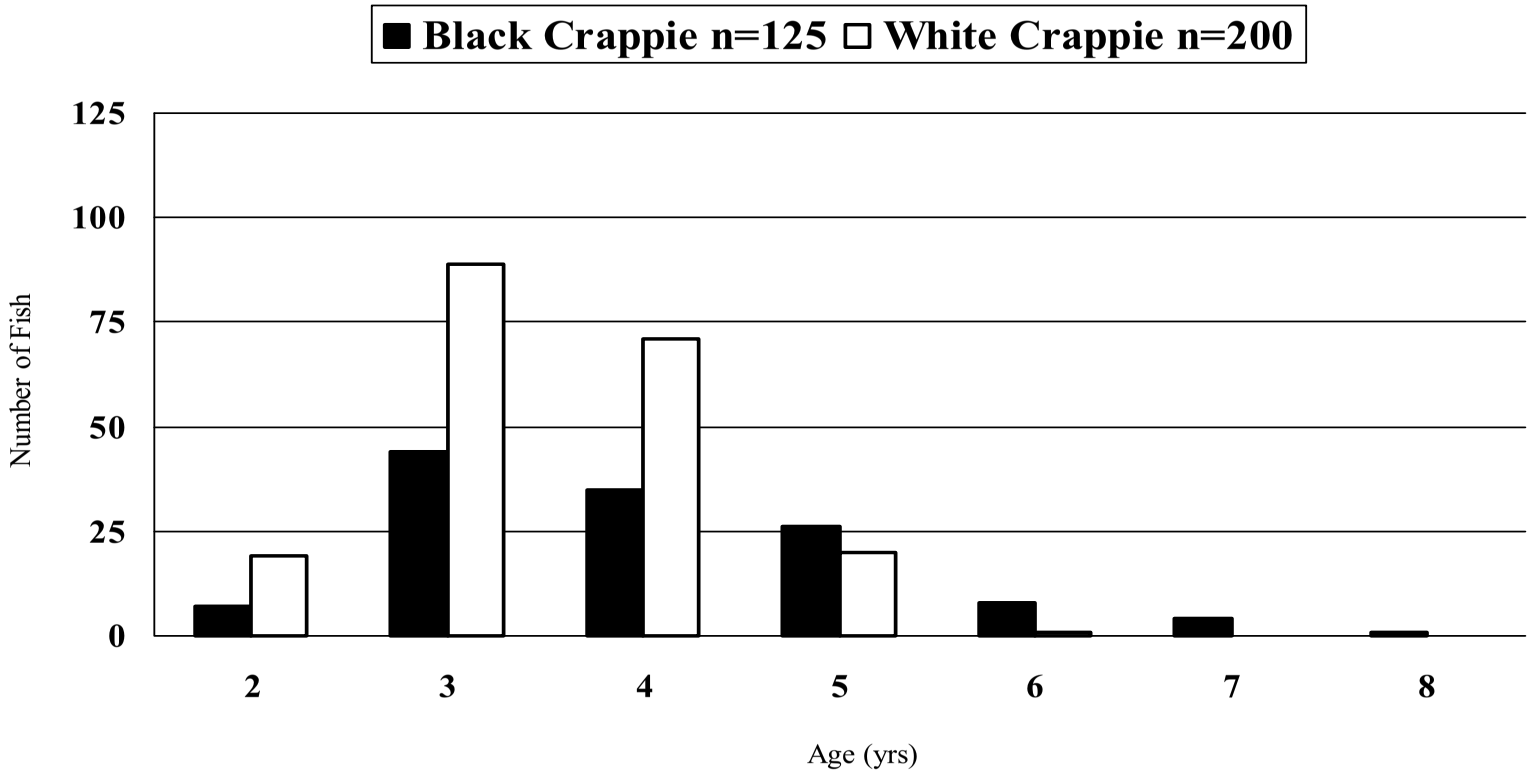


Figure 2-12. Age distribution of angler-harvested black and white crappie from the Watts Bar Tailwater, April 1996 through April 1998.

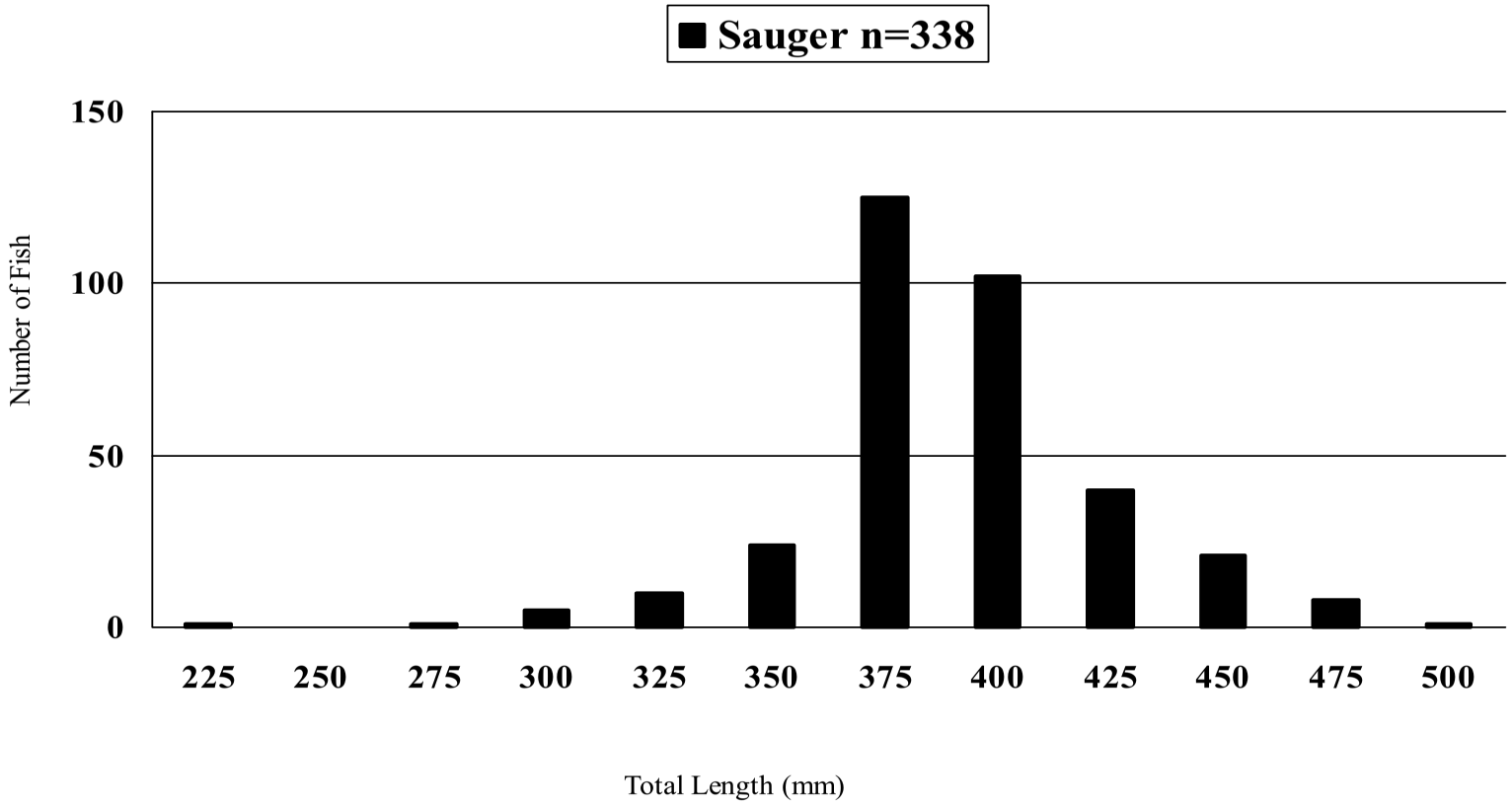


Figure 2-13. Length frequency of angler-harvested sauger from Watts Bar Tailwater, April 1996 through April 1998.

Figure 2-14. Age distribution of angler-harvested sauger from Watts bar Tailwater, April 1996 through April 1998.

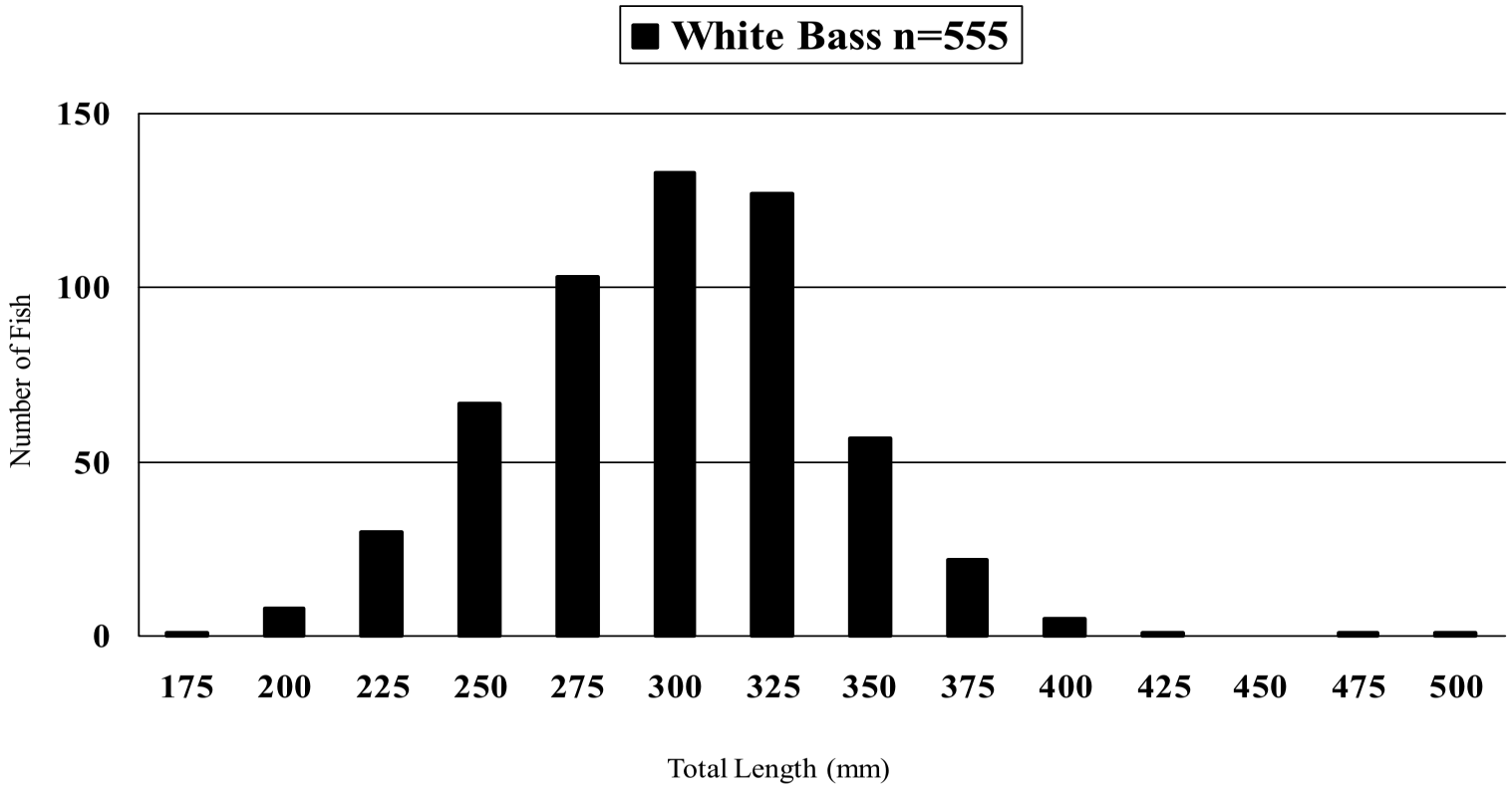


Figure 2-15. Length frequency of angler-harvested white bass from Watts Bar Tailwater, April 1996 through April 1998.

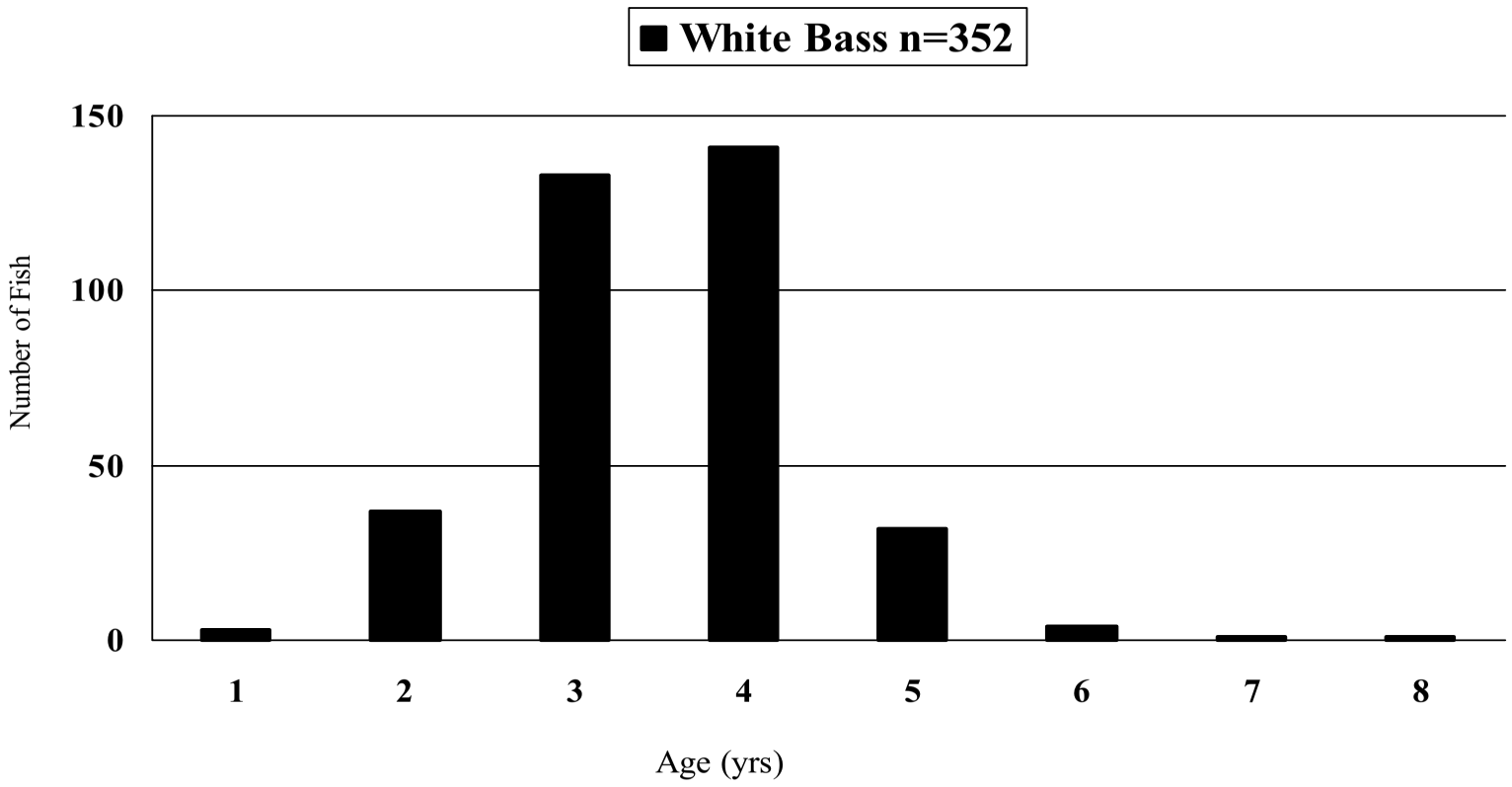


Figure 2-16. Age frequency of angler-harvested white bass from Watts Bar Tailwater, April 1996 through April 1998.

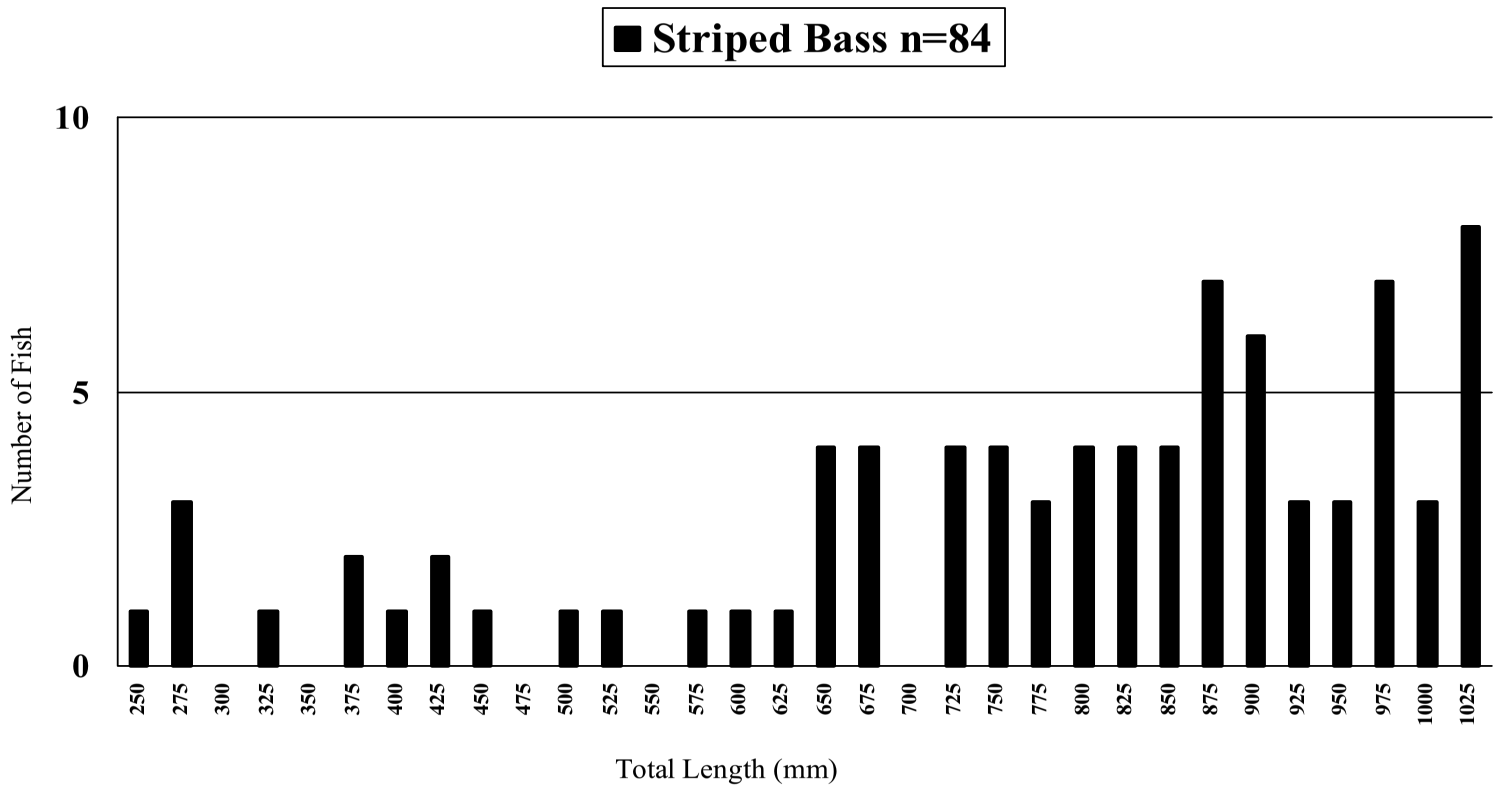


Figure 2-17. Length frequency of angler-harvested striped bass from Watts Bar Tailwaer, April 1996 through April 1998.

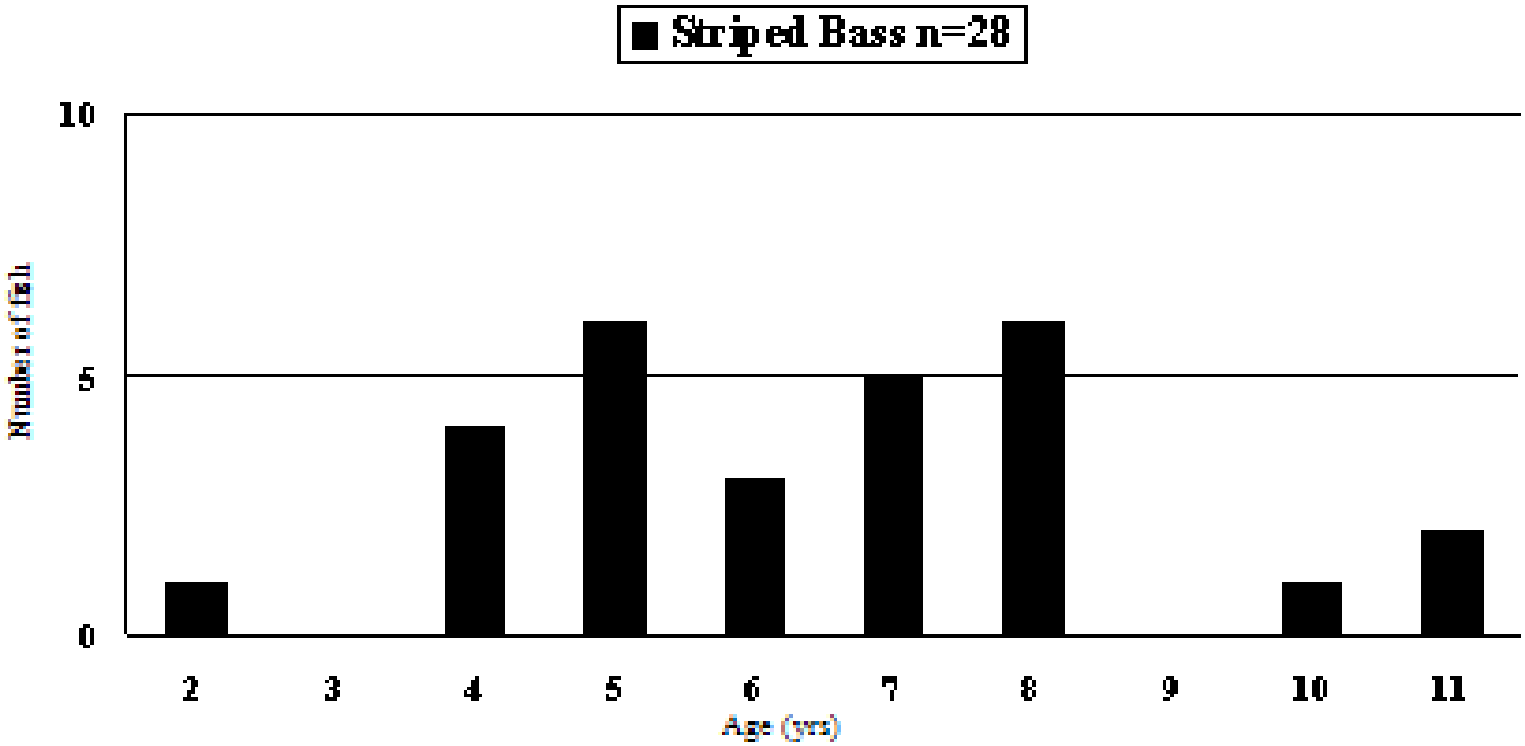


Figure 2-18. Age distribution of angler-harvested striped bass from Watts Bar Tailwater, April 1996 through April 1998.

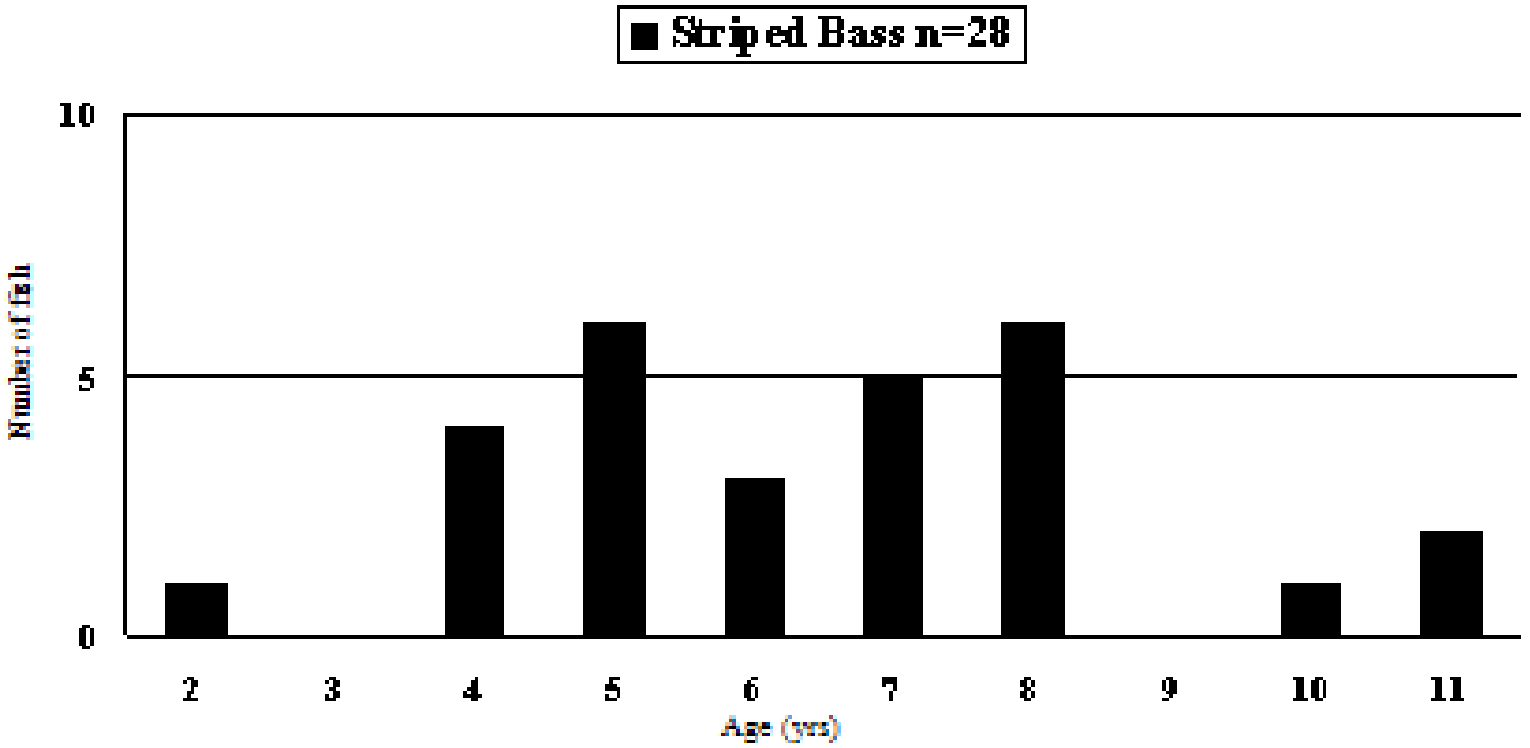


Figure 2-18. Age distribution of angler-harvested striped bass from Watts Bar Tailwater, April 1996 through April 1998.

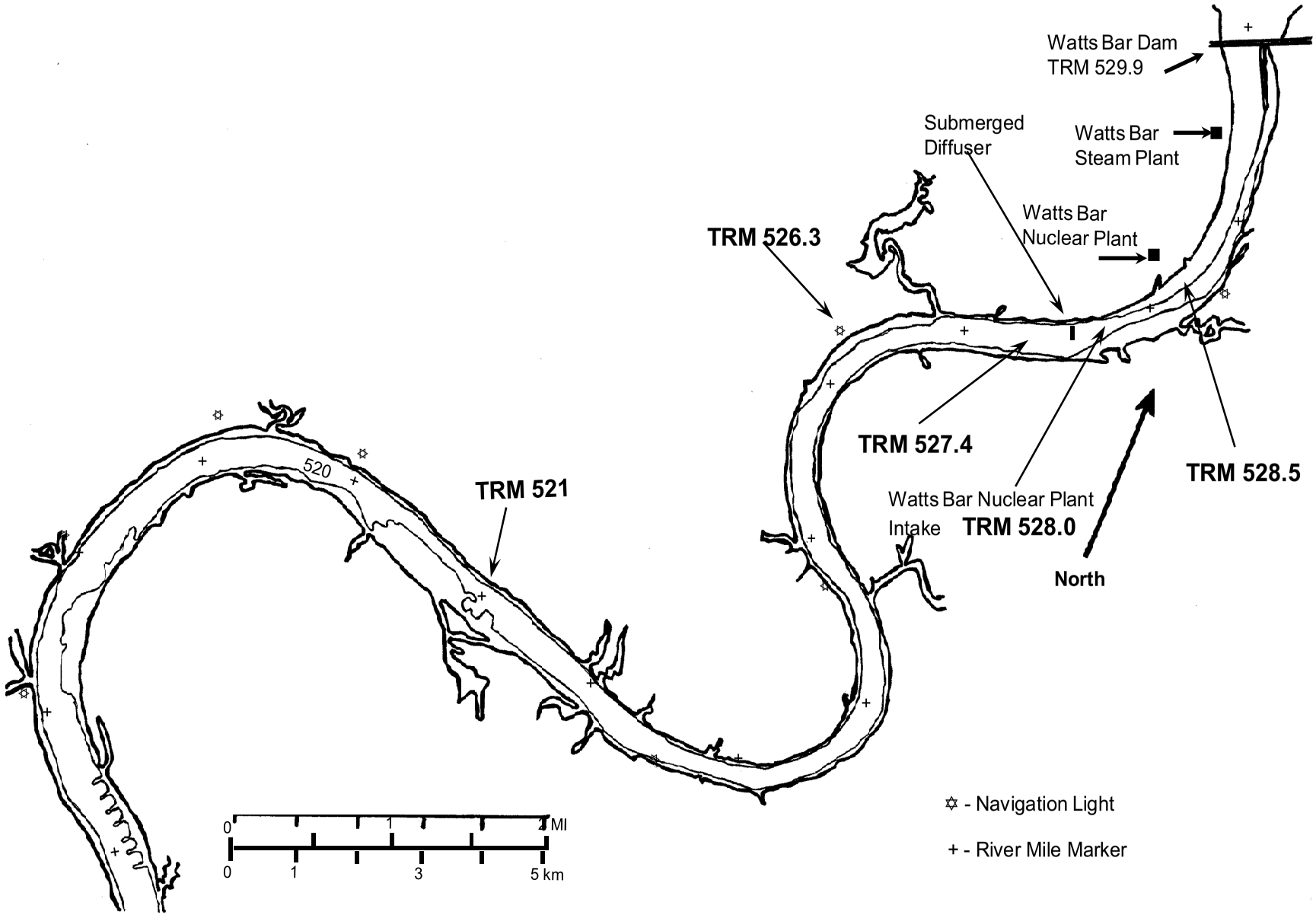


Figure 3-1. Sample locations for benthic macroinvertebrates near Watts Bar Nuclear Plant , 1996-1997.

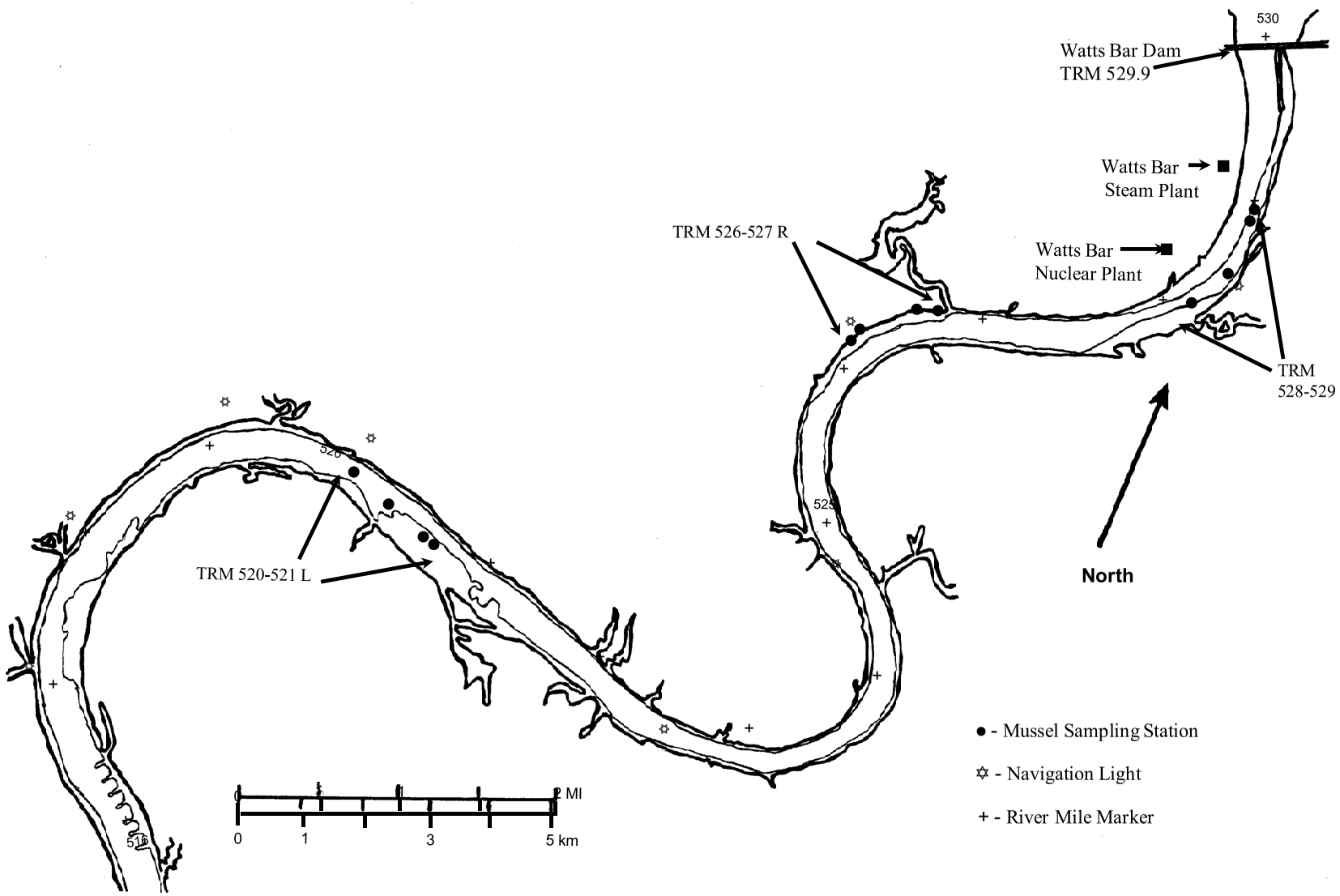


Figure 3-2. Locations of sampling stations at three native mussel beds surveyed during the preoperational (1983-1994) and operational (1996 and 1997) monitoring program for Watts Bar Nuclear Plant.

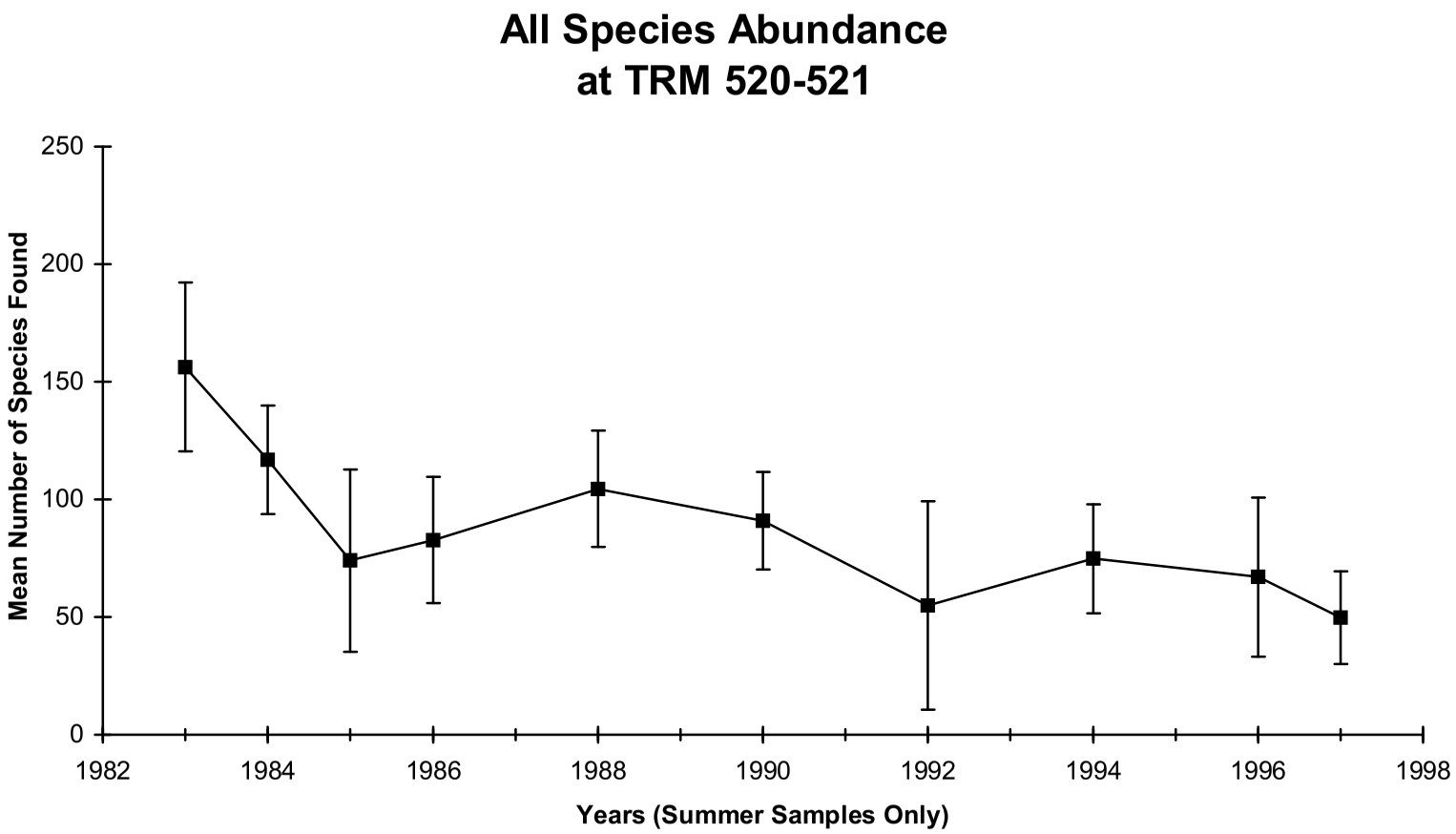


Figure 3-3. Relationships among the mean numbers of all mussel species encountered on the bed at Tennessee River Mile 520-521 during the 10 surveys conducted in the summers of 1983-1997. Vertical bars indicate one standard deviation above and below the mean values.

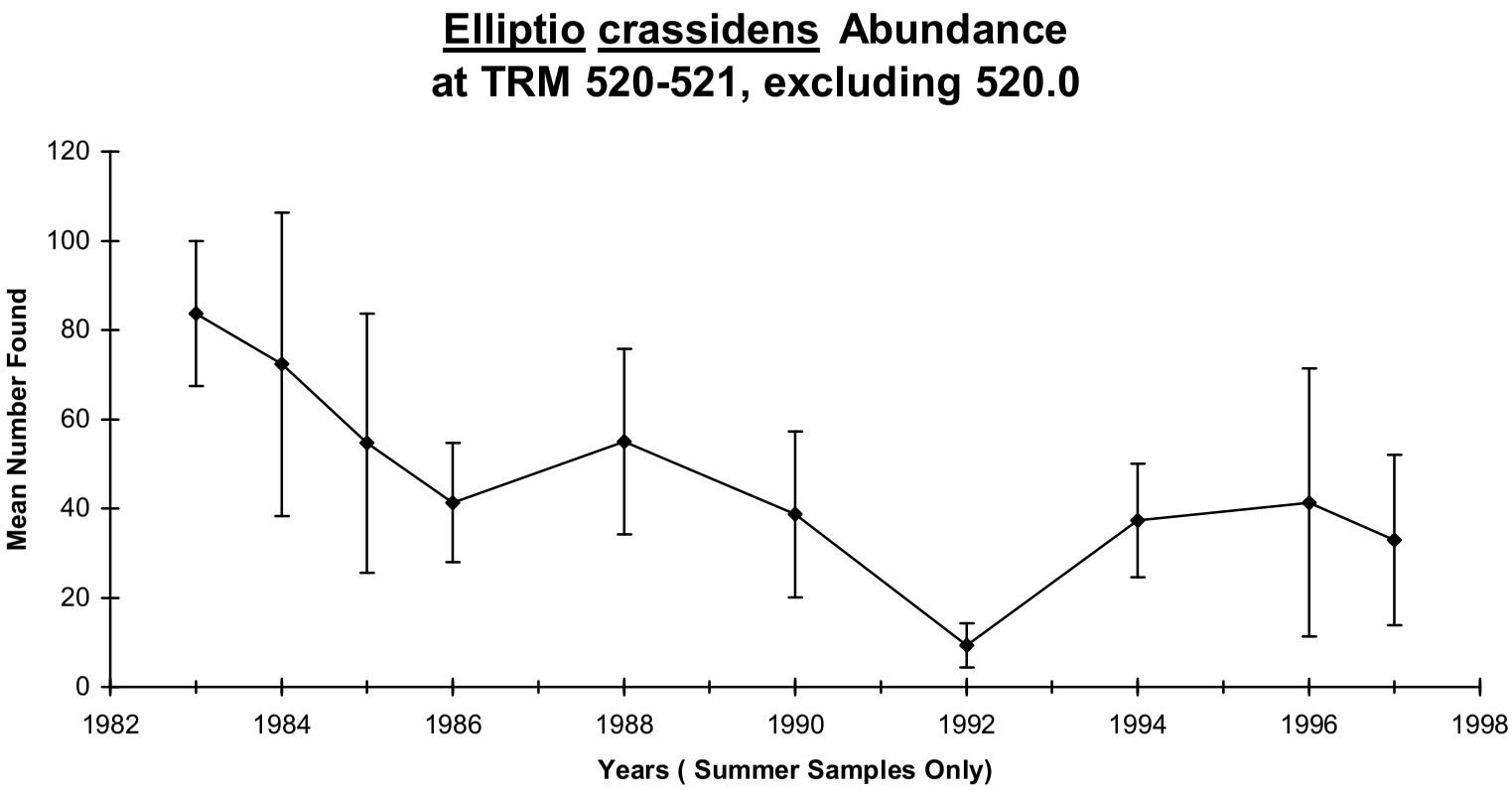


Figure 3-4. Relationships among the mean numbers of Elliptio crassidens encountered on three of the four sampling sites on the mussel bed at Tennessee River Mile 520-521 during the 10 surveys conducted in the summers of 1983-1997. Vertical bars indicate one standard deviation above and below the mean values.

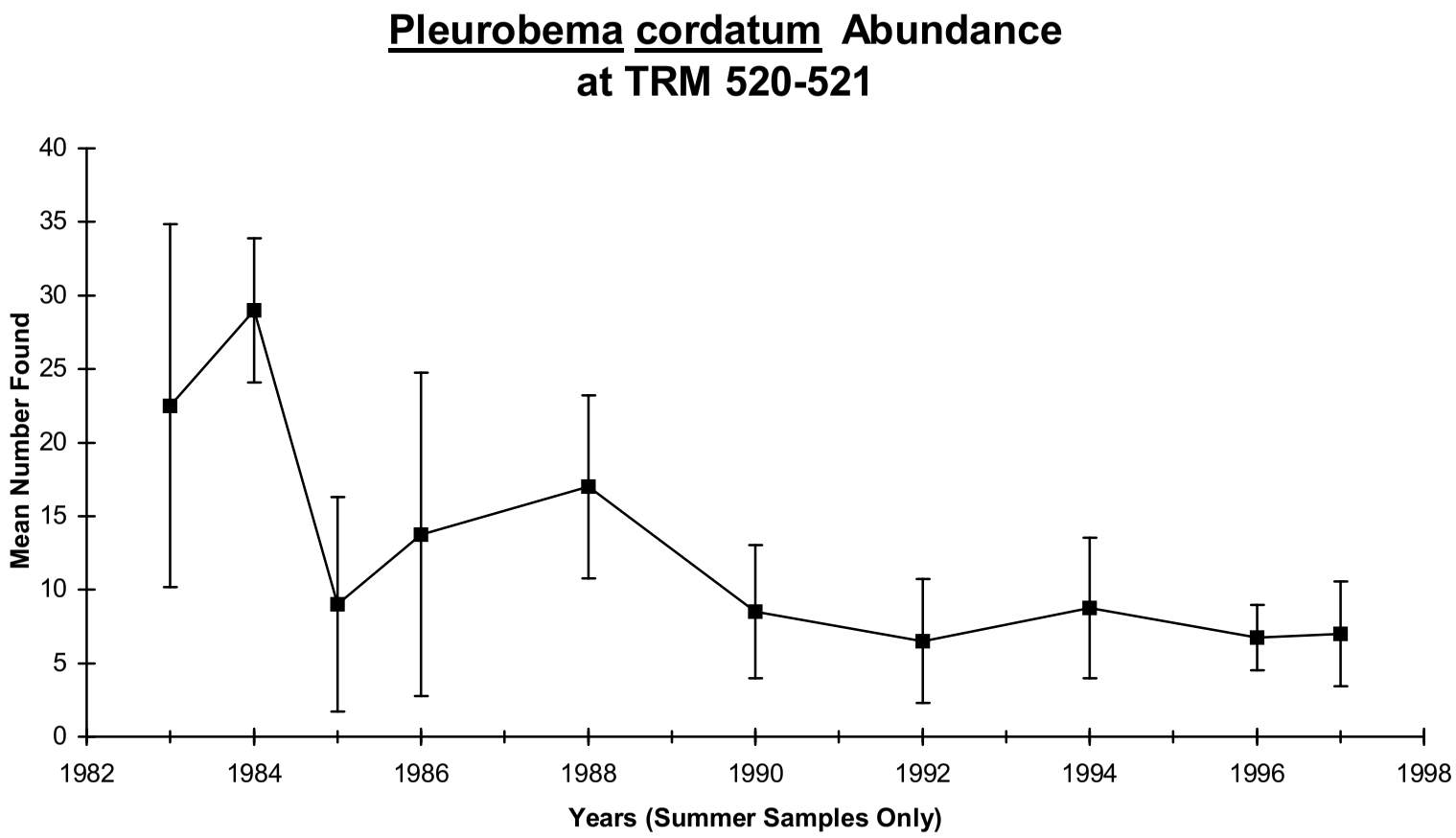


Figure 3-5. Relationships among the mean numbers of Pleurobema cordatum encountered on the mussel bed at Tennessee River Mile 520-521 during the 10 surveys conducted in the summers of 1983-1997. Vertical bars indicate one standard deviation above and below the mean values.

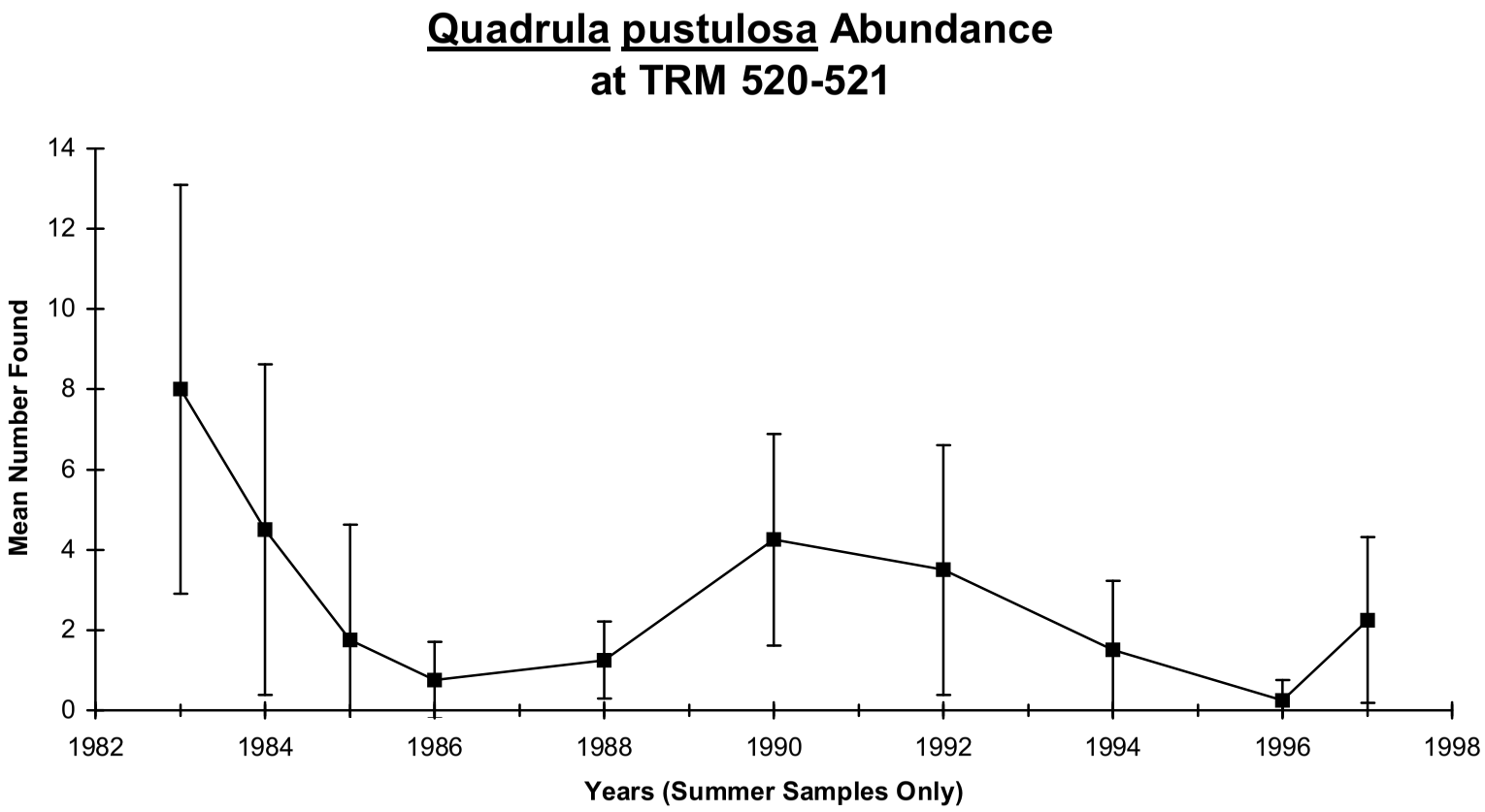


Figure 3-6. Relationships among the mean numbers of Quadrula pustulosa encountered on the mussel bed at Tennessee River Mile 520-521 during the 10 surveys conducted in the summers of 1983-1997. Vertical bars indicate one standard deviation above and below the mean values.

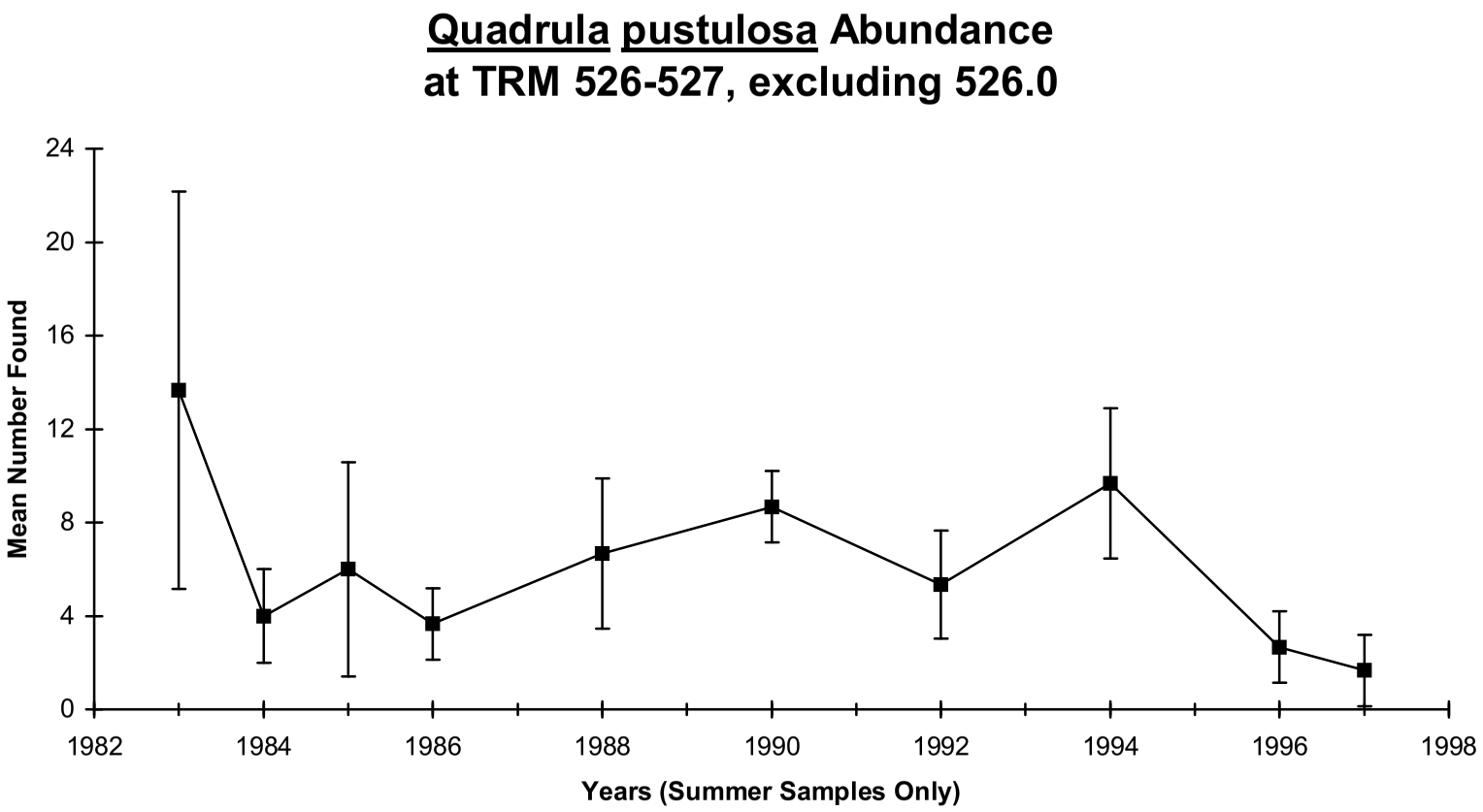


Figure 3-7. Relationships among the mean numbers of Quadrula pustulosa encountered on three of the four sampling sites on the mussel bed at Tennessee River Mile 526-527 during the 10 surveys conducted in the summers of 1983-1997. Vertical bars indicate one standard deviation above and below the mean values.

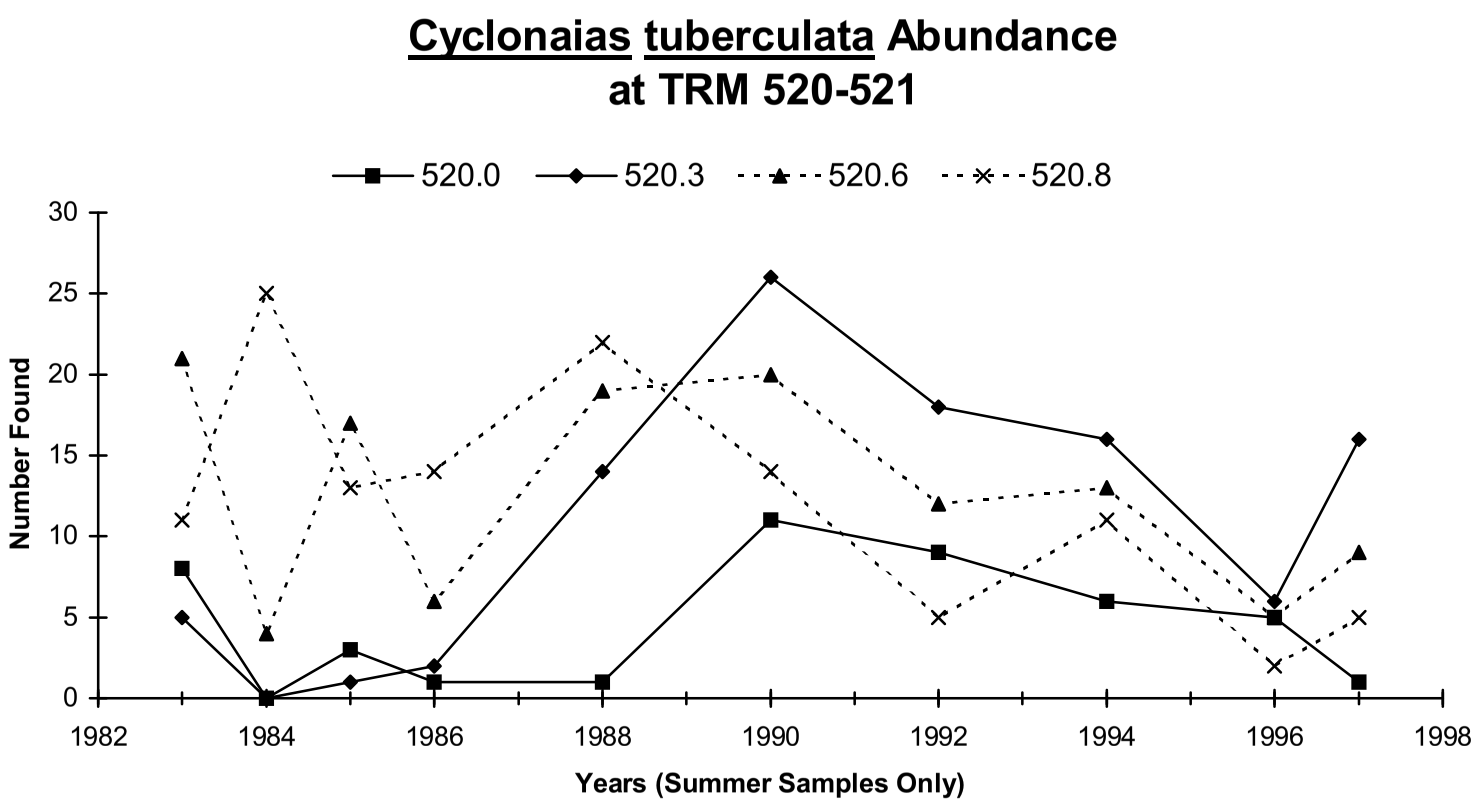


Figure 3-8. Relationships among the numbers of Cyclonaias tuberculata encountered at the four sampling sites on the mussel bed at Tennessee River Mile 520-521 during the 10 surveys conducted in the summers of 1983-1997. While statistically significant trends are present in these data, the slopes of those trends are not parallel with each other.

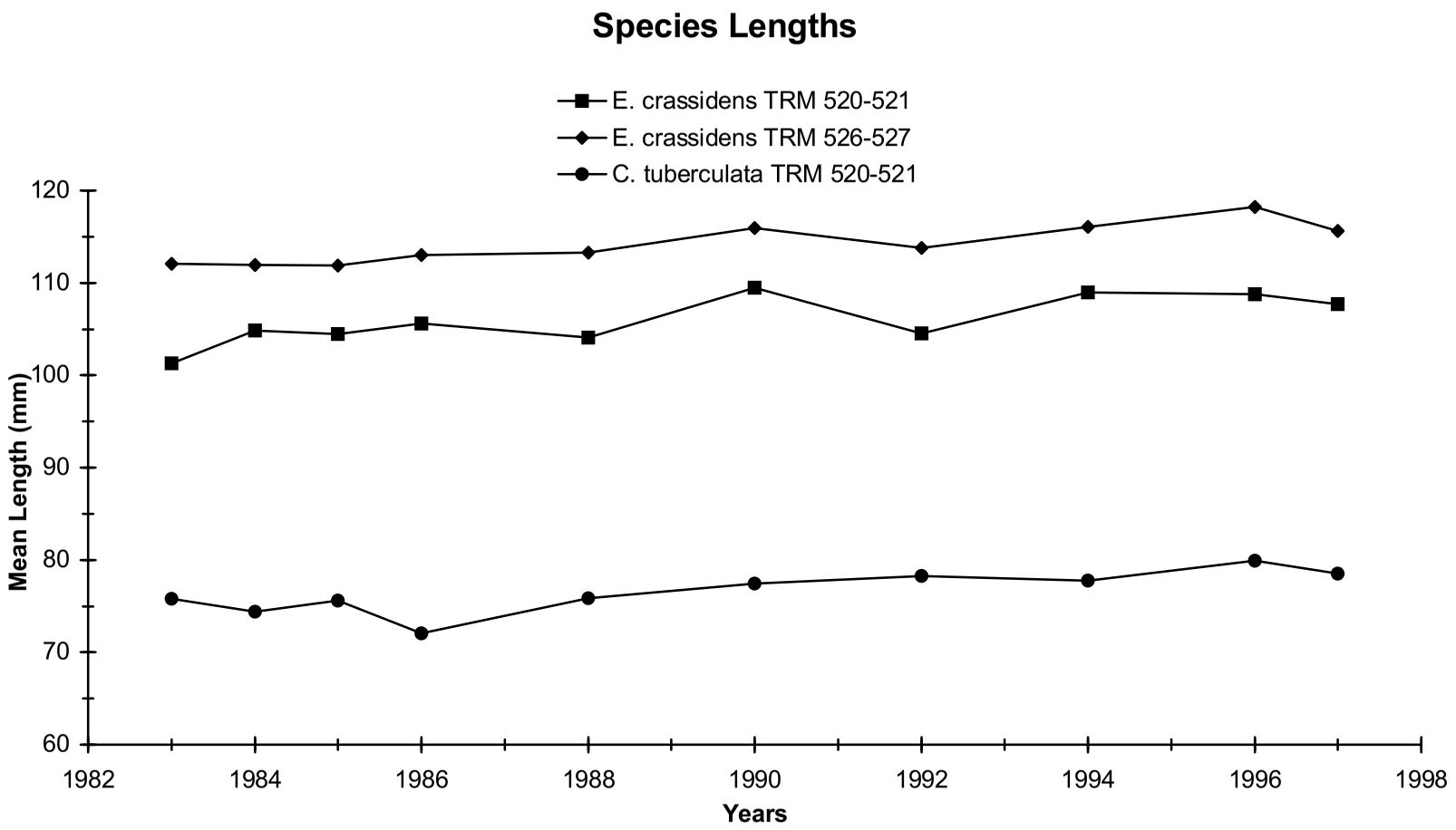


Figure 3-9. Mean lengths of Elliptio crassidens and Cyclonaias tuberculata on the mussel bed at Tennessee River Miles (TRM) 520-521, and Elliptio crassidens on the bed at TRM 526-527 during 1983-1997.

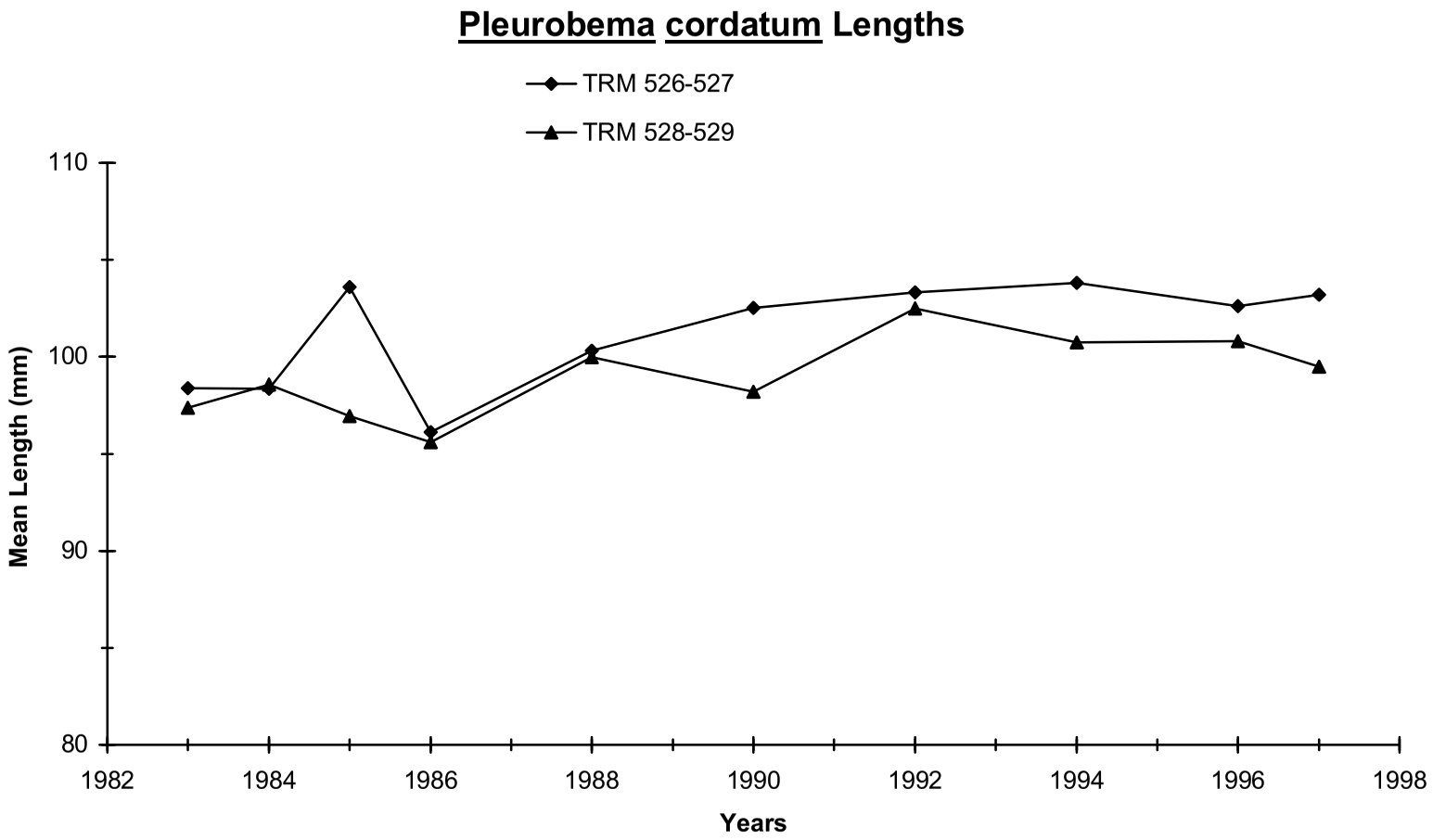


Figure 3-10. Mean lengths of Pleurobema cordatum on two mussel beds, Tennessee River Miles (TRM) 526-527 and TRM 528-529, during 1983-1997.

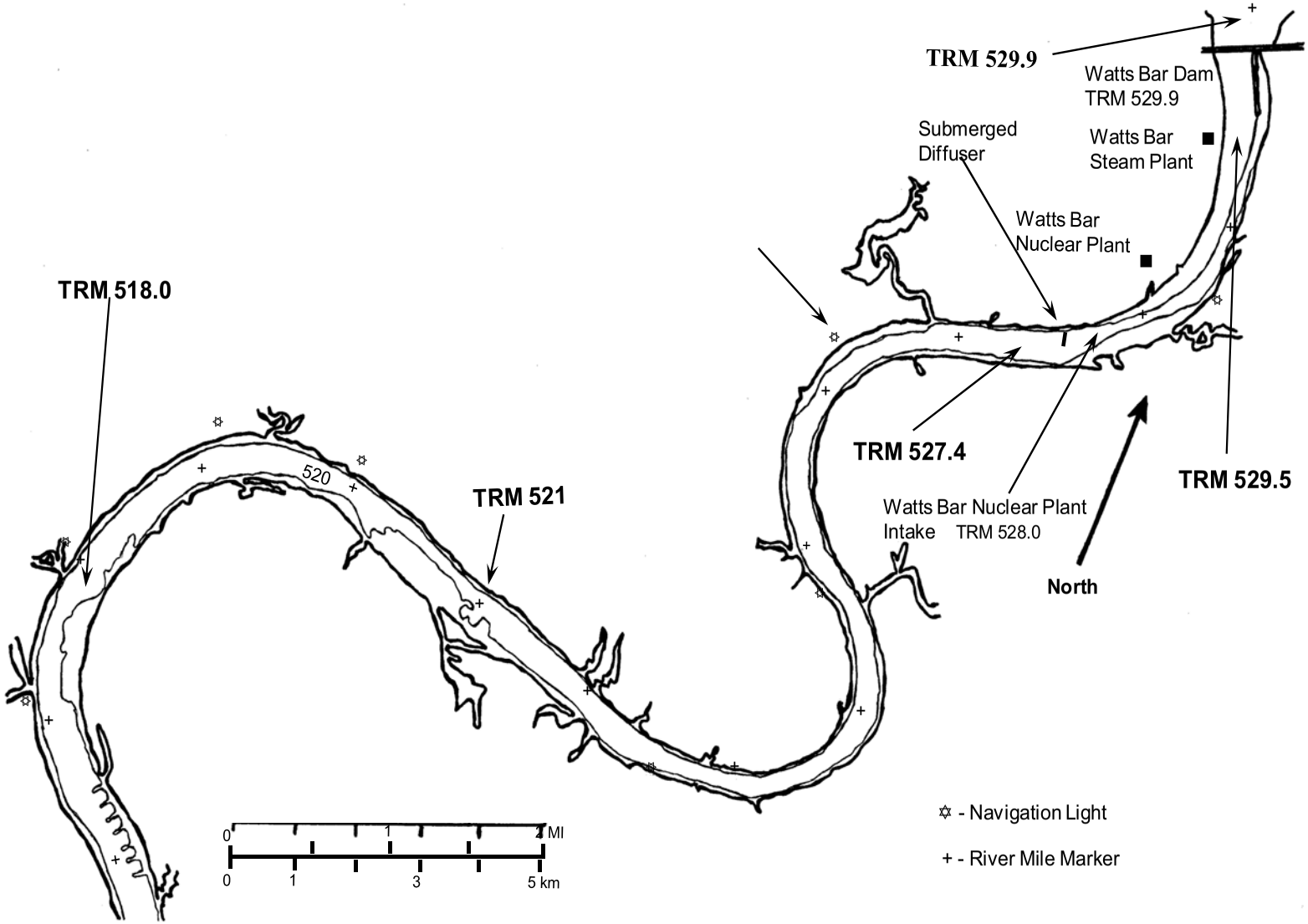


Figure 4-1. Water quality sampling locations during operational monitoring at Watts Bar Nuclear Plant, 1996 and 1997.

Appendices A

Appendix A-1. List of scientific names and densities (number/m^2) of benthic macroinvertebrates collected at five locations in the vicinity of Watts Bar Nuclear Plant during operational monitoring in summer and fall 1996-1997.

Date	July 1996					October 1996				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Nematoda		1								
Hydrozoa										
Hydroida										
Clavidae						6	7	9	7	2
Cordylophora lacustris										
Hydridae										
Hydra americana	4		1	4	3	252	71	2	82	297
Turbellaria										
Tricladida										
Planariidae										
Dugesia tigrina	632	208	1293	962	296	1131	1420	1103	1285	1449
Oligochaeta										
Haplotaxida										
Naididae			1					1	4	2
Dero sp.	41	56	62	37	3	31	6	6	8	34
Nais communis		1	5	1						1
Nais simplex										1
Pristina sp.				2				1	6	4
Slavina appendiculata					1				5	
Tubificidae	243	249	149	70	8	169	21	68	48	383
Branchiura sowerbyi	13	10	6			8	3	3		21
Limnodrilus hoffmeisteri	265	113	106	11		27		8	2	54
Lumbriculida										
Lumbriculidae		1								
Lumbriculus sp.									3	

Appendix A-1. (Continued)

Date	July 1996					October 1996				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Hirudinea	1	6	11	18	4	3		1		
Rhynchobdellida										
Glossiphoniidae										
Helobdella triserialis	14		1	2	2		7	5	2	9
Pharyngobdellida										
Erpobdellidae										
Erpobdella punctata	17		7	1		11	1	21	15	13
Crustacea										
Isopoda										
Asellidae										
Caecidotea sp.		1		31	102			3	40	28
Amphipoda										
Gammaridae										
Gammarus minus	786	307	1066	850	552	279	38	139	141	416
Decapoda										
Cambaridae										
Orconectes sp.	1			2	4			3	1	1
Insecta										
Plecoptera										
Perlidae		1								
Odonata										
Coenagrionidae										
Argia sp.								1	2	
Ephemeroptera										
Baetidae			1							
Baetis amplus						1				

Appendix A-1. (Continued)

Date	July 1996					October 1996				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Heptageniidae				1	1	2			1	1
Stenacron sp.		2							1	
Stenacron interpunctatum	3		1		1	2		7	19	28
Stenonema sp.					1					
Heteroptera										
Corixidae	1									
Trichoptera										
Hydropsychidae										
Cheumatopsyche sp.					2					
Hydroptilidae										
Leptoceridae										
Ceraclea sp.				1		1				
Oecetis sp.	1		1							
Polycentropodidae										
Cyrnellus fraternus	32	215	63	119	63	6	42	279	780	478
Megaloptera										
Corydalidae										
Nigronia sp.			1							
Sialidae										
Sialis sp.		2								
Diptera										
Chironomidae	1	6		1	1	5	5	9	14	13
Ablabesmyia mallochi		4				2			1	
Ablabesmyia parajanta										1
Chironomus sp.			1			1				
Cladotanytarsus sp.		1	1							
Coelotanypus tricolor		1								

Appendix A-1. (Continued)

Date	July 1996					October 1996				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Cryptochironomus fulvus	1	1	2			11	1			3
Dicrotendipes sp.	35	56	67	60	13	23	61	95	77	104
Glyptotendipes sp.	8	122	23	2		1	3	3	5	4
Harnischia sp.	3									
Microtendipes sp.	2	2								
Nanocladius sp.	9	2	5	6	2	109	75	70	129	270
Parachironomus sp.	1			2	1	7	16	9	12	31
Phaenopsectra obediens										2
Polypedilum convictum			1							
Polypedilum halterale	1		3	1						
Pseudochironomus sp.	3									
Rheotanytarsus sp.	2					1	1			
Stenochirohomus sp.										1
Stictochironomus sp.			1							
Synorthocladius semivire										1
Tanytarsus sp.	3	1	1			1	1			
Thienemanniella xena							1			1
Tvetenia discoloripes sp.	1									
Gastropoda										
Mesogastropoda										
Hydrobiidae								1		
Amnicola sp.									1	1
Somatogyrus sp.									1	93
Pleuroceridae										
Leptoxis praerosa						1				
Pleurocera sp.					9					

Appendix A-1. (Continued)

Date	July 1996					October 1996				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Pleurocera canaliculata	115	22	37	12	8	91	49	3	3	1
Basommatophora										
Ancylidae										
Ferrissia rivularis				3		1		1	3	7
Physidae										
Physella sp.	1	1	36	13	16		4	3	5	8
Planorbidae		1			3		3	1	2	
Gyraulus parvus			1		2					
Menetus sp.								1		
Bivalvia										
Unionoida										
Unionidae										
Actinonaias ligamentina							1			
Anodonta imbecillis			1			2				
Elliptio crassidens	4	4		1			1			
Obliquaria reflexa			1							
Quadrula pustulosa pustu			2							
Veneroida										
Corbiculidae										
Corbicula fluminea	713	726	716	767	633	409	353	643	1091	755
Dreissenidae										
Dreissena polymorpha	2	11	28	21	38	8	15	46	60	36
Sphaeriidae					4					
Musculium transversum	4	22	3		2	1	16	7	64	3
Number of samples	10	10	10	10	10	10	10	10	10	10
Sum (Total number)	2963	2156	3705	3001	1775	2603	2222	2552	3920	4558
Number of species	34	32	36	28	28	32	27	32	35	39

Appendix A-1. (Continued)

Date	July 1997					October 1997				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Nematoda				1			1			
Coelenterata						34		2		21
Hydrozoa										
Hydroida										
Hydridae										
Hydra americana	301	66	24	91	1414	209	210	38	24	245
Turbellaria										
Tricladida										
Planariidae										
Dugesia tigrina	611	1141	1643	1489	1414	1457	750	1132	1093	1906
Oligochaeta										
Haplotaxida										
Naididae					1	4		1	9	10
Dero sp.	1	1				11	98	18	12	12
Nais sp.										1
Pristina leidyi										2
Slavina appendiculata				1				1		
Tubificidae	311	69	162	49	68	430	114	21	187	64
Branchiura sowerbyi	2					39	5		3	
Limnodrilus sp.			25		1					
Limnodrilus hoffmeisteri	36	12	150	4	11	49	26	4	17	4
Lumbriculida										
Lumbriculidae	9	14	15	4	4				6	

Appendix A-1. (Continued)

Date	July 1997					October 1997				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Hirudinea		1		1	1					6
Rhynchobdellida										
Glossiphoniidae		1	3	14						
Helobdella sp.				2			1			
Helobdella triserialis				13	3	5	2	1	5	2
Pharyngobdellida										
Erpobdellidae	3	2	7	6	8	67	5	39	21	8
Erpobdella sp.			1	1						
Crustacea										
Isopoda										
Asellidae										
Caecidotea sp.		1	2	12	84				3	8
Amphipoda										
Gammaridae										
Gammarus sp.	734	574	937	1178	1485	492	77	113	110	277
Gammarus minus	138				207					
Insecta										
Odonata										
Coenagrionidae						1			1	
Corduliidae										
Neurocordulia molesta										1
Ephemeroptera										
Heptageniidae						1			1	
Stenacron interpunctatum						1		2		3
Leptophlebiidae										
Paraleptophlebia sp.							1			

Appendix A-1. (Continued)

Date	July 1997					October 1997				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Trichoptera	1									
Hydropsychidae					1				4	1
Cheumatopsyche sp.	3	3	2	7	20				1	3
Leptoceridae					3					
Ceraclea sp.		5	4	2	3	2				
Polycentropodidae										
Cyrnellus fraternus	2			3	5	21	35	548	514	340
Diptera										
Chironomidae	16	5	5	12	8	1	2	2	6	1
Ablabesmyia annulata										1
Ablabesmyia sp.		1							1	
Ablabesmyia mallochi				1						
Ablabesmyia parajanta		1								
Clinotanypus pinguis.					1					
Cricotopus bicinctus	1									
Cryptochironomus fulvus	26	11	7			5	2		1	
Dicrotendipes sp.	60	129	51	29	35	38	56	49	82	46
Glyptotendipes sp.	15	70	15	9	10	1	3	6	18	
Nanocladius sp.	7	9	6	48	83	64	87	85	133	74
Parachironomus sp.	41	10	14	47	50	19	40	15	22	55
Paratanytarsus sp.										6
Paratendipes sp.	4									
Polypedilum sp.		1								
Polypedilum convictum				1						
Polypedilum illinoense	1			1						
Procladius sp.		1	1							
Pseudochironomus sp.		1								
Rheotanytarsus sp.	1		2	5		1		1	1	

Appendix A-1. (Continued)

Date	July 1997					October 1997				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Synorthocladius semivirens	1									
Tanytarsus sp.			1	1		1				
Thienemanniella xena	1	1								
Thienemannimyia sp.				2						
Coleoptera										
Elmidae										
Dubiraphia sp.						1				
Stenelmis sp.									1	
Gastropoda										
Mesogastropoda										
Hydrobiidae										
Amnicola sp.				3	5			9		
Somatogyrus sp.					11	3		1		16
Pleuroceridae										
Pleurocera canaliculata	175	23	27	1	2	71	17	1	22	
Viviparidae										
Campeloma decisum							1			
Basommatophora										
Ancylidae										
Ferrissia rivularis	20	5	2	3	2	5		3		1
Physidae										
Physella sp.	6	12	50	27	68	2	2	2	2	14
Planorbidae										
Micromenetus dilatatus	1	4	4			1		1		

Appendix A-1. (Continued)

Date	July 1997					October 1997				
Tennessee River Mile	521.0	526.3	527.4	528.0	528.5	521.0	526.3	527.4	528.0	528.5
Taxon										
Bivalvia										
Unionoida										
Unionidae										
Elliptio crassidens	5	1	1		1	3	2	1		3
Lampsilis abrupta			1							
Pleurobema cordatum		1		2	1		1			
Potamilus alatus		1								
Quadrula pustulosa pustu			1	1		1				
Veneroida										
Corbiculidae										
Corbicula fluminea	475	724	1018	2440	1138	290	283	835	992	438
Dreissenidae										
Dreissena polymorpha	6	10	26	65	42	4	13	39	17	72
Sphaeriidae										
Musculium transversum		15		20	37		1	11	12	8
Number of samples	10	10	10	10	10	10	10	10	10	10
Sum (Total number)	3014	2926	4207	5596	6226	3335	1835	2981	3321	3649
Number of species	32	35	31	38	33	35	27	29	31	32

Appendix A-2. Results of 14 native mussel surveys at 12 sites in the vicinity of Watts Bar Nuclear Plant, 1983-1997.

September 13-14,1983					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	163	71	78	102	414	21	65	12	34	132	53	43	69	43	208	754	56.23
Pleurobema cordatum	17	41	16	16	90	17	82	7	3	109	12	18	20	15	65	264	19.69
Quadrula pustulosa	8	3	6	15	32	4	22	14	5	45	6	5	9	2	22	99	7.38
Cyclonaias tuberculata	8	5	21	11	45	3	7	4	4	18	5	8	8	4	25	88	6.56
Ellipsaria lineolata	2	3	2	8	15	1	4	2	1	8	0	1	0	0	1	24	1.79
Amblema plicata	0	0	1	0	1	0	5	5	5	15	0	1	1	0	2	18	1.34
Anodonta grandis	0	0	0	0	0	4	1	3	6	14	0	0	1	3	4	18	1.34
Obliquaria reflexa	1	0	0	0	1	0	4	6	2	12	0	1	0	0	1	14	1.04
Potamilus alatus	2	1	3	0	6	3	0	1	3	7	0	0	1	0	1	14	1.04
Quadrula metanevra	1	0	5	2	8	2	0	2	0	4	1	1	0	0	2	14	1.04
Ligumia recta	1	1	0	1	3	0	0	0	1	1	0	1	1	0	2	6	0.45
Tritogonia verrucosa	0	0	0	0	0	2	1	0	2	5	0	0	1	0	1	6	0.45
Elliptio dilatata	1	0	1	1	3	0	0	0	0	0	0	0	0	1	1	4	0.30
Actinonaias ligamentina	1	0	0	0	1	0	1	0	0	1	0	1	0	0	1	3	0.22
Lampsilis abrupta	0	0	0	0	0	0	1	0	0	1	0	1	1	0	2	3	0.22
Lampsilis ovata	1	0	1	0	2	0	0	0	0	0	0	0	1	0	1	3	0.22
Cyprogenia stegaria	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	2	0.15
Fusconaia subrotunda	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	2	0.15
Megalonaias nervosa	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	2	0.15
Dromus dromas	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Leptodea fragilis	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0.07
Pleurobema plenum	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Grand Total	206	125	136	158	625	58	194	57	66	375	77	81	115	68	341	1341	100.00
Species Count	12	7	12	10	17	10	12	11	11	16	5	11	13	6	18	22	

Appendix A-2. (Continued)

November 1-2,1983					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	0	145	100	102	347	21	52	26	72	171	54	108	91	65	318	836	58.79
Pleurobema cordatum	32	13	13	24	82	9	24	22	2	57	8	51	46	31	136	275	19.34
Quadrula pustulosa	6	0	6	10	22	4	8	6	0	18	12	7	1	15	35	75	5.27
Cyclonaias tuberculata	5	4	14	15	38	1	8	5	0	14	1	4	4	9	18	70	4.92
Amblema plicata	2	0	3	1	6	6	6	10	2	24	0	1	0	2	3	33	2.32
Ellipsaria lineolata	1	2	4	6	13	1	1	0	3	5	1	7	0	3	11	29	2.04
Potamilus alatus	1	1	3	0	5	7	0	6	7	20	1	1	1	1	4	29	2.04
Quadrula metanevra	5	2	1	2	10	1	2	0	0	3	2	5	1	3	11	24	1.69
Tritogonia verrucosa	0	0	0	0	0	7	0	2	3	12	0	0	0	0	0	12	0.84
Anodonta grandis	0	0	0	0	0	4	0	1	3	8	0	1	1	0	2	10	0.70
Lampsilis abrupta	0	1	1	0	2	0	0	0	0	0	1	1	1	2	5	7	0.49
Obliquaria reflexa	0	0	0	0	0	1	1	2	2	6	0	0	0	0	0	6	0.42
Leptodea fragilis	0	0	1	1	2	0	0	0	0	0	0	0	0	1	1	3	0.21
Ligumia recta	0	1	0	0	1	0	1	0	0	1	0	0	1	0	1	3	0.21
Actinonaias ligamentina	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	2	0.14
Elliptio dilatata	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	2	0.14
Plethobasus cyphyus	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	2	0.14
Cyprogenia stegaria	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0.07
Lampsilis ovata	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Megalonaias nervosa	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0.07
Pleurobema plenum	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Grand Total	53	172	146	161	532	65	104	80	94	343	81	186	147	133	547	1422	100.00
Species Count	8	11	10	8	15	13	10	9	8	15	9	10	9	11	14	21	

Appendix A-2. (Continued)

July 11-12, 1984					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	110	63	15	44	232	9	33	21	18	81	11	88	195	172	466	779	61.34
Pleurobema cordatum	33	27	24	23	107	4	7	1	0	12	3	18	55	25	101	220	17.32
Quadrula pustulosa	4	0	13	10	27	8	2	6	4	20	5	13	9	11	38	85	6.69
Cyclonaias tuberculata	0	4	33	25	62	0	0	2	0	2	0	3	6	0	9	73	5.75
Ellipsaria lineolata	1	2	7	3	13	2	1	0	1	4	1	4	2	0	7	24	1.89
Amblema plicata	0	0	4	0	4	4	1	7	0	12	1	1	1	0	3	19	1.50
Potamilus alatus	0	2	3	2	7	2	1	0	6	9	0	1	1	0	2	18	1.42
Quadrula metanevra	0	2	2	2	6	0	0	1	0	1	0	2	2	0	4	11	0.87
Obliquaria reflexa	0	0	1	0	1	1	0	5	1	7	0	0	0	0	0	8	0.63
Lampsilis abrupta	0	1	0	0	1	1	1	0	0	2	0	0	2	1	3	6	0.47
Anodonta grandis	0	0	0	0	0	1	2	2	0	5	0	0	0	0	0	5	0.39
Tritogonia verrucosa	0	0	1	0	1	3	0	0	0	3	0	1	0	0	1	5	0.39
Leptodea fragilis	0	0	0	0	0	0	1	0	2	3	0	1	0	0	1	4	0.31
Ligumia recta	2	0	0	0	2	0	0	0	0	0	0	0	2	0	2	4	0.31
Actinonaias ligamentina	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2	0.16
Pleurobema oviforme	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0.16
Pleurobema plenum	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	2	0.16
Elliptio dilatata	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0.08
Lampsilis ovata	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.08
Ptychobranchus fasciolaris	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0.08
Grand Total	151	101	106	109	467	35	49	45	32	161	23	133	275	211	642	1270	100.00
Species Count	6	7	12	7	15	10	9	8	6	13	7	11	10	5	15	20	

Appendix A-2. (Continued)

November 1-2, 1984					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	128	58	92	102	380	41	60	36	67	204	18	31	200	151	400	984	71.93
Pleurobema cordatum	12	13	25	20	70	3	27	0	1	31	3	12	25	15	55	156	11.40
Cyclonaias tuberculata	2	11	20	10	43	1	3	1	0	5	1	0	11	2	14	62	4.53
Quadrula pustulosa	3	7	7	9	26	0	7	1	1	9	1	0	10	7	18	53	3.87
Potamilus alatus	1	0	2	4	7	4	0	2	8	14	3	4	1	0	8	29	2.12
Ellipsaria lineolata	0	1	6	3	10	2	2	0	4	8	1	1	4	1	7	25	1.83
Quadrula metanevra	0	4	1	3	8	0	0	0	0	0	1	0	4	0	5	13	0.95
Amblema plicata	0	1	0	1	2	1	1	0	2	4	2	0	2	1	5	11	0.80
Ligumia recta	0	0	1	2	3	0	0	0	0	0	0	5	1	1	7	10	0.73
Tritogonia verrucosa	0	0	0	0	0	2	0	1	0	3	1	1	0	0	2	5	0.37
Anodonta grandis	0	0	0	0	0	2	0	0	1	3	0	0	0	1	1	4	0.29
Lampsilis ovata	0	0	0	0	0	0	0	1	0	1	0	3	0	0	3	4	0.29
Obliquaria reflexa	0	0	0	0	0	0	1	1	0	2	0	0	0	1	1	3	0.22
Anodonta imbecillis	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	2	0.15
Lampsilis abrupta	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	2	0.15
Leptodea fragilis	0	0	0	0	0	0	1	0	1	2	0	0	0	0	0	2	0.15
Cyprogenia stegaria	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Elliptio dilatata	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Megalonaias nervosa	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0.07
Grand Total	146	96	156	154	552	56	104	44	85	289	31	57	259	180	527	1368	100.00
Species Count	5	8	10	9	12	8	10	8	8	15	9	7	10	9	14	19	

Appendix A-2. (Continued)

July 31-August 1, 1985					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	39	41	35	88	203	38	25	8	24	95	44	91	150	155	440	738	69.43
Pleurobema cordatum	1	13	5	17	36	2	18	2	1	23	5	11	13	25	54	113	10.63
Cyclonaias tuberculata	3	1	17	13	34	0	5	1	1	7	0	5	11	3	19	60	5.64
Quadrula pustulosa	0	0	1	6	7	0	11	5	2	18	2	4	15	7	28	53	4.99
Potamilus alatus	0	0	0	3	3	3	0	5	17	25	0	0	5	1	6	34	3.20
Amblema plicata	0	0	0	0	0	0	2	7	0	9	2	0	5	1	8	17	1.60
Ellipsaria lineolata	0	0	3	1	4	0	2	0	0	2	0	0	2	0	2	8	0.75
Anodonta grandis	0	0	0	0	0	1	0	0	0	1	0	1	1	0	2	3	0.28
Obliquaria reflexa	0	0	0	0	0	0	2	4	0	6	0	0	0	1	1	7	0.66
Tritogonia verrucosa	0	0	0	0	0	2	0	2	0	4	0	0	0	0	0	4	0.38
Quadrula metanevra	1	1	2	2	6	0	0	0	0	0	0	0	0	0	0	6	0.56
Lampsilis abrupta	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.09
Leptodea fragilis	0	0	0	0	0	0	0	0	2	2	0	0	1	0	1	3	0.28
Ligumia recta	0	0	0	0	0	0	0	0	0	0	1	1	1	0	3	3	0.28
Megalonaias nervosa	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0.09
Actinonaias ligamentina	0	0	0	1	1	0	0	0	0	0	0	0	3	0	3	4	0.38
Lampsilis ovata	1	0	0	0	1	0	0	0	0	0	2	0	2	0	4	5	0.47
Cyprogenia stegaria	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0.09
Pleurobema plenum	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.09
Lasmigona complanata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.09
Grand Total	45	56	64	131	296	46	66	34	47	193	56	113	211	194	574	1063	100.00
Species Count	5	4	7	8	10	5	8	8	6	12	6	6	14	8	16	20	

Appendix A-2. (Continued)

October 16-17,1985					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	79	128	73	47	327	23	32	29	32	116	8	70	182	226	486	929	65.10
Pleurobema cordatum	22	17	10	18	67	2	26	3	9	40	0	18	31	21	70	177	12.40
Quadrula pustulosa	2	7	1	9	19	6	5	6	8	25	0	14	16	11	41	85	5.96
Cyclonaias tuberculata	3	7	6	24	40	0	2	1	1	4	2	9	10	1	22	66	4.63
Potamilus alatus	1	1	5	5	12	7	3	14	0	24	0	3	2	2	7	43	3.01
Ellipsaria lineolata	2	0	0	1	3	2	4	2	3	11	0	3	4	6	13	27	1.89
Amblema plicata	1	1	1	0	3	2	1	3	5	11	0	3	5	3	11	25	1.75
Tritogonia verrucosa	0	0	0	1	1	8	1	2	2	13	1	0	0	0	1	15	1.05
Quadrula metanevra	0	0	1	4	5	2	1	0	0	3	0	0	0	2	2	10	0.70
Ligumia recta	0	1	2	1	4	0	0	1	0	1	0	0	2	1	3	8	0.56
Actinonaias ligamentina	2	0	2	0	4	0	0	0	0	0	0	1	2	0	3	7	0.49
Anodonta grandis	0	0	0	0	0	4	0	0	1	5	0	1	0	1	2	7	0.49
Lampsilis abrupta	0	1	1	0	2	0	0	0	0	0	0	1	4	0	5	7	0.49
Obliquaria reflexa	1	0	0	0	1	1	0	1	0	2	1	0	1	0	2	5	0.35
Lampsilis ovata	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	4	0.28
Megalonaias nervosa	0	1	0	1	2	0	0	0	0	0	0	0	0	2	2	4	0.28
Pleurobema rubrum	0	1	0	0	1	0	0	0	0	0	0	1	1	0	2	3	0.21
Elliptio dilatata	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	2	0.14
Leptodea fragilis	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	2	0.14
Pleurobema oviforme	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.07
Grand Total	114	165	103	111	493	57	78	63	62	260	12	124	262	276	674	1427	100.00
Species Count	10	10	11	10	17	10	11	11	9	15	4	11	13	11	17	20	

Appendix A-2. (Continued)

July 9-10, 1986					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	100	56	38	30	224	28	23	47	44	142	86	86	34	162	368	734	68.28
Pleurobema cordatum	7	30	7	11	55	2	1	3	2	8	15	16	4	12	47	110	10.23
Cyclonaias tuberculata	1	2	6	14	23	2	2	4	0	8	9	7	2	6	24	55	5.12
Quadrula pustulosa	1	0	0	2	3	1	4	5	2	12	7	6	1	2	16	31	2.88
Potamilus alatus	2	1	0	1	4	3	6	5	9	23	1	1	4	8	14	41	3.81
Amblema plicata	1	0	0	2	3	1	5	7	1	14	4	2	0	0	6	23	2.14
Ellipsaria lineolata	1	0	1	3	5	0	2	4	0	6	1	2	0	5	8	19	1.77
Anodonta grandis	0	0	0	0	0	1	2	1	0	4	0	0	1	4	5	9	0.84
Obliquaria reflexa	0	0	0	0	0	2	2	4	0	8	0	0	0	1	1	9	0.84
Tritogonia verrucosa	0	0	0	0	0	2	4	1	1	8	0	0	0	0	0	8	0.74
Quadrula metanevra	0	0	1	3	4	0	1	0	0	1	1	0	1	0	2	7	0.65
Lampsilis abrupta	1	2	0	0	3	0	0	0	1	1	1	1	0	0	2	6	0.56
Leptodea fragilis	0	0	0	0	0	0	4	1	0	5	0	0	1	0	1	6	0.56
Ligumia recta	1	0	2	0	3	0	0	0	1	1	0	2	1	1	4	8	0.74
Megalonaias nervosa	1	1	1	0	3	0	1	1	0	2	0	0	0	0	0	5	0.47
Lampsilis ovata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.09
Elliptio dilatata	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2	0.19
Lasmigona costata	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0.09
Grand Total	116	92	56	67	331	42	57	84	61	244	126	123	50	201	500	1075	100.00
Species Count	10	6	7	9	12	9	13	13	8	16	10	9	10	9	15	18	

Appendix A-2. (Continued)

October 16-17, 1986					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	97	29	73	61	260	14	30	20	28	92	13	100	132	168	413	765	64.83
Pleurobema cordatum	6	18	21	9	54	3	28	1	1	33	1	22	34	25	82	169	14.32
Cyclonaias tuberculata	0	5	28	16	49	0	2	7	0	9	3	1	13	1	18	76	6.44
Quadrula pustulosa	3	0	0	11	14	0	1	6	1	8	4	4	10	1	19	41	3.47
Potamilus alatus	0	1	3	3	7	3	4	4	4	15	5	0	0	0	5	27	2.29
Amblema plicata	0	0	1	1	2	1	6	6	0	13	3	0	4	2	9	24	2.03
Ellipsaria lineolata	2	1	3	4	10	0	0	0	1	1	0	2	3	2	7	18	1.53
Tritogonia verrucosa	0	0	0	0	0	5	2	1	4	12	0	1	0	0	1	13	1.10
Ligumia recta	0	1	2	1	4	0	0	0	1	1	0	3	2	0	5	10	0.85
Actinonaias ligamentina	0	1	1	2	4	0	0	0	0	0	0	2	2	0	4	8	0.68
Anodonta grandis	0	2	0	0	2	2	1	0	1	4	0	0	1	0	1	7	0.59
Quadrula metanevra	1	0	1	3	5	0	0	0	0	0	0	1	1	0	2	7	0.59
Leptodea fragilis	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	3	0.25
Obliquaria reflexa	0	0	0	0	0	0	1	1	0	2	0	1	0	0	1	3	0.25
Lampsilis abrupta	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	2	0.17
Lampsilis ovata	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	2	0.17
Pleurobema oviforme	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	0.17
Anodonta imbecillis	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0.08
Elliptio dilatata	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0.08
Megalonaias nervosa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.08
Grand Total	109	59	134	113	415	28	77	46	41	192	29	139	204	201	573	1180	100.00
Species Count	5	9	10	12	15	6	11	8	8	13	6	11	11	8	17	20	

Appendix A-2. (Continued)

July 12 & 14, 1988					Bed					Bed					Bed		Survey
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	71	43	43	79	236	14	28	25	20	87	76	80	248	243	647	970	60.25
Pleurobema cordatum	8	22	18	20	68	10	28	6	0	44	16	22	38	36	112	224	13.91
Cyclonaias tuberculata	1	14	19	22	56	1	1	3	3	8	4	4	17	4	29	93	5.78
Quadrula pustulosa	0	2	1	2	5	1	3	9	8	21	11	9	25	9	54	80	4.97
Potamilus alatus	0	2	5	3	10	5	4	9	12	30	9	3	0	3	15	55	3.42
Amblema plicata	1	4	4	3	12	4	0	10	9	23	10	1	3	0	14	49	3.04
Ellipsaria lineolata	2	1	2	4	9	0	4	0	0	4	3	3	3	1	10	23	1.43
Anodonta grandis	0	1	2	0	3	9	1	4	5	19	2	0	1	4	7	29	1.80
Obliquaria reflexa	0	0	0	0	0	1	0	3	3	7	0	0	0	0	0	7	0.43
Tritogonia verrucosa	0	0	1	2	3	4	5	0	4	13	0	1	0	1	2	18	1.12
Quadrula metanevra	0	2	3	1	6	0	0	0	0	0	0	0	2	0	2	8	0.50
Lampsilis abrupta	0	0	0	0	0	1	0	1	0	2	4	1	3	2	10	12	0.75
Leptodea fragilis	0	0	0	0	0	1	1	1	6	9	2	1	0	0	3	12	0.75
Ligumia recta	1	0	1	0	2	0	0	0	0	0	0	1	3	1	5	7	0.43
Megalonaias nervosa	0	1	1	2	4	0	0	0	0	0	4	0	1	0	5	9	0.56
Actinonaias ligamentina	0	0	0	2	2	0	0	0	1	1	0	0	0	0	0	3	0.19
Lampsilis ovata	0	1	0	0	1	0	0	1	0	1	0	1	0	0	1	3	0.19
Elliptio dilatata	0	0	1	0	1	0	0	0	0	0	0	0	2	0	2	3	0.19
Pleurobema oviforme	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0.12
Anodonta imbecillis	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0.06
Anodonta suborbiculata	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0.06
Pleurobema pyramidatum	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0.06
Grand Total	84	93	101	140	418	51	76	72	72	271	142	127	346	306	921	1610	100.00
Species Count	6	11	13	11	15	11	10	11	11	16	12	12	12	11	18	22	

Appendix A-2. (Continued)

July 24-25, 1990					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	79	21	37	58	195	23	17	18	27	85	25	67	84	68	244	524	52.88
Pleurobema cordatum	11	2	12	9	34	3	13	8	0	24	9	33	19	20	81	139	14.03
Cyclonaias tuberculata	11	26	20	14	71	1	2	2	0	5	6	4	4	0	14	90	9.08
Quadrula pustulosa	2	4	8	3	17	0	9	10	7	26	9	9	13	5	36	79	7.97
Potamilus alatus	2	2	5	4	13	8	2	8	10	28	1	0	2	1	4	45	4.54
Amblema plicata	0	1	0	4	5	0	1	2	1	4	0	1	0	0	1	10	1.01
Ellipsaria lineolata	4	1	8	3	16	3	0	0	0	3	3	3	2	1	9	28	2.83
Anodonta grandis	0	0	0	1	1	5	4	3	5	17	0	1	1	0	2	20	2.02
Obliquaria reflexa	0	1	0	1	2	0	1	2	3	6	0	0	2	1	3	11	1.11
Tritogonia verrucosa	0	1	0	0	1	2	3	0	2	7	1	0	0	0	1	9	0.91
Quadrula metanevra	1	1	0	0	2	1	1	0	0	2	0	1	3	0	4	8	0.81
Lampsilis abrupta	0	0	0	0	0	0	0	0	1	1	0	1	2	0	3	4	0.40
Leptodea fragilis	0	0	2	0	2	3	1	1	0	5	0	0	1	0	1	8	0.81
Ligumia recta	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	2	0.20
Megalonaias nervosa	1	0	1	0	2	0	0	0	0	0	0	0	0	1	1	3	0.30
Actinonaias ligamentina	0	2	0	0	2	1	0	0	0	1	1	0	1	0	2	5	0.50
Lampsilis ovata	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.10
Elliptio dilatata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.10
Pleurobema oviforme	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0.10
Anodonta imbecillis	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0.10
Anodonta suborbiculata	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0.10
Ptychobranchus fasciolaris	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0.10
Grand Total	111	62	93	98	364	50	54	56	56	216	55	122	135	99	411	991	100.00
Species Count	8	11	8	10	15	10	11	11	8	16	8	11	13	9	20	22	

Appendix A-2. (Continued)

Summer 1992					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	82	15	6	7	110	19	8	13	2	42	6	49	118	99	272	424	59.89
Pleurobema cordatum	11	9	2	4	26	3	7	4	13	27	6	6	8	9	29	82	11.58
Cyclonaias tuberculata	9	18	12	5	44	2	4	6	0	12	1	2	6	3	12	68	9.60
Quadrula pustulosa	3	8	2	1	14	0	8	4	4	16	1	1	14	2	18	48	6.78
Potamilus alatus	2	2	0	2	6	1	0	1	3	5	0	3	1	1	5	16	2.26
Amblema plicata	1	0	0	1	2	1	1	2	2	6	1	1	3	0	5	13	1.84
Ellipsaria lineolata	7	1	0	0	8	3	0	0	0	3	0	0	2	1	3	14	1.98
Anodonta grandis	0	0	0	1	1	1	1	0	2	4	0	0	0	0	0	5	0.71
Obliquaria reflexa	0	1	0	0	1	0	1	1	2	4	0	0	0	1	1	6	0.85
Tritogonia verrucosa	1	0	0	1	2	0	2	4	1	7	0	0	0	0	0	9	1.27
Quadrula metanevra	0	0	2	0	2	0	2	1	0	3	0	0	2	1	3	8	1.13
Lampsilis abrupta	0	0	0	0	0	0	0	1	1	2	0	2	2	0	4	6	0.85
Ligumia recta	2	0	0	0	2	0	0	0	0	0	0	0	1	0	1	3	0.42
Megalonaias nervosa	0	0	0	1	1	0	0	2	1	3	0	0	0	0	0	4	0.56
Actinonaias ligamentina	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0.14
Plethobasus cyphyus	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0.14
Grand Total	118	54	25	23	220	31	34	39	31	135	15	64	157	117	353	708	100.00
Species Count	9	7	6	9	14	8	9	11	10	14	5	7	10	8	11	16	

Appendix A-2. (Continued)

Summer 1994 Species	520.0	520.3	520.6	520.8	Bed Total	526.0	526.3	526.5	526.8	Bed Total	528.2	528.5	528.8	528.9	Bed Total	Survey Total	Survey Percent
Elliptio crassidens	85	31	52	29	197	24	50	11	25	110	23	56	75	122	276	583	66.25
Pleurobema cordatum	14	3	7	11	35	1	13	2	3	19	8	6	12	15	41	95	10.80
Quadrula pustulosa	0	1	1	4	6	1	6	11	12	30	1	14	3	11	29	65	7.39
Cyclonaias tuberculata	6	16	13	11	46	1	2	3	2	8	0	6	1	3	10	64	7.27
Amblema plicata	0	1	0	1	2	3	2	4	2	11	0	0	0	0	0	13	1.48
Ellipsaria lineolata	1	0	4	2	7	0	0	0	1	1	0	2	0	1	3	11	1.25
Obliquaria reflexa	0	0	0	0	0	0	1	7	3	11	0	0	0	0	0	11	1.25
Potamilus alatus	0	1	0	1	2	2	1	1	1	5	1	1	0	1	3	10	1.14
Anodonta grandis	0	0	0	0	0	2	0	1	4	7	0	0	0	0	0	7	0.80
Tritogonia verrucosa	0	0	0	0	0	0	0	1	4	5	0	0	1	1	2	7	0.80
Quadrula metanevra	0	1	1	1	3	0	0	0	0	0	0	0	0	1	1	4	0.45
Leptodea fragilis	0	0	0	0	0	0	1	1	0	2	0	1	0	0	1	3	0.34
Lampsilis abrupta	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	2	0.23
Megalonaias nervosa	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	2	0.23
Ligumia recta	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0.11
Plethobasus cyphyus	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0.11
Pleurobema oviforme	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.11
Grand Total	106	54	78	61	299	34	77	43	58	212	33	87	92	157	369	880	100.00
Species Count	4	7	6	9	9	7	9	11	11	14	4	8	5	10	12	17	

Appendix A-2. (Continued)

July 22-23, 1996					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	88	22	76	26	212	10	54	27	23	114	24	71	73	100	268	594	70.21
Pleurobema cordatum	6	4	8	9	27	0	12	7	1	20	9	10	7	21	47	94	11.11
Cyclonaias tuberculata	5	6	5	2	18	0	3	4	0	7	3	6	1	3	13	38	4.49
Potamilus alatus	0	0	2	1	3	8	6	9	5	28	0	0	1	3	4	35	4.14
Quadrula pustulosa	0	0	0	1	1	1	1	3	4	9	8	10	0	2	20	30	3.55
Ellipsaria lineolata	0	0	1	1	2	1	3	0	0	4	0	4	4	1	9	15	1.77
Amblema plicata	0	0	0	2	2	1	4	1	0	6	1	2	0	0	3	11	1.30
Anodonta grandis	0	0	0	0	0	3	0	2	1	6	0	0	0	1	1	7	0.83
Obliquaria reflexa	0	0	0	0	0	0	0	6	0	6	0	0	0	0	0	6	0.71
Lampsilis abrupta	1	0	0	0	1	0	1	1	0	2	0	0	1	0	1	4	0.47
Tritogonia verrucosa	0	0	0	0	0	1	1	0	1	3	0	0	1	0	1	4	0.47
Ligumia recta	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	2	0.24
Quadrula metanevra	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	2	0.24
Elliptio dilatata	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.12
Lasmigona costata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.12
Leptodea fragilis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0.12
Megalonaias nervosa	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0.12
Grand Total	100	33	92	43	268	25	86	61	35	207	47	104	89	131	371	846	100.00
Species Count	4	4	5	8	10	7	10	10	6	13	7	7	8	7	14	17	

Appendix A-2. (Continued)

July 7-8, 1997					Bed					Bed					Bed	Survey	
Species	520.0	520.3	520.6	520.8	Total	526.0	526.3	526.5	526.8	Total	528.2	528.5	528.8	528.9	Total	Total	Percent
Elliptio crassidens	24	13	51	35	123	45	33	17	14	109	20	66	126	45	257	489	70.16
Pleurobema cordatum	4	4	9	11	28	2	16	0	0	18	3	33	7	12	55	101	14.49
Cyclonaias tuberculata	1	16	9	5	31	1	2	0	0	3	2	7	4	0	13	47	6.74
Quadrula pustulosa	0	5	2	2	9	1	0	2	3	6	1	7	1	0	9	24	3.44
Potamilus alatus	0	0	1	1	2	0	1	4	1	6	4	0	0	0	4	12	1.72
Ellipsaria lineolata	1	0	2	2	5	0	0	0	1	1	1	0	1	0	2	8	1.15
Amblema plicata	0	0	0	0	0	0	0	3	1	4	0	0	1	0	1	5	0.72
Obliquaria reflexa	0	0	0	1	1	0	0	0	2	2	0	0	0	0	0	3	0.43
Leptodea fragilis	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0.29
Quadrula metanevra	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	2	0.29
Anodonta grandis	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0.14
Lampsilis ovata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0.14
Ligumia recta	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.14
Tritogonia verrucosa	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0.14
Grand Total	30	38	74	57	199	49	53	26	26	154	32	114	141	57	344	697	100.00
Species Count	4	4	6	7	7	4	5	4	9	12	7	5	7	2	10	14	

Appendix A-2. (Continued)

TRM 520-521 and Year 1983	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	104.30	102.6	106.0	76.50	72.9	80.1	49.50	46.8	52.2
Amblema plicata	7	85.33	74.4	96.1	64.81	56.8	72.3	40.49	36.1	48.7
Cyclonaias tuberculata	72	75.80	62.1	92.6	65.60	52.1	80.2	38.20	32.4	44.1
Cyprogenia stegaria	1	51.60	51.6	51.6	49.70	49.7	49.7	36.00	36.0	36.0
Dromus dromas	1	60.10	60.1	60.1	58.30	58.3	58.3	32.80	32.8	32.8
Ellipsaria lineolata	20	78.94	56.8	94.5	61.21	44.6	72.0	37.78	30.1	48.8
Elliptio crassidens	102	101.28	87.5	125.5	63.90	54.0	80.5	40.59	21.0	50.3
Elliptio dilatata	3	106.37	102.3	113.3	45.70	42.2	48.8	33.40	30.9	34.7
Lampsilis abrupta	2	91.40	83.7	99.1	67.05	61.4	72.7	44.75	43.4	46.1
Lampsilis ovata	3	122.47	122.0	123.2	84.40	74.7	92.3	65.87	62.0	69.4
Leptodea fragilis	2	71.20	59.6	82.8	41.35	34.6	48.1	23.10	20.1	26.1
Ligumia recta	3	150.60	145.1	154.9	59.70	56.6	63.4	45.93	42.5	48.6
Obliquaria reflexa	1	48.30	48.3	48.3	24.10	24.1	24.1	24.60	24.6	24.6
Pleurobema cordatum	102	90.57	72.1	108.8	72.31	60.6	84.8	45.72	31.4	59.8
Pleurobema plenum	1	58.10	58.1	58.1	52.90	52.9	52.9	36.40	36.4	36.4
Potamilus alatus	11	122.31	46.9	156.9	88.34	71.1	104.9	35.58	30.6	40.9
Quadrula metanevra	16	73.55	63.5	85.3	58.82	52.3	68.0	43.65	38.3	49.2
Quadrula pustulosa	38	52.02	43.7	61.7	49.89	40.5	59.6	31.92	26.3	36.9

Appendix A-2. (Continued)

TRM 520-521 and Year 1984	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	6	96.08	80.5	107.3	72.63	62.6	80.4	42.58	34.6	46.6
Anodonta imbecillis	1	52.50	52.5	52.5	24.70	24.7	24.7	14.30	14.3	14.3
Cyclonaias tuberculata	101	74.39	59.1	92.2	63.86	52.2	76.5	37.48	29.5	44.9
Cyprogenia stegaria	1	52.90	52.9	52.9	51.40	51.4	51.4	36.40	36.4	36.4
Ellipsaria lineolata	23	77.57	56.6	102.2	58.68	44.0	74.2	35.53	26.3	42.0
Elliptio crassidens	101	104.82	89.2	122.7	66.24	56.3	78.4	41.70	24.4	60.9
Elliptio dilatata	1	100.10	100.1	100.1	42.20	42.2	42.2	28.00	28.0	28.0
Lampsilis abrupta	1	90.60	90.6	90.6	60.70	60.7	60.7	48.10	48.1	48.1
Lampsilis ovata	1	102.10	102.1	102.1	72.90	72.9	72.9	56.50	56.5	56.5
Ligumia recta	5	149.30	140.9	155.9	57.52	50.5	60.3	46.68	40.0	49.7
Obliquaria reflexa	1	36.50	36.5	36.5	32.90	32.9	32.9	22.90	22.9	22.9
Pleurobema cordatum	100	90.46	62.1	112.9	71.74	44.7	86.7	44.20	32.8	52.8
Pleurobema plenum	2	60.10	51.3	68.9	57.70	49.4	66.0	44.00	39.4	48.6
Potamilus alatus	14	126.87	96.7	160.0	90.56	74.4	108.0	36.16	30.0	42.5
Ptychobranchus fasciolaris	1	94.40	94.4	94.4	56.70	56.7	56.7	34.80	34.8	34.8
Quadrula metanevra	14	74.78	64.5	82.8	59.29	52.6	66.6	40.09	32.4	50.6
Quadrula pustulosa	53	53.28	40.0	74.1	50.63	39.5	64.1	31.69	22.0	40.1
Tritogonia verrucosa	1	76.70	76.7	76.7	42.70	42.7	42.7	19.70	19.7	19.7

Appendix A-2. (Continued)

TRM 520-521 and Year 1985	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	5	105.42	97.4	112.3	75.42	70.6	78.9	52.78	50.2	54.9
Amblema plicata	3	94.77	92.1	97.9	69.83	69.1	70.3	39.80	36.6	42.8
Cyclonaias tuberculata	72	75.62	60.5	86.6	65.14	54.7	74.5	36.95	30.6	43.1
Cyprogenia stegaria	1	57.70	57.7	57.7	55.60	55.6	55.6	44.10	44.1	44.1
Ellipsaria lineolata	7	79.13	62.3	92.5	61.27	46.9	69.9	34.84	32.0	36.2
Elliptio crassidens	101	104.43	90.1	122.5	65.82	54.1	88.5	41.43	29.5	50.9
Elliptio dilatata	1	96.80	96.8	96.8	44.20	44.2	44.2	29.80	29.8	29.8
Lampsilis abrupta	2	96.45	82.3	110.6	71.65	69.8	73.5	51.95	43.5	60.4
Lampsilis ovata	1	121.20	121.2	121.2	86.50	86.5	86.5	62.30	62.3	62.3
Ligumia recta	4	158.93	142.2	170.2	59.88	57.2	60.8	45.15	41.3	48.5
Megalonaias nervosa	2	165.15	160.1	170.2	109.35	102.3	116.4	54.45	52.4	56.5
Obliquaria reflexa	1	46.60	46.6	46.6	36.10	36.1	36.1	23.40	23.4	23.4
Pleurobema cordatum	88	91.57	70.4	108.5	73.40	58.2	89.5	43.91	30.2	52.7
Pleurobema oviforme	1	72.90	72.9	72.9	56.50	56.5	56.5	40.20	40.2	40.2
Pleurobema rubrum	1	80.70	80.7	80.7	64.30	64.3	64.3	44.50	44.5	44.5
Potamilus alatus	15	128.51	98.0	150.7	87.92	76.5	106.7	36.53	30.9	40.7
Quadrula metanevra	11	75.45	67.3	88.2	60.21	56.1	70.3	40.83	36.8	46.2
Quadrula pustulosa	26	54.20	46.3	72.8	51.48	44.7	64.3	31.89	25.7	37.4
Tritogonia verrucosa	1	104.10	104.1	104.1	52.80	52.8	52.8	36.10	36.1	36.1

Appendix A-2. (Continued)

TRM 520-521 and Year 1986	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	4	94.93	91.3	97.5	68.15	65.3	71.6	46.03	40.3	53.8
Amblema plicata	5	102.18	90.3	112.9	72.96	66.4	78.2	44.38	39.3	52.1
Anodonta grandis	2	123.05	119.4	126.7	70.00	63.3	76.7	47.05	43.4	50.7
Anodonta imbecillis	1	39.20	39.2	39.2	17.40	17.4	17.4	7.10	7.1	7.1
Cyclonaias tuberculata	72	72.03	56.9	85.1	61.53	47.6	76.6	34.82	23.7	44.9
Ellipsaria lineolata	15	73.42	51.8	86.9	54.71	39.2	65.3	30.81	22.6	42.0
Elliptio crassidens	100	105.59	87.2	151.8	64.88	55.9	82.5	40.83	31.1	51.4
Elliptio dilatata	1	109.40	109.4	109.4	45.50	45.5	45.5	39.90	39.9	39.9
Lampsilis abrupta	4	98.43	86.1	104.7	72.45	66.3	80.7	50.15	48.3	52.2
Lampsilis ovata	1	139.10	139.1	139.1	90.30	90.3	90.3	55.90	55.9	55.9
Lasmigona costata	1	122.10	122.1	122.1	69.90	69.9	69.9	25.50	25.5	25.5
Ligumia recta	7	133.40	107.7	150.2	51.84	45.0	55.9	40.80	33.1	48.6
Megalonaias nervosa	3	148.97	146.9	150.3	102.27	97.6	109.3	57.37	53.9	63.2
Pleurobema cordatum	94	88.69	54.9	109.6	70.34	49.7	88.5	42.39	25.2	54.6
Potamilus alatus	11	127.29	93.4	144.9	84.49	67.9	95.8	32.73	26.8	40.0
Quadrula metanevra	9	69.98	54.9	80.9	54.79	42.4	64.3	37.06	31.0	42.4
Quadrula pustulosa	17	48.40	38.2	55.9	45.26	37.2	52.8	27.30	20.5	35.7

Appendix A-2. (Continued)

TRM 520-521 and Year 1988	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	93.00	90.9	95.1	71.65	71.3	72.0	49.35	47.6	51.1
Amblema plicata	12	97.95	73.2	115.3	72.45	53.0	86.1	43.01	33.3	52.1
Anodonta grandis	3	101.60	81.7	119.9	59.83	53.6	65.3	44.00	34.5	50.4
Cyclonaias tuberculata	50	75.88	64.3	88.6	64.96	55.2	75.2	38.08	32.2	44.9
Ellipsaria lineolata	9	79.49	65.1	100.0	59.98	47.5	70.6	37.53	32.7	50.3
Elliptio crassidens	52	104.08	92.4	124.5	66.17	60.1	84.9	42.50	34.1	50.7
Elliptio dilatata	1	96.80	96.8	96.8	45.40	45.4	45.4	26.90	26.9	26.9
Lampsilis ovata	1	110.70	110.7	110.7	76.90	76.9	76.9	61.80	61.8	61.8
Ligumia recta	2	156.05	144.4	167.7	57.45	54.2	60.7	48.65	44.4	52.9
Megalonaias nervosa	4	155.25	144.2	170.2	109.25	100.8	117.2	59.88	53.3	65.6
Pleurobema cordatum	52	91.03	68.5	110.1	73.16	54.9	83.6	46.47	38.2	54.8
Potamilus alatus	10	132.07	114.9	151.0	96.46	76.3	113.4	39.75	34.4	48.3
Quadrula metanevra	6	80.70	66.7	92.1	63.15	54.2	70.1	43.43	38.4	47.3
Quadrula pustulosa	5	57.08	52.2	68.8	52.20	46.9	61.3	34.66	31.3	37.3
Tritogonia verrucosa	3	101.07	91.8	109.4	55.10	50.5	57.4	27.93	23.2	34.0

TRM 520-521 and Year 1990	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	97.35	96.0	98.7	72.15	71.4	72.9	49.60	47.6	51.6
Amblema plicata	5	100.30	76.6	120.1	71.08	54.5	87.2	41.74	33.6	47.2
Anodonta grandis	1	136.30	136.3	136.3	76.70	76.7	76.7	51.00	51.0	51.0
Anodonta imbecillis	1	52.00	52.0	52.0	24.80	24.8	24.8	14.30	14.3	14.3
Cyclonaias tuberculata	50	77.43	62.0	111.0	65.32	52.1	92.1	37.12	28.0	46.5
Ellipsaria lineolata	16	85.20	64.2	94.8	63.94	51.6	71.3	37.67	32.1	44.6
Elliptio crassidens	50	109.49	87.5	130.1	68.71	62.4	79.9	42.94	36.3	50.2
Leptodea fragilis	2	100.15	89.9	110.4	67.65	62.7	72.6	37.85	36.5	39.2
Megalonaias nervosa	2	164.85	155.6	174.1	115.65	110.7	120.6	56.20	56.2	56.2
Obliquaria reflexa	2	45.40	44.5	46.3	36.80	36.7	36.9	26.60	25.4	27.8
Pleurobema cordatum	34	91.89	75.6	110.1	71.37	59.5	82.4	42.27	32.9	52.0
Potamilus alatus	13	141.24	131.6	152.9	105.18	83.3	120.9	55.30	37.2	139.8
Quadrula metanevra	2	73.35	65.2	81.5	53.60	48.1	59.1	39.40	35.5	43.3
Quadrula pustulosa	17	52.47	45.7	64.1	49.12	42.8	55.7	31.34	25.3	37.5
Tritogonia verrucosa	1	94.00	94.0	94.0	52.20	52.2	52.2	32.50	32.5	32.5

Appendix A-2. (Continued)

TRM 520-521 and Year 1992	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	1	94.80	94.8	94.8	65.40	65.4	65.4	49.60	49.6	49.6
Amblema plicata	2	119.45	114.2	124.7	85.55	84.7	86.4	51.95	49.1	54.8
Anodonta grandis	1	131.50	131.5	131.5	84.90	84.9	84.9	57.20	57.2	57.2
Cyclonaias tuberculata	44	78.27	63.2	89.0	65.77	53.4	87.1	37.92	30.8	44.7
Ellipsaria lineolata	8	86.17	69.6	95.5	65.55	49.7	75.1	38.46	31.3	44.8
Elliptio crassidens	43	104.55	88.4	116.5	65.75	55.6	74.3	42.35	27.2	51.7
Ligumia recta	2	153.05	148.0	158.1	59.65	56.9	62.4	48.50	47.3	49.7
Megalonaias nervosa	1	182.10	182.1	182.1	116.20	116.2	116.2	58.40	58.4	58.4
Obliquaria reflexa	1	52.70	52.7	52.7	41.60	41.6	41.6	29.80	29.8	29.8
Pleurobema cordatum	26	89.13	64.7	104.0	70.92	60.9	82.9	43.46	37.5	51.2
Potamilus alatus	6	141.35	124.8	155.3	105.82	98.1	114.8	42.15	35.2	45.4
Quadrula metanevra	2	82.65	82.5	82.8	62.55	61.7	63.4	42.80	42.0	43.6
Quadrula pustulosa	14	52.09	45.3	57.4	48.60	40.2	54.9	31.74	25.2	37.9
Tritogonia verrucosa	2	108.60	100.9	116.3	60.15	59.4	60.9	33.45	31.3	35.6

TRM 520-521 and Year 1994	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	2	97.85	84.7	111.0	65.95	59.2	72.7	43.10	35.0	51.2
Cyclonaias tuberculata	46	77.77	66.2	91.1	65.59	58.4	74.3	38.82	32.9	48.9
Ellipsaria lineolata	7	82.13	76.1	89.6	63.57	57.7	69.0	37.46	32.9	42.1
Elliptio crassidens	65	108.95	96.8	128.7	68.19	61.3	88.6	43.51	36.6	50.4
Megalonaias nervosa	1	180.20	180.2	180.2	119.70	119.7	119.7	69.00	69.0	69.0
Pleurobema cordatum	35	90.84	59.8	107.7	72.35	58.1	86.8	45.37	35.5	53.0
Potamilus alatus	2	129.80	128.3	131.3	103.60	99.6	107.6	38.90	38.5	39.3
Quadrula metanevra	3	71.60	68.4	75.5	56.63	54.4	59.5	40.67	39.9	42.2
Quadrula pustulosa	6	55.28	52.1	57.3	51.02	46.6	54.5	32.85	28.9	35.1

Appendix A-2. (Continued)

TRM 520-521 and Year 1996	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	2	101.80	78.2	125.4	68.60	52.4	84.9	36.70	26.7	46.7
Cyclonaias tuberculata	18	79.90	73.0	91.3	67.10	58.4	75.6	39.30	34.6	45.3
Ellipsaria lineolata	2	79.50	69.7	89.3	59.90	48.0	71.9	37.60	30.8	44.3
Elliptio crassidens	61	108.80	97.8	127.2	66.30	56.9	75.2	43.50	34.2	50.2
Elliptio dilatata	1	95.40	95.4	95.4	41.00	41.0	41.0	29.70	29.7	29.7
Lampsilis abrupta	1	99.40	99.4	99.4	73.10	73.1	73.1	55.30	55.3	55.3
Ligumia recta	1	160.00	160.0	160.0	61.10	61.1	61.1	49.40	49.4	49.4
Pleurobema cordatum	27	94.50	82.8	107.7	72.50	67.2	79.2	46.20	39.0	53.0
Potamilus alatus	3	117.10	98.2	133.0	70.40	60.1	79.9	36.80	28.9	45.5
Quadrula pustulosa	1	56.60	56.6	56.6	54.90	54.9	54.9	34.50	34.5	34.5

TRM 520-521 and Year 1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Cyclonaias tuberculata	31	78.50	67.0	91.4	65.40	56.5	73.7	41.60	35.6	49.8
Ellipsaria lineolata	5	83.10	56.4	105.5	61.00	45.9	71.6	41.60	33.8	52.6
Elliptio crassidens	52	107.70	92.2	120.8	64.90	53.7	73.1	44.40	34.7	51.1
Obliquaria reflexa	1	50.60	50.6	50.6	34.70	34.7	34.7	33.90	33.9	33.9
Pleurobema cordatum	28	93.40	83.1	117.2	71.70	60.2	92.3	47.50	41.7	52.8
Potamilus alatus	2	113.60	105.7	121.4	70.00	63.3	76.6	36.00	33.3	38.8
Quadrula pustulosa	9	56.60	49.7	65.2	51.50	45.2	57.9	36.00	30.9	45.6

Appendix A-2. (Continued)

TRM 520-521 and Years 1983-1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	16	99.43	90.9	112.3	72.23	65.3	80.1	49.66	40.3	54.9
Amblema plicata	44	97.36	73.2	125.4	71.11	52.4	87.2	42.46	26.7	54.8
Anodonta grandis	7	116.96	81.7	136.3	68.73	53.6	84.9	47.76	34.5	57.2
Anodonta imbecillis	3	47.90	39.2	52.5	22.30	17.4	24.8	11.90	7.1	14.3
Cyclonaias tuberculata	556	75.83	56.9	111.0	64.66	47.6	92.1	37.61	23.7	49.8
Cyprogenia stegaria	3	54.07	51.6	57.7	52.23	49.7	55.6	38.83	36.0	44.1
Dromus dromas	1	60.10	60.1	60.1	58.30	58.3	58.3	32.80	32.8	32.8
Ellipsaria lineolata	112	79.78	51.8	105.5	60.54	39.2	75.1	36.80	22.6	52.6
Elliptio crassidens	727	105.54	87.2	151.8	65.89	53.7	88.6	42.08	21.0	60.9
Elliptio dilatata	8	102.20	95.4	113.3	44.42	41.0	48.8	31.81	26.9	39.9
Lampsilis abrupta	10	95.94	82.3	110.6	70.10	60.7	80.7	49.74	43.4	60.4
Lampsilis ovata	7	120.07	102.1	139.1	82.83	72.9	92.3	62.01	55.9	69.4
Lasmigona costata	1	122.10	122.1	122.1	69.90	69.9	69.9	25.50	25.5	25.5
Leptodea fragilis	4	85.67	59.6	110.4	54.50	34.6	72.6	30.48	20.1	39.2
Ligumia recta	24	147.75	107.7	170.2	56.85	45.0	63.4	45.05	33.1	52.9
Megalonaias nervosa	13	160.78	144.2	182.1	109.98	97.6	120.6	58.48	52.4	69.0
Obliquaria reflexa	7	46.50	36.5	52.7	34.72	24.1	41.6	26.83	22.9	33.9
Pleurobema cordatum	586	90.78	54.9	117.2	72.00	44.7	92.3	44.50	25.2	59.8
Pleurobema oviforme	1	72.90	72.9	72.9	56.50	56.5	56.5	40.20	40.2	40.2
Pleurobema plenum	3	59.43	51.3	68.9	56.10	49.4	66.0	41.47	36.4	48.6
Pleurobema rubrum	1	80.70	80.7	80.7	64.30	64.3	64.3	44.50	44.5	44.5
Potamilus alatus	87	129.80	46.9	160.0	92.11	60.1	120.9	39.49	26.8	139.8
Ptychobranchus fasciolaris	1	94.40	94.4	94.4	56.70	56.7	56.7	34.80	34.8	34.8
Quadrula metanevra	63	74.52	54.9	92.1	58.85	42.4	70.3	41.10	31.0	50.6
Quadrula pustulosa	186	52.89	38.2	74.1	49.94	37.2	64.3	31.68	20.5	45.6
Tritogonia verrucosa	8	99.40	76.7	116.3	54.16	42.7	60.9	29.87	19.7	36.1

Appendix A-2. (Continued)

TRM 526-527 and Year 1983	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	1	105.50	105.5	105.5	70.30	70.3	70.3	53.60	53.6	53.6
Amblema plicata	41	98.06	76.5	121.1	73.71	56.6	99.7	46.80	34.8	56.9
Anodonta grandis	22	124.84	101.6	154.6	68.28	55.3	89.6	53.76	39.6	67.9
Cyclonaias tuberculata	32	82.55	66.4	94.7	70.40	60.8	78.1	40.98	34.2	49.8
Ellipsaria lineolata	13	90.57	71.1	96.5	71.33	61.5	78.6	42.22	36.6	50.9
Elliptio crassidens	104	112.07	93.1	134.2	69.83	59.4	79.1	44.82	36.3	52.5
Elliptio dilatata	1	102.20	102.2	102.2	46.30	46.3	46.3	31.20	31.2	31.2
Lampsilis abrupta	1	103.10	103.1	103.1	84.40	84.4	84.4	58.20	58.2	58.2
Leptodea fragilis	1	112.40	112.4	112.4	66.40	66.4	66.4	32.70	32.7	32.7
Ligumia recta	2	162.50	160.0	165.0	66.05	63.8	68.3	55.35	54.0	56.7
Megalonaias nervosa	3	173.83	164.4	180.6	117.43	111.7	120.7	60.50	57.2	63.0
Obliquaria reflexa	18	54.35	45.1	64.1	44.40	35.3	51.5	34.88	25.5	41.4
Plethobasus cyphyus	2	91.80	89.3	94.3	64.55	62.8	66.3	45.00	43.6	46.4
Pleurobema cordatum	94	98.39	81.1	129.1	78.17	62.2	99.5	49.67	39.0	62.9
Potamilus alatus	27	142.29	96.6	162.8	104.00	79.3	120.9	38.95	24.1	46.5
Quadrula metanevra	7	84.54	75.1	92.2	64.21	60.1	71.1	47.81	44.0	50.9
Quadrula pustulosa	63	57.01	46.2	66.0	55.09	46.3	66.0	35.49	28.2	43.8
Tritogonia verrucosa	17	110.26	96.0	128.7	58.53	54.3	64.1	36.48	30.1	42.7

Appendix A-2. (Continued)

TRM 526-527 and Year 1984	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	16	100.54	84.8	120.1	73.24	62.3	88.0	44.96	38.9	52.4
Anodonta grandis	8	127.31	104.3	144.3	68.77	56.6	74.1	50.76	42.1	54.6
Anodonta imbecillis	1	54.70	54.7	54.7	23.20	23.2	23.2	16.90	16.9	16.9
Cyclonaias tuberculata	7	80.50	66.6	92.6	70.53	60.5	80.9	37.67	31.5	43.1
Ellipsaria lineolata	12	90.98	62.7	109.7	70.40	50.4	86.0	40.49	31.3	50.2
Elliptio crassidens	100	111.95	96.9	130.8	70.98	60.5	82.4	44.64	38.2	53.1
Lampsilis abrupta	3	98.63	96.4	100.2	70.80	66.1	74.8	57.07	54.7	60.2
Lampsilis ovata	1	139.80	139.8	139.8	92.60	92.6	92.6	68.80	68.8	68.8
Leptodea fragilis	5	109.62	104.5	118.1	65.02	62.1	68.4	35.10	30.9	38.4
Megalonaias nervosa	1	180.00	180.0	180.0	130.20	130.2	130.2	63.00	63.0	63.0
Obliquaria reflexa	9	55.80	49.2	64.0	43.27	36.1	52.3	34.44	26.3	39.8
Pleurobema cordatum	31	98.37	82.0	119.1	77.38	69.3	99.8	47.24	40.6	58.7
Potamilus alatus	23	153.90	132.3	182.1	105.20	80.5	134.5	41.12	36.8	46.5
Quadrula metanevra	1	79.10	79.1	79.1	64.60	64.6	64.6	54.90	54.9	54.9
Quadrula pustulosa	29	59.12	50.2	66.8	55.92	49.5	61.7	34.46	29.4	40.8
Tritogonia verrucosa	6	118.87	94.2	134.9	61.53	56.1	66.8	38.98	29.3	44.8

Appendix A-2. (Continued)

TRM 526-527 and Year 1985	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	20	100.06	84.1	119.5	71.56	58.2	84.8	43.86	36.1	56.7
Anodonta grandis	6	122.98	108.7	142.6	72.18	62.9	80.4	50.47	41.9	58.7
Cyclonaias tuberculata	11	82.09	73.5	91.5	70.28	62.1	76.6	39.97	35.6	42.7
Ellipsaria lineolata	13	89.20	80.9	100.4	69.52	62.3	76.9	39.52	34.9	46.8
Elliptio crassidens	105	111.88	90.7	134.8	70.36	60.1	82.9	43.96	34.2	53.7
Elliptio dilatata	1	100.80	100.8	100.8	44.20	44.2	44.2	34.80	34.8	34.8
Lampsilis ovata	2	127.20	120.8	133.6	81.15	76.1	86.2	63.05	61.5	64.6
Leptodea fragilis	4	103.30	86.9	114.7	61.30	55.4	66.8	34.38	30.2	39.8
Ligumia recta	1	170.10	170.1	170.1	72.40	72.4	72.4	50.10	50.1	50.1
Megalonaias nervosa	1	190.80	190.8	190.8	121.10	121.1	121.1	57.10	57.1	57.1
Obliquaria reflexa	8	57.25	52.4	66.9	43.74	40.1	50.8	33.39	30.1	36.6
Pleurobema cordatum	52	103.59	83.6	160.2	81.47	66.5	134.9	46.31	34.3	54.4
Potamilus alatus	49	143.15	104.7	170.2	103.43	81.6	125.6	40.52	28.4	49.6
Quadrula metanevra	3	85.90	80.6	88.9	67.27	64.7	70.3	43.80	40.2	50.3
Quadrula pustulosa	43	60.61	46.3	72.3	57.34	32.1	68.1	36.61	28.9	44.2
Tritogonia verrucosa	17	125.20	92.3	148.8	61.35	40.6	70.0	40.43	34.1	48.7

Appendix A-2. (Continued)

TRM 526-527 and Year 1986	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	27	97.68	66.7	121.4	69.54	50.6	84.9	44.09	26.8	57.4
Anodonta grandis	8	125.85	80.9	147.8	70.95	50.7	82.0	52.32	35.1	63.2
Cyclonaias tuberculata	17	79.26	63.2	96.7	67.04	55.9	80.2	39.89	33.1	51.0
Ellipsaria lineolata	7	96.04	83.6	112.3	70.80	61.5	78.2	43.99	34.1	52.5
Elliptio crassidens	105	113.05	92.3	145.2	68.73	59.1	87.1	43.35	35.1	54.1
Elliptio dilatata	1	107.10	107.1	107.1	50.00	50.0	50.0	35.40	35.4	35.4
Lampsilis abrupta	1	114.80	114.8	114.8	77.70	77.7	77.7	57.20	57.2	57.2
Lampsilis ovata	1	132.90	132.9	132.9	91.30	91.3	91.3	72.60	72.6	72.6
Leptodea fragilis	6	100.25	80.1	112.1	57.62	46.6	67.5	31.87	25.3	36.0
Ligumia recta	2	158.55	153.1	164.0	67.00	66.4	67.6	49.75	48.8	50.7
Megalonaias nervosa	2	145.80	124.6	167.0	103.25	87.2	119.3	58.35	57.0	59.7
Obliquaria reflexa	10	55.84	46.6	66.7	44.39	34.1	52.4	34.92	25.7	41.2
Pleurobema cordatum	38	96.12	75.7	117.9	75.20	63.2	83.5	47.08	42.4	56.3
Potamilus alatus	38	142.16	79.8	174.0	90.65	56.7	112.8	40.22	26.7	57.9
Quadrula metanevra	1	81.40	81.4	81.4	70.40	70.4	70.4	55.30	55.3	55.3
Quadrula pustulosa	20	57.10	42.4	67.0	54.51	42.4	66.1	33.57	25.7	40.0
Tritogonia verrucosa	20	111.93	87.1	133.0	56.05	47.6	66.7	33.90	24.7	42.9

Appendix A-2. (Continued)

TRM 526-527 and Year 1988	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	1	107.60	107.6	107.6	76.80	76.8	76.8	55.40	55.4	55.4
Amblema plicata	22	105.73	64.8	117.6	77.38	51.1	89.3	49.21	34.8	56.9
Anodonta grandis	19	131.44	101.0	155.1	72.65	56.1	89.9	55.26	43.5	71.2
Anodonta imbecillis	1	54.00	54.0	54.0	24.10	24.1	24.1	16.20	16.2	16.2
Cyclonaias tuberculata	8	82.56	63.4	94.7	71.49	60.7	78.1	41.26	31.3	45.0
Ellipsaria lineolata	4	88.22	81.7	94.3	68.20	61.5	72.8	40.80	38.4	42.3
Elliptio crassidens	51	113.30	100.1	129.2	70.47	44.2	79.3	45.82	39.9	55.3
Lampsilis abrupta	2	96.10	93.4	98.8	69.75	69.5	70.0	57.50	51.4	63.6
Lampsilis ovata	1	139.90	139.9	139.9	90.40	90.4	90.4	77.30	77.3	77.3
Leptodea fragilis	9	98.76	70.4	126.3	61.44	44.9	76.0	32.27	23.8	39.8
Obliquaria reflexa	7	54.84	44.2	62.7	43.20	36.2	49.6	32.27	24.4	36.0
Pleurobema cordatum	31	100.33	83.4	113.9	79.15	70.3	89.2	49.45	43.1	54.5
Pleurobema rubrum	1	88.30	88.3	88.3	69.50	69.5	69.5	46.70	46.7	46.7
Potamilus alatus	29	147.89	110.3	187.7	109.59	86.7	131.2	41.57	31.0	50.3
Quadrula pustulosa	21	58.90	52.6	64.0	55.89	46.6	64.1	36.14	30.0	40.6
Tritogonia verrucosa	13	114.88	96.3	140.8	64.74	50.1	76.3	41.53	29.7	50.7

Appendix A-2. (Continued)

TRM 526-527 and Year 1990	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	1	115.40	115.4	115.4	82.60	82.6	82.6	58.30	58.3	58.3
Amblema plicata	4	102.48	87.2	112.4	73.68	66.7	80.7	48.68	43.4	50.9
Anodonta grandis	17	136.27	108.7	159.1	76.23	61.5	99.9	56.54	44.4	68.8
Anodonta suborbiculata	1	126.20	126.2	126.2	96.40	96.4	96.4	48.30	48.3	48.3
Cyclonaias tuberculata	5	80.92	73.5	86.7	69.12	64.2	72.2	39.28	35.8	43.2
Ellipsaria lineolata	3	87.13	64.7	101.6	67.33	53.1	76.9	41.37	39.5	42.3
Elliptio crassidens	50	115.95	104.0	149.3	71.21	61.4	82.1	45.56	38.3	51.0
Lampsilis abrupta	1	98.10	98.1	98.1	83.70	83.7	83.7	62.10	62.1	62.1
Leptodea fragilis	5	111.74	101.8	130.1	69.30	61.0	89.5	36.24	32.8	40.0
Ligumia recta	1	173.10	173.1	173.1	73.50	73.5	73.5	59.90	59.9	59.9
Obliquaria reflexa	6	57.62	48.5	64.6	45.73	39.6	49.9	36.08	29.9	45.1
Pleurobema cordatum	24	102.52	90.2	120.7	78.21	69.0	90.6	48.51	41.7	52.8
Potamilus alatus	28	146.09	120.1	169.1	108.90	88.4	126.3	40.99	33.1	47.7
Quadrula metanevra	2	84.35	77.9	90.8	66.20	62.3	70.1	50.65	49.9	51.4
Quadrula pustulosa	26	60.05	50.1	74.4	55.38	44.9	66.9	35.37	28.0	42.1
Tritogonia verrucosa	7	105.43	78.1	130.1	56.16	43.4	65.9	35.67	26.6	42.5

Appendix A-2. (Continued)

TRM 526-527 and Year 1992	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	6	99.72	94.7	105.1	73.83	65.5	82.1	47.28	44.7	51.6
Anodonta grandis	4	129.70	122.0	136.8	73.85	67.3	79.2	58.88	54.0	65.1
Cyclonaias tuberculata	12	84.87	75.5	92.4	70.85	64.1	75.4	40.52	36.5	43.2
Ellipsaria lineolata	3	95.83	94.6	96.7	73.90	71.1	77.2	41.23	36.1	44.5
Elliptio crassidens	42	113.78	100.1	126.7	71.49	63.2	81.6	45.96	39.1	52.3
Lampsilis abrupta	2	107.55	99.8	115.3	72.35	66.3	78.4	52.55	52.2	52.9
Megalonaias nervosa	3	170.43	155.9	183.2	122.43	112.2	128.2	61.77	53.1	69.3
Obliquaria reflexa	4	57.75	52.0	61.5	44.05	40.9	47.9	33.78	30.9	36.7
Plethobasus cyphyus	1	91.40	91.4	91.4	64.80	64.8	64.8	50.30	50.3	50.3
Pleurobema cordatum	27	103.31	82.5	127.9	78.67	68.5	90.7	45.82	39.5	49.7
Potamilus alatus	5	142.44	116.6	161.2	106.72	94.0	116.9	40.20	35.1	47.4
Quadrula metanevra	3	79.53	75.7	87.2	61.43	58.3	66.5	44.37	40.9	48.2
Quadrula pustulosa	16	58.32	51.5	64.7	54.97	50.1	62.7	35.34	30.3	44.8
Tritogonia verrucosa	7	105.57	77.0	127.3	58.67	43.1	66.7	37.10	21.7	48.3

TRM 526-527 and Year 1994	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	11	108.42	97.6	119.1	78.67	72.2	89.7	49.41	45.2	54.7
Anodonta grandis	7	135.29	121.4	142.7	79.13	66.7	85.1	57.84	47.6	64.6
Cyclonaias tuberculata	8	79.01	72.0	85.1	68.94	63.7	73.5	38.94	34.8	41.6
Ellipsaria lineolata	1	96.10	96.1	96.1	76.70	76.7	76.7	42.30	42.3	42.3
Elliptio crassidens	85	116.05	96.5	129.8	72.99	62.5	82.4	46.66	39.4	52.9
Lampsilis abrupta	1	101.20	101.2	101.2	86.10	86.1	86.1	65.40	65.4	65.4
Leptodea fragilis	2	117.15	112.2	122.1	74.05	71.2	76.9	39.70	39.4	40.0
Ligumia recta	1	161.40	161.4	161.4	73.30	73.3	73.3	61.20	61.2	61.2
Obliquaria reflexa	11	57.30	52.8	69.5	45.68	41.4	51.7	35.04	29.6	42.7
Plethobasus cyphyus	1	88.60	88.6	88.6	59.40	59.4	59.4	46.20	46.2	46.2
Pleurobema cordatum	19	103.80	83.1	116.5	79.25	69.1	90.1	48.48	37.4	57.6
Potamilus alatus	5	153.00	131.9	168.6	117.24	109.4	128.5	43.88	38.4	46.5
Quadrula pustulosa	30	57.93	49.5	66.0	54.34	45.7	64.1	35.61	27.1	49.9
Tritogonia verrucosa	5	113.86	95.8	127.7	56.80	52.4	60.6	36.54	30.7	39.9

Appendix A-2. (Continued)

TRM 526-527 and Year 1996	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	6	103.30	84.0	117.1	73.70	59.1	86.5	49.20	41.0	57.3
Anodonta grandis	6	144.90	130.6	160.0	84.20	71.9	102.4	58.50	52.1	64.2
Cyclonaias tuberculata	7	84.50	75.5	87.9	69.80	67.8	71.5	42.30	40.0	46.5
Ellipsaria lineolata	4	94.40	89.0	100.9	71.10	66.5	75.6	43.30	42.0	44.4
Elliptio crassidens	29	118.20	101.4	151.1	73.10	63.5	82.5	48.40	42.3	56.9
Lampsilis abrupta	2	115.70	109.1	122.4	84.30	83.0	85.5	63.00	59.1	66.9
Megalonaias nervosa	1	180.00	180.0	180.0	123.60	123.6	123.6	66.00	66.0	66.0
Obliquaria reflexa	6	56.10	51.8	59.6	43.90	39.8	50.1	36.40	33.4	40.3
Pleurobema cordatum	20	102.60	77.1	120.9	79.30	65.2	91.2	50.20	41.2	56.0
Potamilus alatus	28	148.90	125.9	180.0	83.90	70.8	97.3	41.30	32.2	51.5
Quadrula metanevra	1	77.80	77.8	77.8	61.00	61.0	61.0	51.60	51.6	51.6
Quadrula pustulosa	9	59.60	50.6	68.6	55.40	48.9	60.0	38.10	31.3	47.7
Tritogonia verrucosa	3	101.60	88.5	127.5	54.20	49.4	60.8	35.50	29.6	40.3

TRM 526-527 and Year 1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	4	100.60	73.5	123.0	71.90	57.0	78.9	47.40	35.1	53.2
Anodonta grandis	1	147.00	147.0	147.0	81.00	81.0	81.0	63.40	63.4	63.4
Cyclonaias tuberculata	3	86.20	75.3	96.8	71.10	60.4	78.8	42.70	37.8	49.4
Ellipsaria lineolata	1	85.10	85.1	85.1	71.60	71.6	71.6	41.50	41.5	41.5
Elliptio crassidens	50	115.60	96.7	131.5	71.50	58.8	80.5	46.90	39.6	59.8
Leptodea fragilis	2	92.20	69.3	115.0	56.10	40.5	71.7	26.90	21.5	37.3
Obliquaria reflexa	2	55.80	54.2	57.4	45.70	44.6	46.7	34.80	33.0	36.6
Pleurobema cordatum	18	103.20	93.5	112.6	77.60	70.5	83.9	52.40	43.8	57.3
Potamilus alatus	6	154.00	142.4	166.9	87.10	78.4	95.8	43.20	39.7	48.9
Quadrula metanevra	1	85.00	85.0	85.0	65.70	65.7	65.7	45.40	45.4	45.4
Quadrula pustulosa	6	60.50	53.7	65.3	55.80	51.6	58.9	37.20	31.9	42.0
Tritogonia verrucosa	1	109.60	109.6	109.6	52.80	52.8	52.8	38.30	38.3	38.3

Appendix A-2. (Continued)

TRM 526-527 and Years 1983-1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	3	109.50	105.5	115.4	76.57	70.3	82.6	55.77	53.6	58.3
Amblema plicata	157	100.74	64.8	123.0	73.92	50.6	99.7	46.47	26.8	57.4
Anodonta grandis	98	130.67	80.9	160.0	73.11	50.7	102.4	54.85	35.1	71.2
Anodonta imbecillis	2	54.35	54.0	54.7	23.65	23.2	24.1	16.55	16.2	16.9
Anodonta suborbiculata	1	126.20	126.2	126.2	96.40	96.4	96.4	48.30	48.3	48.3
Cyclonaias tuberculata	110	82.01	63.2	96.8	69.81	55.9	80.9	40.37	31.3	51.0
Ellipsaria lineolata	61	91.17	62.7	112.3	70.50	50.4	86.0	41.38	31.3	52.5
Elliptio crassidens	721	113.59	90.7	151.1	70.76	44.2	87.1	45.15	34.2	59.8
Elliptio dilatata	3	103.37	100.8	107.1	46.83	44.2	50.0	33.80	31.2	35.4
Lampsilis abrupta	13	103.98	93.4	122.4	76.00	66.1	86.1	58.47	51.4	65.4
Lampsilis ovata	5	133.40	120.8	139.9	87.32	76.1	92.6	68.96	61.5	77.3
Leptodea fragilis	34	104.16	69.3	130.1	63.01	40.5	89.5	33.58	21.5	40.0
Ligumia recta	7	163.81	153.1	173.1	69.33	63.8	73.5	54.49	48.8	61.2
Megalonaias nervosa	11	170.47	124.6	190.8	118.27	87.2	130.2	60.87	53.1	69.3
Obliquaria reflexa	81	56.00	44.2	69.5	44.35	34.1	52.4	34.63	24.4	45.1
Plethobasus cyphyus	4	90.90	88.6	94.3	63.33	59.4	66.3	46.63	43.6	50.3
Pleurobema cordatum	354	100.51	75.7	160.2	78.49	62.2	134.9	48.39	34.3	62.9
Pleurobema rubrum	1	88.30	88.3	88.3	69.50	69.5	69.5	46.70	46.7	46.7
Potamilus alatus	238	145.99	79.8	187.7	91.15	56.7	134.5	40.76	24.1	57.9
Quadrula metanevra	19	83.16	75.1	92.2	64.72	58.3	71.1	47.77	40.2	55.3
Quadrula pustulosa	263	58.64	42.4	74.4	55.53	32.1	68.1	35.59	25.7	49.9
Tritogonia verrucosa	96	113.63	77.0	148.8	59.09	40.6	76.3	37.46	21.7	50.7

Appendix A-2. (Continued)

TRM 528-529 and Year 1983	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	102.95	92.5	113.4	72.95	69.3	76.6	53.40	48.3	58.5
Amblema plicata	5	103.20	84.7	132.3	75.74	64.1	94.6	40.42	30.4	51.3
Anodonta grandis	6	111.01	83.0	128.0	63.24	46.1	72.3	46.23	35.4	54.9
Cyclonaias tuberculata	43	82.19	66.8	96.5	69.89	57.3	79.9	40.56	32.6	46.6
Cyprogenia stegaria	2	56.45	52.9	60.0	51.14	50.9	51.4	38.71	36.8	40.6
Ellipsaria lineolata	12	90.16	66.4	108.8	67.22	52.4	76.8	42.40	36.6	51.3
Elliptio crassidens	105	110.49	86.8	134.6	68.14	54.4	89.9	43.39	34.9	56.1
Elliptio dilatata	1	95.30	95.3	95.3	44.10	44.1	44.1	30.50	30.5	30.5
Fusconaia subrotunda	1	66.09	66.1	66.1	53.56	53.6	53.6	36.58	36.6	36.6
Lampsilis abrupta	7	94.00	70.5	106.4	70.46	59.4	80.4	51.68	39.8	60.1
Lampsilis ovata	1	132.30	132.3	132.3	91.64	91.6	91.6	76.30	76.3	76.3
Leptodea fragilis	1	81.70	81.7	81.7	48.20	48.2	48.2	29.50	29.5	29.5
Ligumia recta	3	155.31	145.8	160.1	62.95	60.3	65.1	51.84	50.6	53.8
Obliquaria reflexa	1	49.00	49.0	49.0	39.70	39.7	39.7	34.30	34.3	34.3
Pleurobema cordatum	105	97.39	73.3	114.2	76.61	59.3	86.7	49.44	32.3	61.2
Potamilus alatus	5	126.89	110.3	141.8	88.62	69.1	119.8	39.26	34.5	44.1
Quadrula metanevra	13	75.86	46.9	92.6	59.96	42.2	74.4	42.98	26.2	54.7
Quadrula pustulosa	57	57.27	44.8	69.9	54.45	42.1	66.9	35.05	28.8	43.5
Tritogonia verrucosa	1	106.72	106.7	106.7	62.81	62.8	62.8	32.64	32.6	32.6

Appendix A-2. (Continued)

TRM 528-529 and Year 1984	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	109.55	99.4	119.7	81.00	74.0	88.0	53.25	53.1	53.4
Amblema plicata	8	95.05	73.6	113.8	71.76	59.5	84.3	37.02	26.8	48.4
Anodonta grandis	1	102.70	102.7	102.7	56.90	56.9	56.9	39.60	39.6	39.6
Cyclonaias tuberculata	23	82.19	69.4	99.1	69.40	60.3	79.1	39.06	33.5	46.3
Ellipsaria lineolata	14	84.82	63.6	108.7	63.59	50.1	78.3	39.51	34.1	46.3
Elliptio crassidens	101	112.00	94.7	129.8	69.07	58.0	78.5	43.58	36.0	54.5
Elliptio dilatata	1	92.60	92.6	92.6	43.70	43.7	43.7	21.50	21.5	21.5
Lampsilis abrupta	4	96.70	86.8	106.8	68.78	64.6	74.0	57.80	52.9	62.4
Lampsilis ovata	3	132.67	118.5	142.7	88.90	82.0	102.7	70.83	63.5	76.7
Leptodea fragilis	1	119.90	119.9	119.9	66.50	66.5	66.5	40.80	40.8	40.8
Ligumia recta	9	162.78	146.6	185.2	60.77	56.1	66.6	51.30	44.0	54.9
Obliquaria reflexa	1	51.20	51.2	51.2	40.20	40.2	40.2	30.80	30.8	30.8
Pleurobema cordatum	103	98.58	76.1	132.6	77.42	52.1	90.6	47.97	34.2	79.9
Pleurobema oviforme	2	69.80	63.5	76.1	55.70	50.6	60.8	40.35	40.0	40.7
Potamilus alatus	10	139.25	110.2	163.2	91.64	72.5	102.3	40.80	34.3	44.8
Quadrula metanevra	9	84.71	72.5	94.8	67.19	56.9	76.1	46.33	39.7	50.9
Quadrula pustulosa	56	58.80	46.4	72.0	55.34	44.4	64.8	34.54	20.2	40.9
Tritogonia verrucosa	3	104.83	84.6	121.4	59.37	49.5	64.4	29.40	24.3	32.4

Appendix A-2. (Continued)

TRM 528-529 and Year 1985	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	6	104.13	92.7	113.4	72.30	66.8	80.3	50.88	46.6	54.6
Amblema plicata	19	108.21	76.3	132.5	79.99	62.9	94.9	42.61	30.5	54.4
Anodonta grandis	4	123.38	107.9	130.1	65.80	60.9	69.6	46.20	40.7	50.1
Cyclonaias tuberculata	41	82.26	70.5	94.6	68.68	59.5	78.4	38.85	32.0	44.9
Ellipsaria lineolata	15	90.71	70.1	98.4	68.05	52.2	76.1	40.40	36.4	44.7
Elliptio crassidens	100	114.33	99.1	130.5	69.92	20.1	84.7	44.20	36.1	52.4
Lampsilis abrupta	6	103.77	92.6	113.3	75.07	64.4	81.1	56.83	50.6	64.4
Lampsilis ovata	6	128.43	114.0	142.0	84.58	70.0	103.4	62.65	57.3	70.2
Lasmigona complanata	1	180.20	180.2	180.2	114.30	114.3	114.3	40.30	40.3	40.3
Leptodea fragilis	1	88.20	88.2	88.2	50.20	50.2	50.2	28.60	28.6	28.6
Ligumia recta	6	168.92	154.4	180.3	64.07	60.2	72.4	53.33	49.9	60.4
Megalonaias nervosa	2	173.70	172.2	175.2	118.25	116.8	119.7	66.15	60.9	71.4
Obliquaria reflexa	3	54.67	50.5	58.8	43.13	40.2	46.8	33.50	30.9	36.7
Pleurobema cordatum	105	96.94	76.3	112.2	76.82	60.6	89.9	46.09	34.1	59.1
Pleurobema plenum	1	84.60	84.6	84.6	70.20	70.2	70.2	50.60	50.6	50.6
Pleurobema rubrum	2	91.60	90.4	92.8	73.20	71.6	74.8	50.60	49.8	51.4
Potamilus alatus	13	140.13	102.6	155.2	102.73	80.6	119.5	41.25	30.6	46.8
Quadrula metanevra	2	80.70	76.9	84.5	63.45	62.8	64.1	48.90	43.6	54.2
Quadrula pustulosa	69	57.78	48.5	80.5	54.68	44.8	68.8	34.83	26.3	42.8
Tritogonia verrucosa	1	136.10	136.1	136.1	72.00	72.0	72.0	34.00	34.0	34.0

Appendix A-2. (Continued)

TRM 528-529 and Year 1986	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	4	103.52	88.2	116.3	71.28	63.2	75.7	48.63	43.4	52.8
Amblema plicata	15	113.97	80.9	137.4	79.28	58.0	94.9	43.03	27.8	55.3
Anodonta grandis	6	117.00	102.2	135.2	64.53	57.0	79.4	46.35	37.2	56.7
Cyclonaias tuberculata	42	81.98	68.4	94.3	69.32	57.0	79.3	39.83	33.0	48.1
Ellipsaria lineolata	15	89.69	63.9	110.8	66.99	50.1	78.8	41.21	35.1	53.3
Elliptio crassidens	99	112.84	93.4	136.2	68.64	53.8	85.2	42.61	31.0	55.5
Elliptio dilatata	1	111.20	111.2	111.2	52.60	52.6	52.6	42.20	42.2	42.2
Lampsilis abrupta	3	98.33	90.3	108.6	72.07	66.4	76.2	53.30	50.7	56.7
Lampsilis ovata	1	152.20	152.2	152.2	101.40	101.4	101.4	72.00	72.0	72.0
Leptodea fragilis	3	90.10	79.4	111.1	51.33	47.3	59.1	29.23	26.7	33.1
Ligumia recta	9	155.47	135.3	173.1	58.03	48.0	64.5	50.77	44.5	55.9
Megalonaias nervosa	1	175.60	175.6	175.6	117.90	117.9	117.9	58.00	58.0	58.0
Obliquaria reflexa	2	51.45	50.7	52.2	36.15	32.0	40.3	25.75	21.6	29.9
Pleurobema cordatum	99	95.61	74.4	116.0	74.47	57.4	84.8	46.86	36.2	61.9
Pleurobema oviforme	2	68.90	68.4	69.4	50.70	48.6	52.8	35.60	33.0	38.2
Potamilus alatus	19	141.82	112.8	164.1	90.17	72.9	123.6	41.89	30.9	79.6
Quadrula metanevra	4	83.83	75.7	91.2	68.80	61.1	84.2	50.20	46.4	54.1
Quadrula pustulosa	35	56.95	46.5	71.6	53.18	43.4	64.2	33.65	24.7	42.1
Tritogonia verrucosa	1	78.80	78.8	78.8	41.40	41.4	41.4	26.70	26.7	26.7

Appendix A-2. (Continued)

TRM 528-529 and Year 1988	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	14	101.22	82.3	119.8	74.19	63.5	89.8	44.59	32.1	52.0
Anodonta grandis	7	125.20	109.7	136.1	66.87	57.6	81.3	52.64	48.4	58.7
Anodonta suborbiculata	1	107.80	107.8	107.8	79.20	79.2	79.2	38.70	38.7	38.7
Cyclonaias tuberculata	29	83.77	67.2	97.5	69.95	58.9	97.7	41.00	36.1	49.3
Ellipsaria lineolata	10	93.77	83.5	102.8	69.20	62.1	77.4	41.00	36.1	44.5
Elliptio crassidens	51	112.93	99.6	136.4	69.48	61.3	76.2	44.49	36.3	54.6
Elliptio dilatata	2	103.25	95.6	110.9	45.45	40.8	50.1	29.15	27.5	30.8
Lampsilis abrupta	10	101.72	86.8	119.8	72.11	62.7	79.8	57.43	51.9	60.9
Lampsilis ovata	1	140.50	140.5	140.5	87.70	87.7	87.7	58.00	58.0	58.0
Leptodea fragilis	3	102.97	98.2	106.4	60.70	56.7	63.0	31.67	28.8	34.0
Ligumia recta	5	161.96	146.6	175.1	64.36	62.0	68.7	53.08	50.2	55.1
Megalonaias nervosa	5	164.90	155.1	170.8	118.14	110.4	126.6	61.18	53.6	68.7
Pleurobema cordatum	50	99.99	86.1	119.1	78.51	69.2	87.5	48.33	39.4	58.6
Pleurobema oviforme	2	72.20	70.2	74.2	55.00	54.0	56.0	40.70	40.7	40.7
Potamilus alatus	15	139.96	118.6	155.2	107.58	90.1	120.9	40.10	34.8	49.3
Quadrula metanevra	2	91.25	90.7	91.8	67.40	67.2	67.6	52.10	50.6	53.6
Quadrula pustulosa	51	58.83	36.1	81.1	55.00	40.7	98.4	35.02	26.2	43.1
Tritogonia verrucosa	2	115.75	98.3	133.2	56.80	51.4	62.2	43.55	26.7	60.4

Appendix A-2. (Continued)

TRM 528-529 and Year 1990	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	120.90	120.8	121.0	81.30	80.1	82.5	60.95	60.1	61.8
Amblema plicata	1	110.20	110.2	110.2	75.70	75.7	75.7	38.50	38.5	38.5
Anodonta grandis	2	127.75	126.4	129.1	74.10	69.2	79.0	52.95	46.8	59.1
Cyclonaias tuberculata	14	87.13	76.3	94.9	73.68	66.8	83.3	40.56	34.1	49.6
Ellipsaria lineolata	9	85.23	72.7	102.3	64.28	53.2	74.6	41.13	36.2	47.4
Elliptio crassidens	60	119.35	104.6	134.7	72.48	61.1	82.7	46.00	38.2	51.6
Elliptio dilatata	1	94.60	94.6	94.6	46.90	46.9	46.9	28.60	28.6	28.6
Lampsilis abrupta	3	108.57	101.0	120.6	83.23	81.8	86.0	62.17	55.7	67.7
Lampsilis ovata	1	121.70	121.7	121.7	78.10	78.1	78.1	68.30	68.3	68.3
Leptodea fragilis	1	124.70	124.7	124.7	69.60	69.6	69.6	39.70	39.7	39.7
Ligumia recta	1	172.10	172.1	172.1	68.30	68.3	68.3	58.70	58.7	58.7
Megalonaias nervosa	1	170.10	170.1	170.1	118.40	118.4	118.4	57.10	57.1	57.1
Obliquaria reflexa	3	56.40	54.8	58.0	42.90	40.3	46.4	30.37	28.5	31.7
Pleurobema cordatum	74	98.21	85.4	116.8	76.30	67.2	90.1	47.50	39.6	56.9
Pleurobema oviforme	1	72.80	72.8	72.8	56.00	56.0	56.0	41.70	41.7	41.7
Potamilus alatus	4	124.70	83.2	147.6	101.20	72.6	116.9	36.65	21.5	43.5
Ptychobranchus fasciolaris	1	116.80	116.8	116.8	61.40	61.4	61.4	44.70	44.7	44.7
Quadrula metanevra	4	89.70	85.3	100.7	66.98	60.2	71.5	48.43	46.3	51.8
Quadrula pustulosa	35	58.17	44.1	82.8	54.31	43.3	67.4	34.77	25.2	45.4
Tritogonia verrucosa	1	136.30	136.3	136.3	70.90	70.9	70.9	34.70	34.7	34.7

Appendix A-2. (Continued)

TRM 528-529 and Year 1992	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	5	106.76	89.9	118.2	78.08	68.4	88.8	39.76	24.9	50.4
Cyclonaias tuberculata	12	82.04	70.3	97.1	70.42	59.6	79.4	39.90	29.5	44.5
Ellipsaria lineolata	3	96.67	90.8	99.6	68.43	67.9	69.1	40.80	39.6	42.2
Elliptio crassidens	52	117.40	99.7	136.6	71.86	63.2	83.3	45.77	39.2	53.3
Lampsilis abrupta	4	109.50	96.8	116.3	75.78	68.8	83.4	55.78	50.7	59.8
Ligumia recta	1	165.70	165.7	165.7	60.70	60.7	60.7	59.90	59.9	59.9
Obliquaria reflexa	1	59.30	59.3	59.3	42.90	42.9	42.9	28.90	28.9	28.9
Pleurobema cordatum	29	102.50	86.8	119.8	78.50	72.0	94.2	49.27	39.3	59.8
Potamilus alatus	5	145.50	139.3	150.1	103.32	90.6	109.4	42.50	39.0	46.8
Quadrula metanevra	3	75.00	61.9	84.7	61.57	60.7	62.0	44.23	37.4	47.7
Quadrula pustulosa	18	57.97	52.2	66.9	53.86	47.6	59.7	33.30	28.2	40.3

TRM 528-529 and Year 1994	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Cyclonaias tuberculata	10	81.57	58.4	91.2	67.30	50.3	72.9	39.50	28.3	46.9
Ellipsaria lineolata	3	97.83	94.0	100.2	71.60	69.5	73.1	46.57	44.4	48.6
Elliptio crassidens	66	115.95	104.6	129.2	71.54	62.5	84.7	45.53	39.2	50.8
Lampsilis abrupta	1	108.90	108.9	108.9	82.30	82.3	82.3	65.90	65.9	65.9
Leptodea fragilis	1	118.70	118.7	118.7	70.50	70.5	70.5	39.40	39.4	39.4
Megalonaias nervosa	1	168.70	168.7	168.7	119.20	119.2	119.2	58.70	58.7	58.7
Pleurobema cordatum	41	100.75	84.4	110.7	77.52	68.1	86.3	47.35	34.3	62.7
Pleurobema oviforme	1	71.90	71.9	71.9	59.80	59.8	59.8	41.70	41.7	41.7
Potamilus alatus	3	158.20	145.7	172.3	119.43	108.8	128.6	45.40	43.6	46.5
Quadrula metanevra	1	81.90	81.9	81.9	60.20	60.2	60.2	39.30	39.3	39.3
Quadrula pustulosa	29	58.69	46.2	66.6	54.43	43.8	64.8	35.44	29.8	42.5
Tritogonia verrucosa	2	119.95	99.6	140.3	64.15	58.7	69.6	36.90	31.8	42.0

Appendix A-2. (Continued)

TRM 528-529 and Year 1996	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	3	109.90	100.4	122.5	76.50	72.1	79.0	46.30	38.0	52.3
Anodonta grandis	1	118.10	118.1	118.1	67.70	67.7	67.7	47.40	47.4	47.4
Cyclonaias tuberculata	13	86.50	75.3	94.9	71.90	65.1	80.8	42.50	35.5	47.7
Ellipsaria lineolata	9	94.00	72.6	107.5	68.30	49.7	80.7	44.70	34.5	50.7
Elliptio crassidens	50	114.90	88.9	131.3	68.90	53.5	85.7	46.30	39.4	61.7
Lampsilis abrupta	1	110.10	110.1	110.1	75.70	75.7	75.7	60.30	60.3	60.3
Lasmigona costata	1	118.40	118.4	118.4	60.60	60.6	60.6	35.20	35.2	35.2
Leptodea fragilis	1	126.20	126.2	126.2	71.30	71.3	71.3	40.70	40.7	40.7
Ligumia recta	1	155.00	155.0	155.0	61.90	61.9	61.9	49.50	49.5	49.5
Pleurobema cordatum	46	100.80	85.3	112.5	78.90	65.4	90.5	49.60	38.3	59.6
Potamilus alatus	4	145.90	135.5	154.1	110.60	86.7	131.7	44.20	39.2	46.8
Quadrula metanevra	1	86.10	86.1	86.1	66.10	66.1	66.1	47.70	47.7	47.7
Quadrula pustulosa	19	61.60	53.0	77.3	56.00	49.6	62.5	38.20	31.1	49.5
Tritogonia verrucosa	1	134.10	134.1	134.1	61.30	61.3	61.3	31.60	31.6	31.6

Appendix A-2. (Continued)

TRM 528-529 and Year 1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	1	77.60	77.6	77.6	57.10	57.1	57.1	31.50	31.5	31.5
Cyclonaias tuberculata	13	87.40	79.3	96.2	72.70	65.4	78.8	44.10	38.5	51.9
Ellipsaria lineolata	2	77.00	69.4	84.6	57.70	54.3	61.0	38.80	35.5	42.2
Elliptio crassidens	50	116.10	101.7	134.5	68.40	59.1	83.4	45.80	33.5	65.0
Lampsilis ovata	1	115.30	115.3	115.3	74.10	74.1	74.1	69.50	69.5	69.5
Ligumia recta	1	160.00	160.0	160.0	71.50	71.5	71.5	59.60	59.6	59.6
Pleurobema cordatum	36	99.50	87.1	107.9	77.30	68.7	88.4	50.50	42.9	57.1
Potamilus alatus	4	151.50	122.0	168.8	85.00	74.6	92.9	44.90	42.4	46.6
Quadrula metanevra	1	91.00	91.0	91.0	63.50	63.5	63.5	46.40	46.4	46.4
Quadrula pustulosa	9	60.50	49.2	67.3	55.60	48.7	60.7	35.80	28.4	41.8

Appendix A-2. (Continued)

TRM 528-529 and Years 1983-1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	16	106.61	88.2	121.0	74.34	63.2	88.0	52.19	43.4	61.8
Amblema plicata	71	105.77	73.6	137.4	76.80	57.1	94.9	42.13	24.9	55.3
Anodonta grandis	27	119.14	83.0	136.1	65.58	46.1	81.3	48.21	35.4	59.1
Anodonta suborbiculata	1	107.80	107.8	107.8	79.20	79.2	79.2	38.70	38.7	38.7
Cyclonaias tuberculata	240	83.12	58.4	99.1	69.95	50.3	97.7	40.27	28.3	51.9
Cyprogenia stegaria	2	56.45	52.9	60.0	51.14	50.9	51.4	38.71	36.8	40.6
Ellipsaria lineolata	92	89.83	63.6	110.8	66.77	50.1	80.7	41.39	34.1	53.3
Elliptio crassidens	734	114.11	86.8	136.6	69.70	20.1	89.9	44.44	31.0	65.0
Elliptio dilatata	6	100.03	92.6	111.2	46.37	40.8	52.6	30.18	21.5	42.2
Fusconaia subrotunda	1	66.09	66.1	66.1	53.56	53.6	53.6	36.58	36.6	36.6
Lampsilis abrupta	39	101.59	70.5	120.6	73.51	59.4	86.0	56.51	39.8	67.7
Lampsilis ovata	14	130.76	114.0	152.2	86.23	70.0	103.4	66.60	57.3	76.7
Lasmigona complanata	1	180.20	180.2	180.2	114.30	114.3	114.3	40.30	40.3	40.3
Lasmigona costata	1	118.40	118.4	118.4	60.60	60.6	60.6	35.20	35.2	35.2
Leptodea fragilis	12	103.22	79.4	126.2	59.36	47.3	71.3	33.45	26.7	40.8
Ligumia recta	36	161.29	135.3	185.2	61.85	48.0	74.1	52.42	44.0	60.4
Megalonaias nervosa	10	168.63	155.1	175.6	118.27	110.4	126.6	61.20	53.6	71.4
Obliquaria reflexa	11	54.15	49.0	59.3	41.20	32.0	46.8	30.65	21.6	36.7
Pleurobema cordatum	688	98.28	73.3	132.6	76.89	52.1	94.2	47.97	32.3	79.9
Pleurobema oviforme	8	70.81	63.5	76.1	54.82	48.6	60.8	39.59	33.0	41.7
Pleurobema plenum	1	84.60	84.6	84.6	70.20	70.2	70.2	50.60	50.6	50.6
Pleurobema rubrum	2	91.60	90.4	92.8	73.20	71.6	74.8	50.60	49.8	51.4
Potamilus alatus	82	140.65	83.2	172.3	98.58	69.1	131.7	41.34	21.5	79.6
Ptychobranchus fasciolaris	1	116.80	116.8	116.8	61.40	61.4	61.4	44.70	44.7	44.7
Quadrula metanevra	40	81.77	46.9	100.7	64.09	42.2	84.2	45.96	26.2	54.7
Quadrula pustulosa	378	58.29	36.1	82.8	54.64	40.7	98.4	34.90	20.2	49.5
Tritogonia verrucosa	12	114.82	78.8	140.3	60.70	41.4	72.0	34.06	24.3	60.4

Appendix A-2. (Continued)

Three Bed Composite and Year 1983	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	5	104.00	92.5	113.4	73.84	69.3	80.1	51.88	46.8	58.5
Amblema plicata	53	96.86	74.4	132.3	72.73	56.6	99.7	45.37	30.4	56.9
Anodonta grandis	28	121.88	83.0	154.6	67.20	46.1	89.6	52.15	35.4	67.9
Cyclonaias tuberculata	147	79.14	62.1	96.5	67.90	52.1	80.2	39.50	32.4	49.8
Cyprogenia stegaria	3	54.83	51.6	60.0	50.66	49.7	51.4	37.81	36.0	40.6
Dromus dromas	1	60.10	60.1	60.1	58.30	58.3	58.3	32.80	32.8	32.8
Ellipsaria lineolata	45	85.29	56.8	108.8	65.74	44.6	78.6	40.30	30.1	51.3
Elliptio crassidens	311	107.96	86.8	134.6	67.29	54.0	89.9	42.93	21.0	56.1
Elliptio dilatata	5	103.32	95.3	113.3	45.50	42.2	48.8	32.38	30.5	34.7
Fusconaia subrotunda	1	66.09	66.1	66.1	53.56	53.6	53.6	36.58	36.6	36.6
Lampsilis abrupta	10	94.39	70.5	106.4	71.17	59.4	84.4	50.94	39.8	60.1
Lampsilis ovata	4	124.93	122.0	132.3	86.21	74.7	92.3	68.48	62.0	76.3
Leptodea fragilis	4	84.13	59.6	112.4	49.33	34.6	66.4	27.10	20.1	32.7
Ligumia recta	8	155.34	145.1	165.0	62.50	56.6	68.3	50.50	42.5	56.7
Megalonaias nervosa	3	173.83	164.4	180.6	117.43	111.7	120.7	60.50	57.2	63.0
Obliquaria reflexa	20	53.78	45.1	64.1	43.15	24.1	51.5	34.33	24.6	41.4
Plethobasus cyphyus	2	91.80	89.3	94.3	64.55	62.8	66.3	45.00	43.6	46.4
Pleurobema cordatum	301	95.39	72.1	129.1	75.65	59.3	99.5	48.25	31.4	62.9
Pleurobema plenum	1	58.10	58.1	58.1	52.90	52.9	52.9	36.40	36.4	36.4
Potamilus alatus	43	135.39	46.9	162.8	98.20	69.1	120.9	38.12	24.1	46.5
Quadrula metanevra	36	76.52	46.9	92.6	60.28	42.2	74.4	44.22	26.2	54.7
Quadrula pustulosa	158	55.91	43.7	69.9	53.61	40.5	66.9	34.47	26.3	43.8
Tritogonia verrucosa	18	110.06	96.0	128.7	58.77	54.3	64.1	36.27	30.1	42.7

Appendix A-2. (Continued)

Three Bed Composite and Year 1984	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	2	109.55	99.4	119.7	81.00	74.0	88.0	53.25	53.1	53.4
Amblema plicata	30	98.18	73.6	120.1	72.73	59.5	88.0	42.37	26.8	52.4
Anodonta grandis	9	124.58	102.7	144.3	67.46	56.6	74.1	49.52	39.6	54.6
Anodonta imbecillis	2	53.60	52.5	54.7	23.95	23.2	24.7	15.60	14.3	16.9
Cyclonaias tuberculata	131	76.09	59.1	99.1	65.19	52.2	80.9	37.77	29.5	46.3
Cyprogenia stegaria	1	52.90	52.9	52.9	51.40	51.4	51.4	36.40	36.4	36.4
Ellipsaria lineolata	49	82.92	56.6	109.7	62.95	44.0	86.0	37.88	26.3	50.2
Elliptio crassidens	302	109.58	89.2	130.8	68.75	56.3	82.4	43.30	24.4	60.9
Elliptio dilatata	2	96.35	92.6	100.1	42.95	42.2	43.7	24.75	21.5	28.0
Lampsilis abrupta	8	96.66	86.8	106.8	68.52	60.7	74.8	56.31	48.1	62.4
Lampsilis ovata	5	127.98	102.1	142.7	86.44	72.9	102.7	67.56	56.5	76.7
Leptodea fragilis	6	111.33	104.5	119.9	65.27	62.1	68.4	36.05	30.9	40.8
Ligumia recta	14	157.96	140.9	185.2	59.61	50.5	66.6	49.65	40.0	54.9
Megalonaias nervosa	1	180.00	180.0	180.0	130.20	130.2	130.2	63.00	63.0	63.0
Obliquaria reflexa	11	53.63	36.5	64.0	42.05	32.9	52.3	33.06	22.9	39.8
Pleurobema cordatum	234	95.08	62.1	132.6	74.99	44.7	99.8	46.26	32.8	79.9
Pleurobema oviforme	2	69.80	63.5	76.1	55.70	50.6	60.8	40.35	40.0	40.7
Pleurobema plenum	2	60.10	51.3	68.9	57.70	49.4	66.0	44.00	39.4	48.6
Potamilus alatus	47	142.73	96.7	182.1	97.96	72.5	134.5	39.57	30.0	46.5
Ptychobranchus fasciolaris	1	94.40	94.4	94.4	56.70	56.7	56.7	34.80	34.8	34.8
Quadrula metanevra	24	78.68	64.5	94.8	62.47	52.6	76.1	43.05	32.4	54.9
Quadrula pustulosa	138	56.75	40.0	74.1	53.65	39.5	64.8	33.43	20.2	40.9
Tritogonia verrucosa	10	110.44	76.7	134.9	59.00	42.7	66.8	34.18	19.7	44.8

Appendix A-2. (Continued)

Three Bed Composite and Year 1985	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	11	104.72	92.7	113.4	73.72	66.8	80.3	51.75	46.6	54.9
Amblema plicata	42	103.37	76.3	132.5	75.25	58.2	94.9	43.01	30.5	56.7
Anodonta grandis	10	123.14	107.9	142.6	69.63	60.9	80.4	48.76	40.7	58.7
Cyclonaias tuberculata	124	78.39	60.5	94.6	66.76	54.7	78.4	37.85	30.6	44.9
Cyprogenia stegaria	1	57.70	57.7	57.7	55.60	55.6	55.6	44.10	44.1	44.1
Ellipsaria lineolata	35	87.83	62.3	100.4	67.24	46.9	76.9	38.96	32.0	46.8
Elliptio crassidens	306	110.22	90.1	134.8	68.72	20.1	88.5	43.21	29.5	53.7
Elliptio dilatata	2	98.80	96.8	100.8	44.20	44.2	44.2	32.30	29.8	34.8
Lampsilis abrupta	8	101.94	82.3	113.3	74.21	64.4	81.1	55.61	43.5	64.4
Lampsilis ovata	9	127.36	114.0	142.0	84.03	70.0	103.4	62.70	57.3	70.2
Lasmigona complanata	1	180.20	180.2	180.2	114.30	114.3	114.3	40.30	40.3	40.3
Leptodea fragilis	5	100.28	86.9	114.7	59.08	50.2	66.8	33.22	28.6	39.8
Ligumia recta	11	165.39	142.2	180.3	63.30	57.2	72.4	50.06	41.3	60.4
Megalonaias nervosa	5	173.70	160.1	190.8	115.26	102.3	121.1	59.66	52.4	71.4
Obliquaria reflexa	12	55.72	46.6	66.9	42.95	36.1	50.8	32.58	23.4	36.7
Pleurobema cordatum	245	96.42	70.4	160.2	76.58	58.2	134.9	45.35	30.2	59.1
Pleurobema oviforme	1	72.90	72.9	72.9	56.50	56.5	56.5	40.20	40.2	40.2
Pleurobema plenum	1	84.60	84.6	84.6	70.20	70.2	70.2	50.60	50.6	50.6
Pleurobema rubrum	3	87.97	80.7	92.8	70.23	64.3	74.8	48.57	44.5	51.4
Potamilus alatus	77	139.79	98.0	170.2	100.29	76.5	125.6	39.87	28.4	49.6
Quadrula metanevra	16	78.07	67.3	88.9	61.94	56.1	70.3	42.39	36.8	54.2
Quadrula pustulosa	138	57.98	46.3	80.5	54.91	32.1	68.8	34.83	25.7	44.2
Tritogonia verrucosa	19	124.66	92.3	148.8	61.46	40.6	72.0	39.86	34.0	48.7

Appendix A-2. (Continued)

Three Bed Composite and Year 1986	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	8	99.23	88.2	116.3	69.71	63.2	75.7	47.32	40.3	53.8
Amblema plicata	47	103.36	66.7	137.4	73.01	50.6	94.9	43.79	26.8	57.4
Anodonta grandis	16	122.18	80.9	147.8	68.42	50.7	82.0	49.42	35.1	63.2
Anodonta imbecillis	1	39.20	39.2	39.2	17.40	17.4	17.4	7.10	7.1	7.1
Cyclonaias tuberculata	131	76.16	56.9	96.7	64.74	47.6	80.2	37.08	23.7	51.0
Ellipsaria lineolata	37	84.30	51.8	112.3	62.73	39.2	78.8	37.52	22.6	53.3
Elliptio crassidens	304	110.53	87.2	151.8	67.43	53.8	87.1	42.28	31.0	55.5
Elliptio dilatata	3	109.23	107.1	111.2	49.37	45.5	52.6	39.17	35.4	42.2
Lampsilis abrupta	8	100.44	86.1	114.8	72.96	66.3	80.7	52.21	48.3	57.2
Lampsilis ovata	3	141.40	132.9	152.2	94.33	90.3	101.4	66.83	55.9	72.6
Lasmigona costata	1	122.10	122.1	122.1	69.90	69.9	69.9	25.50	25.5	25.5
Leptodea fragilis	9	96.87	79.4	112.1	55.52	46.6	67.5	30.99	25.3	36.0
Ligumia recta	18	147.23	107.7	173.1	56.62	45.0	67.6	46.78	33.1	55.9
Megalonaias nervosa	6	152.35	124.6	175.6	105.20	87.2	119.3	57.80	53.9	63.2
Obliquaria reflexa	12	55.11	46.6	66.7	43.02	32.0	52.4	33.39	21.6	41.2
Pleurobema cordatum	231	92.87	54.9	117.9	72.90	49.7	88.5	45.07	25.2	61.9
Pleurobema oviforme	2	68.90	68.4	69.4	50.70	48.6	52.8	35.60	33.0	38.2
Potamilus alatus	68	139.66	79.8	174.0	89.52	56.7	123.6	39.47	26.7	79.6
Quadrula metanevra	14	74.75	54.9	91.2	59.91	42.4	84.2	42.11	31.0	55.3
Quadrula pustulosa	72	54.97	38.2	71.6	51.68	37.2	66.1	32.13	20.5	42.1
Tritogonia verrucosa	21	110.36	78.8	133.0	55.36	41.4	66.7	33.56	24.7	42.9

Appendix A-2. (Continued)

Three Bed Composite and Year 1988	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	3	97.87	90.9	107.6	73.37	71.3	76.8	51.37	47.6	55.4
Amblema plicata	48	102.47	64.8	119.8	75.22	51.1	89.8	46.31	32.1	56.9
Anodonta grandis	29	126.85	81.7	155.1	69.93	53.6	89.9	53.46	34.5	71.2
Anodonta imbecillis	1	54.00	54.0	54.0	24.10	24.1	24.1	16.20	16.2	16.2
Anodonta suborbiculata	1	107.80	107.8	107.8	79.20	79.2	79.2	38.70	38.7	38.7
Cyclonaias tuberculata	87	79.12	63.4	97.5	67.22	55.2	97.7	39.34	31.3	49.3
Ellipsaria lineolata	23	87.22	65.1	102.8	65.42	47.5	77.4	39.61	32.7	50.3
Elliptio crassidens	154	110.06	92.4	136.4	68.69	44.2	84.9	44.26	34.1	55.3
Elliptio dilatata	3	101.10	95.6	110.9	45.43	40.8	50.1	28.40	26.9	30.8
Lampsilis abrupta	12	100.78	86.8	119.8	71.72	62.7	79.8	57.44	51.4	63.6
Lampsilis ovata	3	130.37	110.7	140.5	85.00	76.9	90.4	65.70	58.0	77.3
Leptodea fragilis	12	99.81	70.4	126.3	61.26	44.9	76.0	32.12	23.8	39.8
Ligumia recta	7	160.27	144.4	175.1	62.39	54.2	68.7	51.81	44.4	55.1
Megalonaias nervosa	9	160.61	144.2	170.8	114.19	100.8	126.6	60.60	53.3	68.7
Obliquaria reflexa	7	54.84	44.2	62.7	43.20	36.2	49.6	32.27	24.4	36.0
Pleurobema cordatum	133	96.57	68.5	119.1	76.57	54.9	89.2	47.87	38.2	58.6
Pleurobema oviforme	2	72.20	70.2	74.2	55.00	54.0	56.0	40.70	40.7	40.7
Pleurobema rubrum	1	88.30	88.3	88.3	69.50	69.5	69.5	46.70	46.7	46.7
Potamilus alatus	54	142.76	110.3	187.7	106.60	76.3	131.2	40.82	31.0	50.3
Quadrula metanevra	8	83.34	66.7	92.1	64.21	54.2	70.1	45.60	38.4	53.6
Quadrula pustulosa	77	58.73	36.1	81.1	55.06	40.7	98.4	35.31	26.2	43.1
Tritogonia verrucosa	18	112.68	91.8	140.8	62.25	50.1	76.3	39.49	23.2	60.4

Appendix A-2. (Continued)

Three Bed Composite and Year 1990	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	5	110.38	96.0	121.0	77.90	71.4	82.6	55.88	47.6	61.8
Amblema plicata	10	102.16	76.6	120.1	72.58	54.5	87.2	44.19	33.6	50.9
Anodonta grandis	20	135.42	108.7	159.1	76.04	61.5	99.9	55.90	44.4	68.8
Anodonta imbecillis	1	52.00	52.0	52.0	24.80	24.8	24.8	14.30	14.3	14.3
Anodonta suborbiculata	1	126.20	126.2	126.2	96.40	96.4	96.4	48.30	48.3	48.3
Cyclonaias tuberculata	69	79.65	62.0	111.0	67.29	52.1	92.1	37.97	28.0	49.6
Ellipsaria lineolata	28	85.42	64.2	102.3	64.41	51.6	76.9	39.18	32.1	47.4
Elliptio crassidens	160	115.21	87.5	149.3	70.91	61.1	82.7	44.91	36.3	51.6
Elliptio dilatata	1	94.60	94.6	94.6	46.90	46.9	46.9	28.60	28.6	28.6
Lampsilis abrupta	4	105.95	98.1	120.6	83.35	81.8	86.0	62.15	55.7	67.7
Lampsilis ovata	1	121.70	121.7	121.7	78.10	78.1	78.1	68.30	68.3	68.3
Leptodea fragilis	8	110.46	89.9	130.1	68.93	61.0	89.5	37.08	32.8	40.0
Ligumia recta	2	172.60	172.1	173.1	70.90	68.3	73.5	59.30	58.7	59.9
Megalonaias nervosa	3	166.60	155.6	174.1	116.57	110.7	120.6	56.50	56.2	57.1
Obliquaria reflexa	11	55.06	44.5	64.6	43.34	36.7	49.9	32.80	25.4	45.1
Pleurobema cordatum	132	97.37	75.6	120.7	75.38	59.5	90.6	46.34	32.9	56.9
Pleurobema oviforme	1	72.80	72.8	72.8	56.00	56.0	56.0	41.70	41.7	41.7
Potamilus alatus	45	142.78	83.2	169.1	107.14	72.6	126.3	44.74	21.5	139.8
Ptychobranchus fasciolaris	1	116.80	116.8	116.8	61.40	61.4	61.4	44.70	44.7	44.7
Quadrula metanevra	8	84.28	65.2	100.7	63.44	48.1	71.5	46.72	35.5	51.8
Quadrula pustulosa	78	57.56	44.1	82.8	53.53	42.8	67.4	34.22	25.2	45.4
Tritogonia verrucosa	9	107.59	78.1	136.3	57.36	43.4	70.9	35.21	26.6	42.5

Appendix A-2. (Continued)

Three Bed Composite and Year 1992	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	1	94.80	94.8	94.8	65.40	65.4	65.4	49.60	49.6	49.6
Amblema plicata	13	105.46	89.9	124.7	77.27	65.5	88.8	45.11	24.9	54.8
Anodonta grandis	5	130.06	122.0	136.8	76.06	67.3	84.9	58.54	54.0	65.1
Cyclonaias tuberculata	68	80.10	63.2	97.1	67.49	53.4	87.1	38.73	29.5	44.7
Ellipsaria lineolata	14	90.49	69.6	99.6	67.96	49.7	77.2	39.56	31.3	44.8
Elliptio crassidens	137	112.26	88.4	136.6	69.83	55.6	83.3	44.75	27.2	53.3
Lampsilis abrupta	6	108.85	96.8	116.3	74.63	66.3	83.4	54.70	50.7	59.8
Ligumia recta	3	157.27	148.0	165.7	60.00	56.9	62.4	52.30	47.3	59.9
Megalonaias nervosa	4	173.35	155.9	183.2	120.88	112.2	128.2	60.93	53.1	69.3
Obliquaria reflexa	6	57.17	52.0	61.5	43.45	40.9	47.9	32.30	28.9	36.7
Plethobasus cyphyus	1	91.40	91.4	91.4	64.80	64.8	64.8	50.30	50.3	50.3
Pleurobema cordatum	82	98.53	64.7	127.9	76.15	60.9	94.2	46.29	37.5	59.8
Potamilus alatus	16	142.99	116.6	161.2	105.32	90.6	116.9	41.65	35.1	47.4
Quadrula metanevra	8	78.61	61.9	87.2	61.76	58.3	66.5	43.92	37.4	48.2
Quadrula pustulosa	48	56.37	45.3	66.9	52.70	40.2	62.7	33.52	25.2	44.8
Tritogonia verrucosa	9	106.24	77.0	127.3	59.00	43.1	66.7	36.29	21.7	48.3

Appendix A-2. (Continued)

Three Bed Composite and Year 1994	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	13	106.79	84.7	119.1	76.72	59.2	89.7	48.44	35.0	54.7
Anodonta grandis	7	135.29	121.4	142.7	79.13	66.7	85.1	57.84	47.6	64.6
Cyclonaias tuberculata	64	78.52	58.4	91.2	66.28	50.3	74.3	38.94	28.3	48.9
Ellipsaria lineolata	11	87.68	76.1	100.2	66.95	57.7	76.7	40.38	32.9	48.6
Elliptio crassidens	216	113.88	96.5	129.8	71.10	61.3	88.6	45.37	36.6	52.9
Lampsilis abrupta	2	105.05	101.2	108.9	84.20	82.3	86.1	65.65	65.4	65.9
Leptodea fragilis	3	117.67	112.2	122.1	72.87	70.5	76.9	39.60	39.4	40.0
Ligumia recta	1	161.40	161.4	161.4	73.30	73.3	73.3	61.20	61.2	61.2
Megalonaias nervosa	2	174.45	168.7	180.2	119.45	119.2	119.7	63.85	58.7	69.0
Obliquaria reflexa	11	57.30	52.8	69.5	45.68	41.4	51.7	35.04	29.6	42.7
Plethobasus cyphyus	1	88.60	88.6	88.6	59.40	59.4	59.4	46.20	46.2	46.2
Pleurobema cordatum	95	97.71	59.8	116.5	75.96	58.1	90.1	46.85	34.3	62.7
Pleurobema oviforme	1	71.90	71.9	71.9	59.80	59.8	59.8	41.70	41.7	41.7
Potamilus alatus	10	149.92	128.3	172.3	115.17	99.6	128.6	43.34	38.4	46.5
Quadrula metanevra	4	74.18	68.4	81.9	57.53	54.4	60.2	40.33	39.3	42.2
Quadrula pustulosa	65	58.02	46.2	66.6	54.08	43.8	64.8	35.28	27.1	49.9
Tritogonia verrucosa	7	115.60	95.8	140.3	58.90	52.4	69.6	36.64	30.7	42.0

Appendix A-2. (Continued)

Three Bed Composite and Year 1996	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	11	104.90	78.2	125.4	73.50	52.4	86.5	46.10	26.7	57.3
Anodonta grandis	7	141.10	118.1	160.0	81.80	67.7	102.4	56.90	47.4	64.2
Cyclonaias tuberculata	38	83.00	73.0	94.9	69.20	58.4	80.8	40.90	34.6	47.7
Ellipsaria lineolata	15	92.20	69.7	107.5	67.90	48.0	80.7	43.40	30.8	50.7
Elliptio crassidens	140	112.90	88.9	151.1	68.60	53.5	85.7	45.50	34.2	61.7
Elliptio dilatata	1	95.40	95.4	95.4	41.00	41.0	41.0	29.70	29.7	29.7
Lampsilis abrupta	4	110.20	99.4	122.4	79.30	73.1	85.5	60.40	55.3	66.9
Lasmigona costata	1	118.40	118.4	118.4	60.60	60.6	60.6	35.20	35.2	35.2
Leptodea fragilis	1	126.20	126.2	126.2	71.30	71.3	71.3	40.70	40.7	40.7
Ligumia recta	2	157.50	155.0	160.0	61.50	61.1	61.9	49.40	49.4	49.5
Megalonaias nervosa	1	180.00	180.0	180.0	123.60	123.6	123.6	66.00	66.0	66.0
Obliquaria reflexa	6	56.10	51.8	59.6	43.90	39.8	50.1	36.40	33.4	40.3
Pleurobema cordatum	93	99.40	77.1	120.9	77.20	65.2	91.2	48.70	38.3	59.6
Potamilus alatus	35	145.90	98.2	180.0	85.80	60.1	131.7	41.30	28.9	51.5
Quadrula metanevra	2	81.90	77.8	86.1	63.50	61.0	66.1	49.60	47.7	51.6
Quadrula pustulosa	29	60.80	50.6	77.3	55.80	48.9	62.5	38.10	31.1	49.5
Tritogonia verrucosa	4	109.70	88.5	134.1	56.00	49.4	61.3	34.50	29.6	40.3

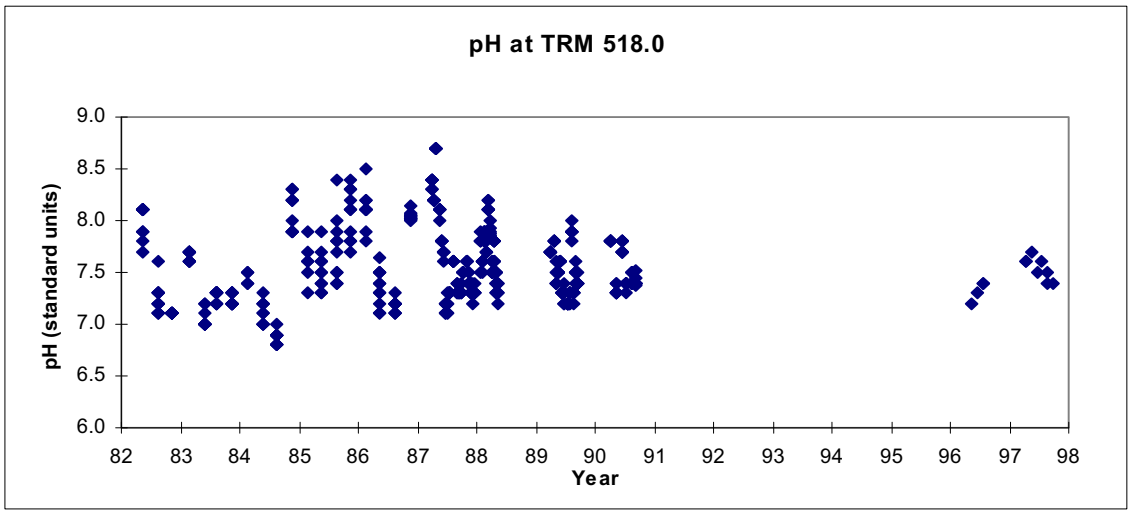
Appendix A-2. (Continued)

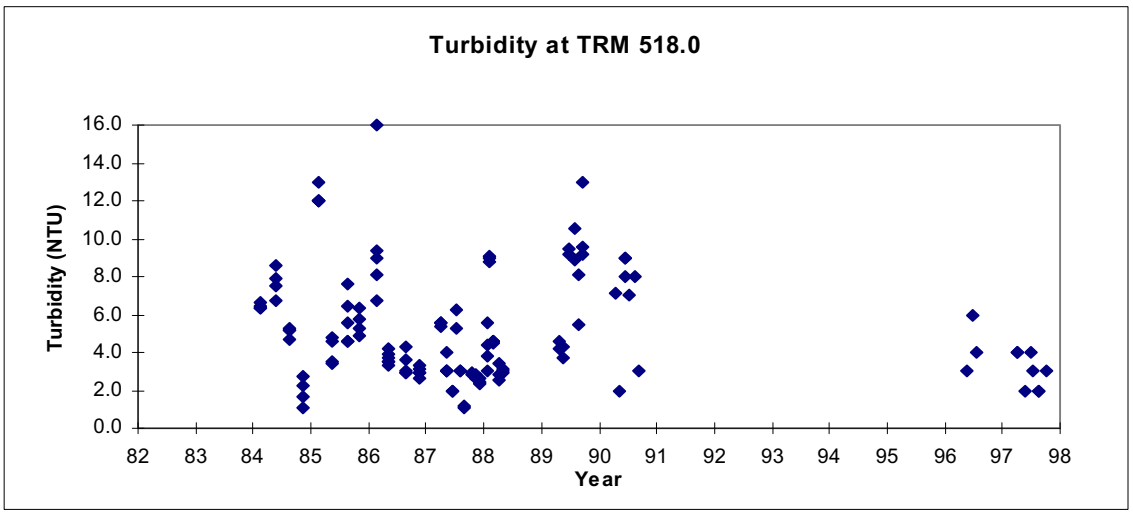
Three Bed Composite and Year 1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Amblema plicata	5	96.00	73.5	123.0	68.90	57.0	78.9	44.20	31.5	53.2
Anodonta grandis	1	147.00	147.0	147.0	81.00	81.0	81.0	63.40	63.4	63.4
Cyclonaias tuberculata	47	81.50	67.0	96.8	67.80	56.5	78.8	42.40	35.6	51.9
Ellipsaria lineolata	8	81.80	56.4	105.5	61.50	45.9	71.6	40.90	33.8	52.6
Elliptio crassidens	152	113.10	92.2	134.5	68.20	53.7	83.4	45.70	33.5	65.0
Lampsilis ovata	1	115.30	115.3	115.3	74.10	74.1	74.1	69.50	69.5	69.5
Leptodea fragilis	2	92.20	69.3	115.0	56.10	40.5	71.7	26.90	21.5	37.3
Ligumia recta	1	160.00	160.0	160.0	71.50	71.5	71.5	59.60	59.6	59.6
Obliquaria reflexa	3	54.10	50.6	57.4	42.00	34.7	46.7	34.50	33.0	36.6
Pleurobema cordatum	82	98.20	83.1	117.2	75.50	60.2	92.3	49.90	41.7	57.3
Potamilus alatus	12	146.40	105.7	168.8	83.50	63.3	95.8	42.60	33.3	48.9
Quadrula metanevra	2	88.00	85.0	91.0	64.60	63.5	65.7	45.90	45.4	46.4
Quadrula pustulosa	24	59.00	49.2	67.3	54.10	45.2	60.7	36.20	28.4	45.6
Tritogonia verrucosa	1	109.60	109.6	109.6	52.80	52.8	52.8	38.30	38.3	38.3

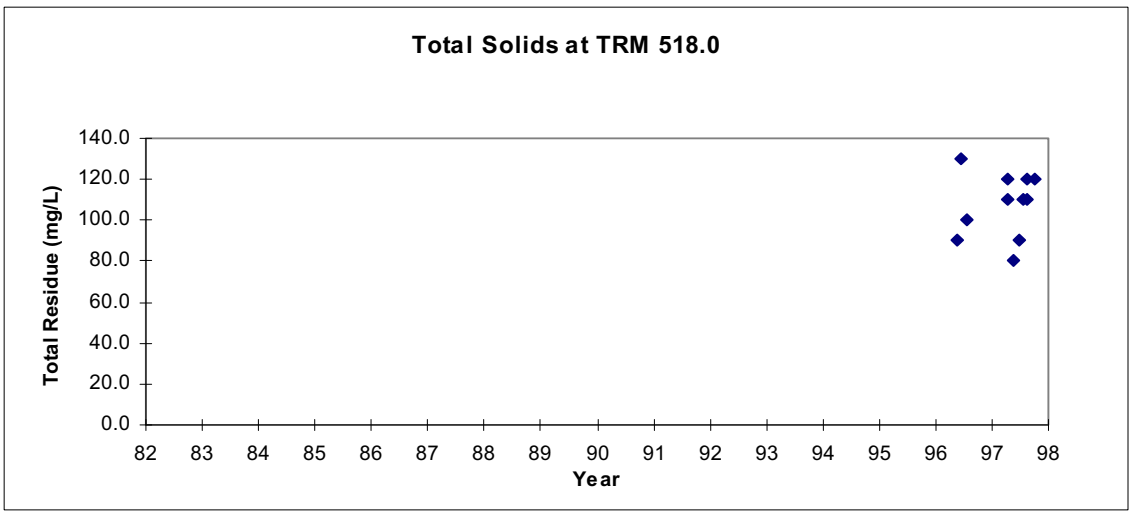
Appendix A-2. (Continued)

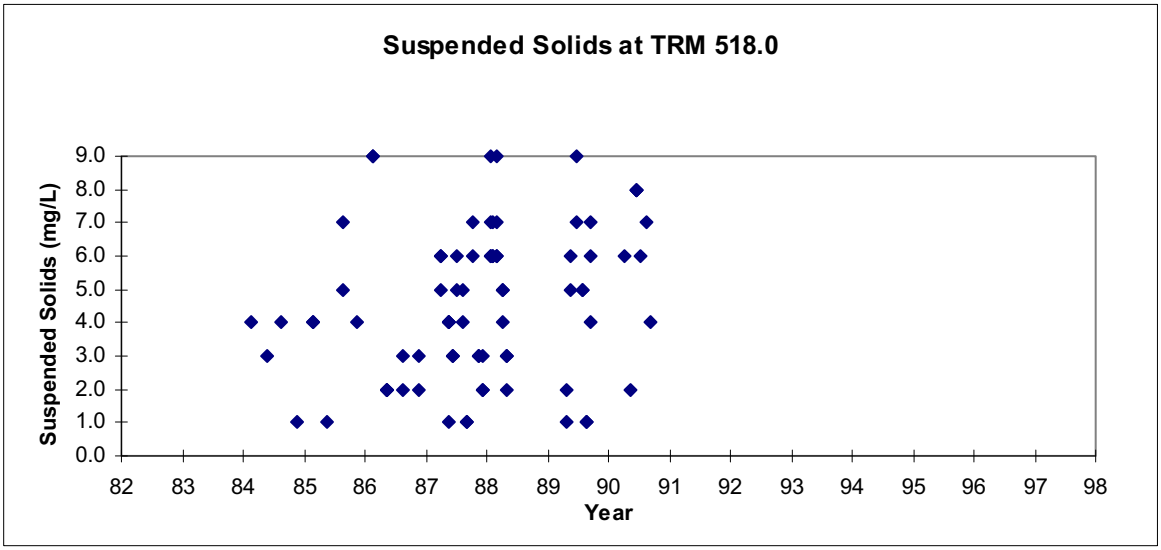
Three Bed Composite and Years 1983-1997	N	Length			Height			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Actinonaias ligamentina	35	103.57	88.2	121.0	73.57	63.2	88.0	51.34	40.3	61.8
Amblema plicata	272	101.52	64.8	137.4	73.97	50.6	99.7	44.66	24.9	57.4
Anodonta grandis	132	127.57	80.9	160.0	71.34	46.1	102.4	53.12	34.5	71.2
Anodonta imbecillis	5	50.48	39.2	54.7	22.84	17.4	24.8	13.76	7.1	16.9
Anodonta suborbiculata	2	117.00	107.8	126.2	87.80	79.2	96.4	43.50	38.7	48.3
Cyclonaias tuberculata	897	79.30	56.9	111.0	67.36	47.6	97.7	39.04	23.7	51.9
Cyprogenia stegaria	5	55.02	51.6	60.0	51.80	49.7	55.6	38.78	36.0	44.1
Dromus dromas	1	60.10	60.1	60.1	58.30	58.3	58.3	32.80	32.8	32.8
Ellipsaria lineolata	265	85.90	51.8	112.3	64.99	39.2	86.0	39.27	22.6	53.3
Elliptio crassidens	2182	111.08	86.8	151.8	68.76	20.1	89.9	43.88	21.0	65.0
Elliptio dilatata	17	101.64	92.6	113.3	45.54	40.8	52.6	31.59	21.5	42.2
Fusconaia subrotunda	1	66.09	66.1	66.1	53.56	53.6	53.6	36.58	36.6	36.6
Lampsilis abrupta	62	101.18	70.5	122.4	73.62	59.4	86.1	55.83	39.8	67.7
Lampsilis ovata	26	128.39	102.1	152.2	85.52	70.0	103.4	65.83	55.9	77.3
Lasmigona complanata	1	180.20	180.2	180.2	114.30	114.3	114.3	40.30	40.3	40.3
Lasmigona costata	2	120.25	118.4	122.1	65.25	60.6	69.9	30.35	25.5	35.2
Leptodea fragilis	50	102.46	59.6	130.1	61.45	34.6	89.5	33.30	20.1	40.8
Ligumia recta	67	156.70	107.7	185.2	60.84	45.0	73.5	49.99	33.1	61.2
Megalonaias nervosa	34	166.23	124.6	190.8	115.10	87.2	130.2	60.06	52.4	71.4
Obliquaria reflexa	99	55.12	36.5	69.5	43.32	24.1	52.4	33.63	21.6	45.1
Plethobasus cyphyus	4	90.90	88.6	94.3	63.33	59.4	66.3	46.63	43.6	50.3
Pleurobema cordatum	1628	96.06	54.9	160.2	75.48	44.7	134.9	46.52	25.2	79.9
Pleurobema oviforme	9	71.04	63.5	76.1	55.01	48.6	60.8	39.66	33.0	41.7
Pleurobema plenum	4	65.73	51.3	84.6	59.63	49.4	70.2	43.75	36.4	50.6
Pleurobema rubrum	4	88.05	80.7	92.8	70.05	64.3	74.8	48.10	44.5	51.4
Potamilus alatus	407	141.46	46.9	187.7	98.42	56.7	134.5	40.60	21.5	139.8
Ptychobranchus fasciolaris	2	105.60	94.4	116.8	59.05	56.7	61.4	39.75	34.8	44.7
Quadrula metanevra	122	78.24	46.9	100.7	61.48	42.2	84.2	43.73	26.2	55.3
Quadrula pustulosa	827	57.18	36.1	82.8	53.87	32.1	98.4	34.39	20.2	49.9
Tritogonia verrucosa	116	112.77	76.7	148.8	58.92	40.6	76.3	36.59	19.7	60.4

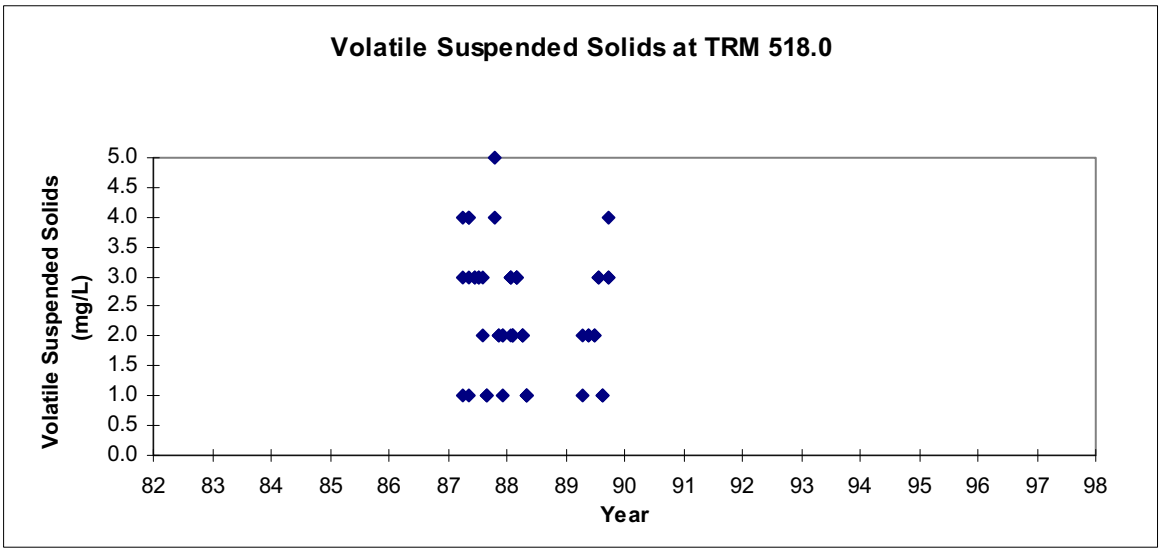
Appendix B-1. Selected water quality values measured during preoperational (1982-1991) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 518.0

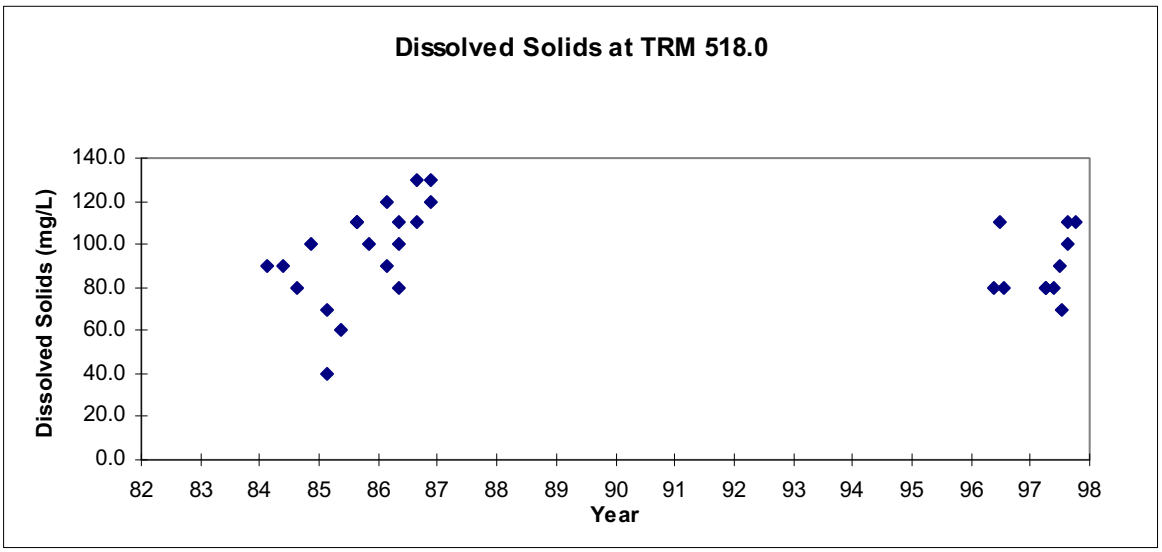


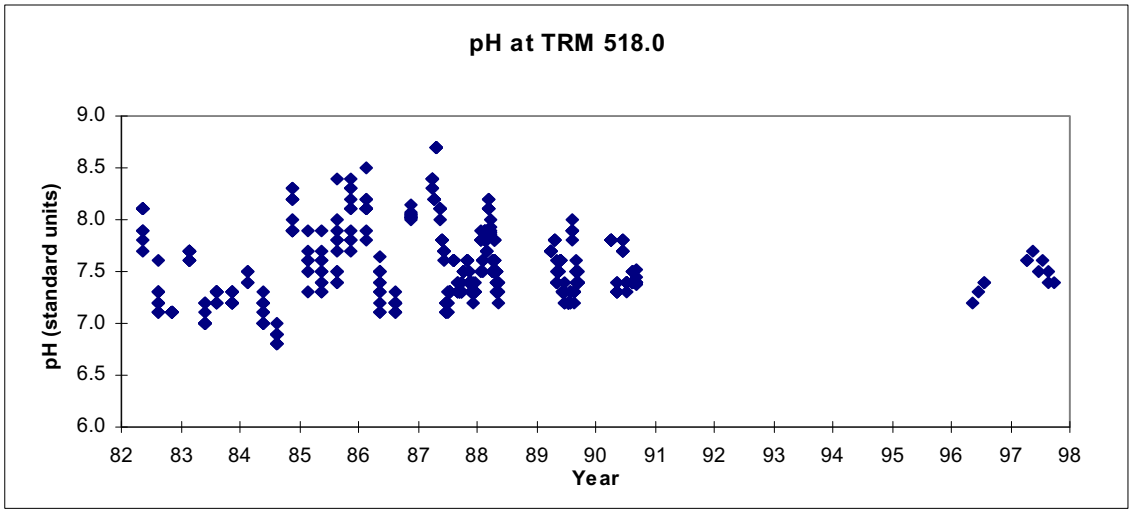


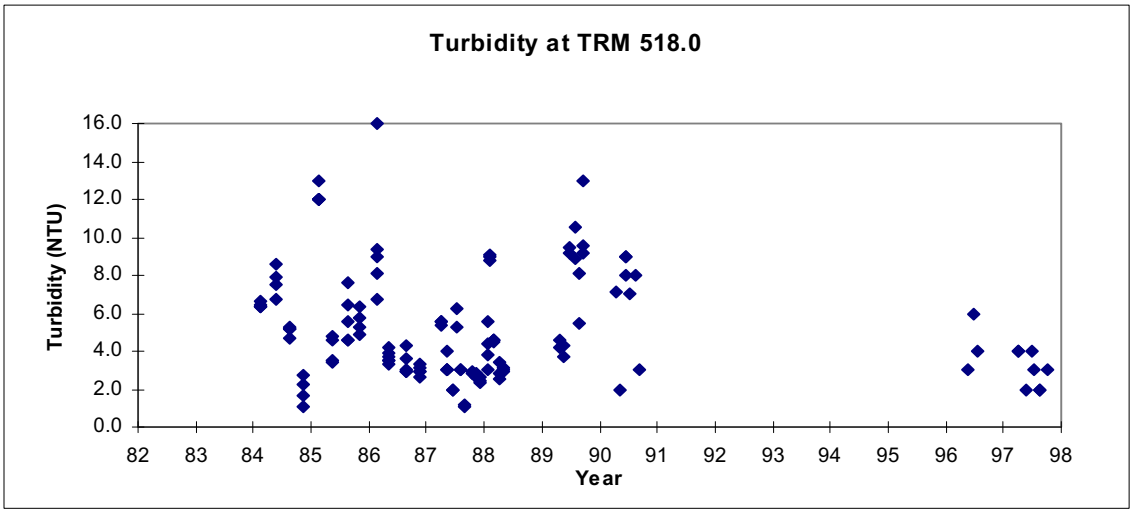


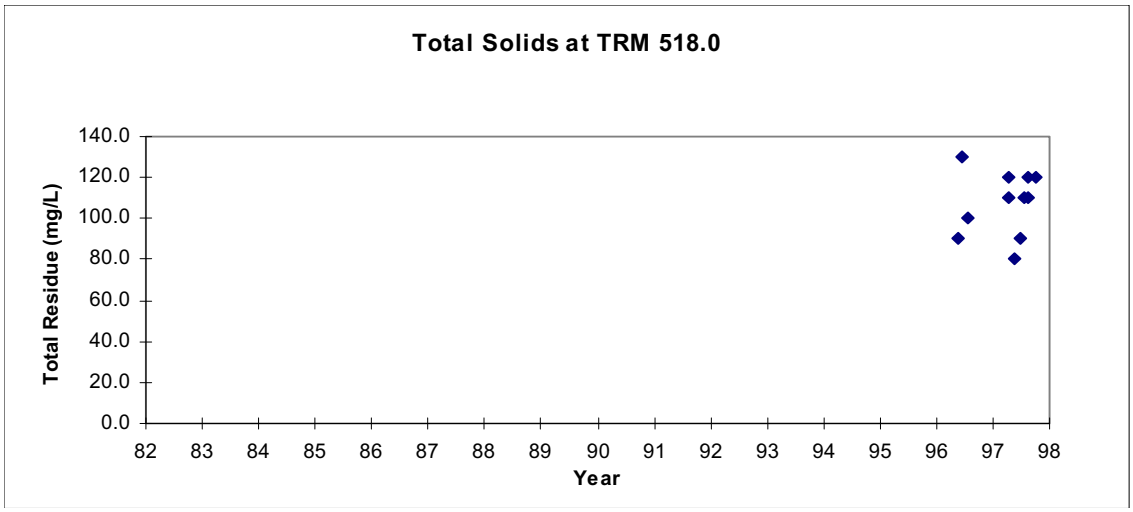

Suspended Solids at TRM 518.0
Suspended Solids (mg/L)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year


Volatile Suspended Solids at TRM 518.0
Volatile Suspended Solids (mg/L)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

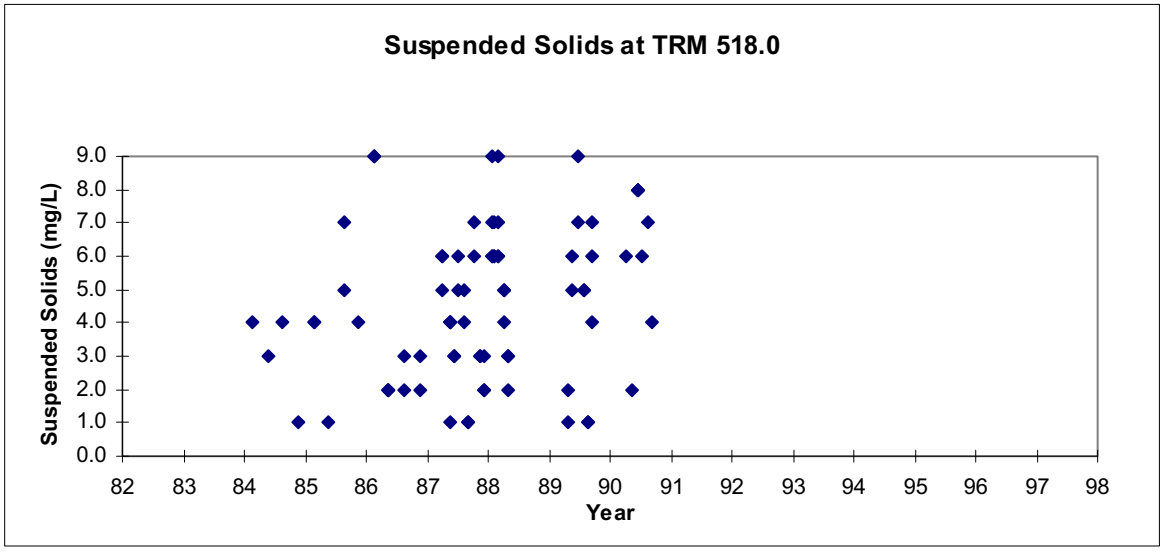

Dissolved Solids at TRM 518.0
Dissolved Solids (mg/L)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

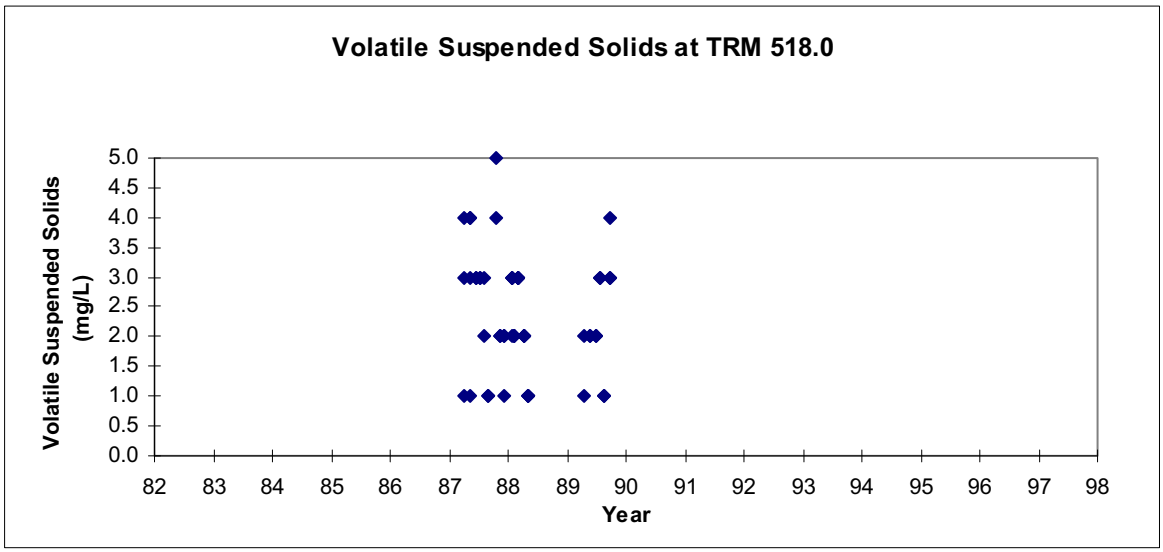

pH at TRM 518.0
pH (standard units)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

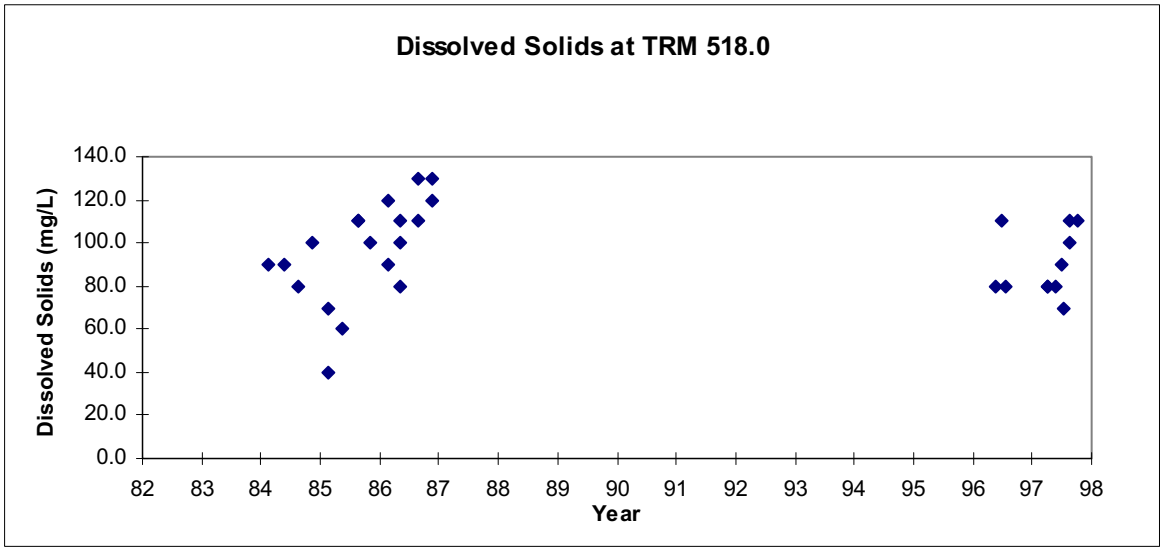

Turbidity at TRM 518.0
Turbidity (NTU)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

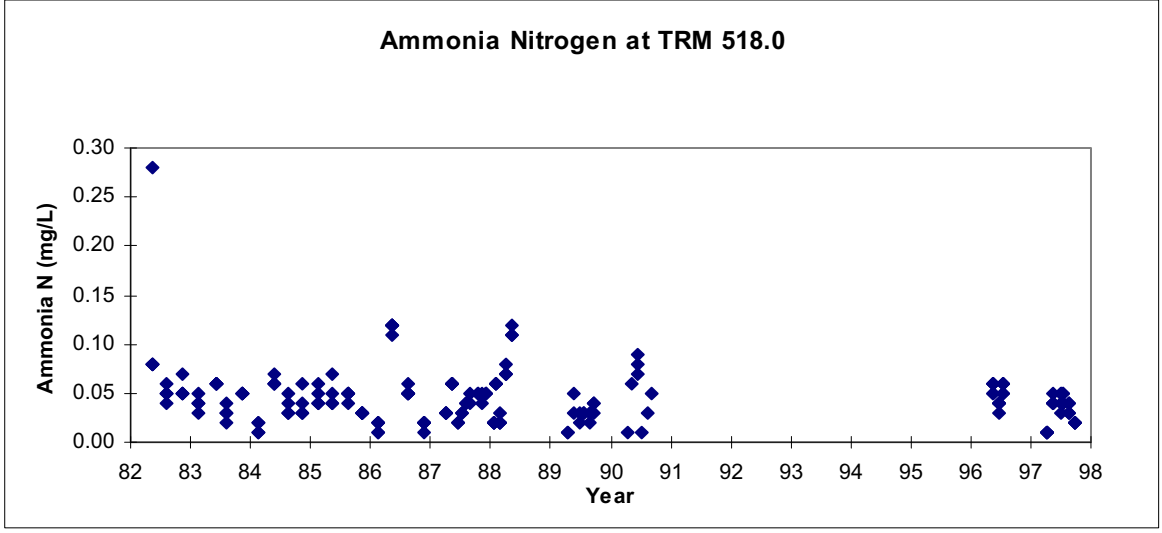

Total Solids at TRM 518.0
Total Residue (mg/L)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

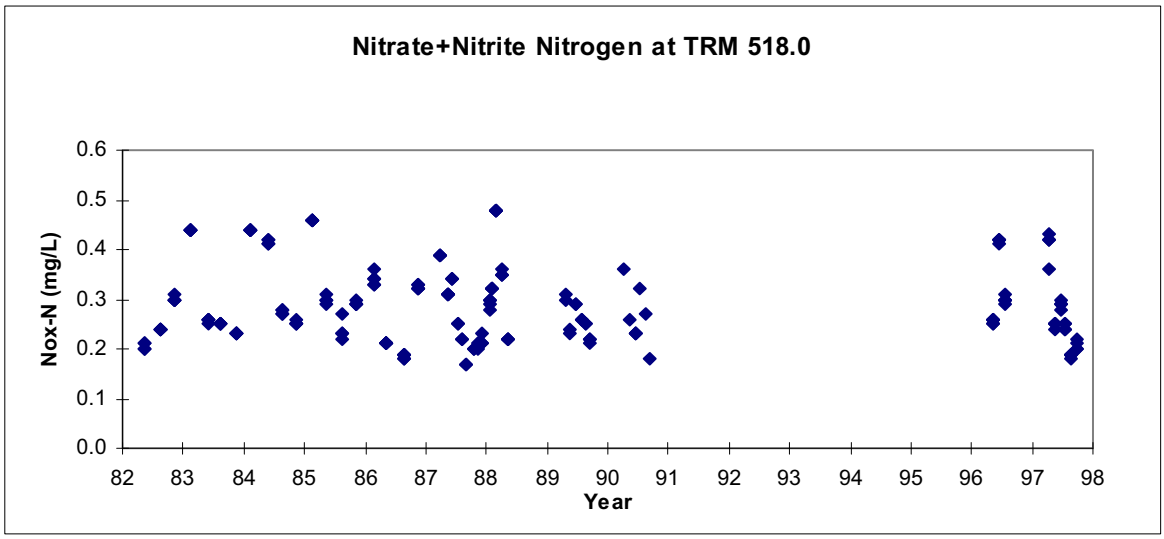
Appendix B-1 (Continued)

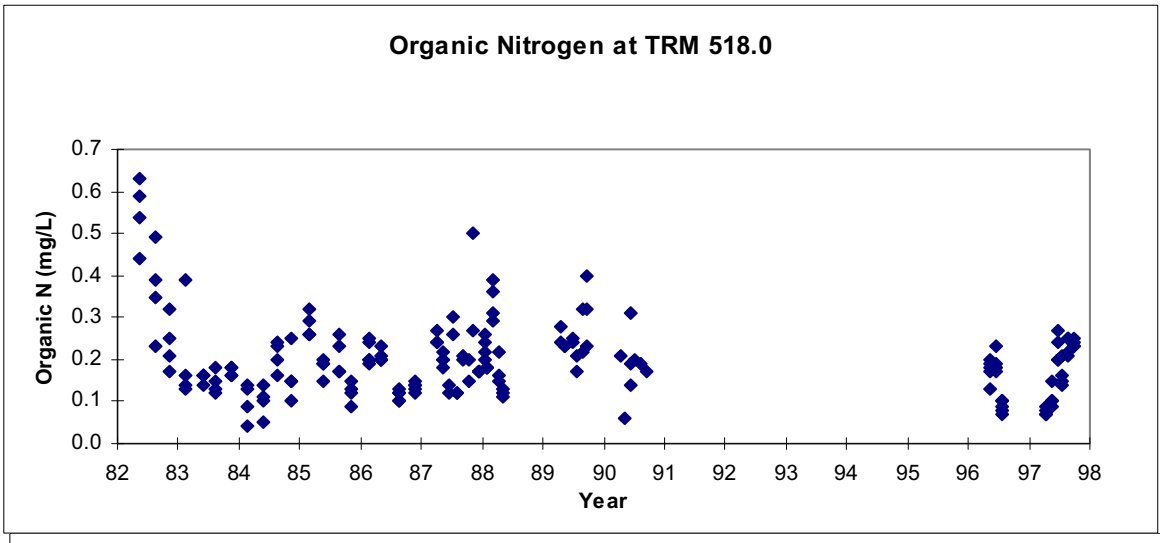


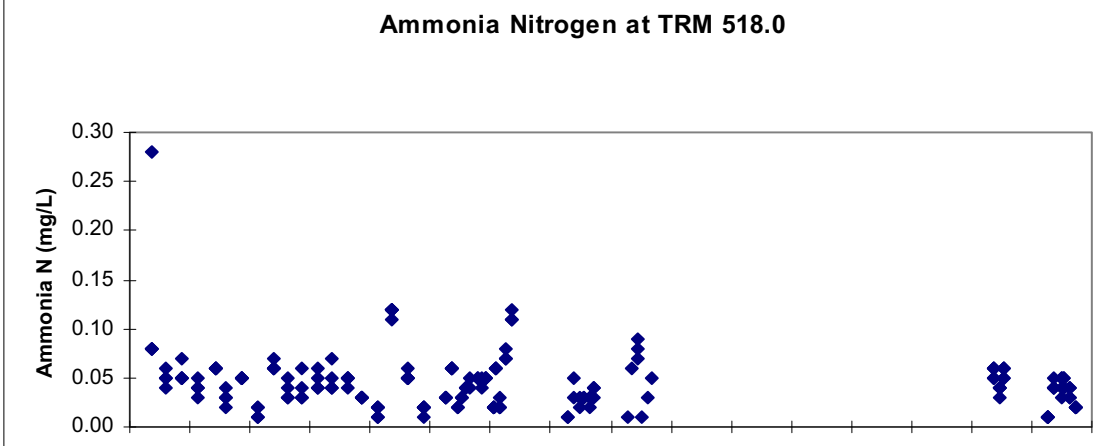





Ammonia Nitrogen at TRM 518.0
Ammonia N (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

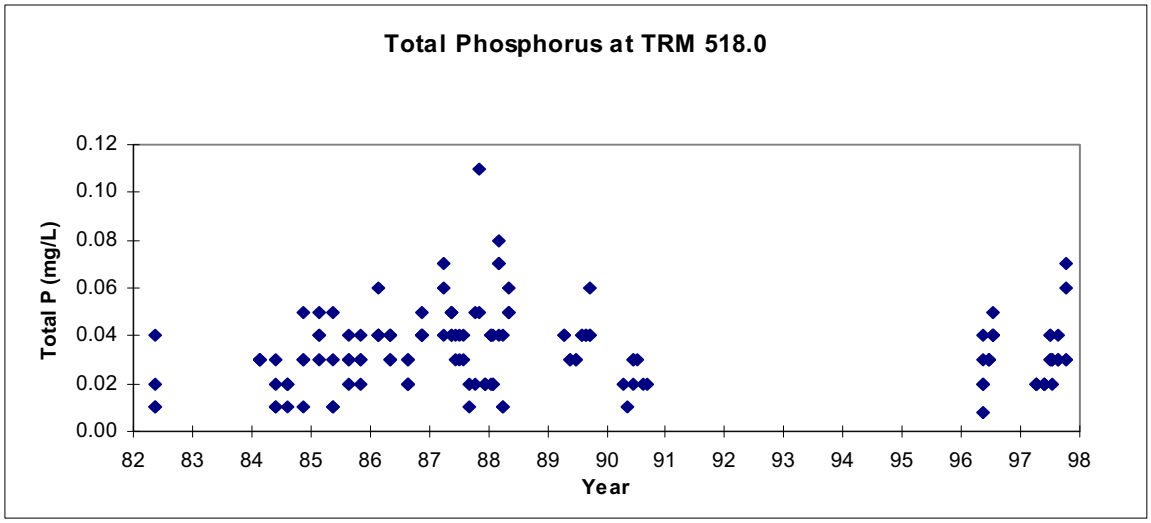

Nitrate+Nitrite Nitrogen at TRM 518.0
Nox-N (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

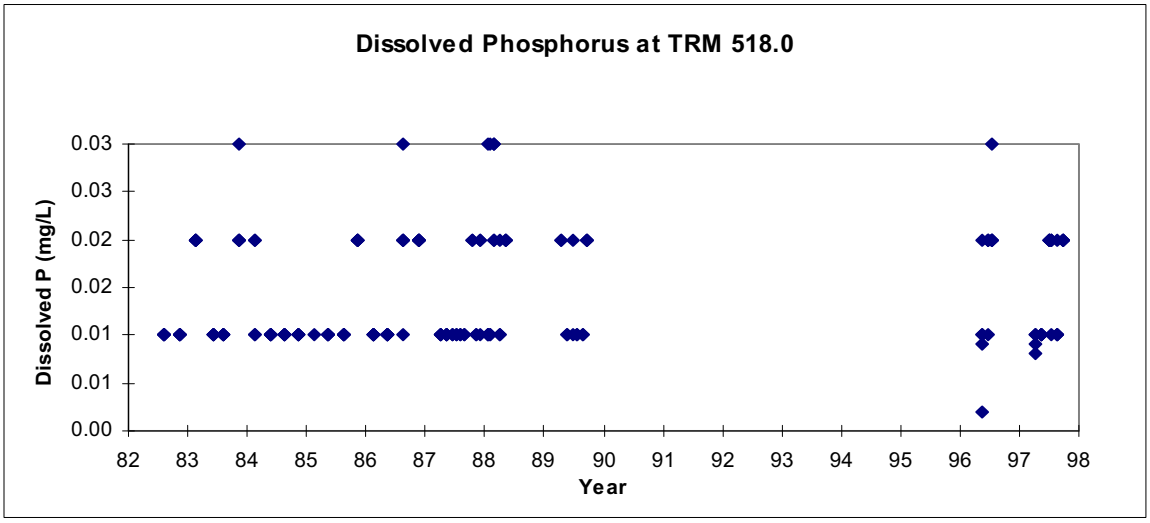

Organic Nitrogen at TRM 518.0
Organic N (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

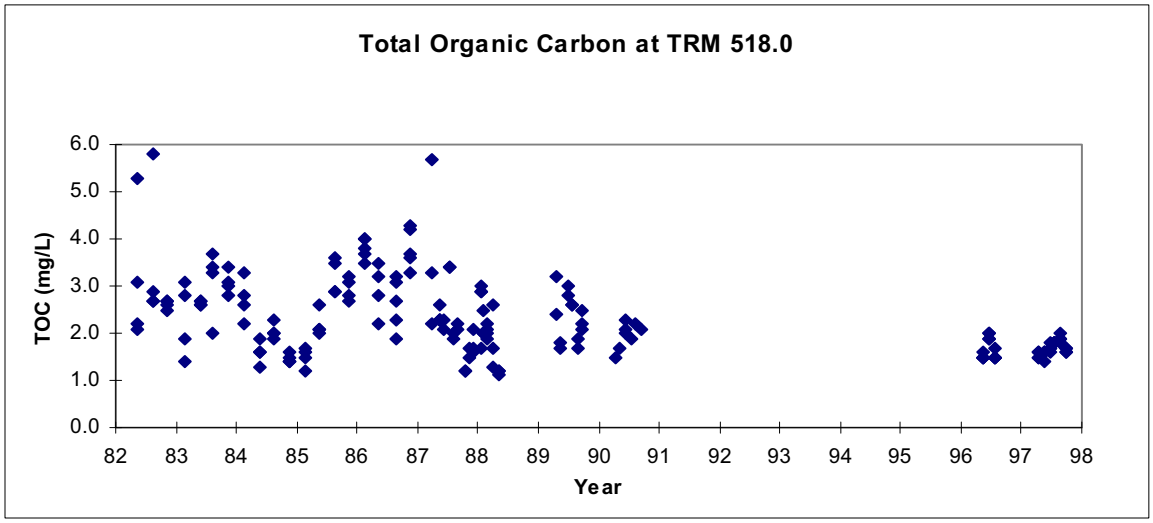

Ammonia Nitrogen at TRM 518.0
Ammonia N (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00

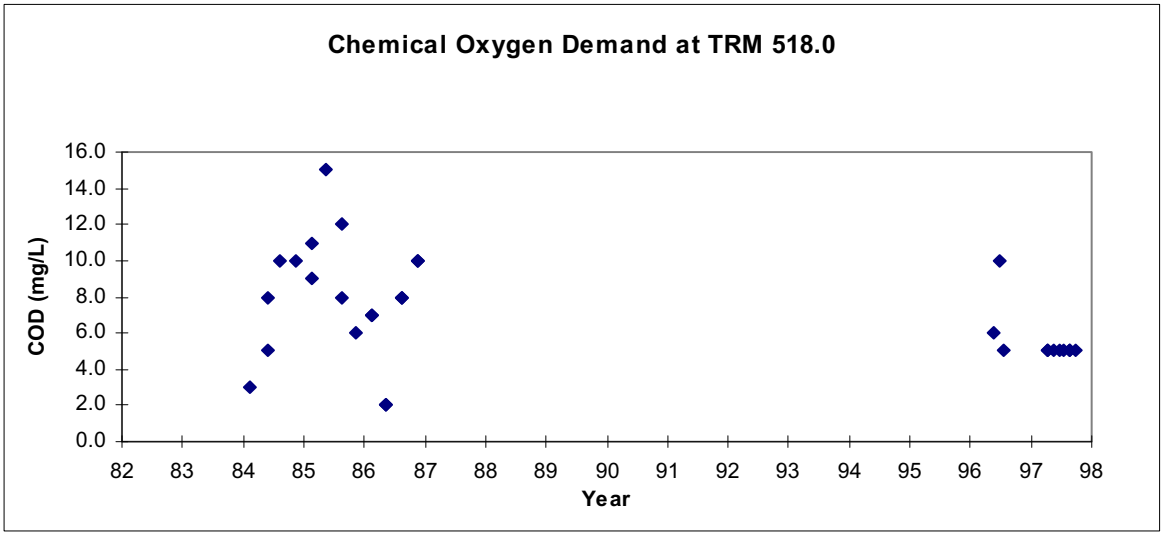
Appendix B-1 (Continued)

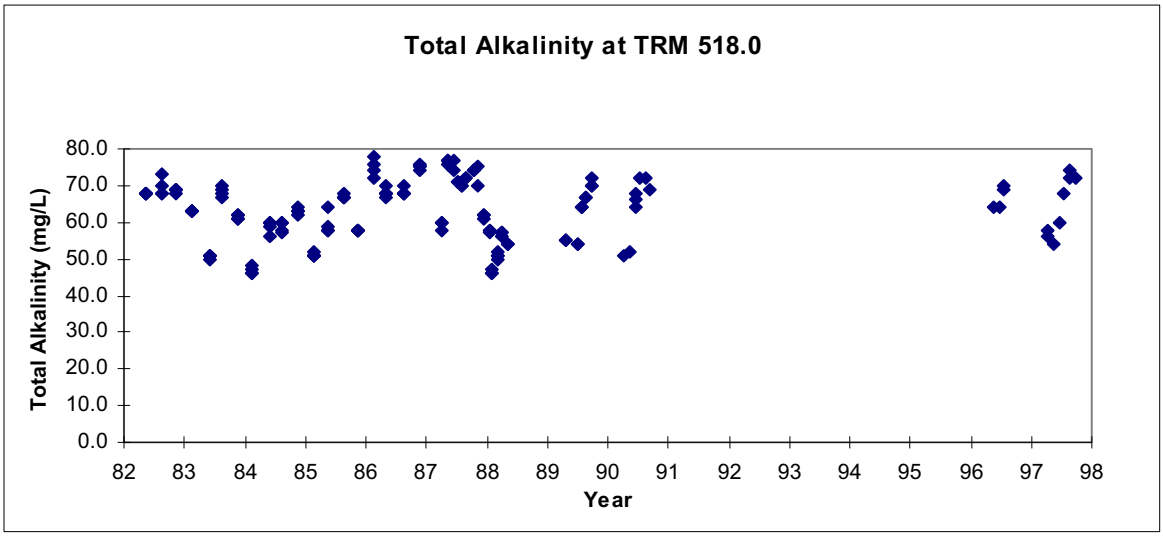
Appendix B-1 (Continued)

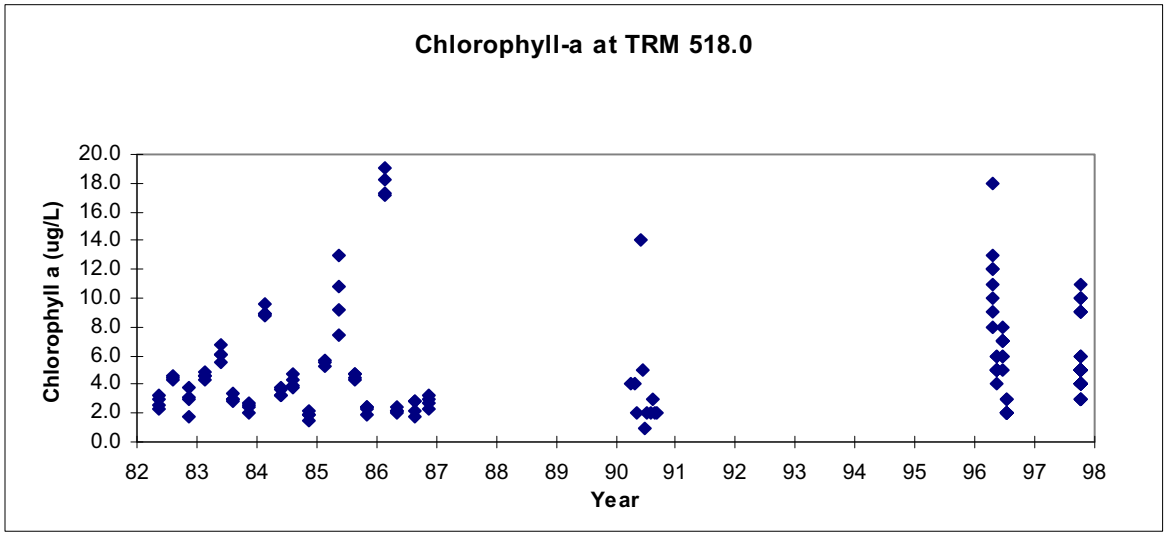

Total Phosphorus at TRM 518.0
Total P (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

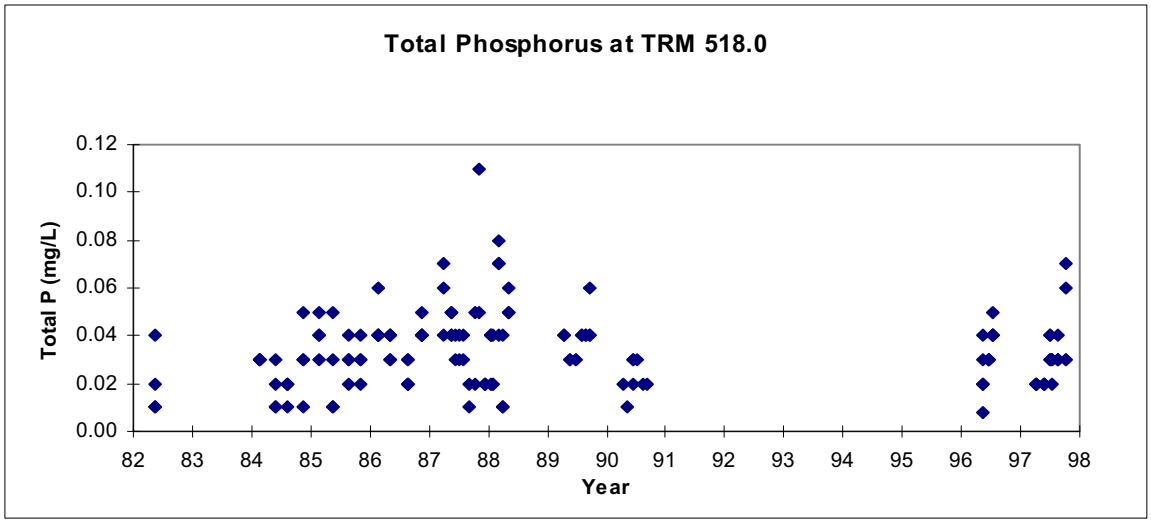

Dissolved Phosphorus at TRM 518.0
Dissolved P (mg/L)
0.03
0.03
0.02
0.02
0.01
0.01
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

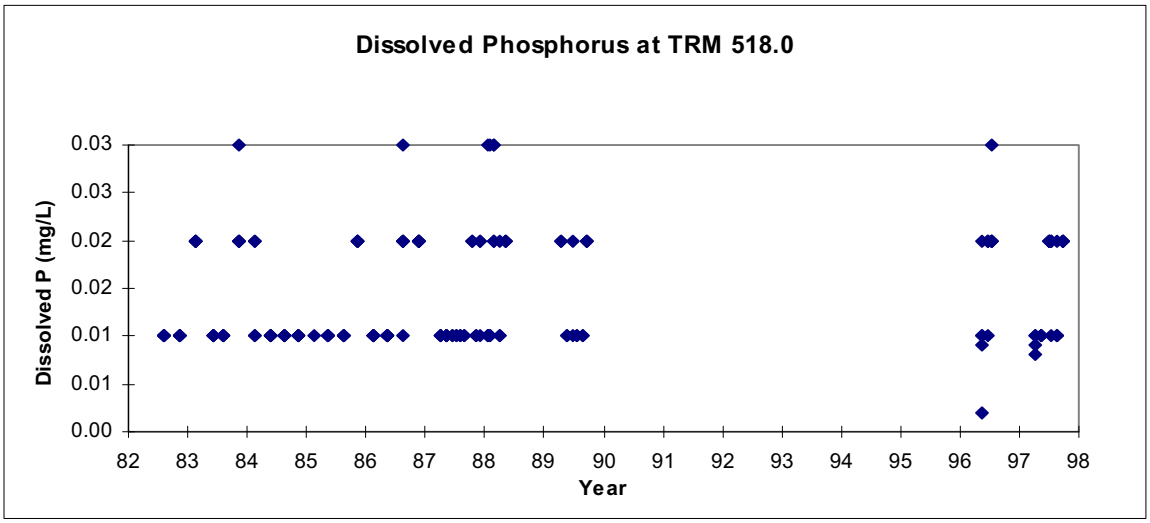

Total Organic Carbon at TRM 518.0
TOC (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

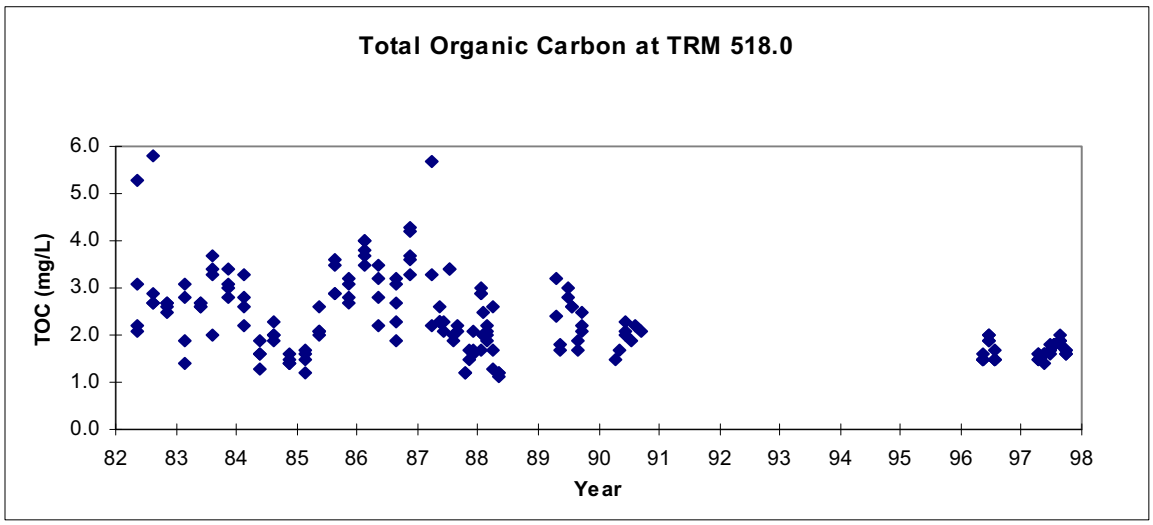

Chemical Oxygen Demand at TRM 518.0
COD (mg/L)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year


Total Alkalinity at TRM 518.0
Total Alkalinity (mg/L)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

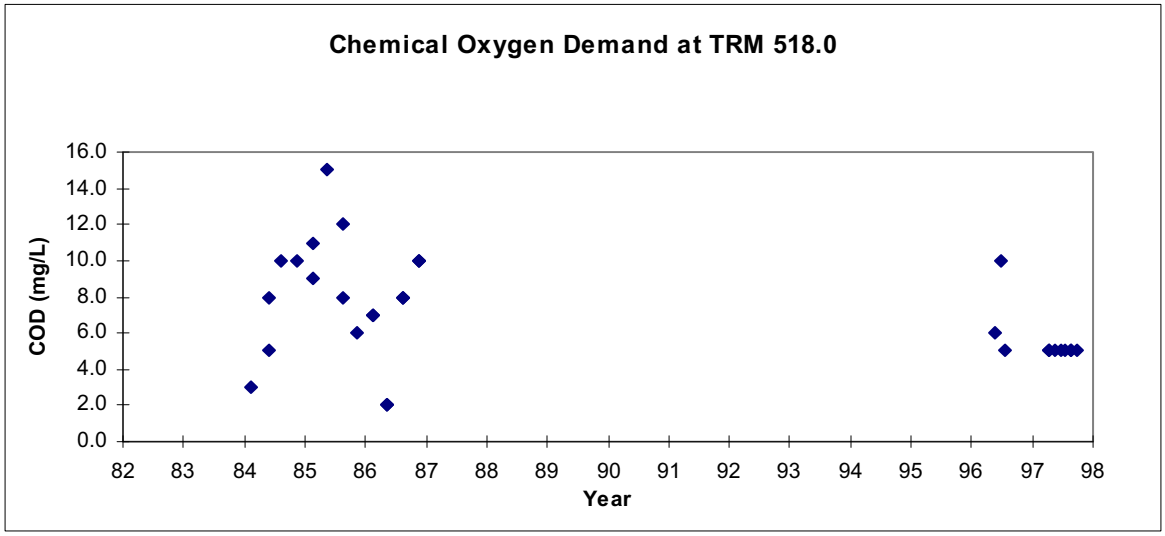

Chlorophyll-a at TRM 518.0
Chlorophyll a (ug/L)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

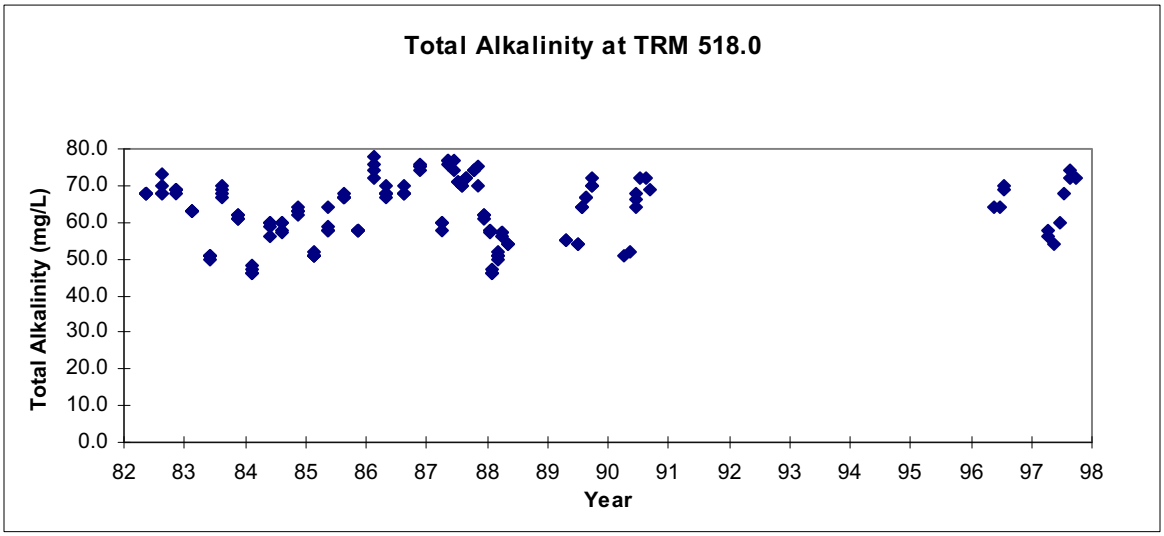

Total Phosphorus at TRM 518.0
Total P (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

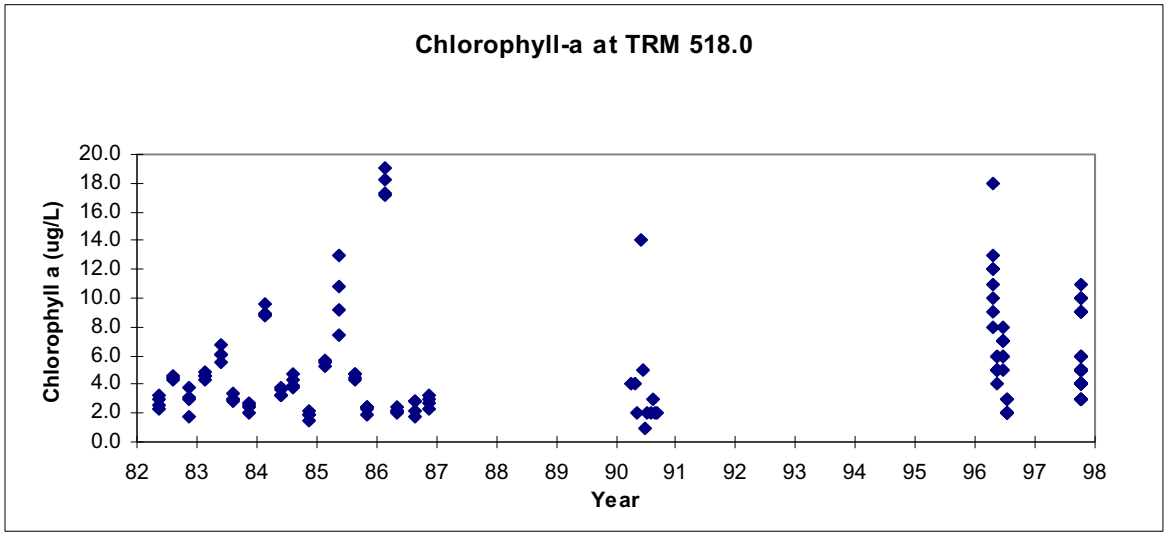

Dissolved Phosphorus at TRM 518.0
Dissolved P (mg/L)
0.03
0.03
0.02
0.02
0.01
0.01
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year


Total Organic Carbon at TRM 518.0
TOC (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

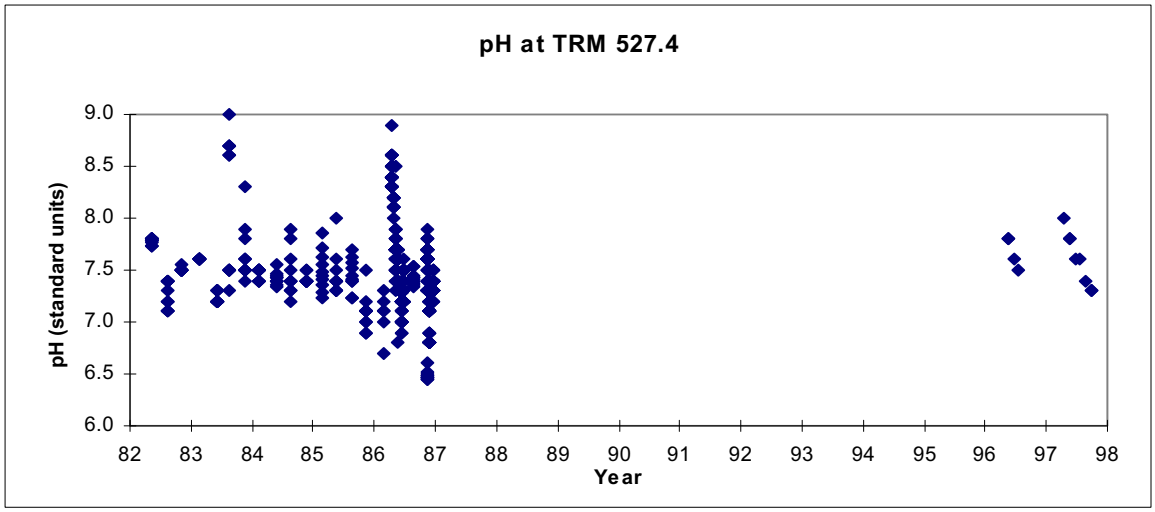
Appendix B-1 (Continued)

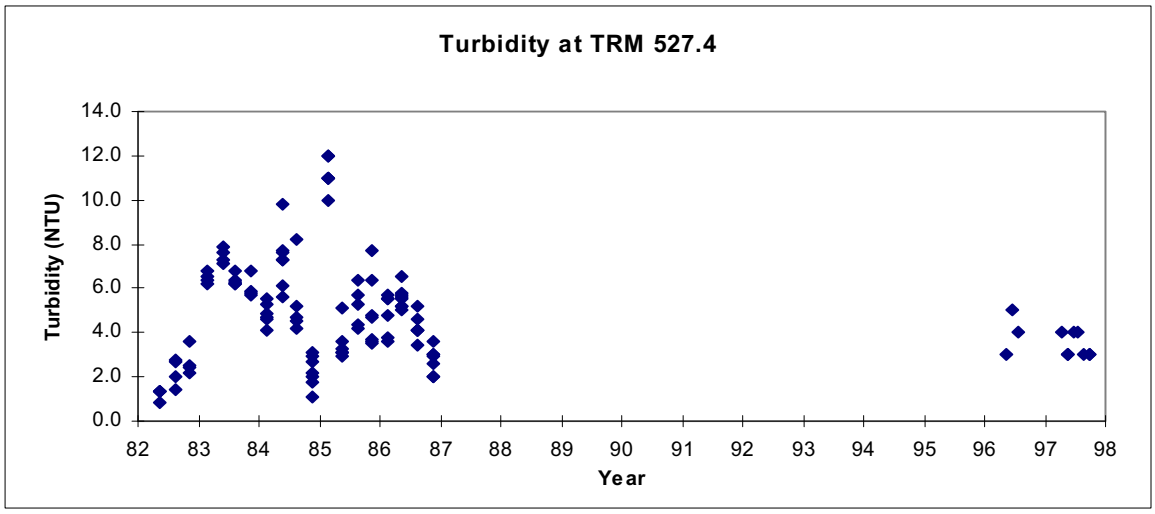


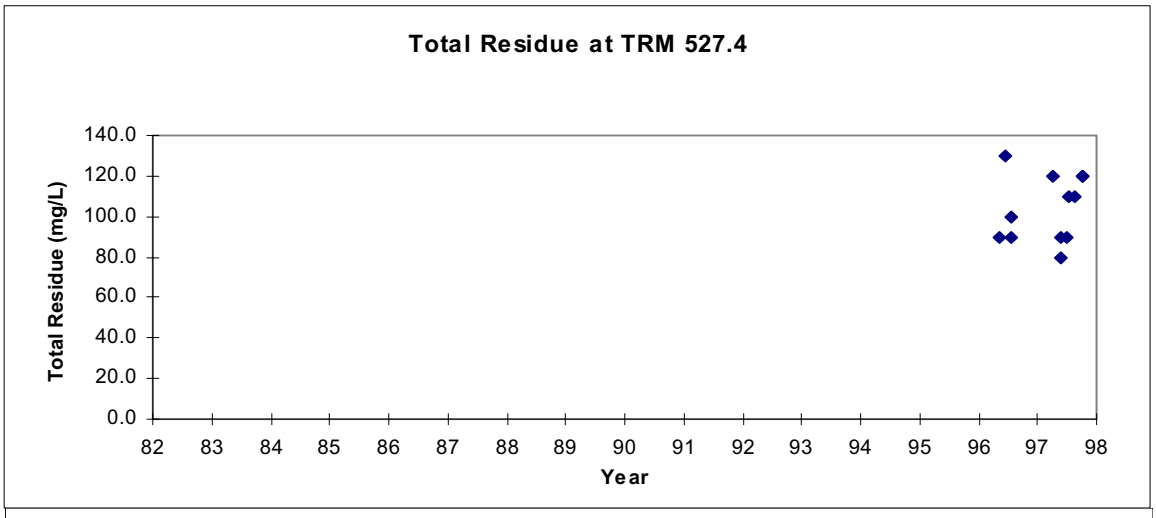


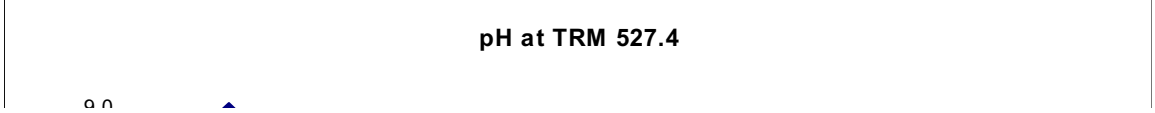


Appendix B-2. Selected water quality values measured during preoperational (1982-1987) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 527.4

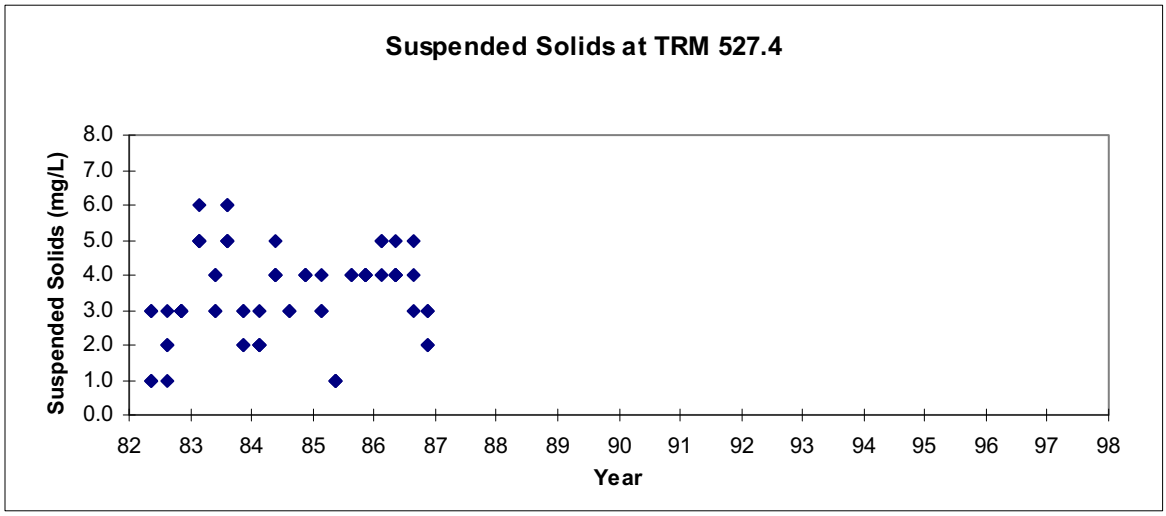


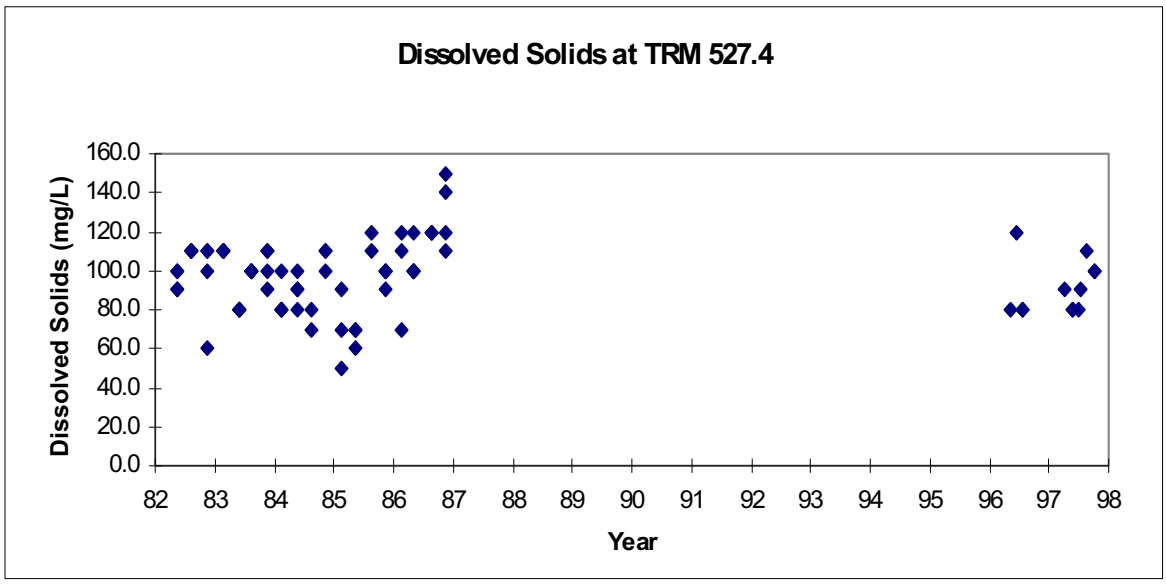


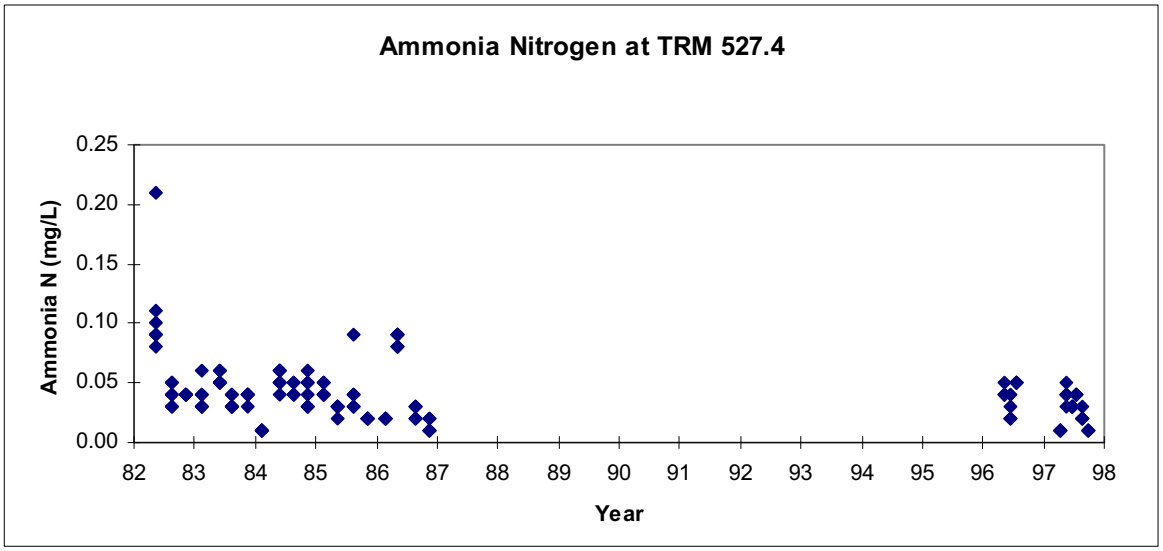


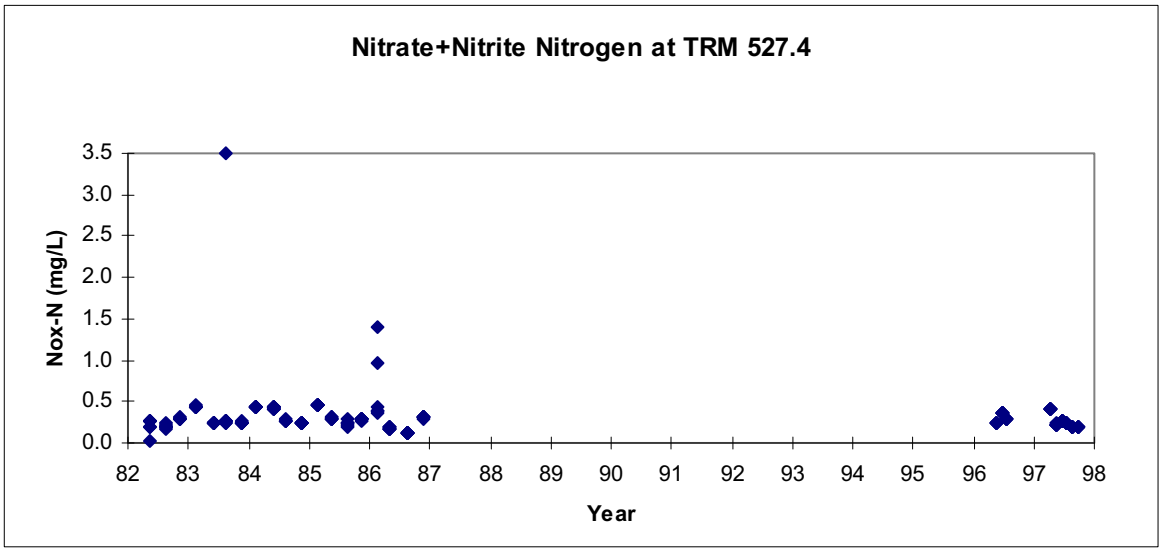


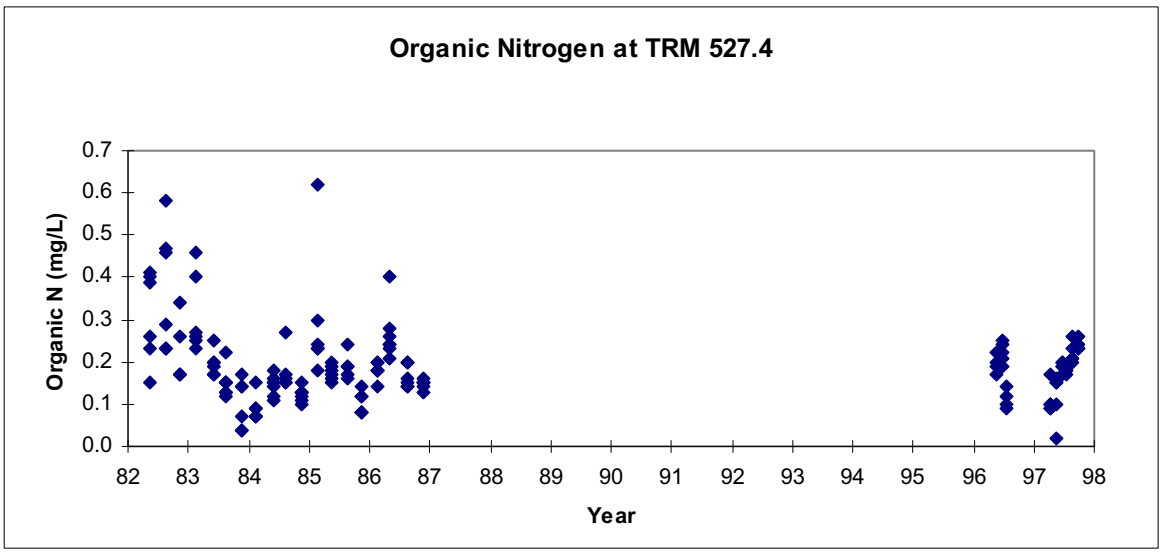
Appendix B-2 (Continued)

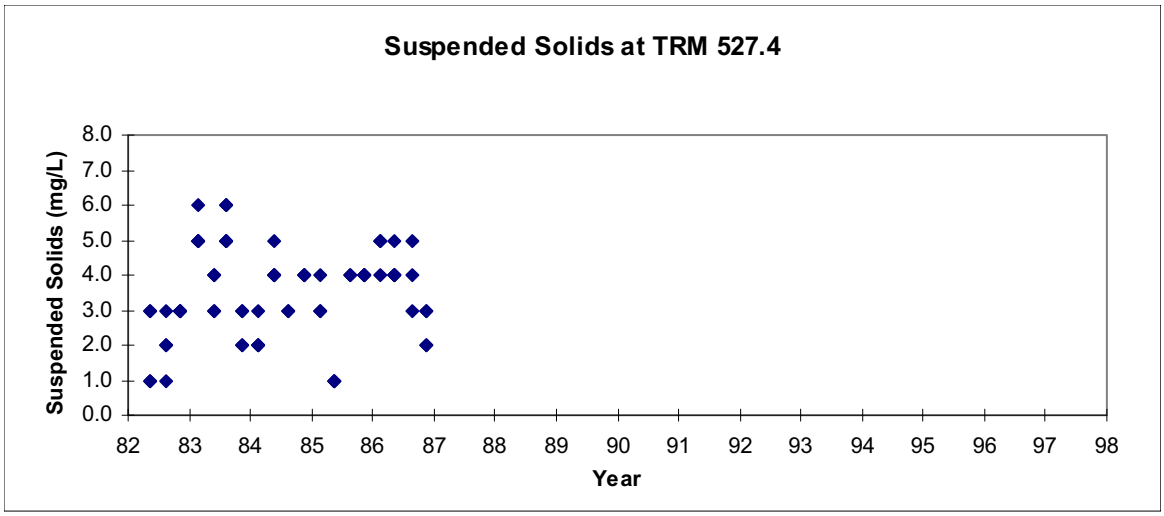


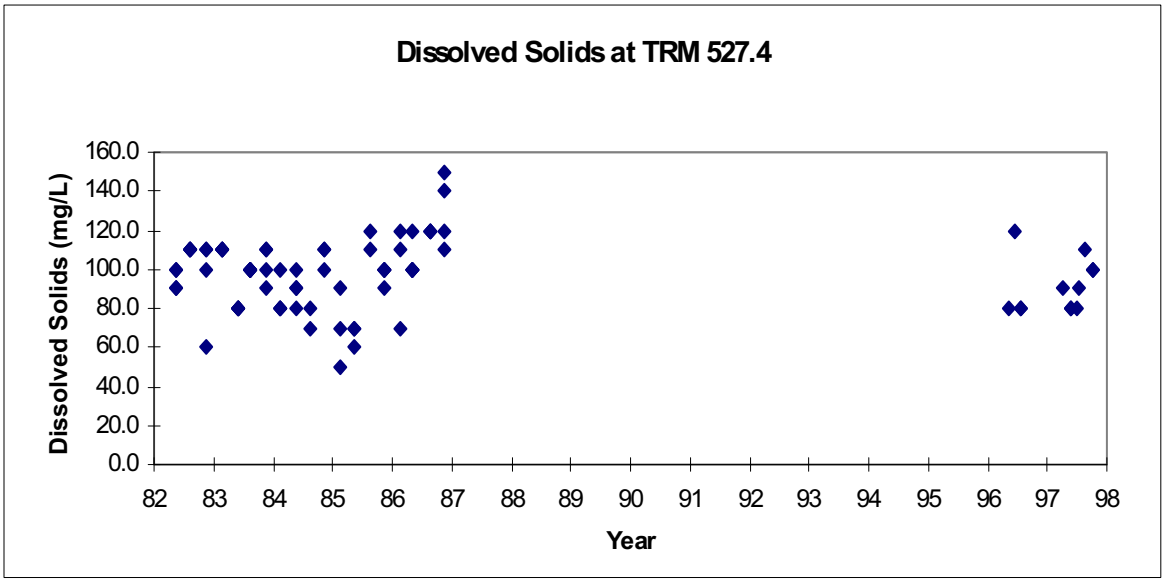



Ammonia Nitrogen at TRM 527.4
Ammonia N (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

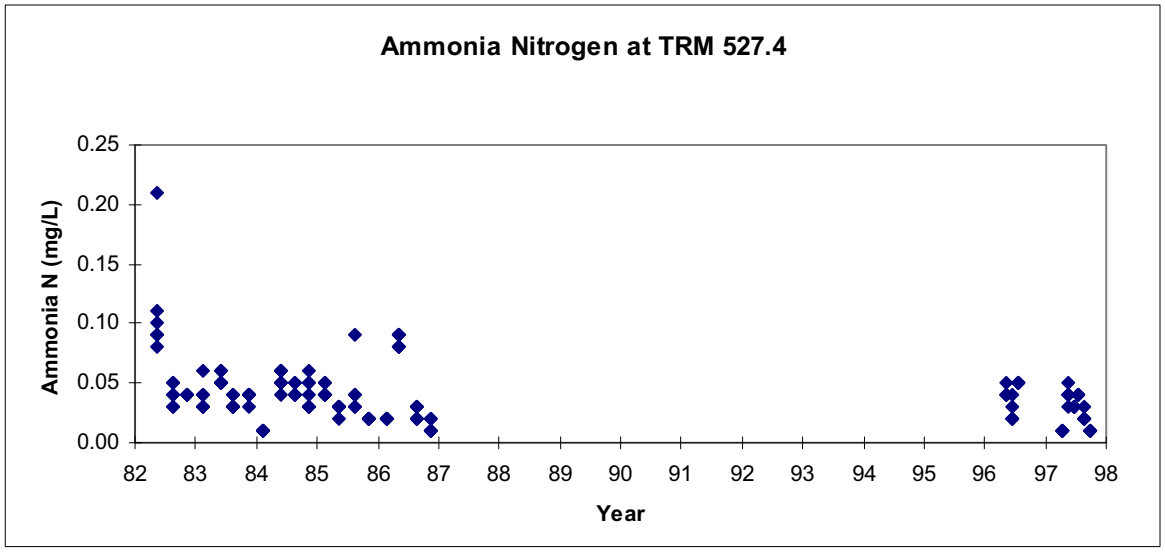

Nitrate+Nitrite Nitrogen at TRM 527.4
Nox-N (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

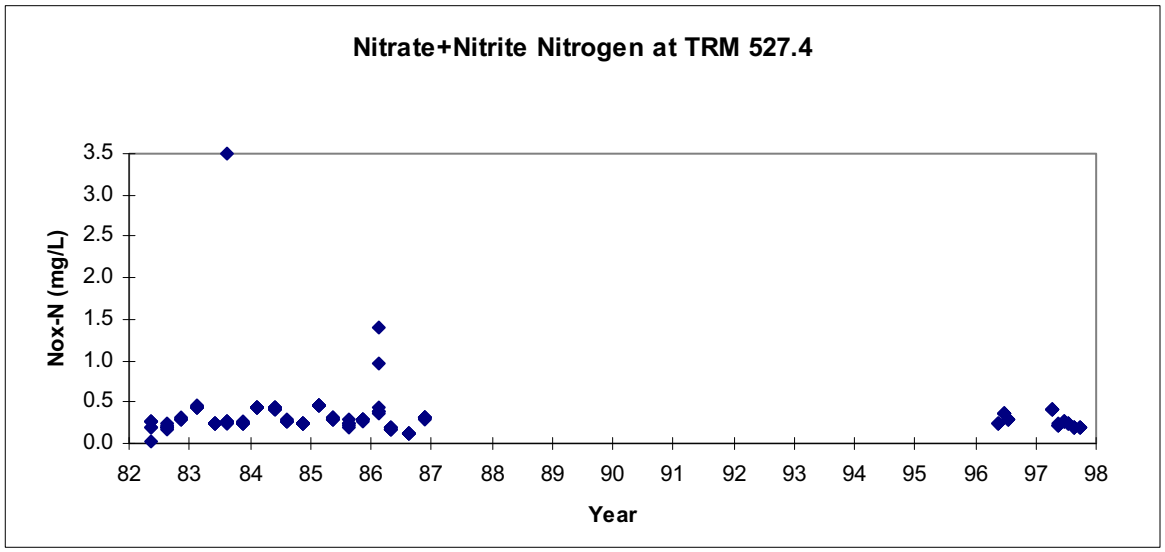

Organic Nitrogen at TRM 527.4
Organic N (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

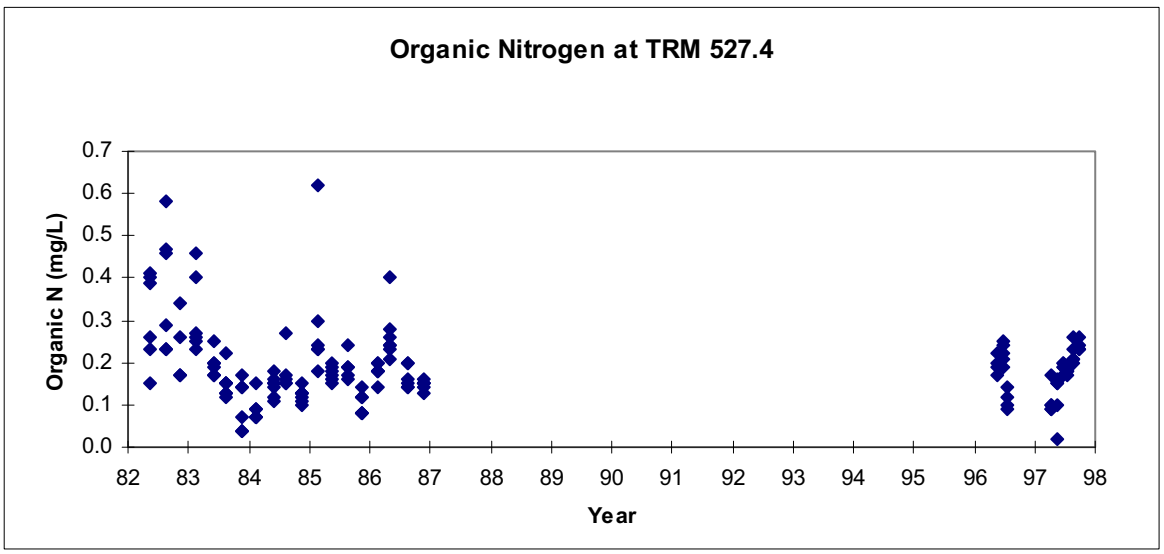

Suspended Solids at TRM 527.4
Suspended Solids (mg/L)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year


Dissolved Solids at TRM 527.4
Dissolved Solids (mg/L)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

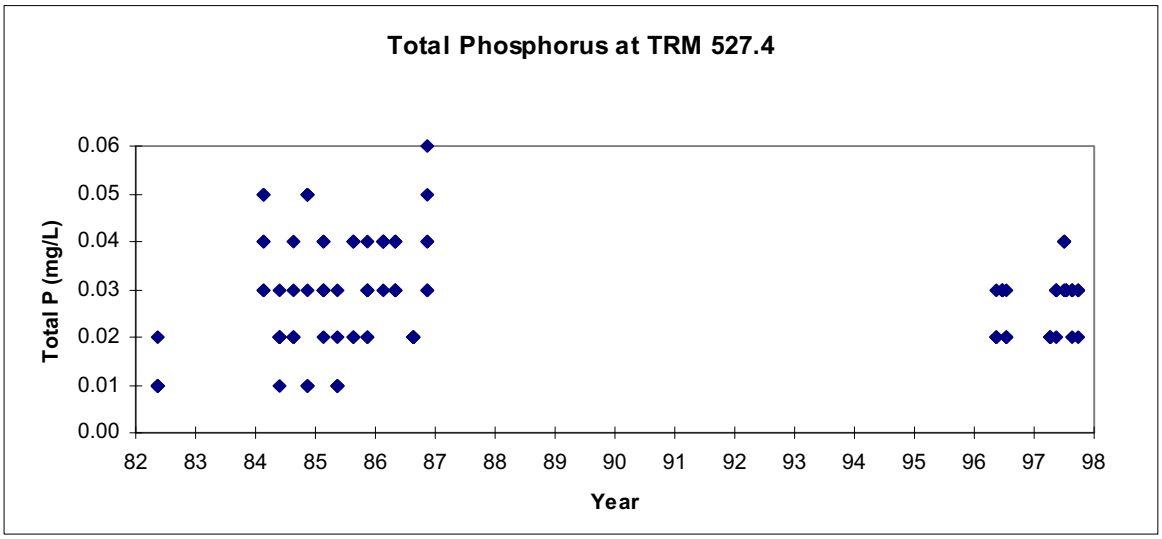
Appendix B-2 (Continued)

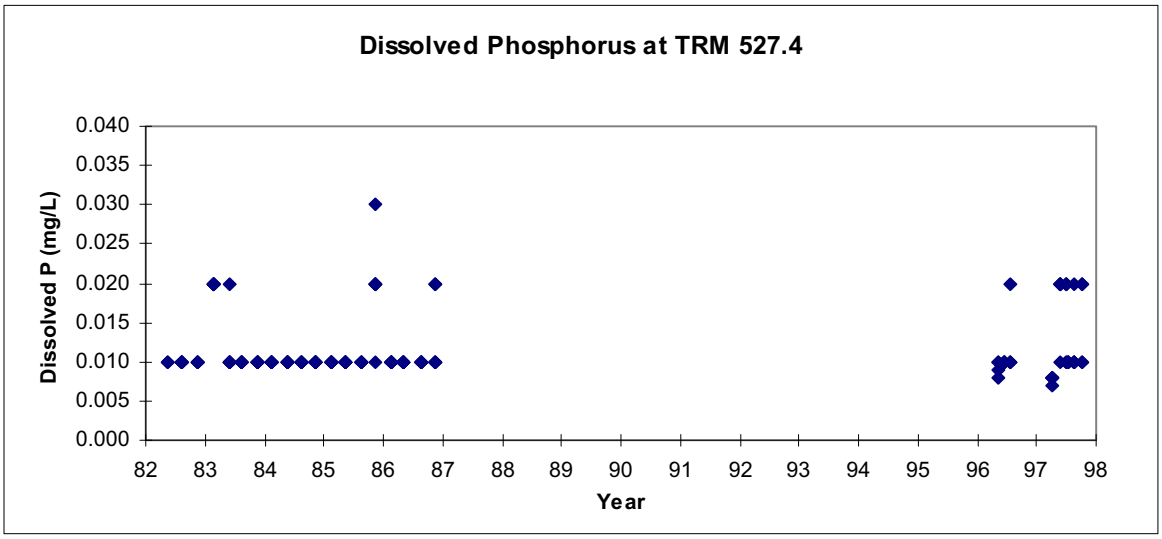


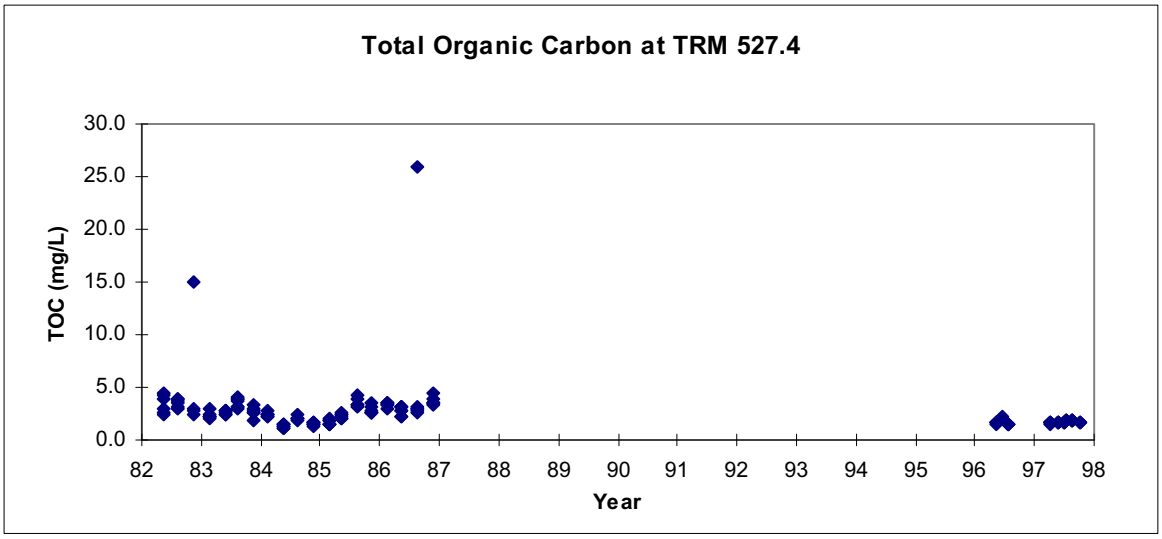


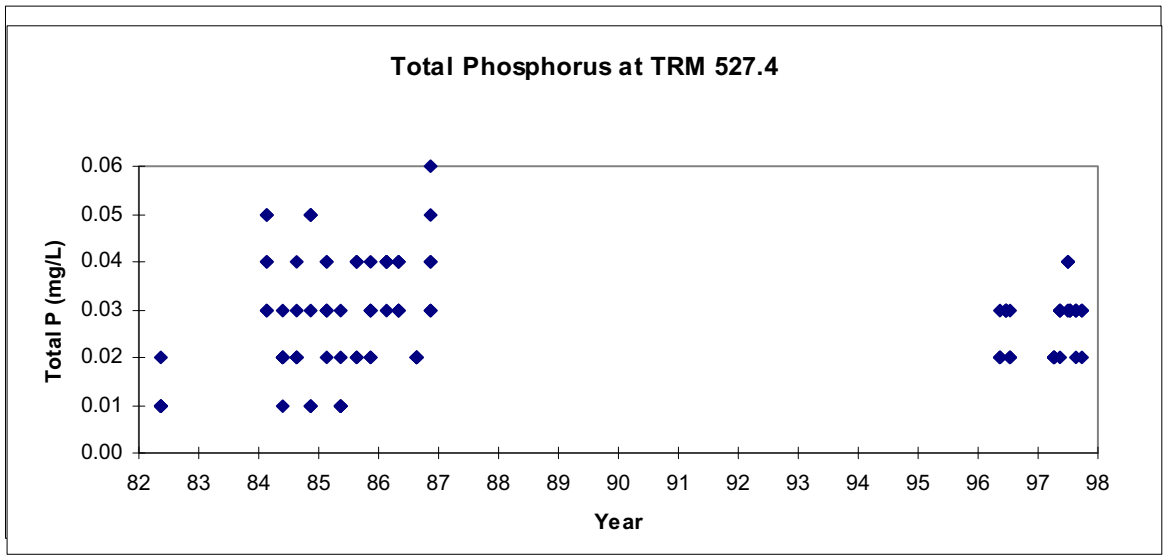


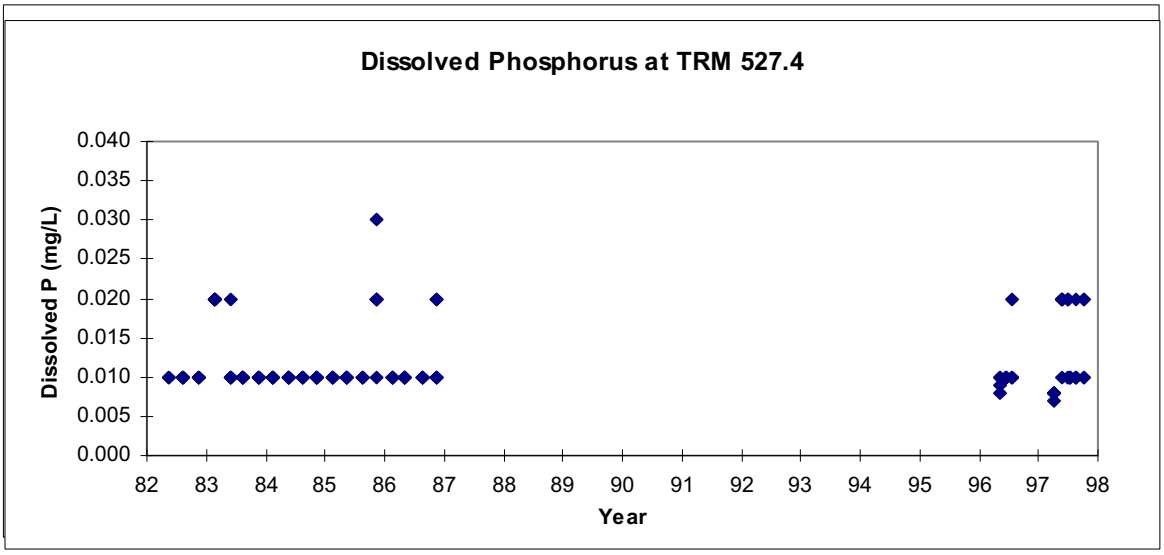
Appendix B-2 (Continued)

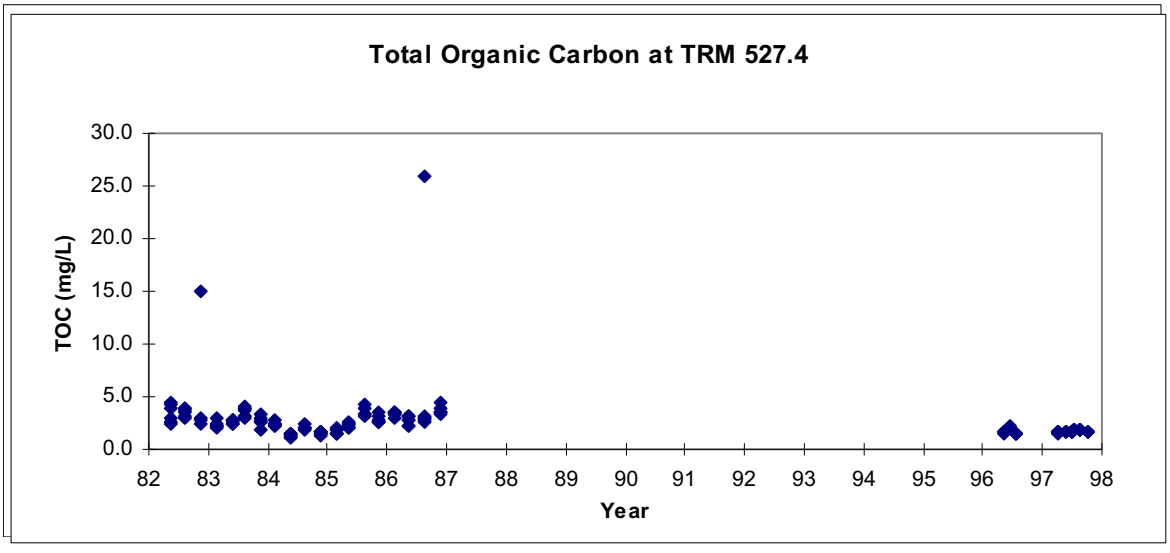




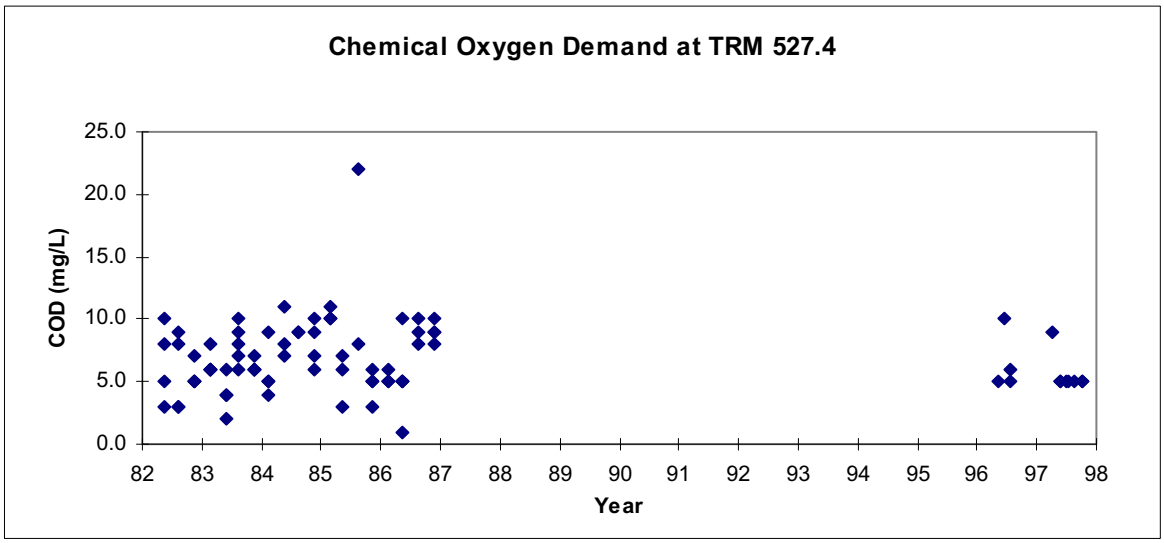


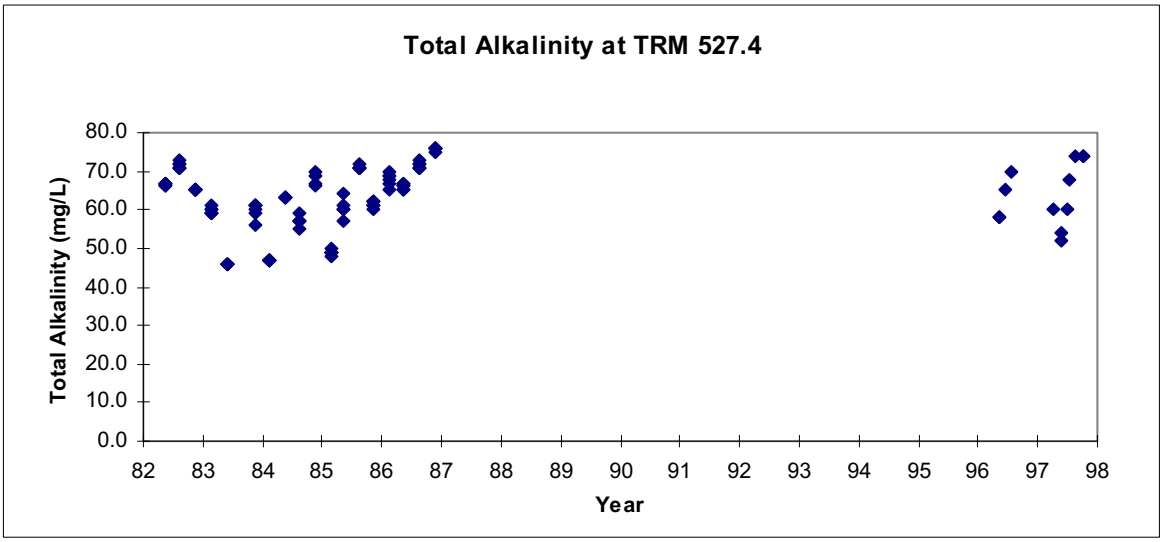

Total Phosphorus at TRM 527.4
Total P (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

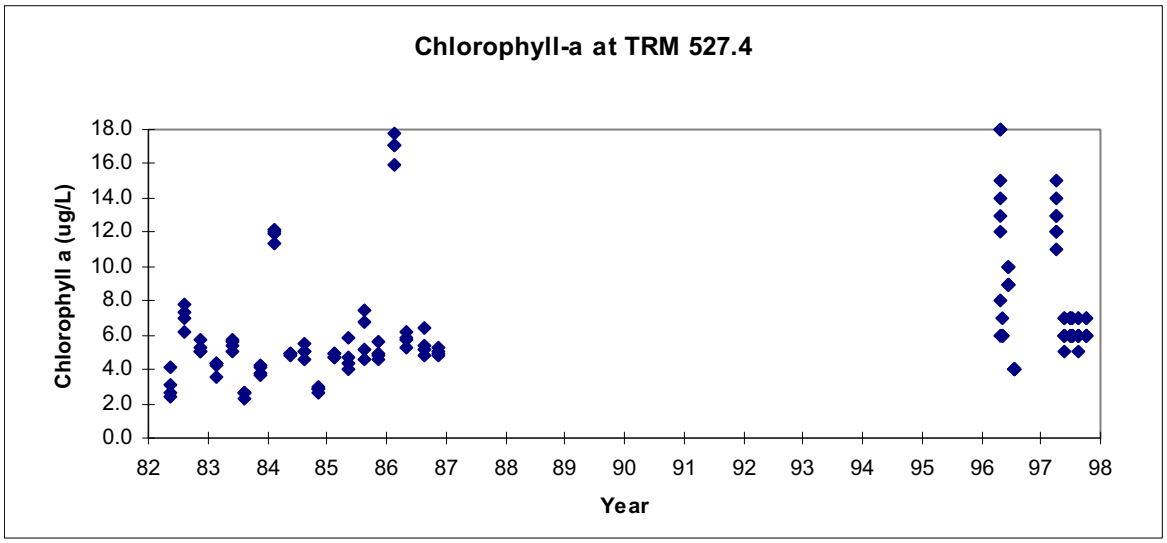

Dissolved Phosphorus at TRM 527.4
Dissolved P (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year


Total Organic Carbon at TRM 527.4
TOC (mg/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

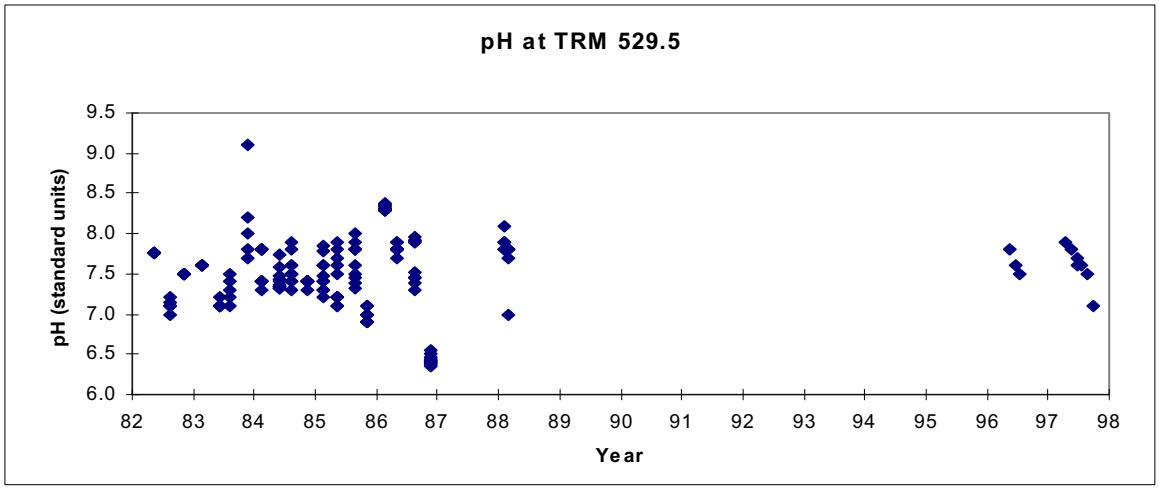
Appendix B-2 (Continued)

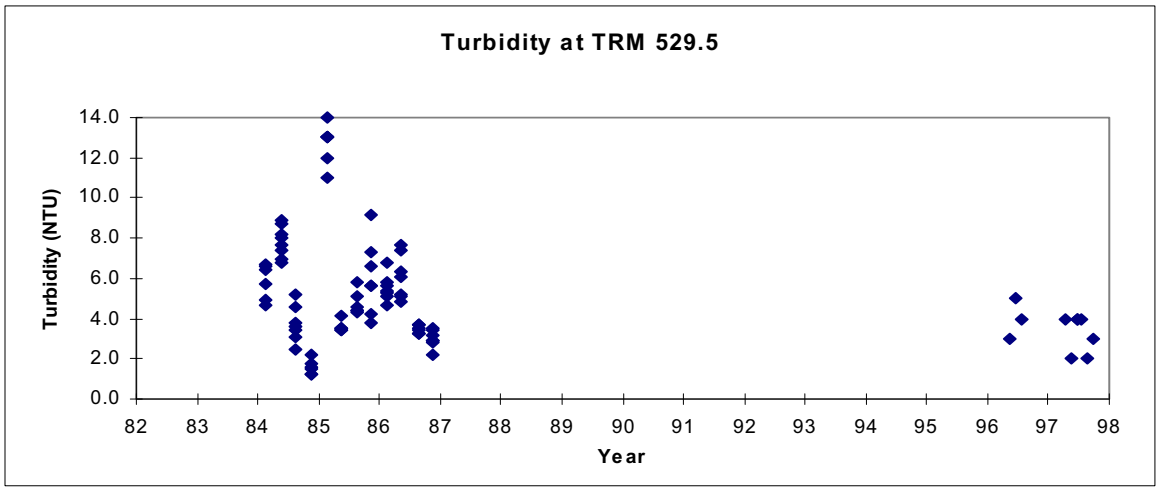


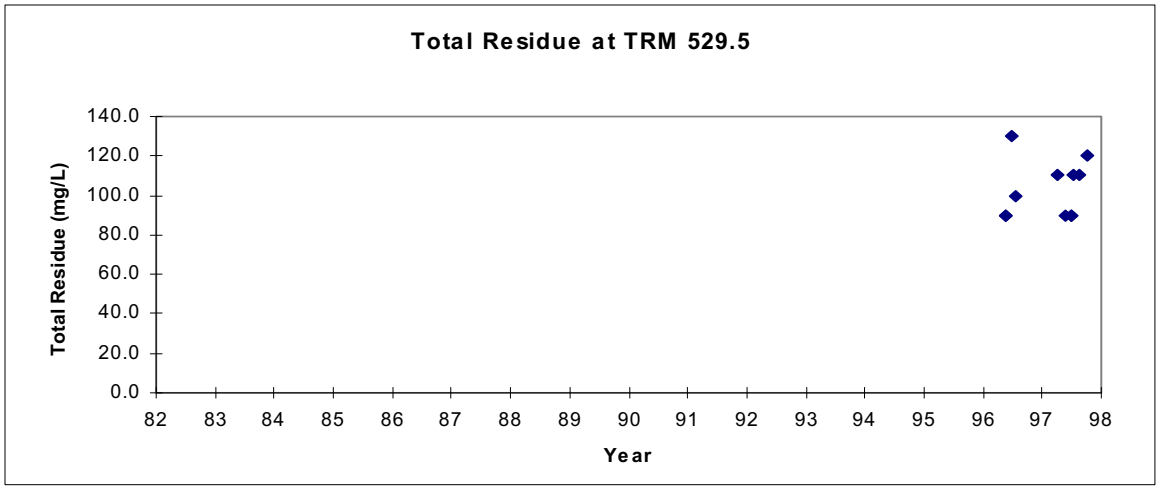


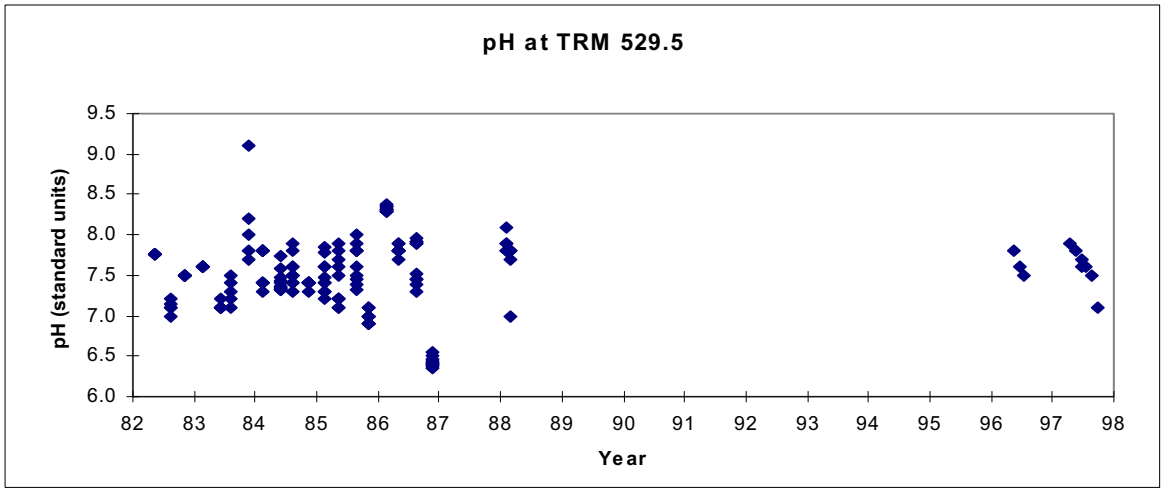


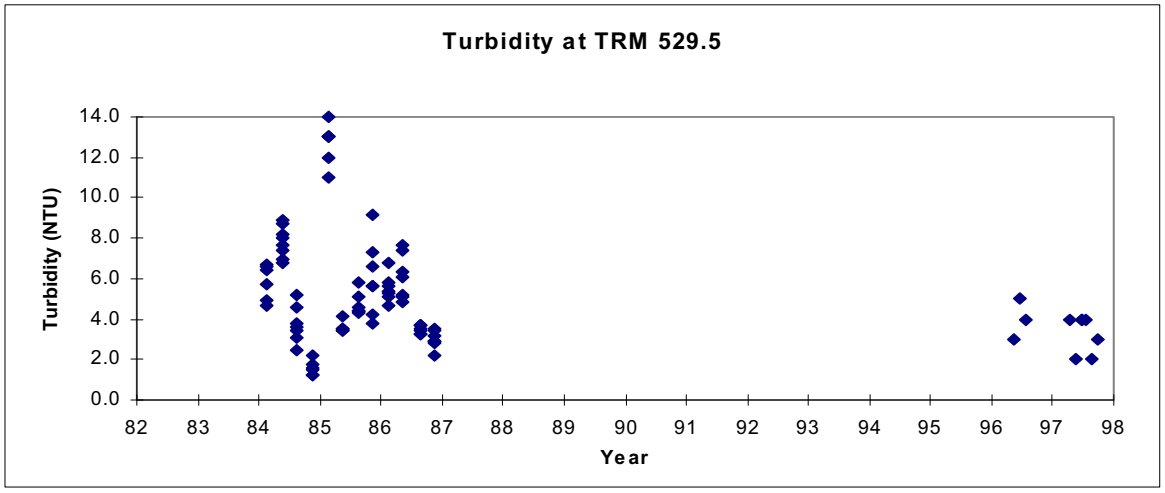
Appendix B-3. Selected water quality values measured during preoperational (1982-1987) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 529.5

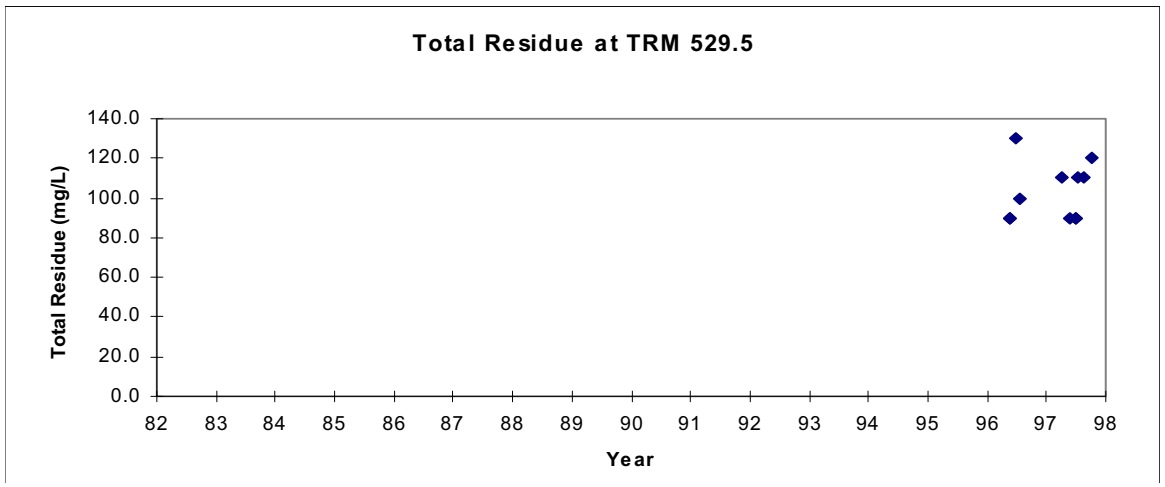




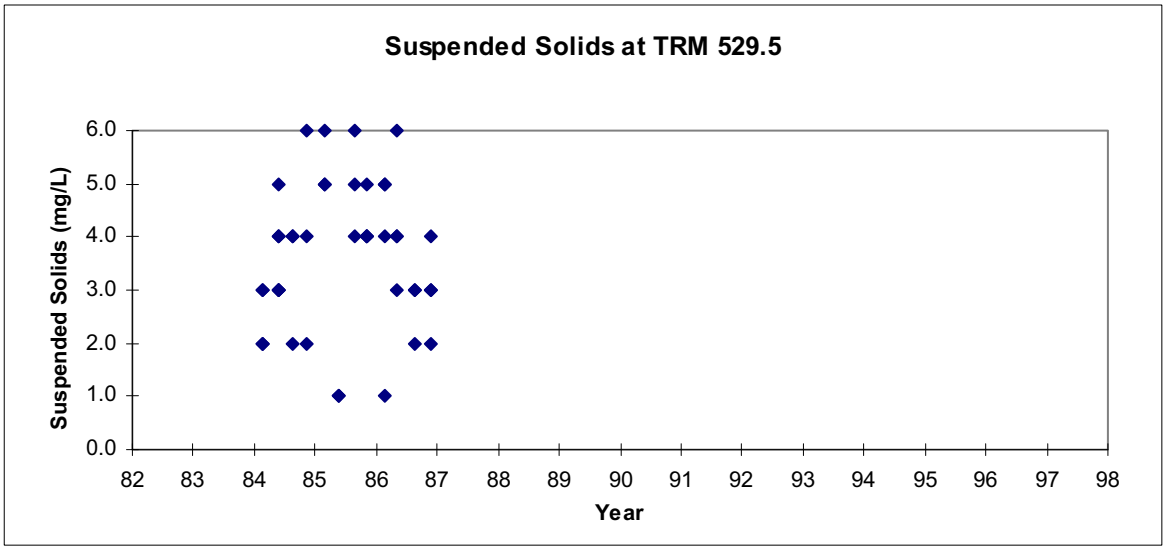


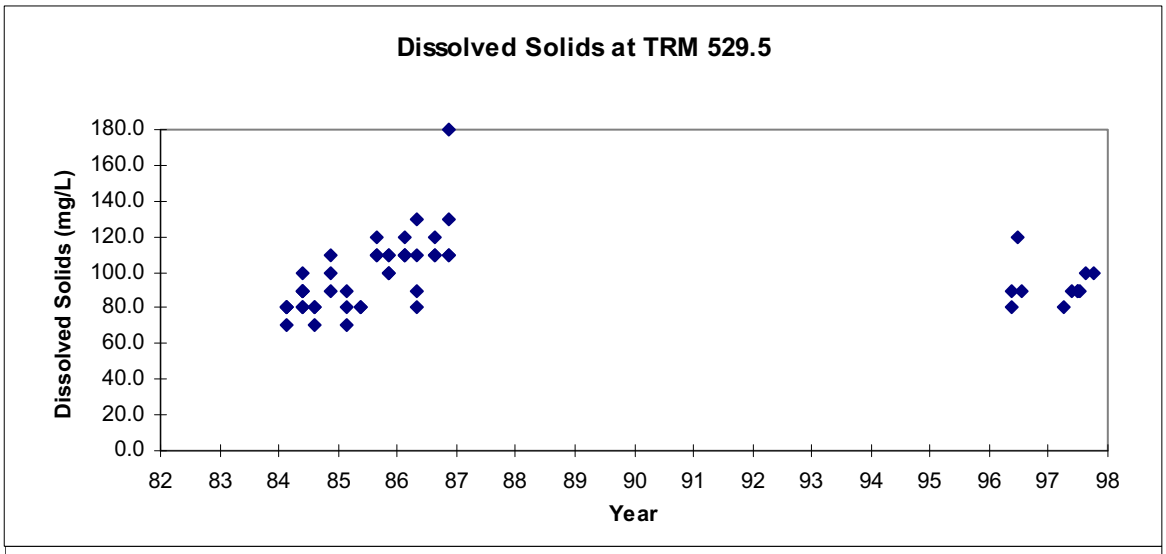


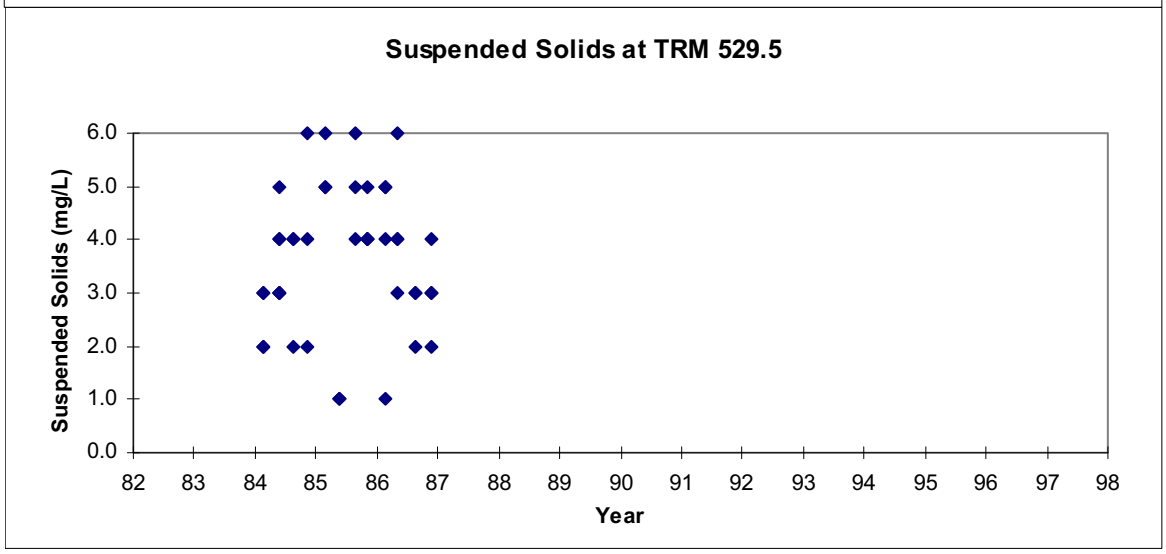


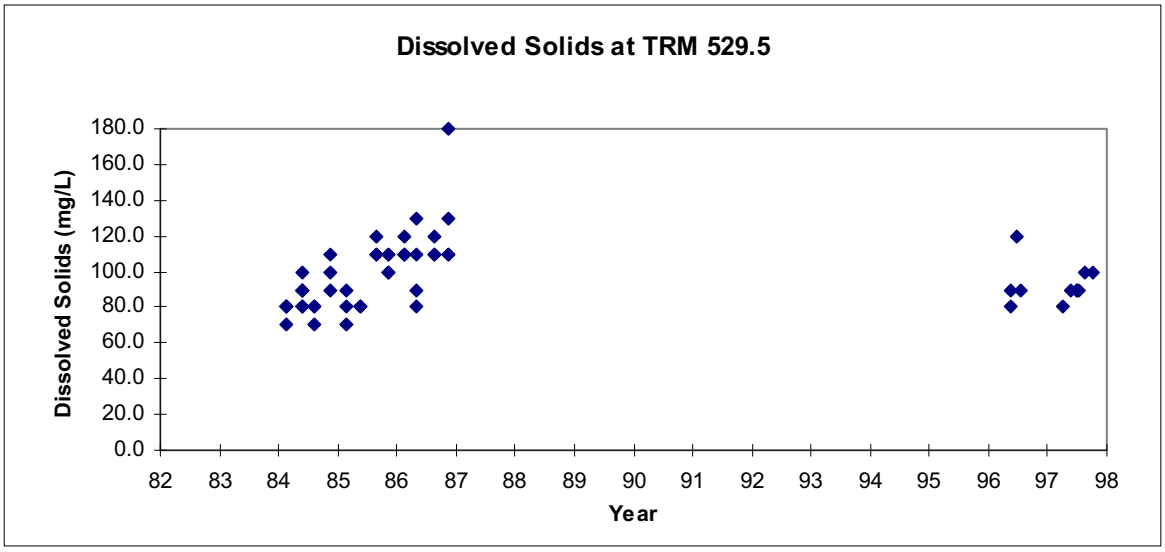


Appendix B-3 (Continued)

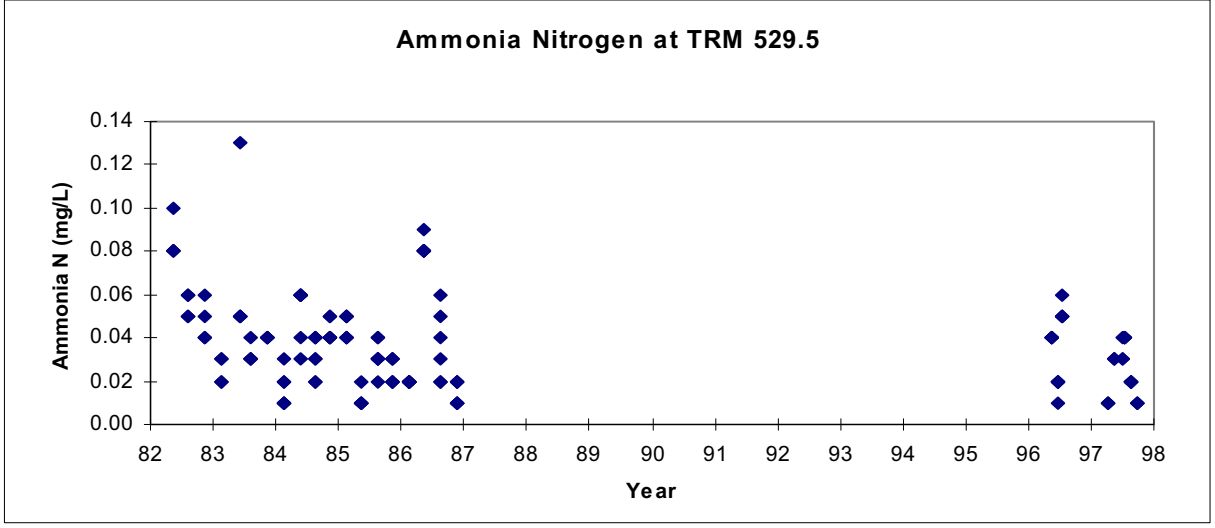

Suspended Solids at TRM 529.5
Suspended Solids (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

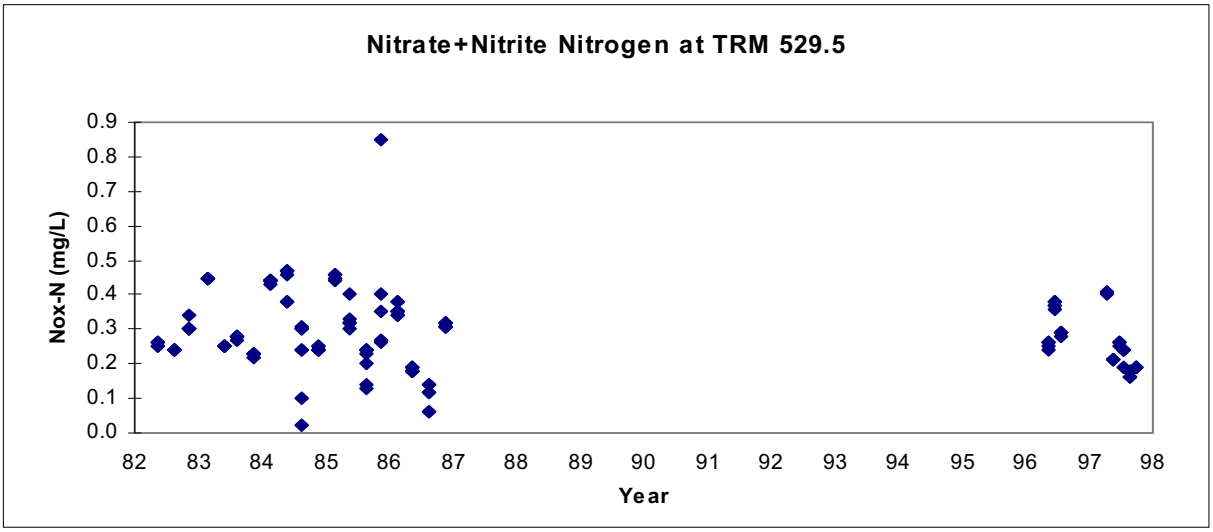

Dissolved Solids at TRM 529.5
Dissolved Solids (mg/L)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

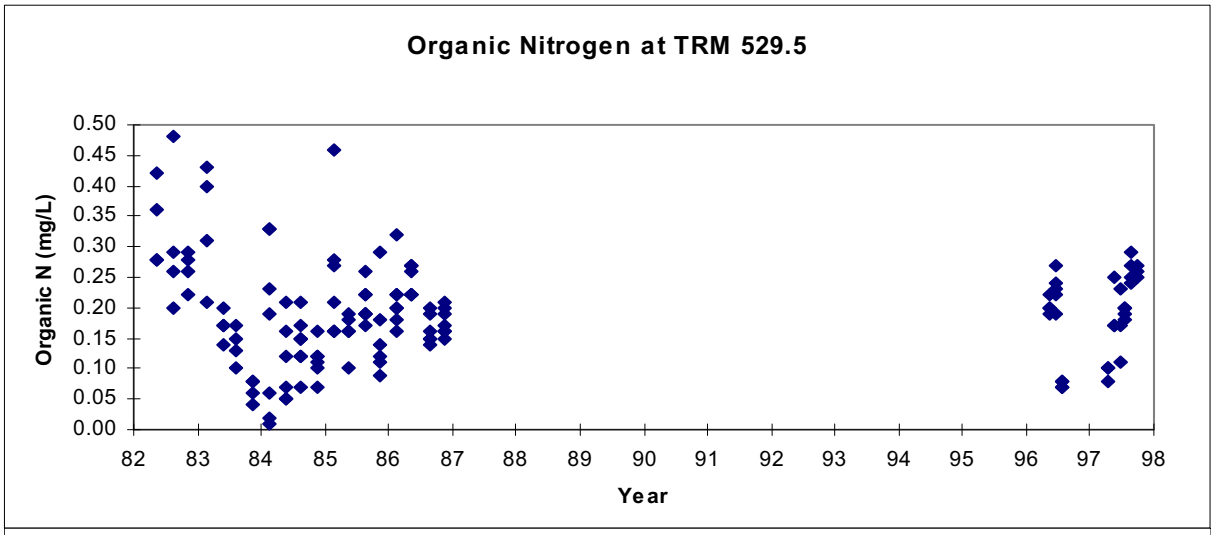

Suspended Solids at TRM 529.5
Suspended Solids (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

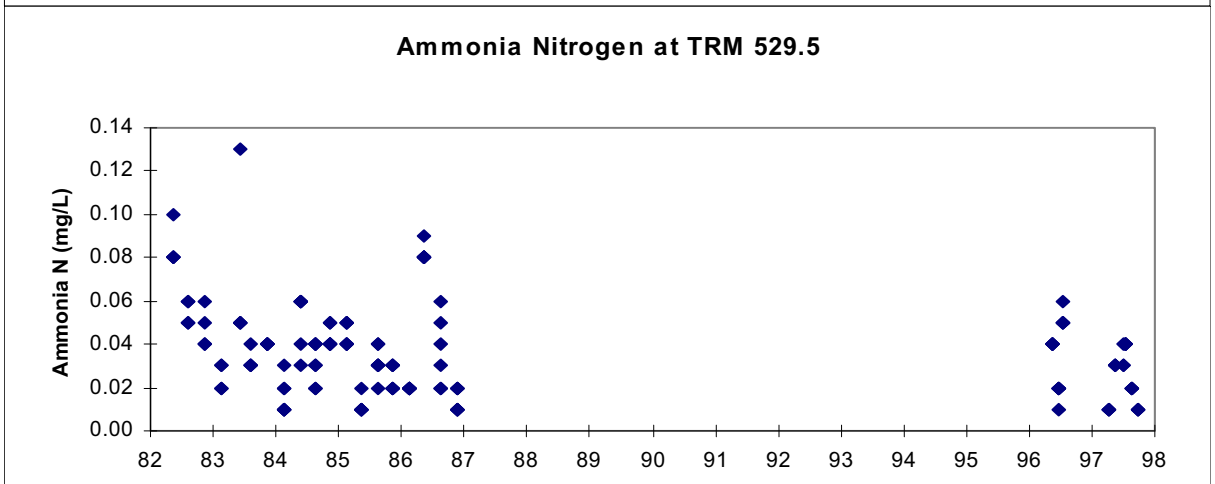

Dissolved Solids at TRM 529.5
Dissolved Solids (mg/L)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
Year

Appendix B-3 (Continued)

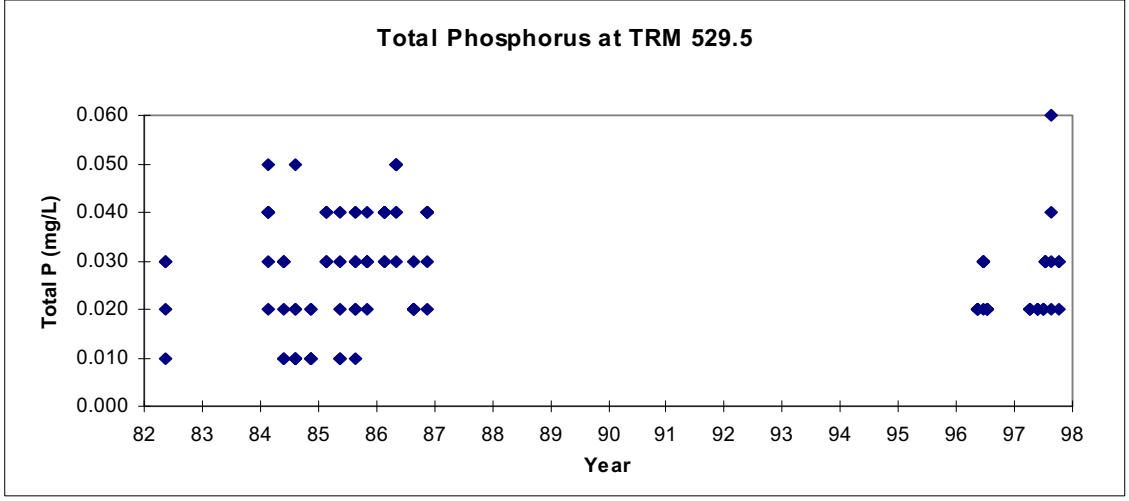

Ammonia Nitrogen at TRM 529.5
Ammonia N (mg/L)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

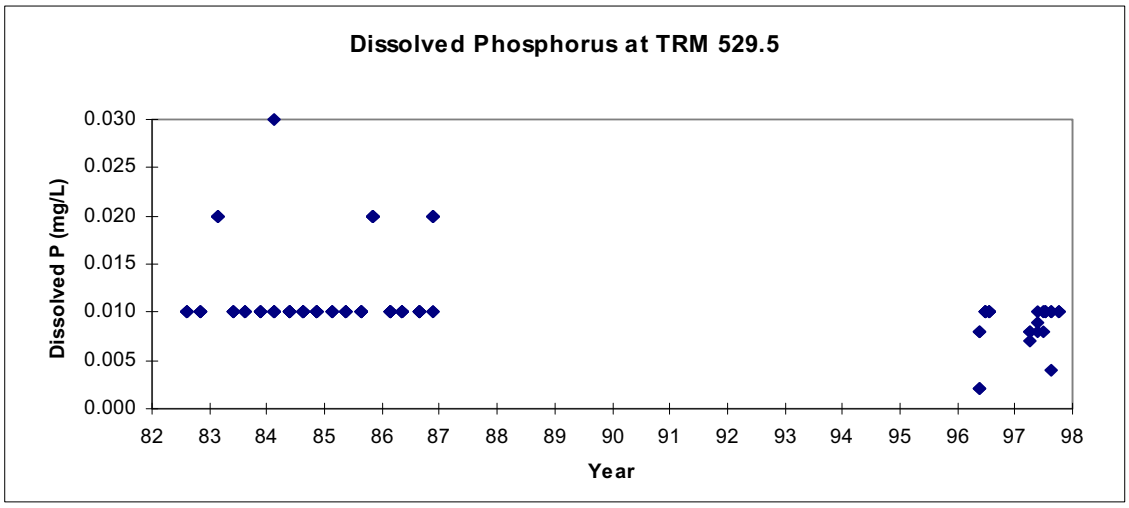

Nitrate+Nitrite Nitrogen at TRM 529.5
Nox-N (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

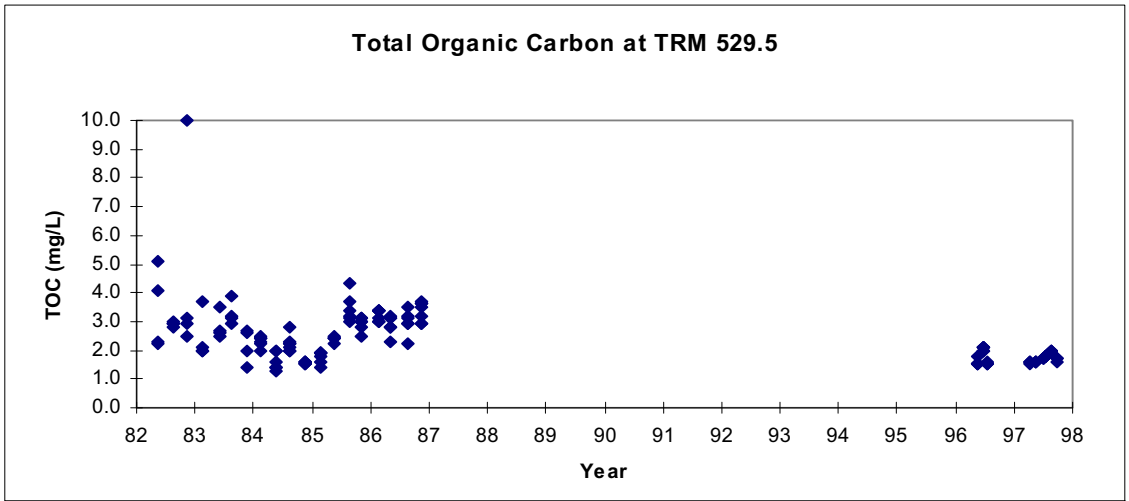

Organic Nitrogen at TRM 529.5
Organic N (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

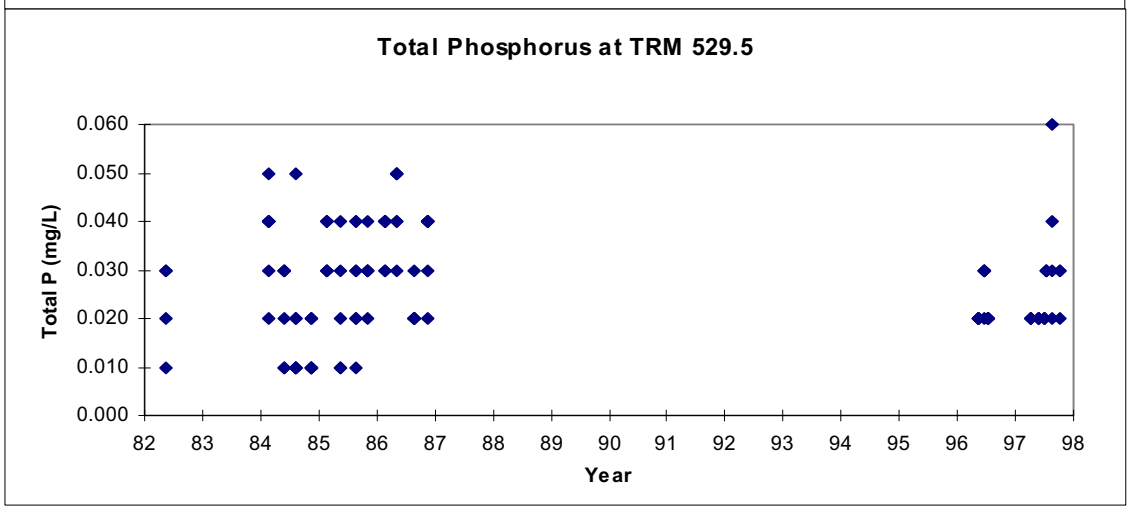

Ammonia Nitrogen at TRM 529.5
Ammonia N (mg/L)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

Appendix B-3 (Continued)

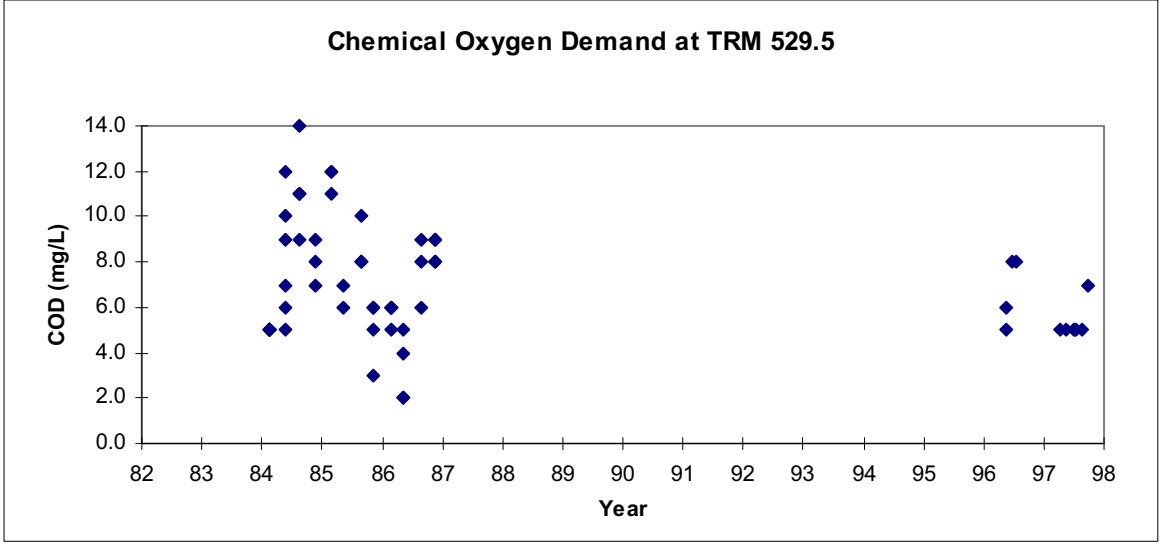

Total Phosphorus at TRM 529.5
Total P (mg/L)
0.060
0.050
0.040
0.030
0.020
0.010
0.000
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

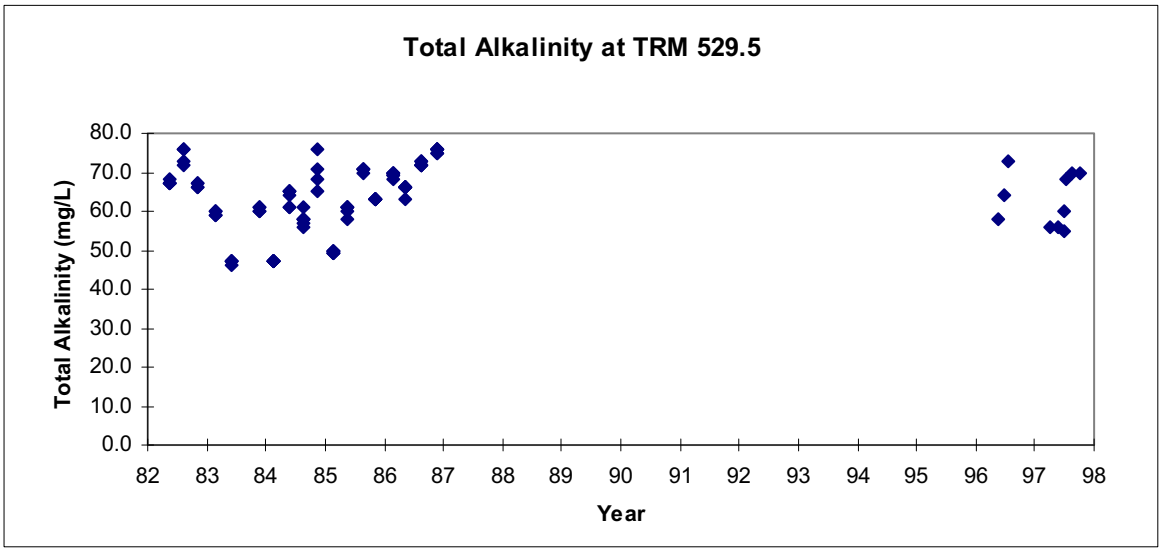

Dissolved Phosphorus at TRM 529.5
Dissolved P (mg/L)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

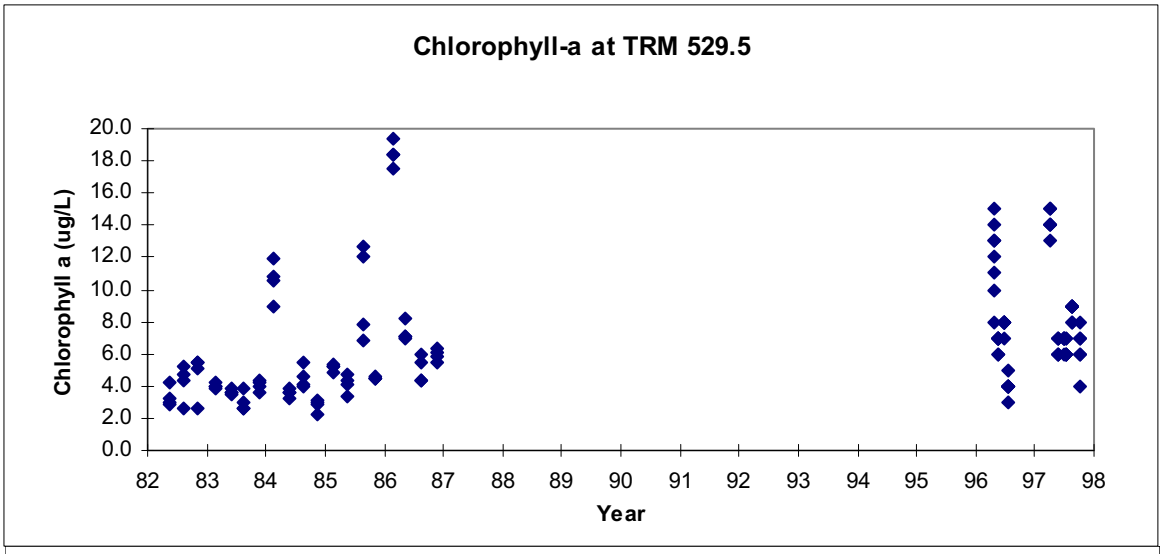

Total Organic Carbon at TRM 529.5
TOC (mg/L)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

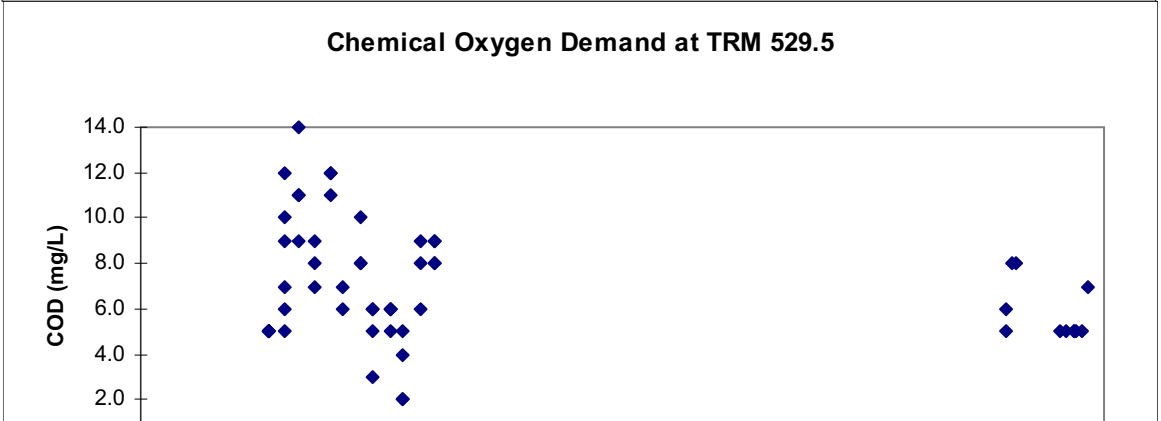

Total Phosphorus at TRM 529.5
Total P (mg/L)
0.060
0.050
0.040
0.030
0.020
0.010
0.000
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

Appendix B-3 (Continued)

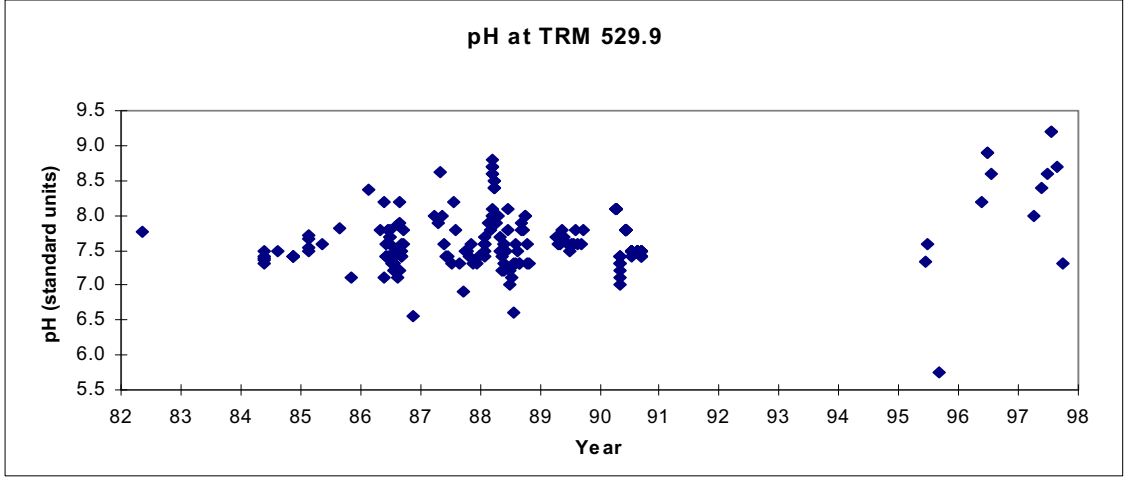

Chemical Oxygen Demand at TRM 529.5
COD (mg/L)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

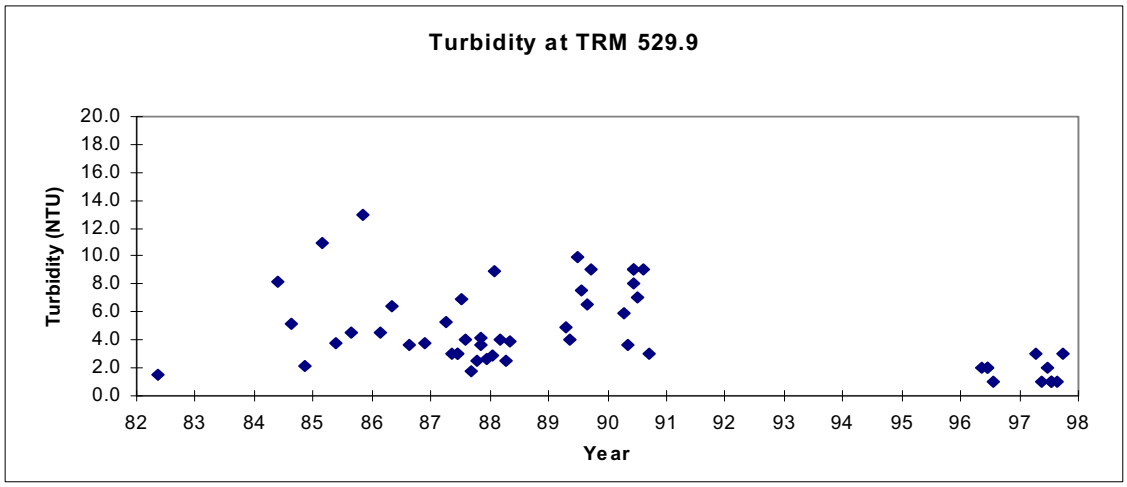

Total Alkalinity at TRM 529.5
Total Alkalinity (mg/L)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

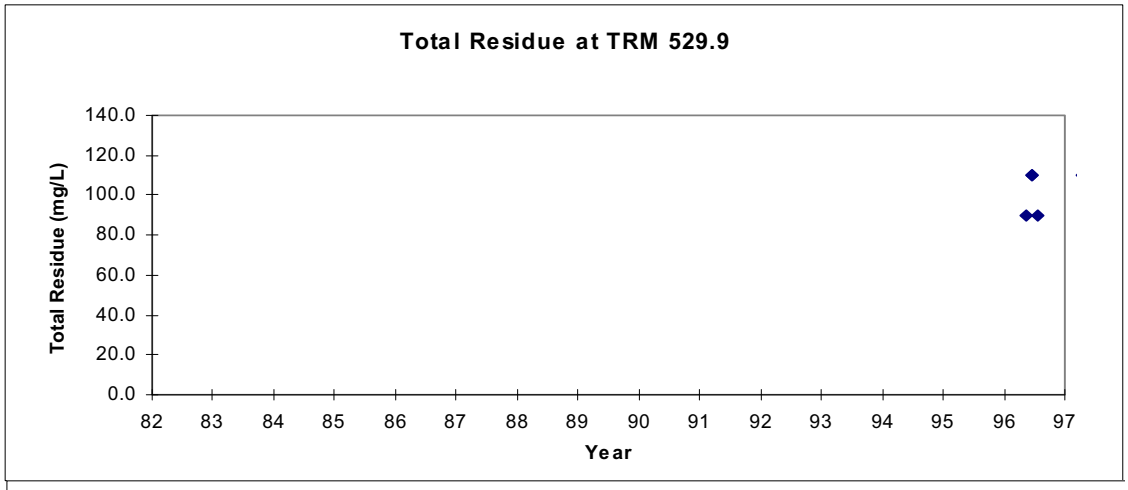

Chlorophyll-a at TRM 529.5
Chlorophyll a (ug/L)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

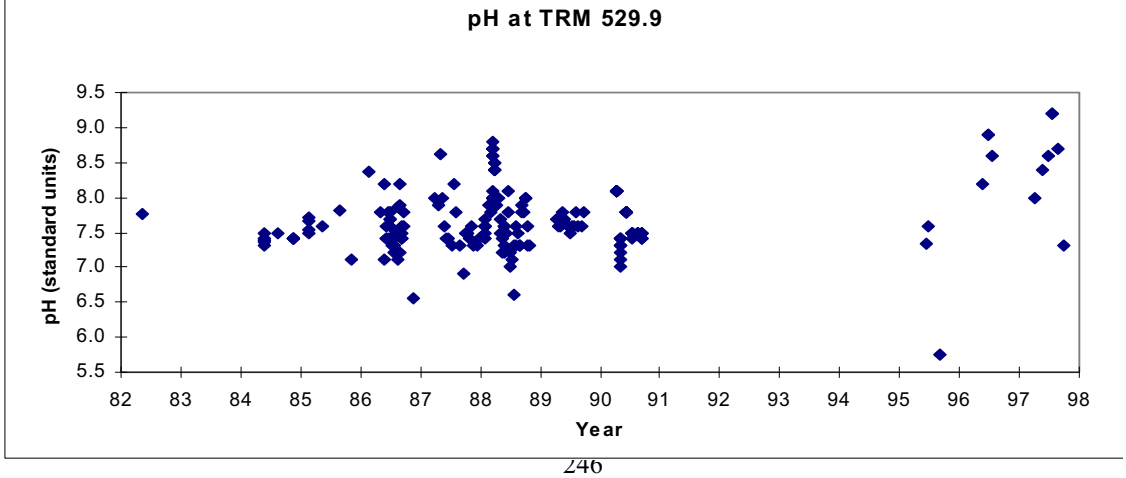

Chemical Oxygen Demand at TRM 529.5
COD (mg/L)
14.0
12.0
10.0
8.0
6.0
4.0
2.0

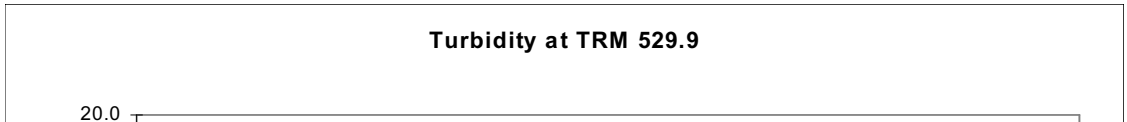
Appendix B-4. Selected water quality values measured during preoperational (1982-1991) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 529.9


pH at TRM 529.9
pH (standard units)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

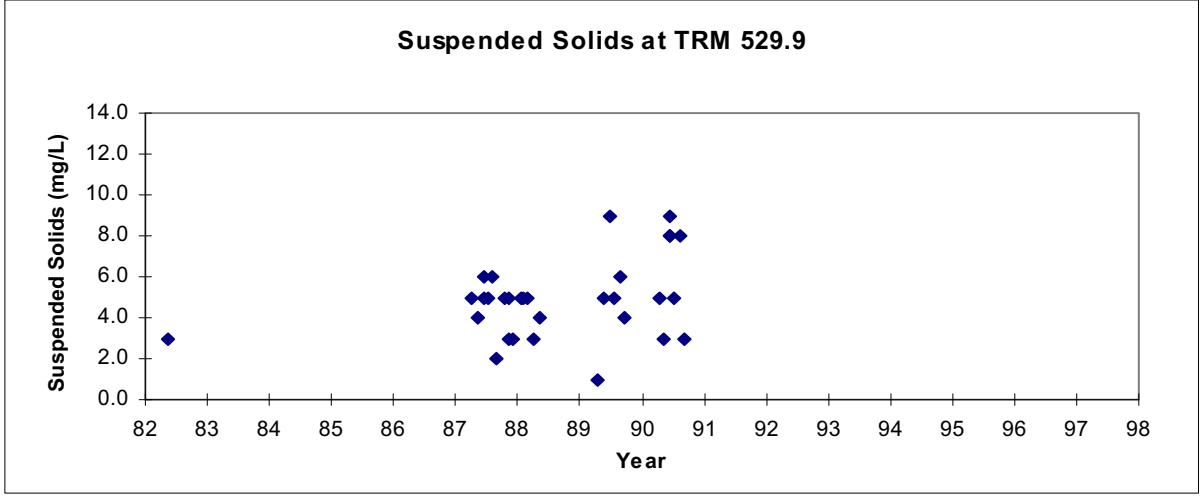

Turbidity at TRM 529.9
Turbidity (NTU)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

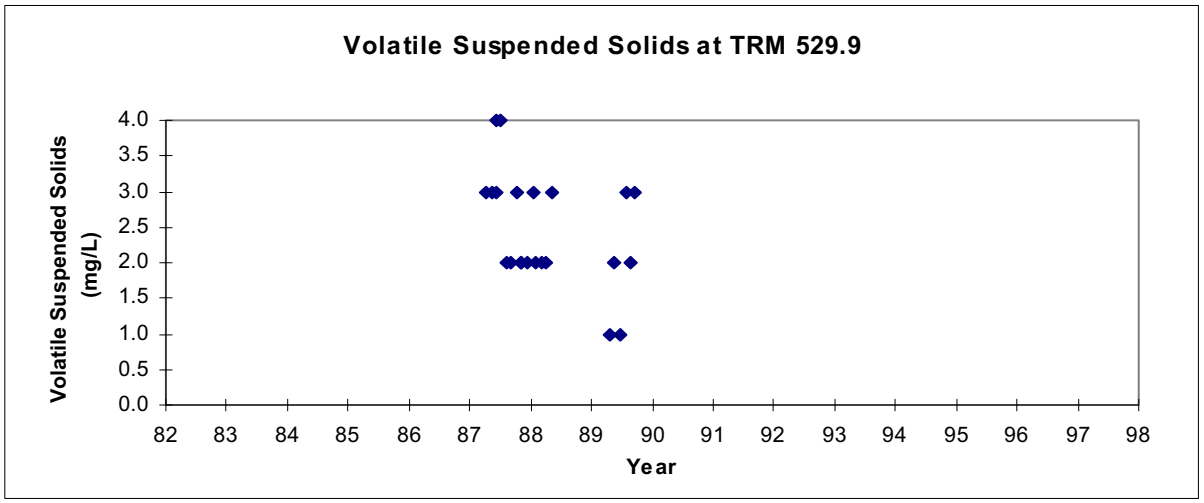

Total Residue at TRM 529.9
Total Residue (mg/L)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
Year

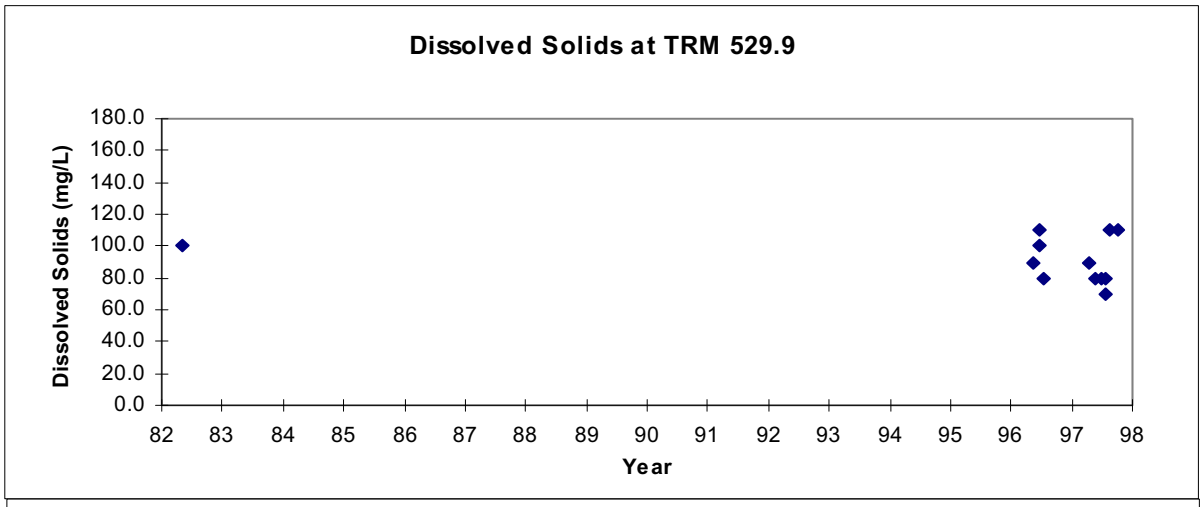

pH at TRM 529.9
pH (standard units)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

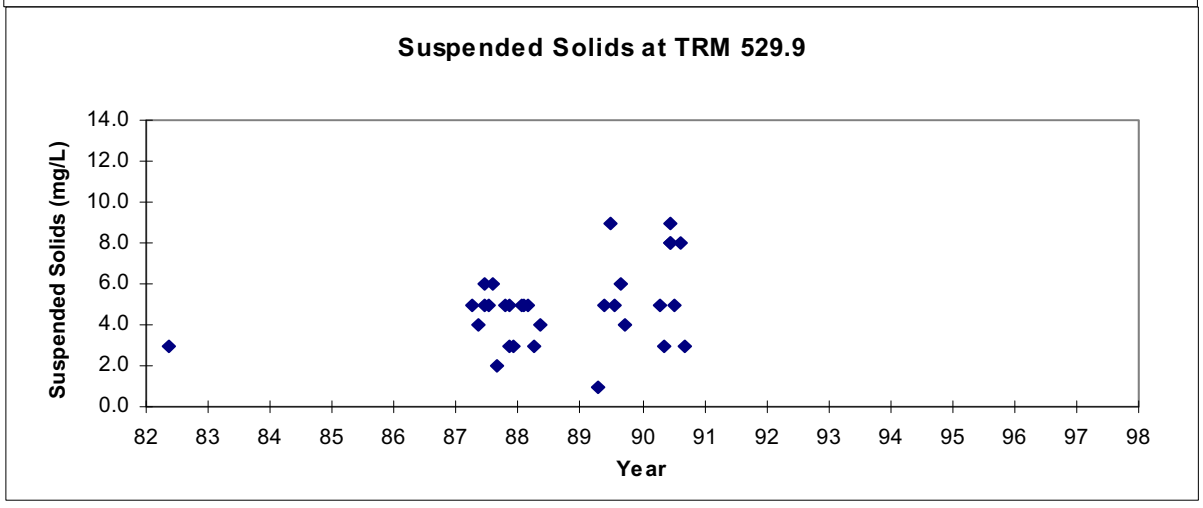

Turbidity at TRM 529.9
20.0

Appendix B-4 (Continued)

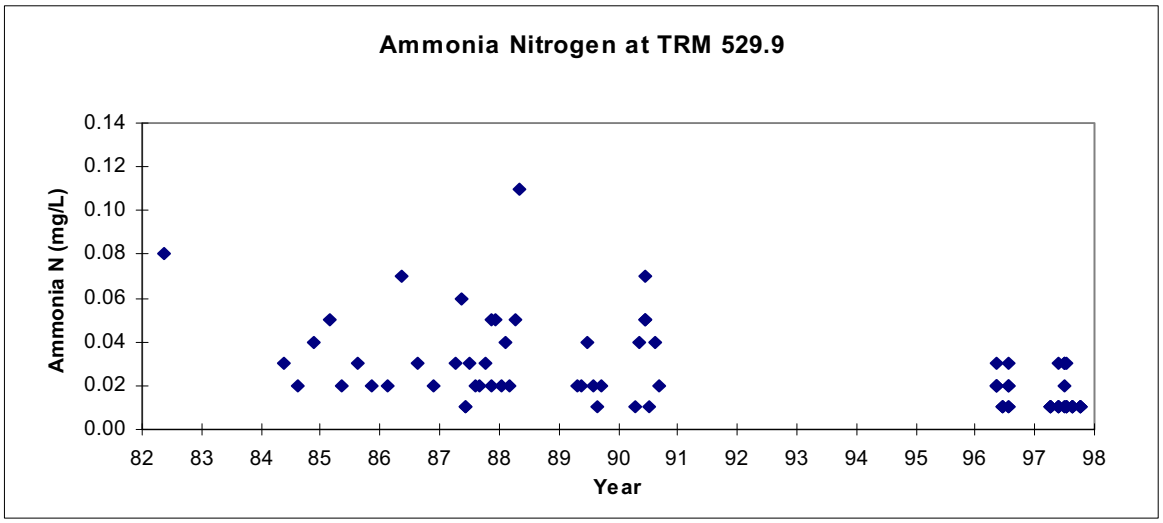

Suspended Solids at TRM 529.9
Suspended Solids (mg/L)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

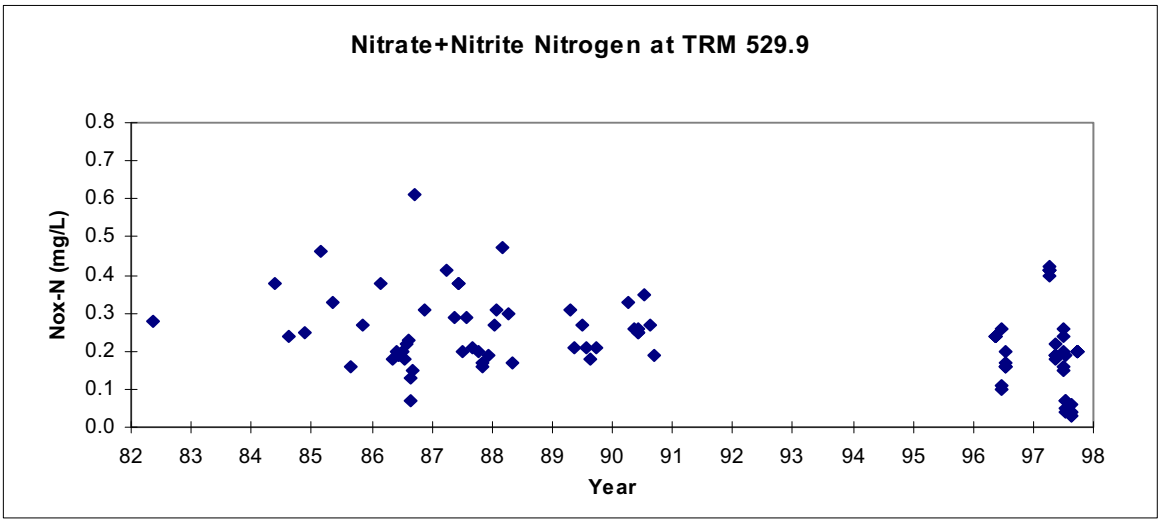

Volatile Suspended Solids at TRM 529.9
Volatile Suspended Solids (mg/L)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

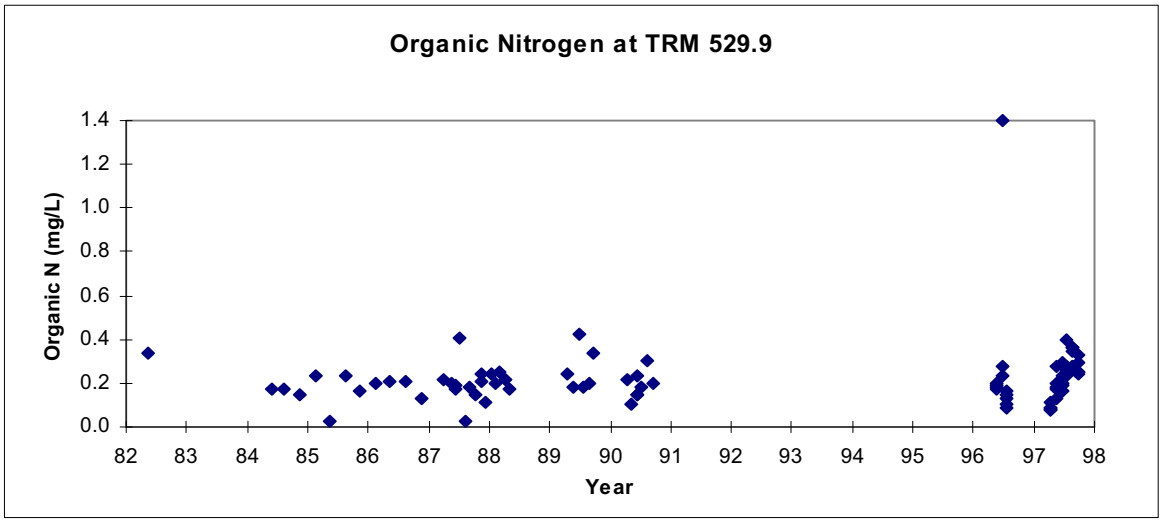

Dissolved Solids at TRM 529.9
Dissolved Solids (mg/L)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

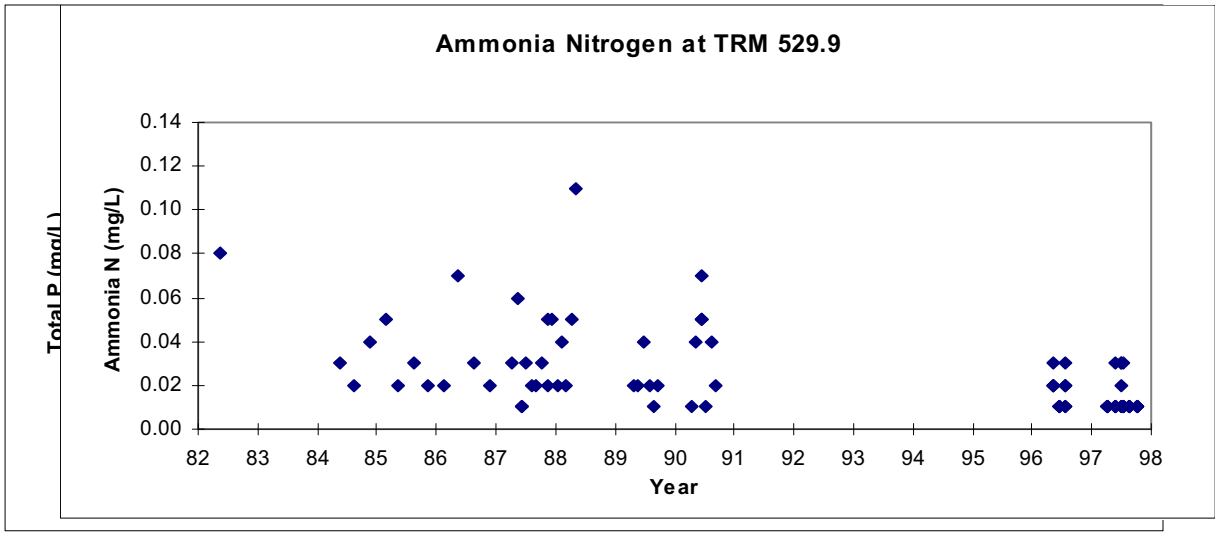

Suspended Solids at TRM 529.9
Suspended Solids (mg/L)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

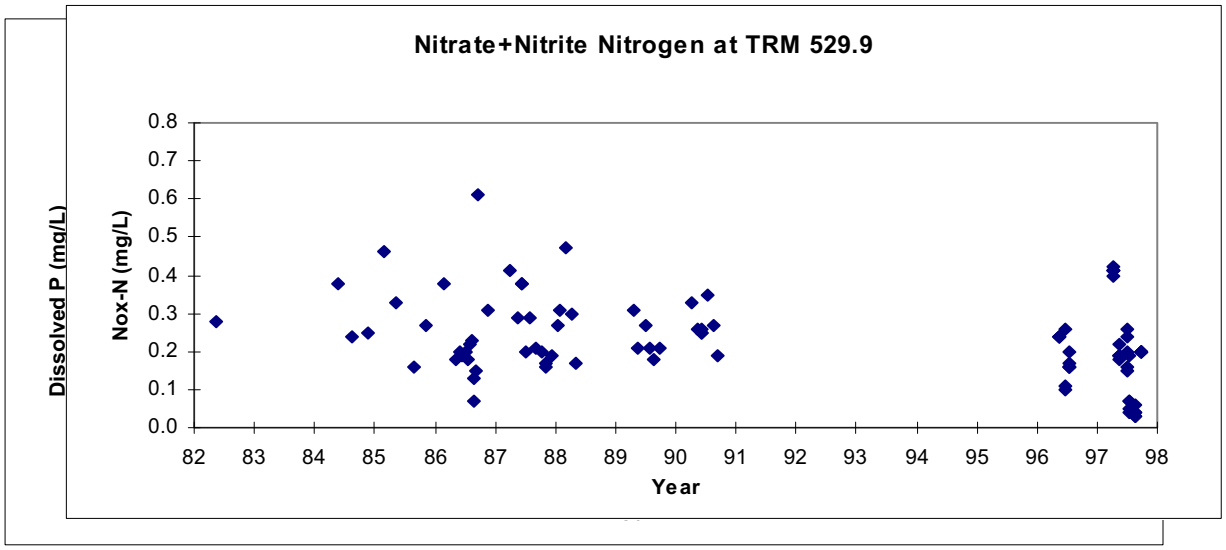
Appendix B-4 (Continued)

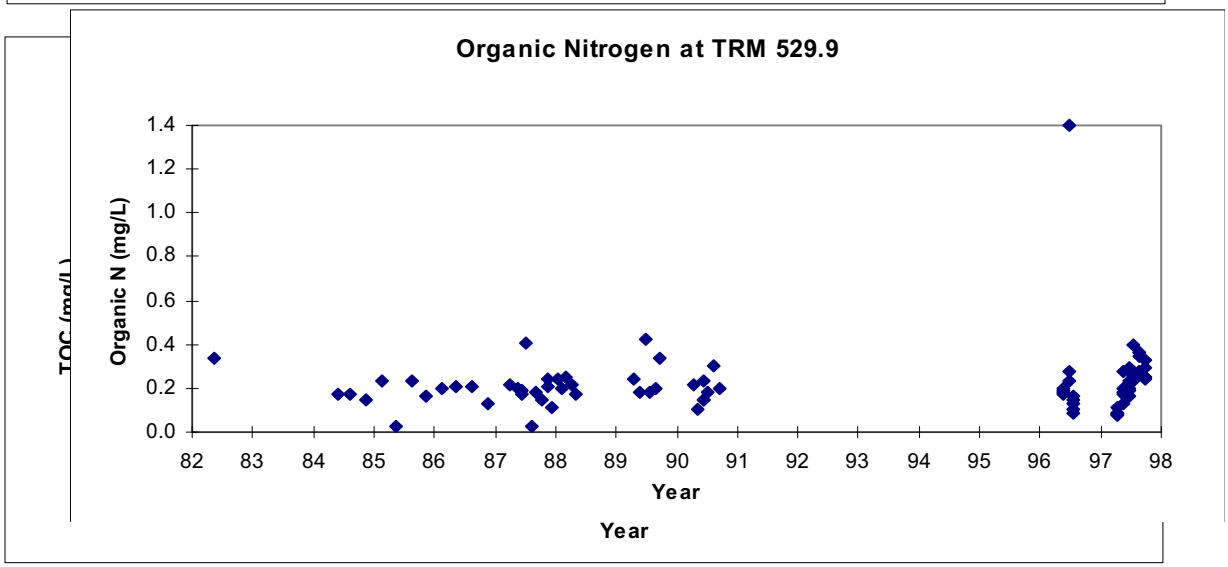




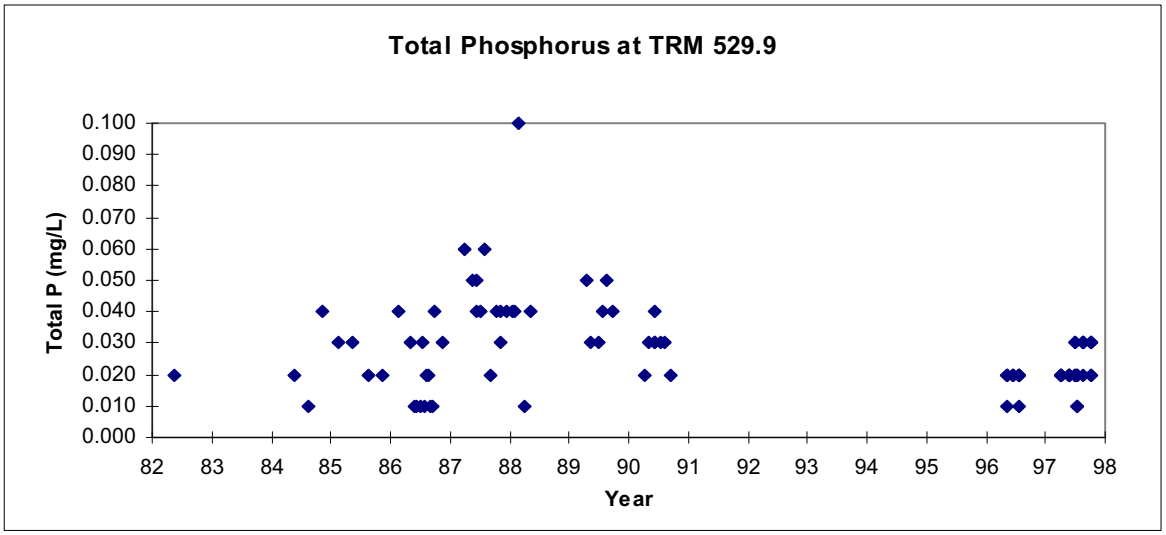


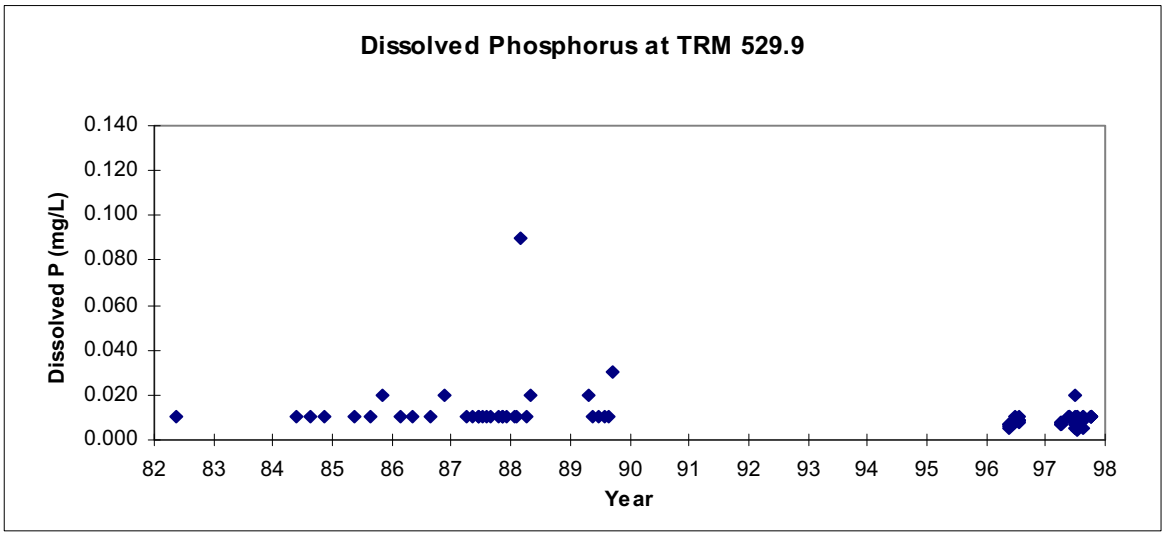

Ammonia Nitrogen at TRM 529.9
Ammonia N (mg/L)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

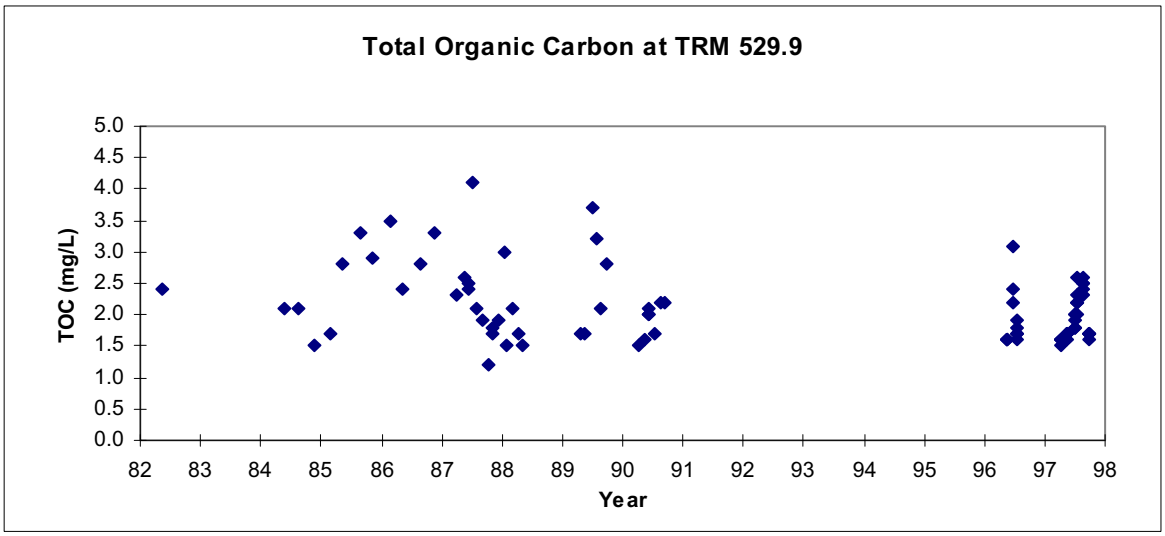

Nitrate+Nitrite Nitrogen at TRM 529.9
Dissolved P (mg/L)
Nox-N (mg/L)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year


Organic Nitrogen at TRM 529.9
Organic N (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year
Year

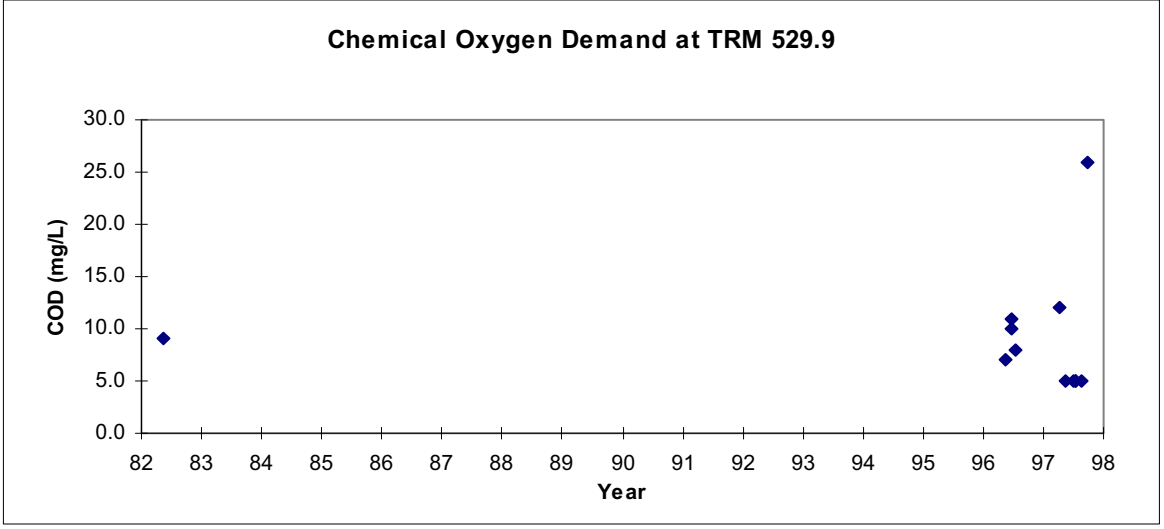
Appendix B-4 (Continued)

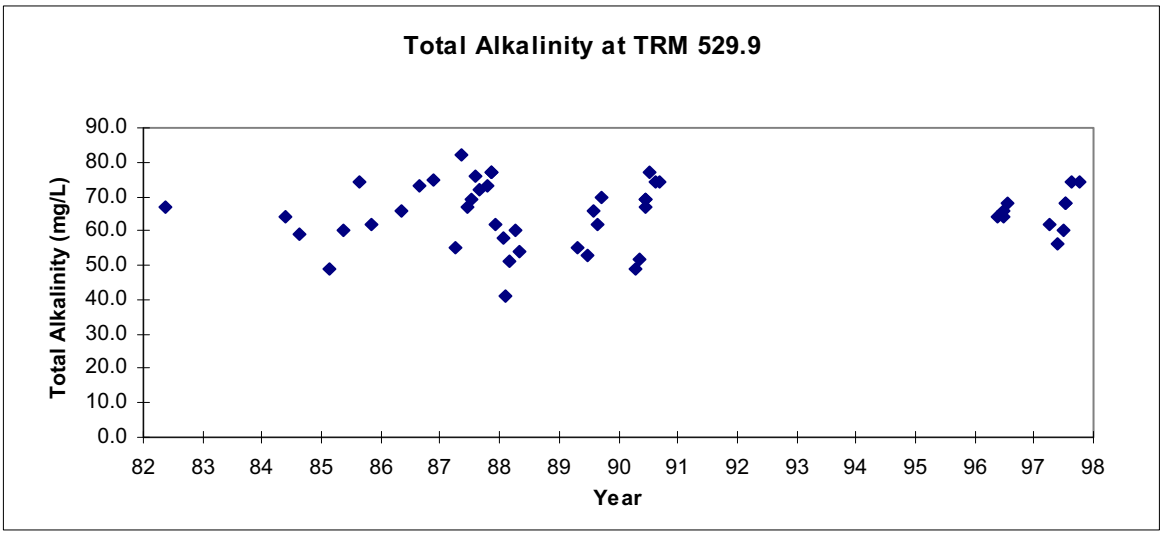


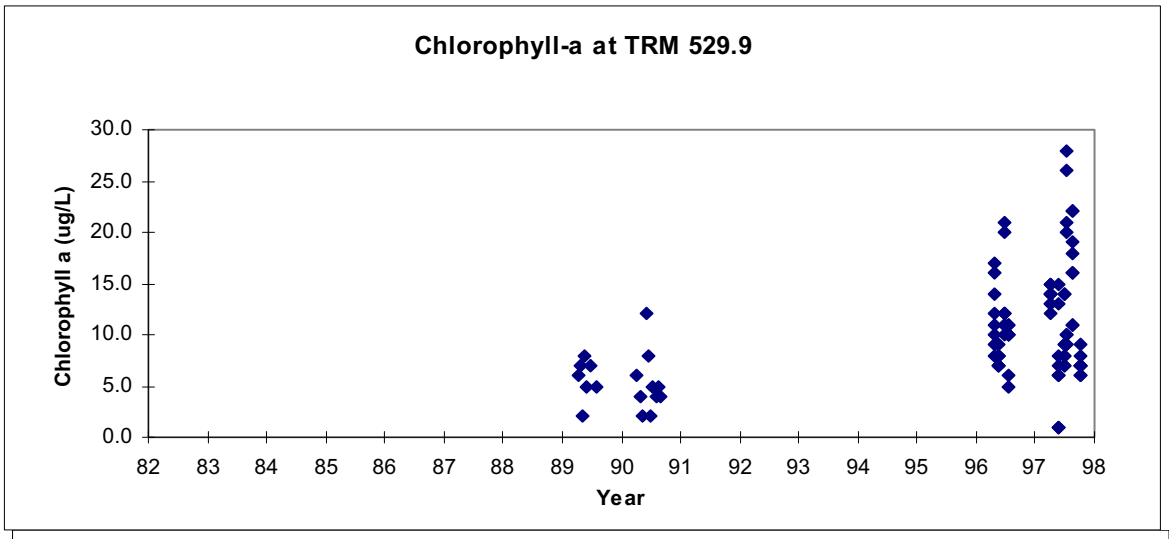


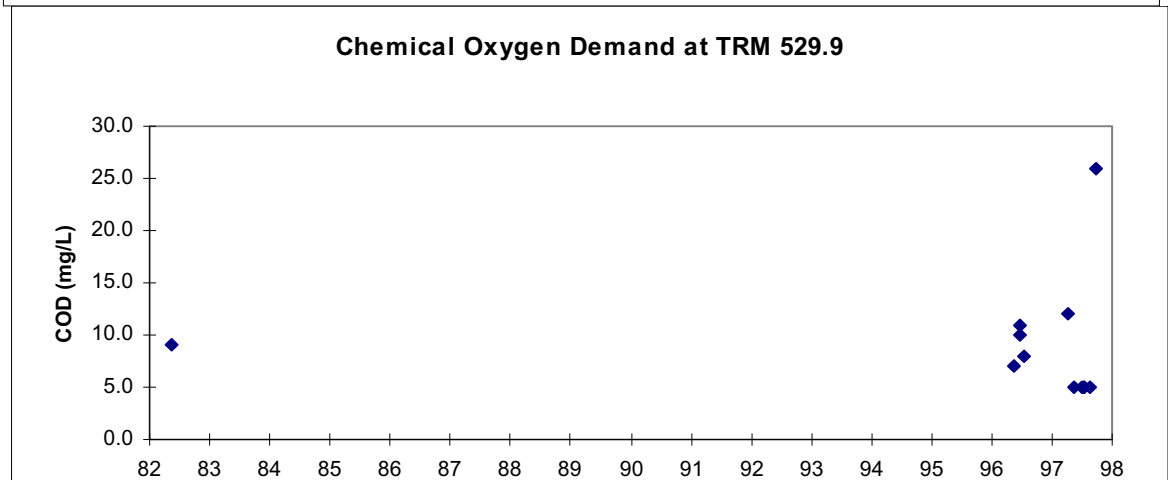


Appendix B-4 (Continued)

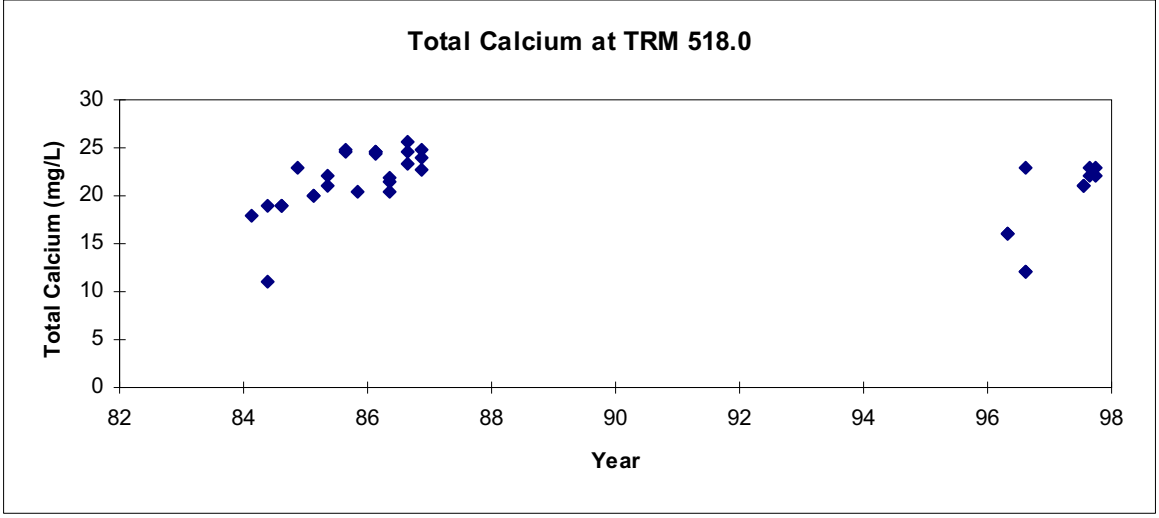

Chemical Oxygen Demand at TRM 529.9
COD (mg/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

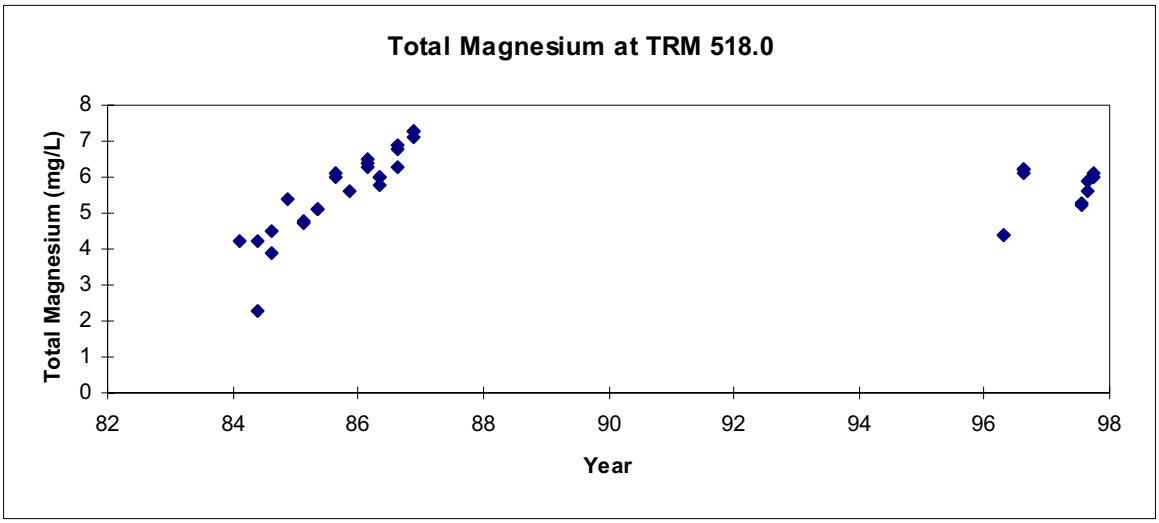

Total Alkalinity at TRM 529.9
Total Alkalinity (mg/L)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

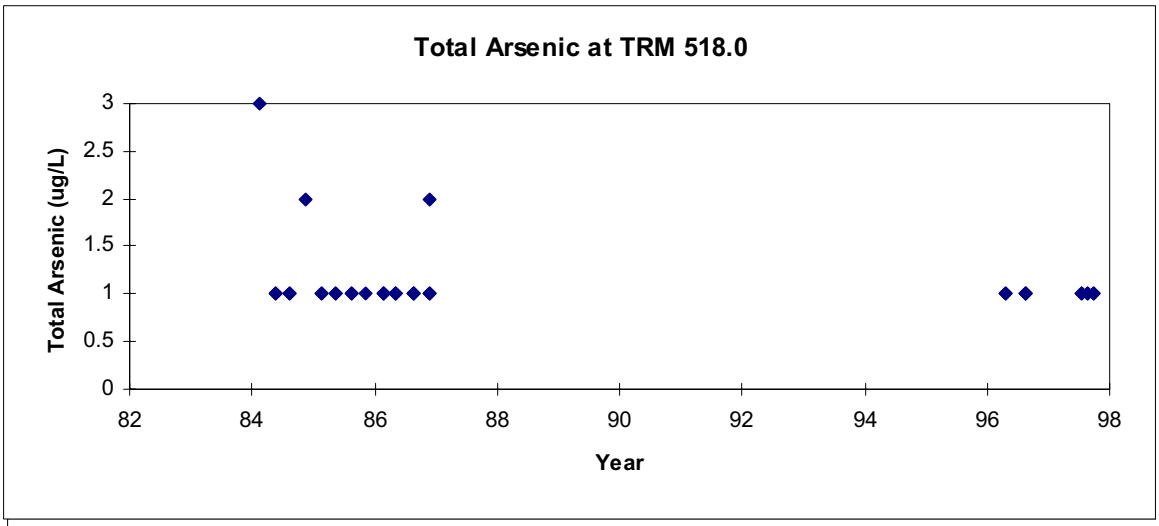

Chlorophyll-a at TRM 529.9
Chlorophyll a (ug/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98
Year

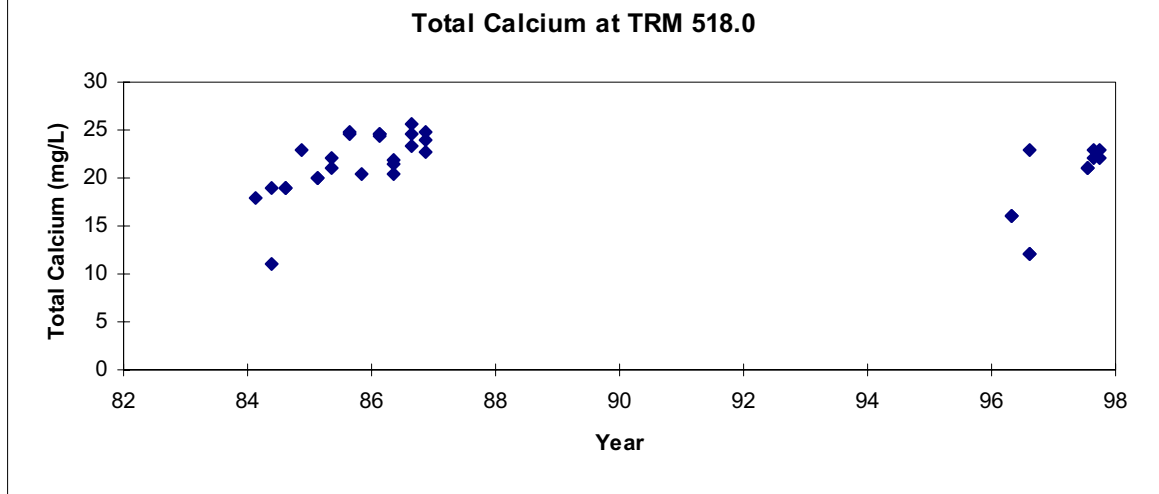

Chemical Oxygen Demand at TRM 529.9
COD (mg/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

Appendix B-5. Concentrations of selected metals during preoperational (1982-1987) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 518.0

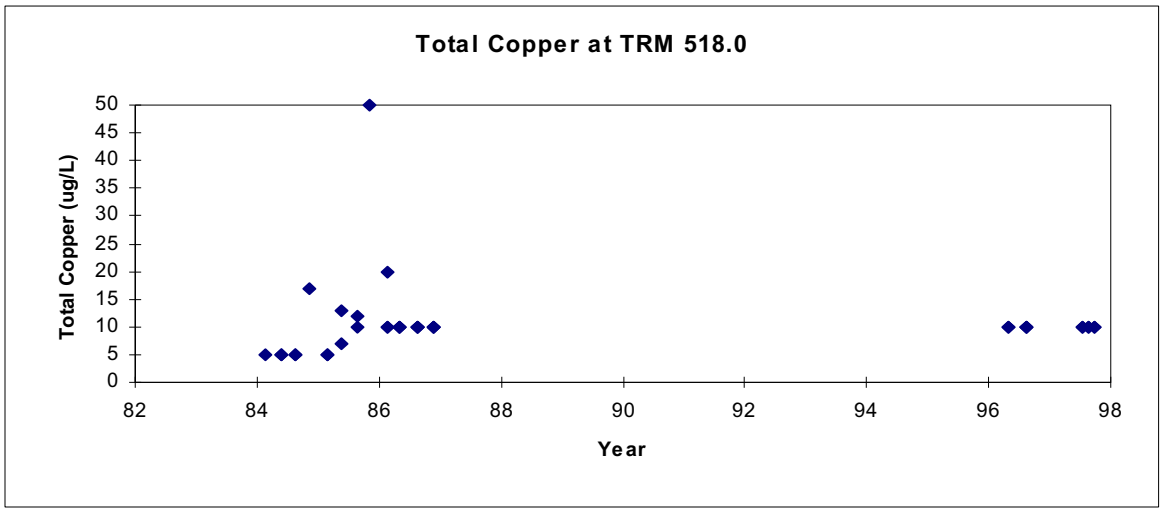

Total Calcium at TRM 518.0
Total Calcium (mg/L)
0
5
10
15
20
25
30
82
84
86
88
90
92
94
96
98
Year

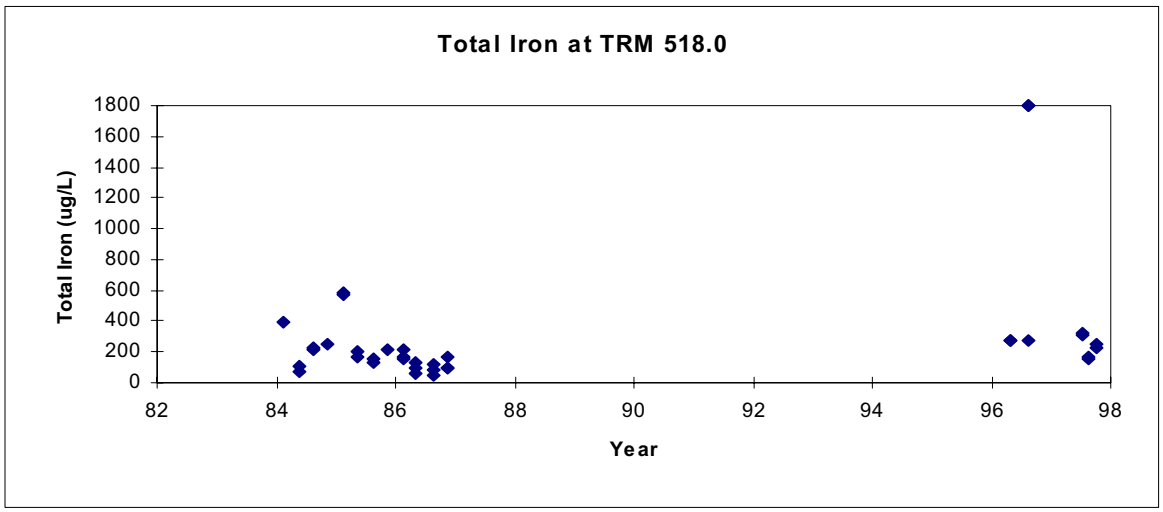

Total Magnesium at TRM 518.0
Total Magnesium (mg/L)
0
1
2
3
4
5
6
7
8
82
84
86
88
90
92
94
96
98
Year

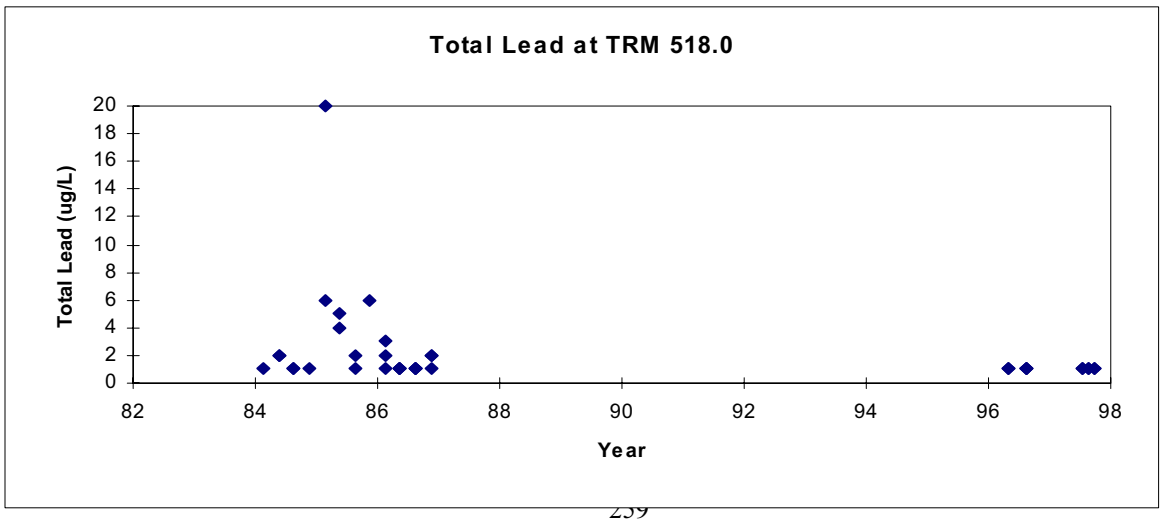

Total Arsenic at TRM 518.0
Total Arsenic (ug/L)
0
0.5
1
1.5
2
2.5
3
82
84
86
88
90
92
94
96
98
Year

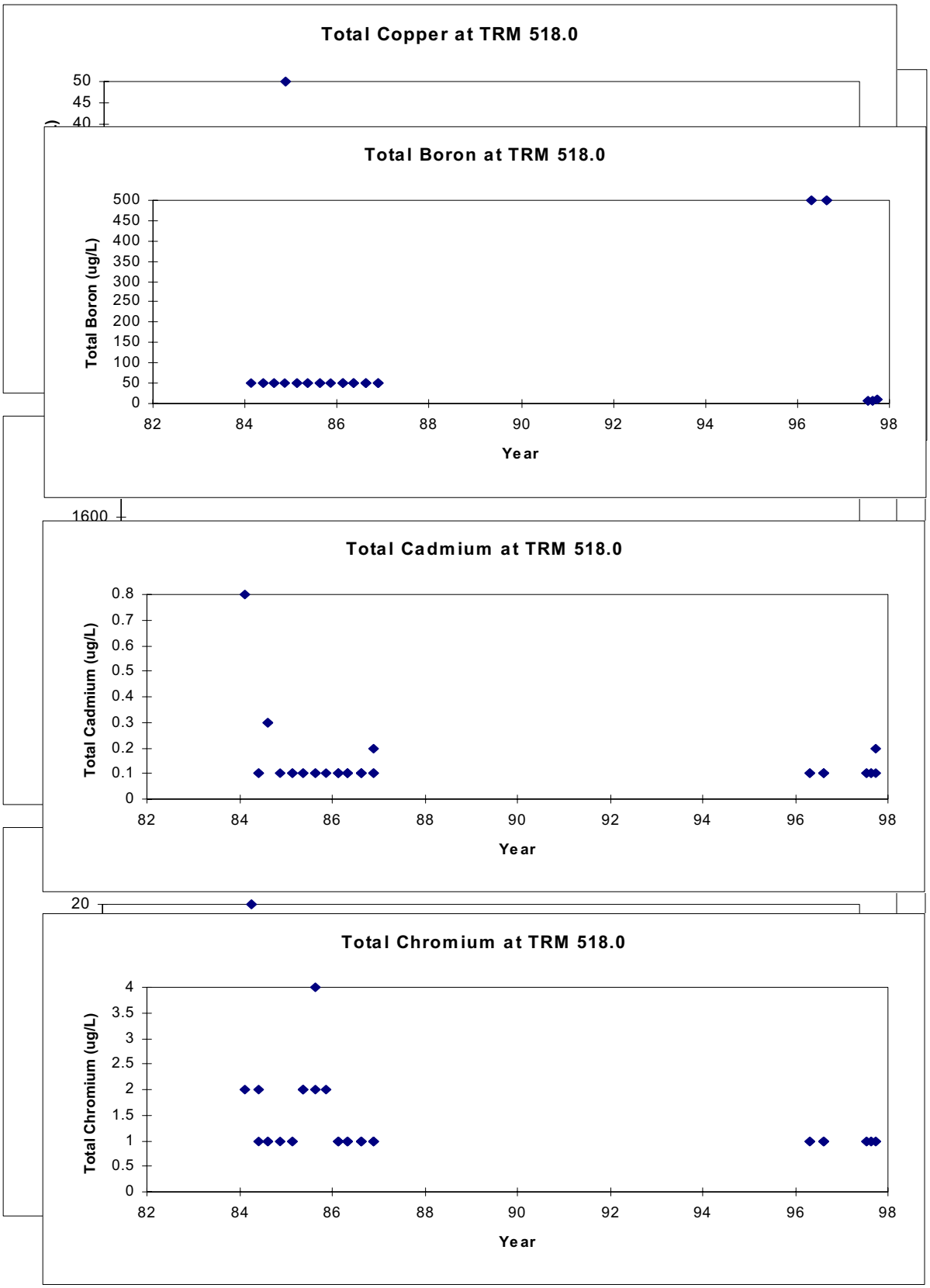

Total Calcium at TRM 518.0
Total Calcium (mg/L)
0
5
10
15
20
25
30
82
84
86
88
90
92
94
96
98
Year

Appendix B-5 (Continued)

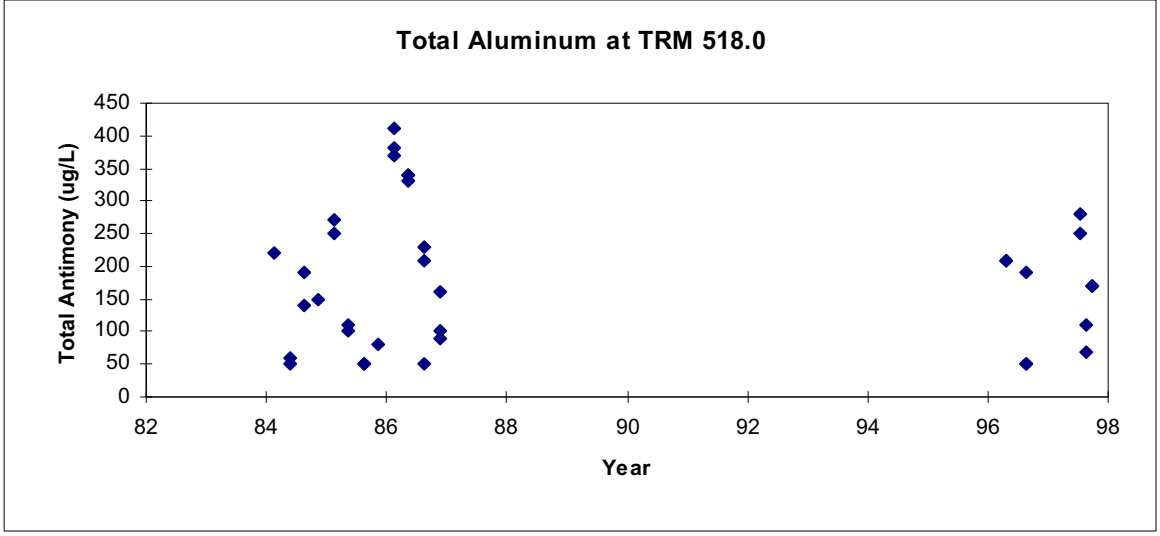


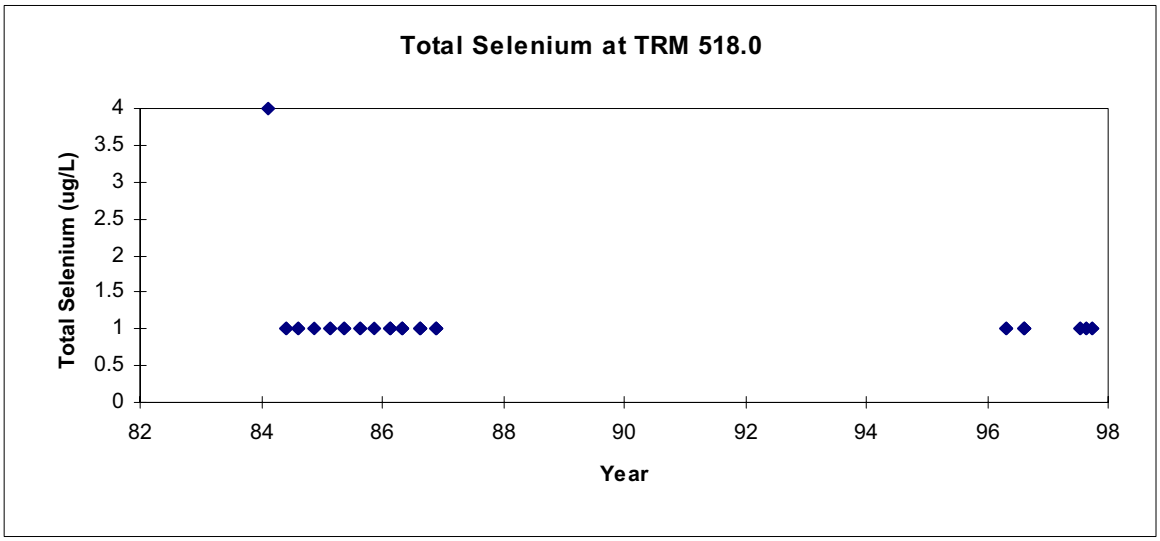


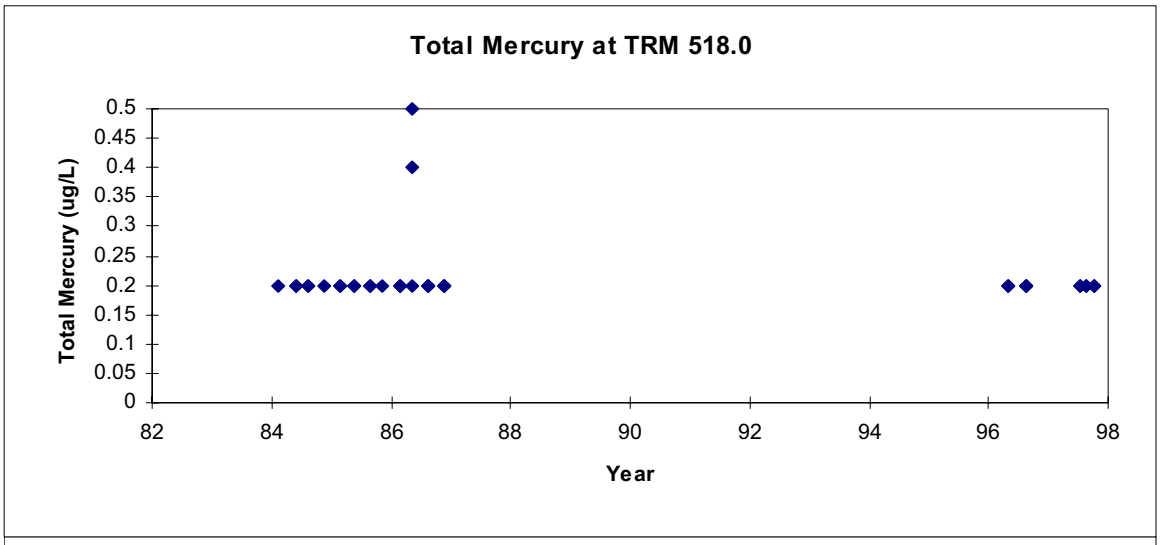


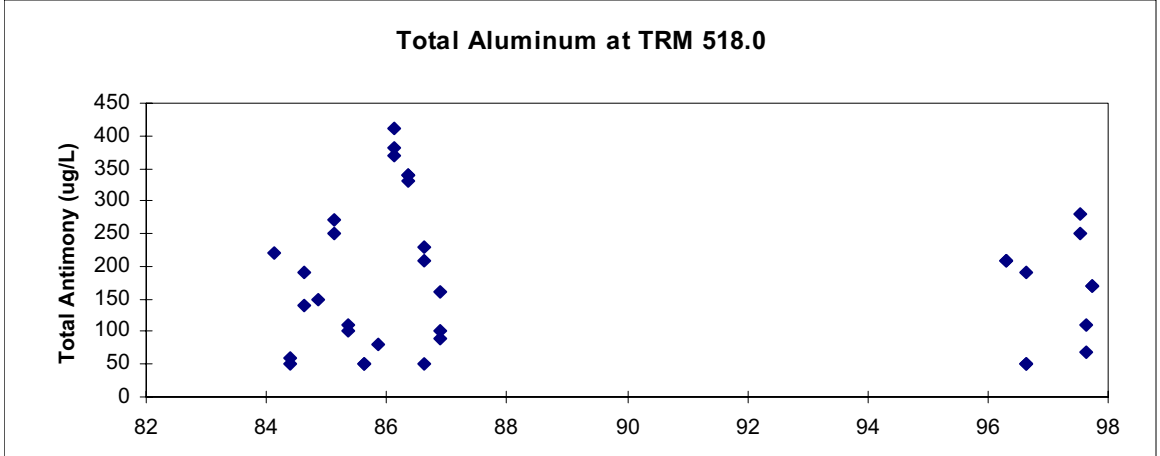

Total Copper at TRM 518.0
50
45
40
Total Boron at TRM 518.0
Total Boron (ug/L)
500
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year
1600
Total Cadmium at TRM 518.0
Total Cadmium (ug/L)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
82
84
86
88
90
92
94
96
98
Year
20
Total Chromium at TRM 518.0
Total Chromium (ug/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
82
84
86
88
90
92
94
96
98
Year

Appendix B-5 (Continued)


Total Aluminum at TRM 518.0
Total Antimony (ug/L)
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year

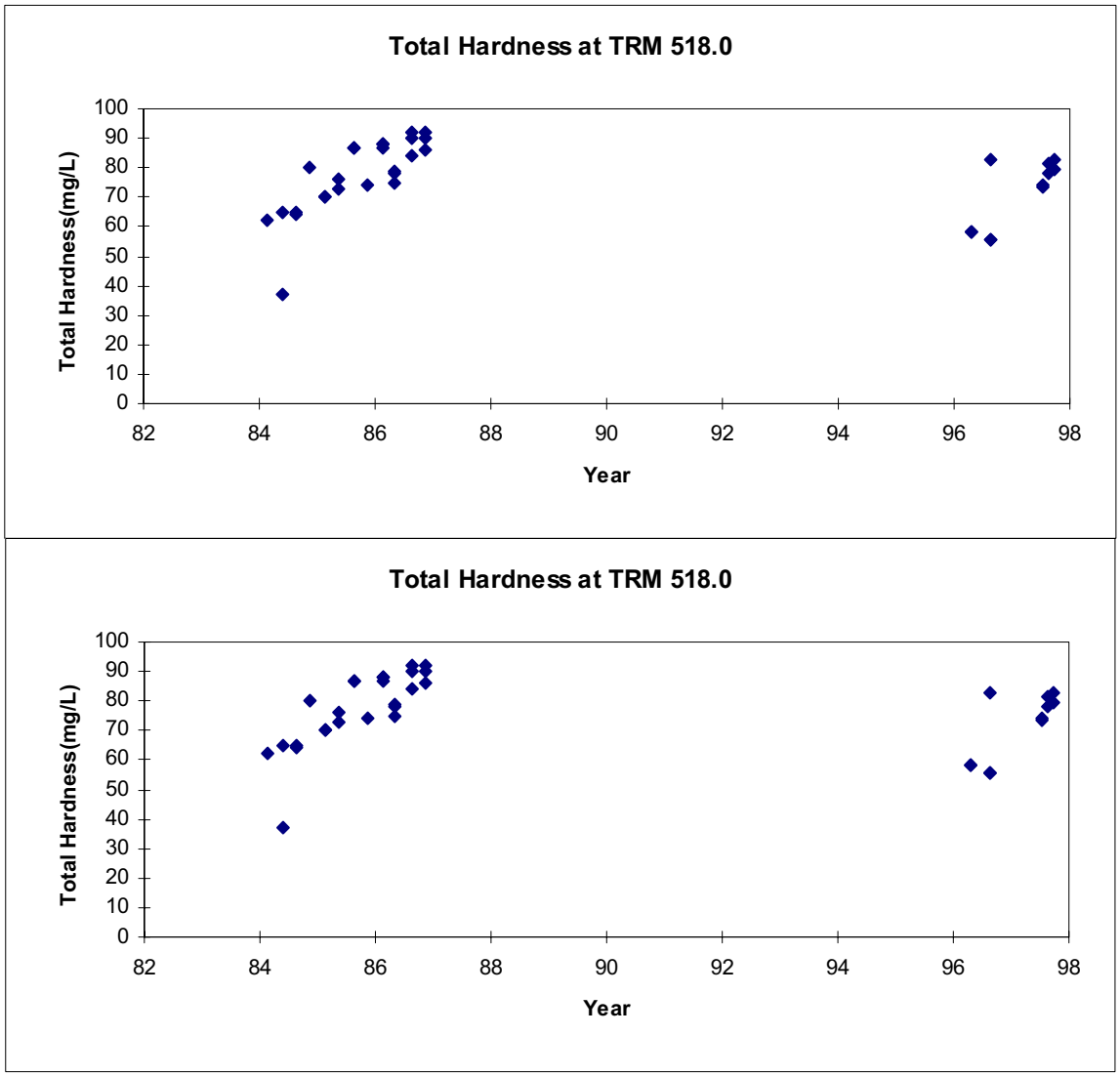

Total Selenium at TRM 518.0
Total Selenium (ug/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
82
84
86
88
90
92
94
96
98
Year


Total Mercury at TRM 518.0
Total Mercury (ug/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
82
84
86
88
90
92
94
96
98
Year

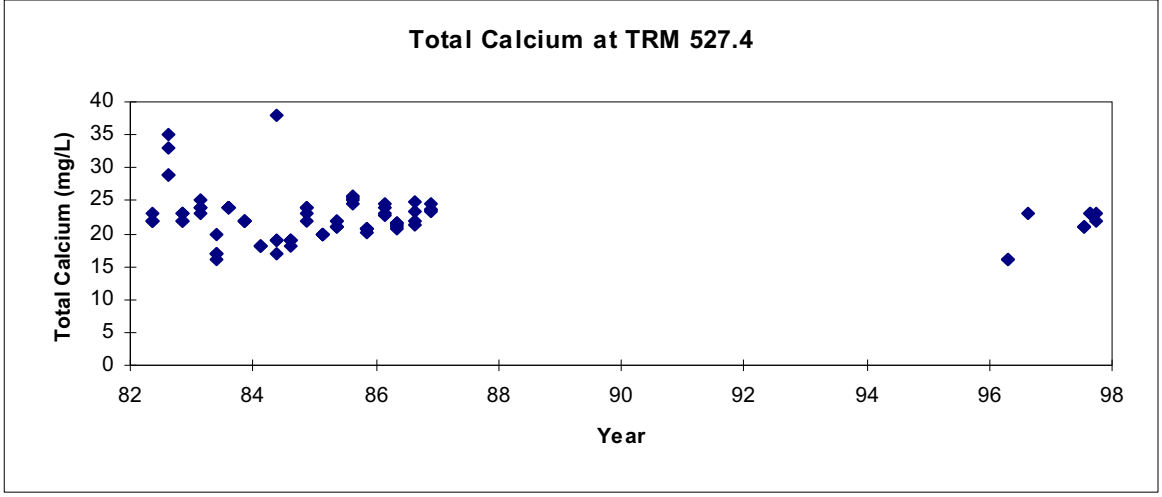

Total Aluminum at TRM 518.0
Total Antimony (ug/L)
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98

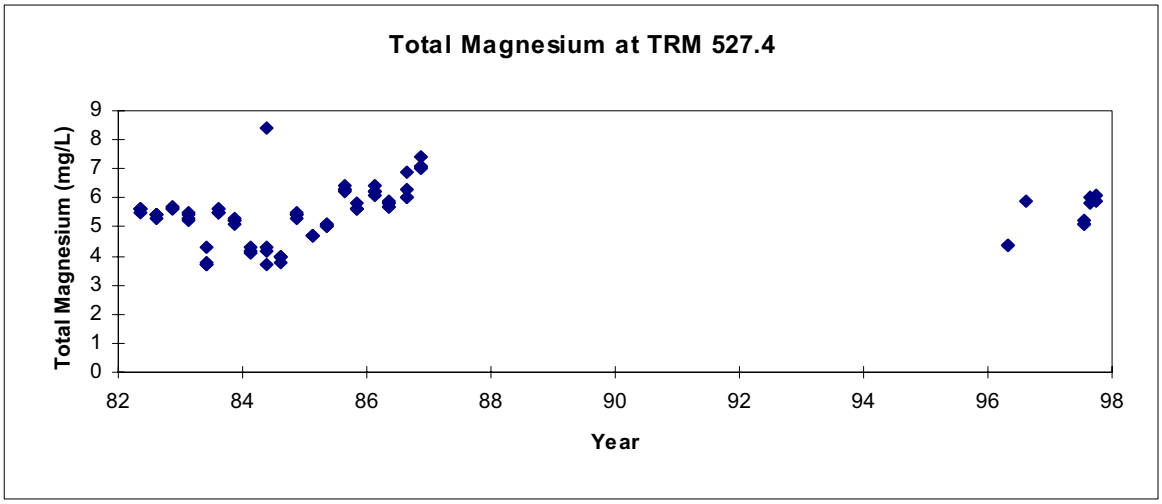
Appendix B-5 (Continued)

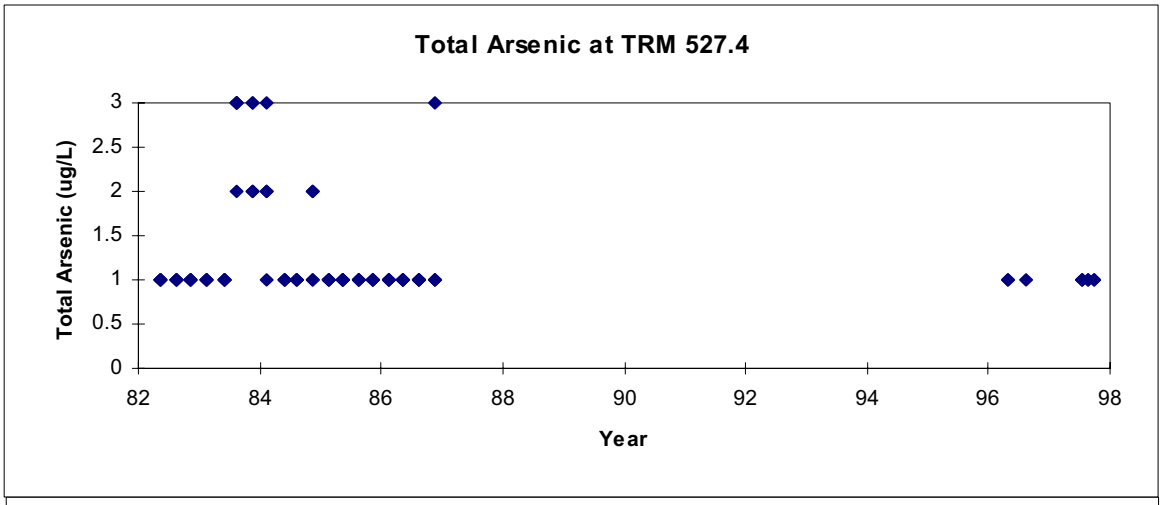
Appendix B-5 (Continued)

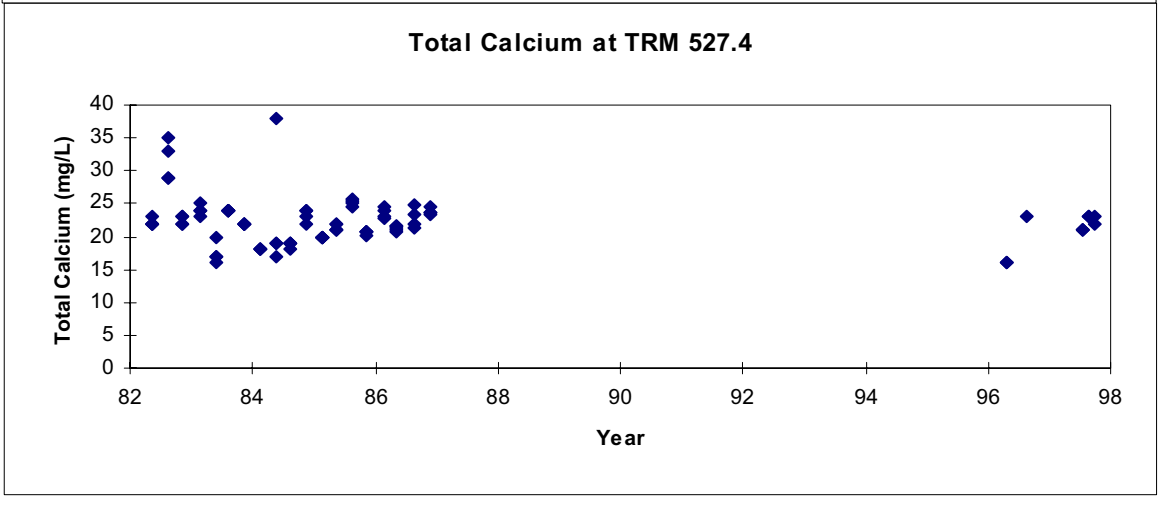


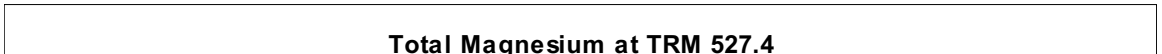
Appendix B-6. Concentrations of selected metals during preoperational (1982-1987) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 527.4


Total Calcium at TRM 527.4
Total Calcium (mg/L)
0
5
10
15
20
25
30
35
40
82
84
86
88
90
92
94
96
98
Year

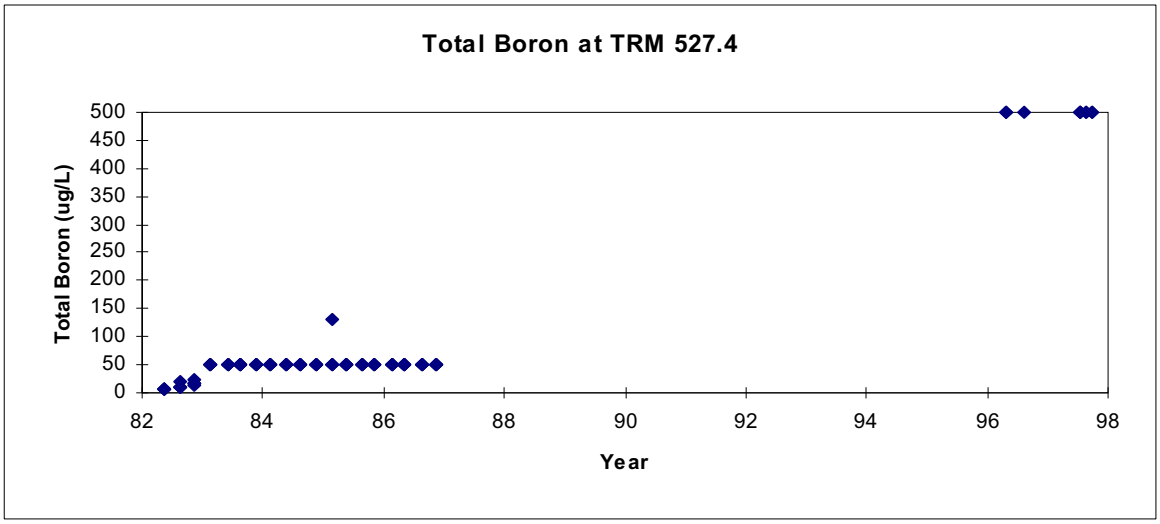

Total Magnesium at TRM 527.4
Total Magnesium (mg/L)
0
1
2
3
4
5
6
7
8
9
82
84
86
88
90
92
94
96
98
Year

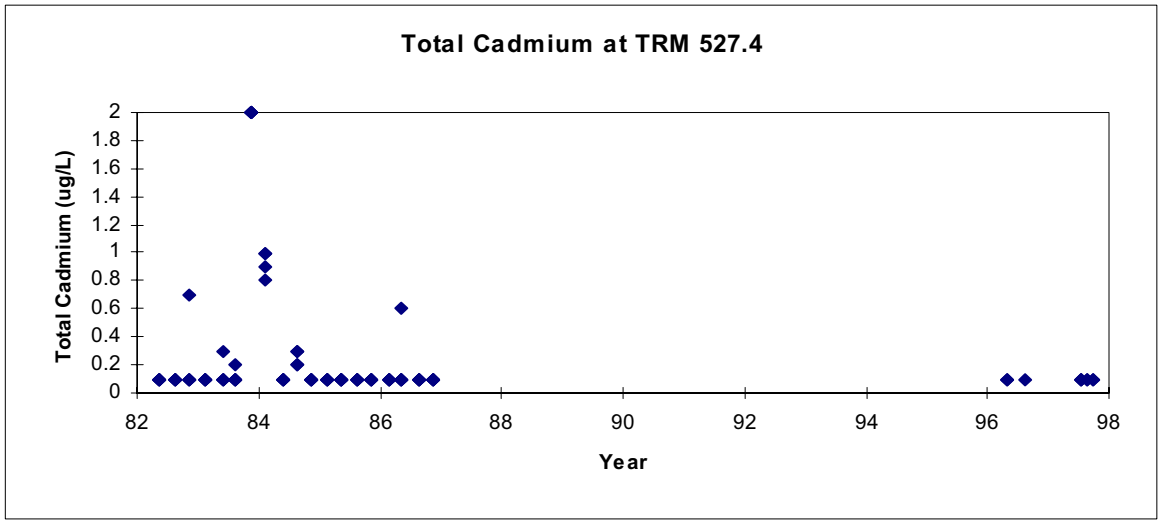

Total Arsenic at TRM 527.4
Total Arsenic (ug/L)
0
0.5
1
1.5
2
2.5
3
82
84
86
88
90
92
94
96
98
Year

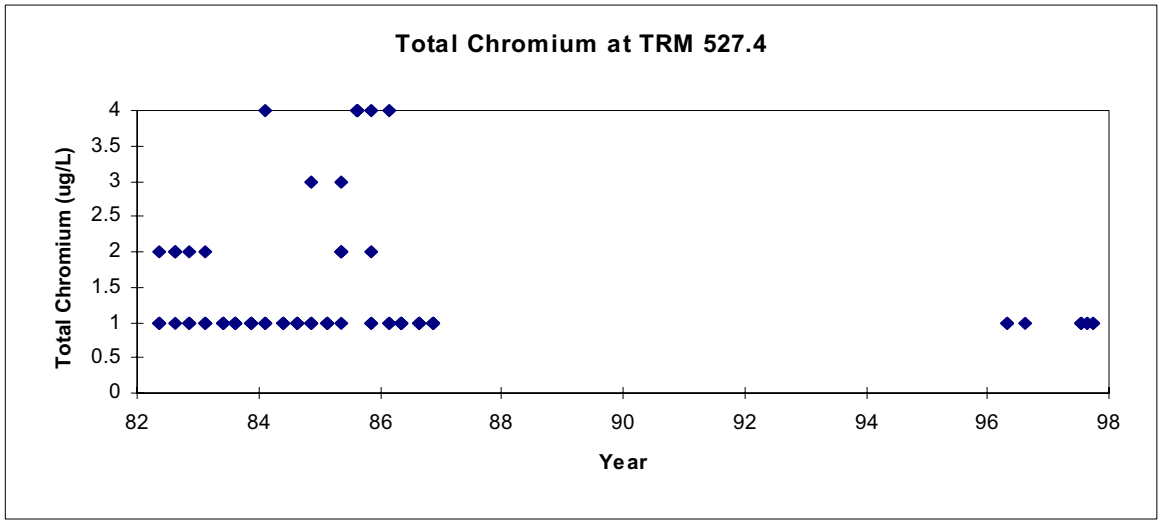

Total Calcium at TRM 527.4
Total Calcium (mg/L)
0
5
10
15
20
25
30
35
40
82
84
86
88
90
92
94
96
98
Year

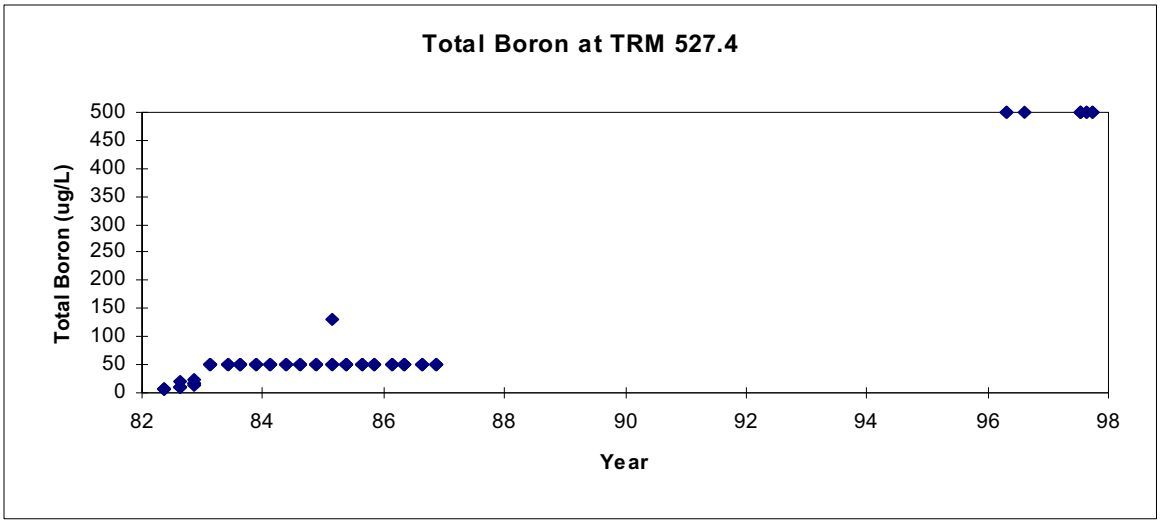

Total Magnesium at TRM 527.4

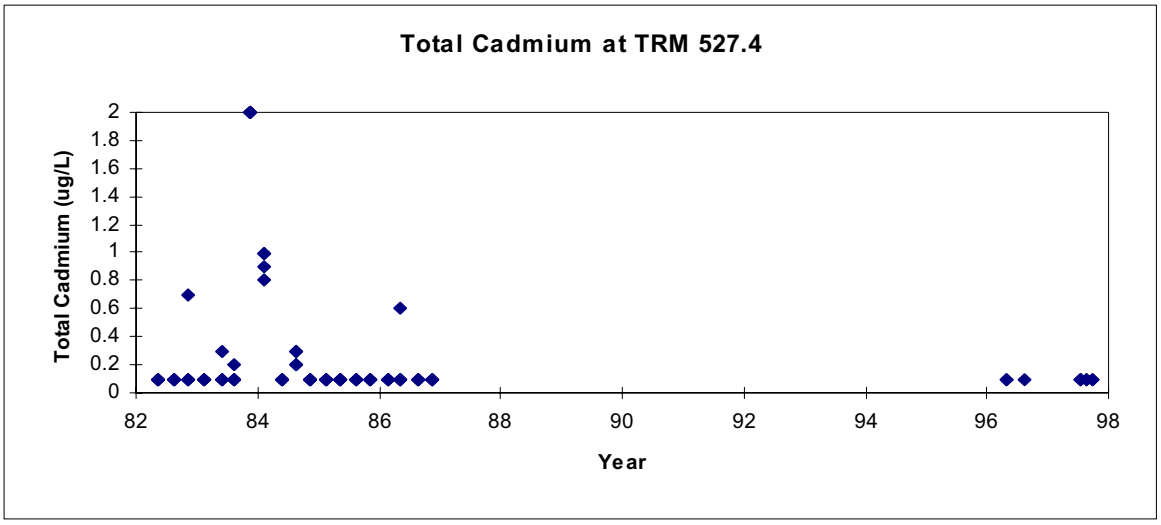
Appendix B-6 (Continued)

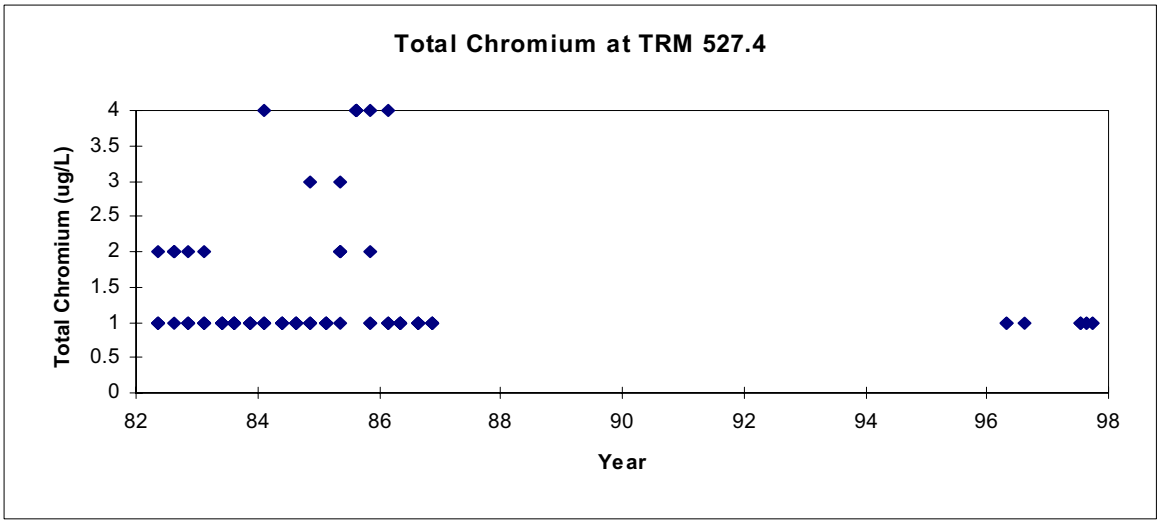

Total Boron at TRM 527.4
Total Boron (ug/L)
500
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year


Total Cadmium at TRM 527.4
Total Cadmium (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
82
84
86
88
90
92
94
96
98
Year

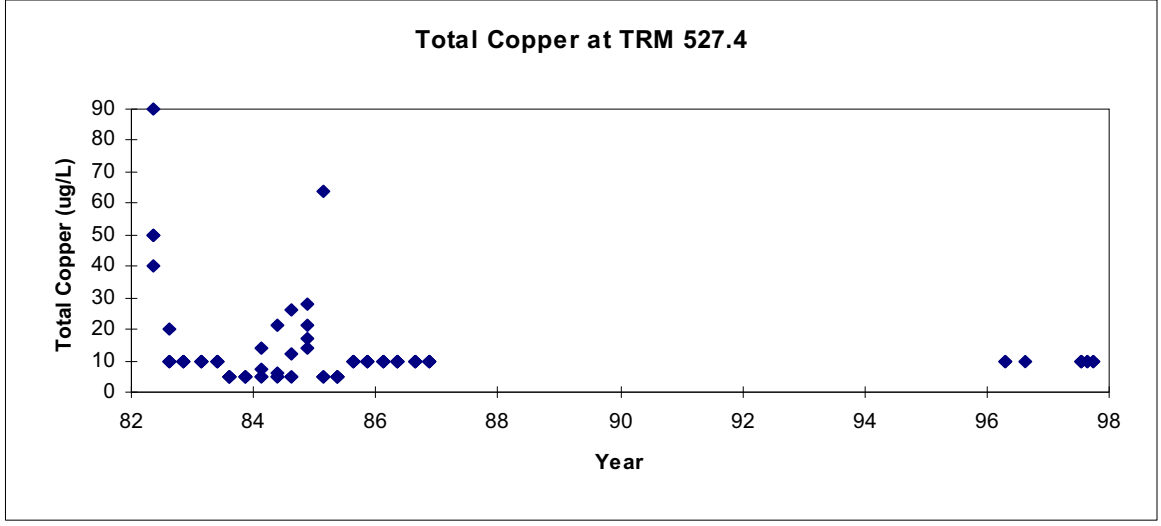

Total Chromium at TRM 527.4
Total Chromium (ug/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
82
84
86
88
90
92
94
96
98
Year

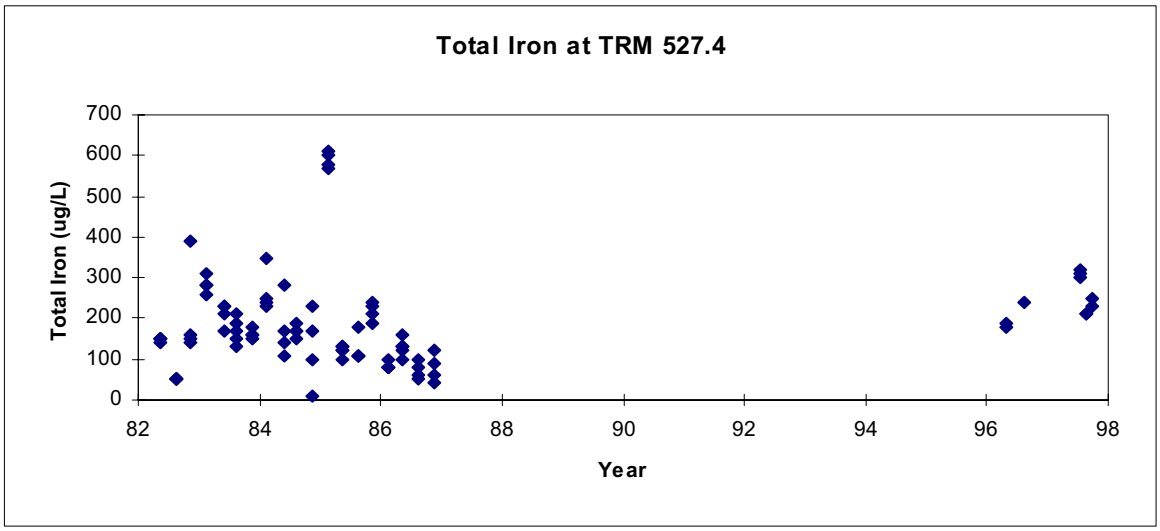

Total Boron at TRM 527.4
Total Boron (ug/L)
500
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year

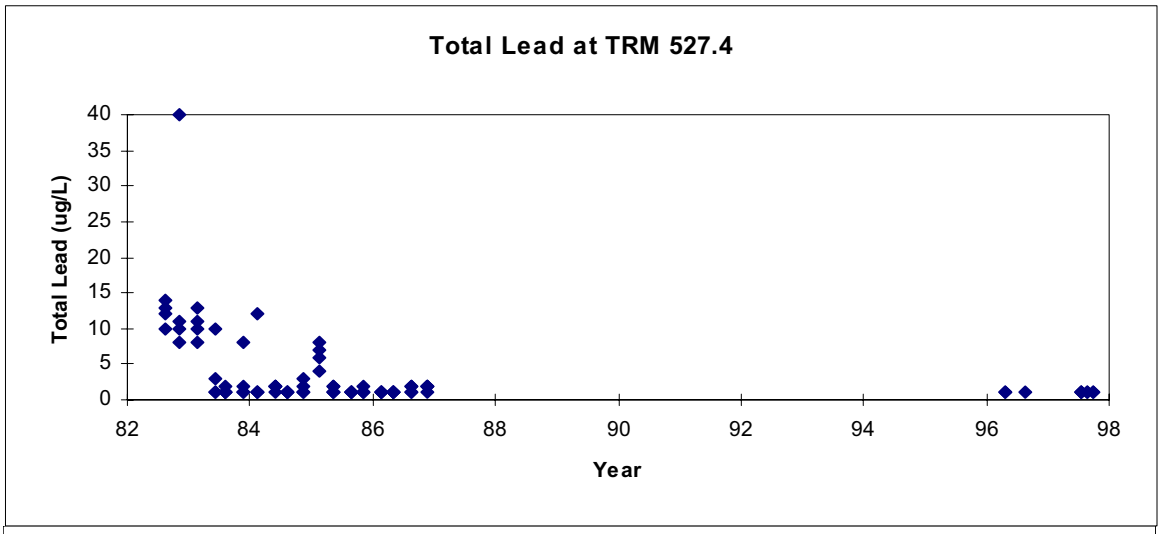

Total Cadmium at TRM 527.4
Total Cadmium (ug/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
82
84
86
88
90
92
94
96
98
Year

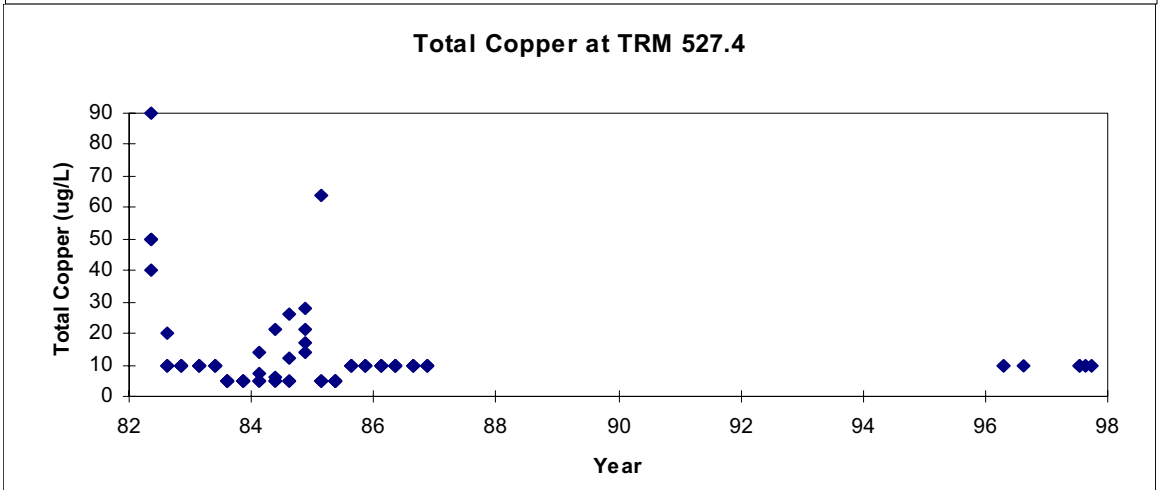

Total Chromium at TRM 527.4
Total Chromium (ug/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
82
84
86
88
90
92
94
96
98
Year

Appendix B-6 (Continued)

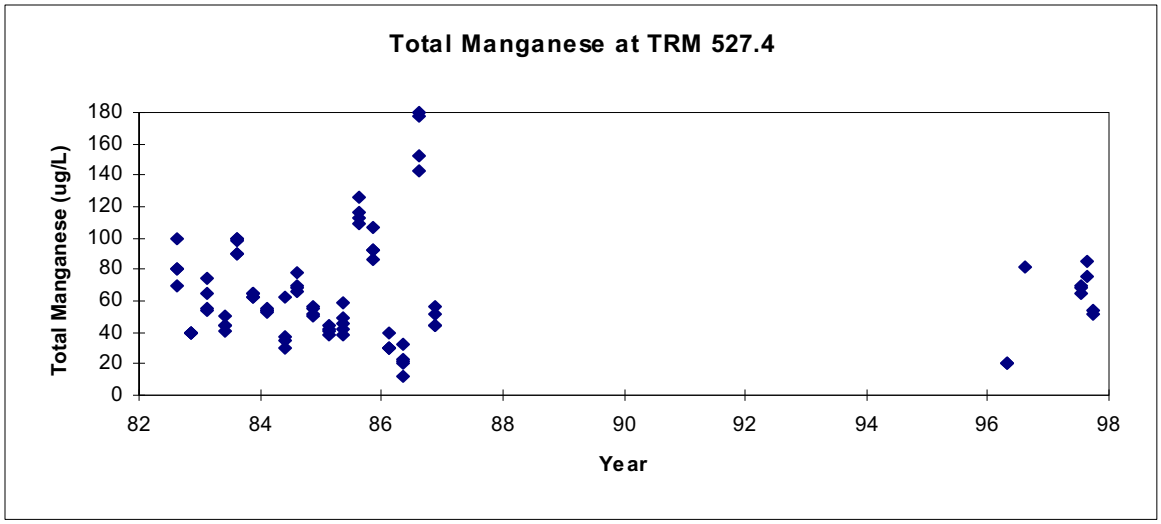

Total Copper at TRM 527.4
Total Copper (ug/L)
0
10
20
30
40
50
60
70
80
90
82
84
86
88
90
92
94
96
98
Year

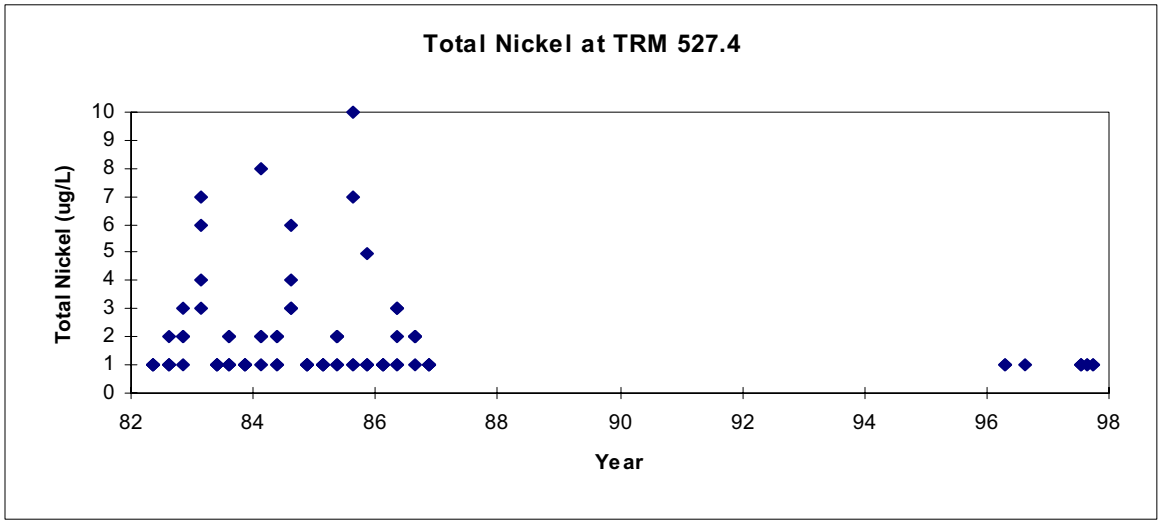

Total Iron at TRM 527.4
Total Iron (ug/L)
0
100
200
300
400
500
600
700
82
84
86
88
90
92
94
96
98
Year

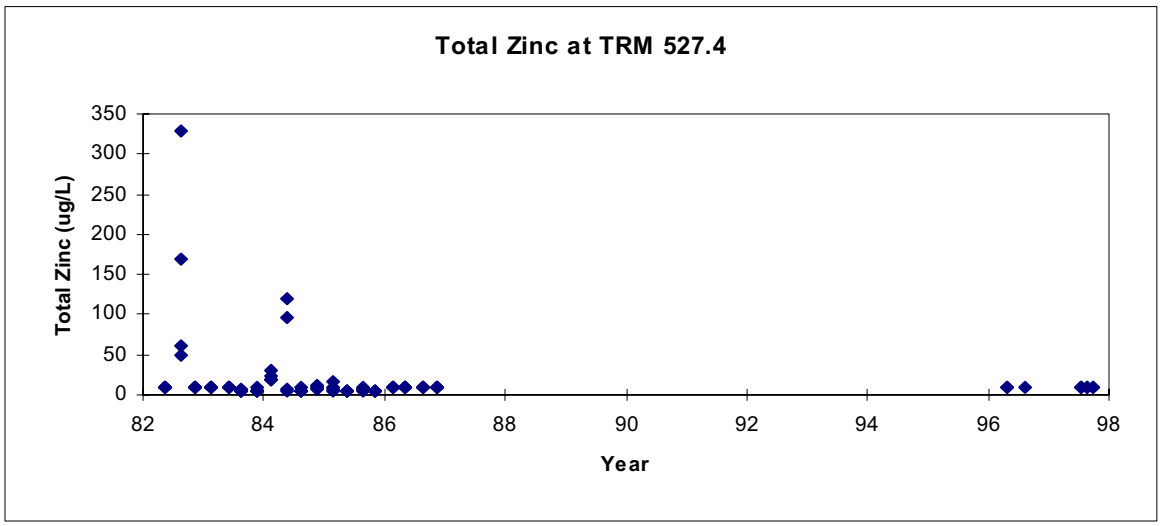

Total Lead at TRM 527.4
Total Lead (ug/L)
0
5
10
15
20
25
30
35
40
82
84
86
88
90
92
94
96
98
Year

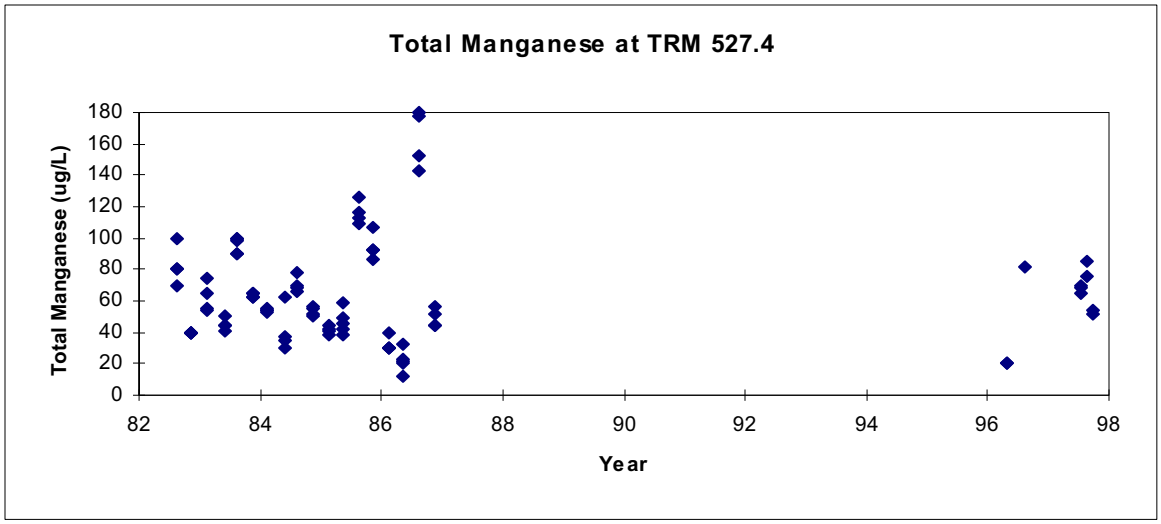

Total Copper at TRM 527.4
Total Copper (ug/L)
0
10
20
30
40
50
60
70
80
90
82
84
86
88
90
92
94
96
98
Year

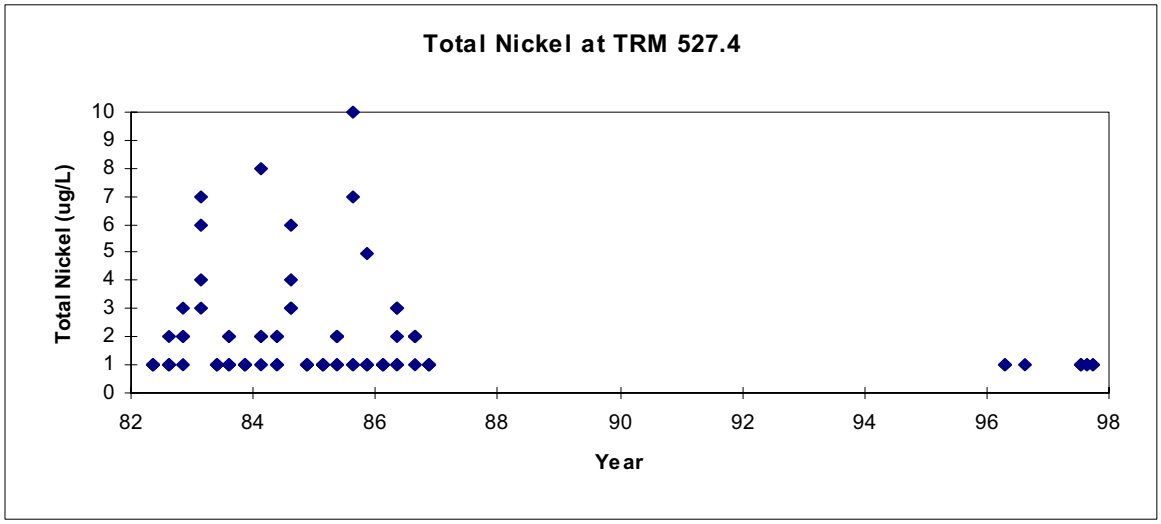
Appendix B-6 (Continued)

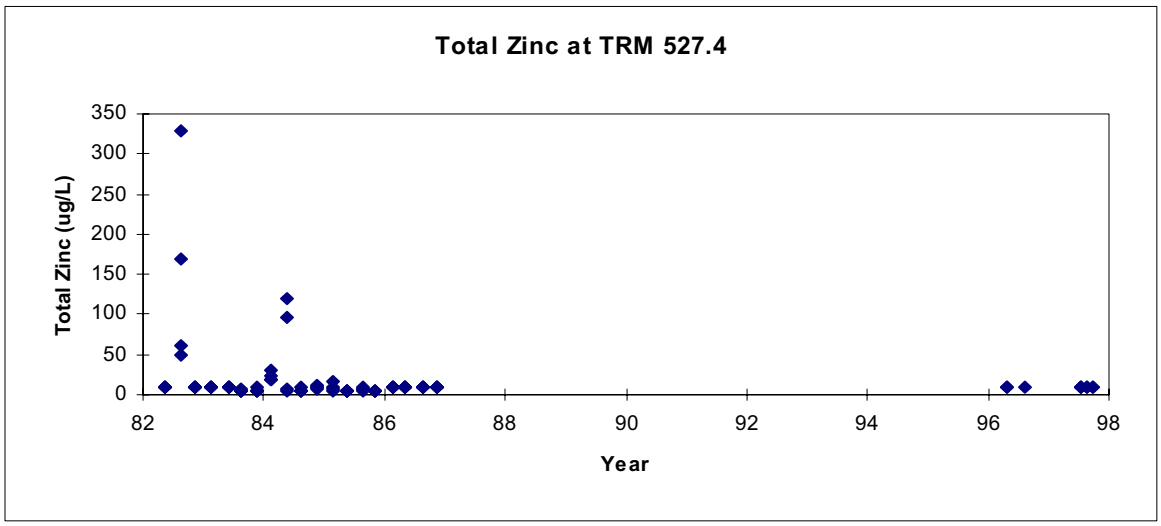

Total Manganese at TRM 527.4
Total Manganese (ug/L)
0
20
40
60
80
100
120
140
160
180
82
84
86
88
90
92
94
96
98
Year


Total Nickel at TRM 527.4
Total Nickel (ug/L)
0
1
2
3
4
5
6
7
8
9
10
82
84
86
88
90
92
94
96
98
Year


Total Zinc at TRM 527.4
Total Zinc (ug/L)
0
50
100
150
200
250
300
350
82
84
86
88
90
92
94
96
98
Year







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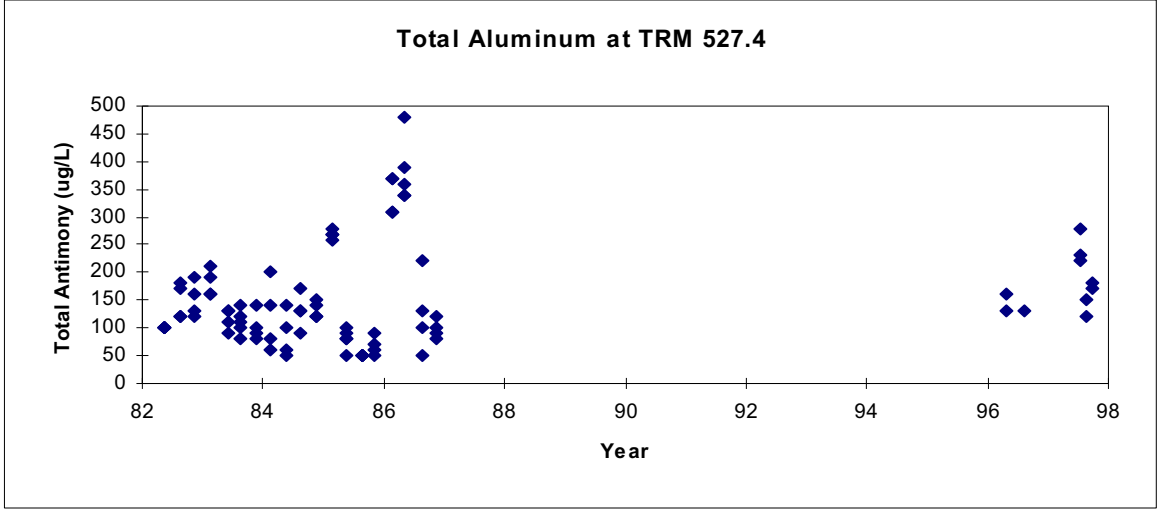
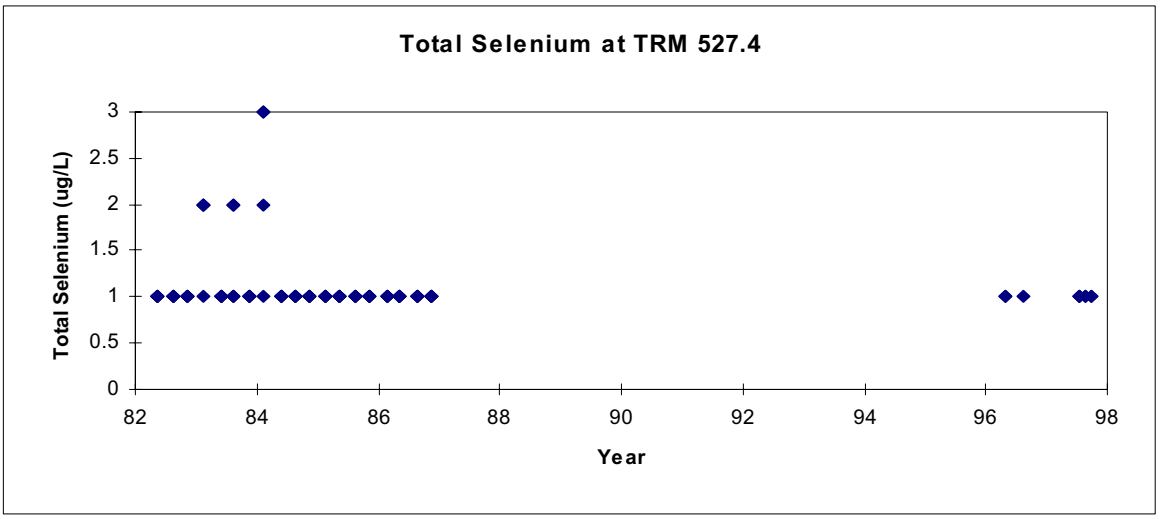
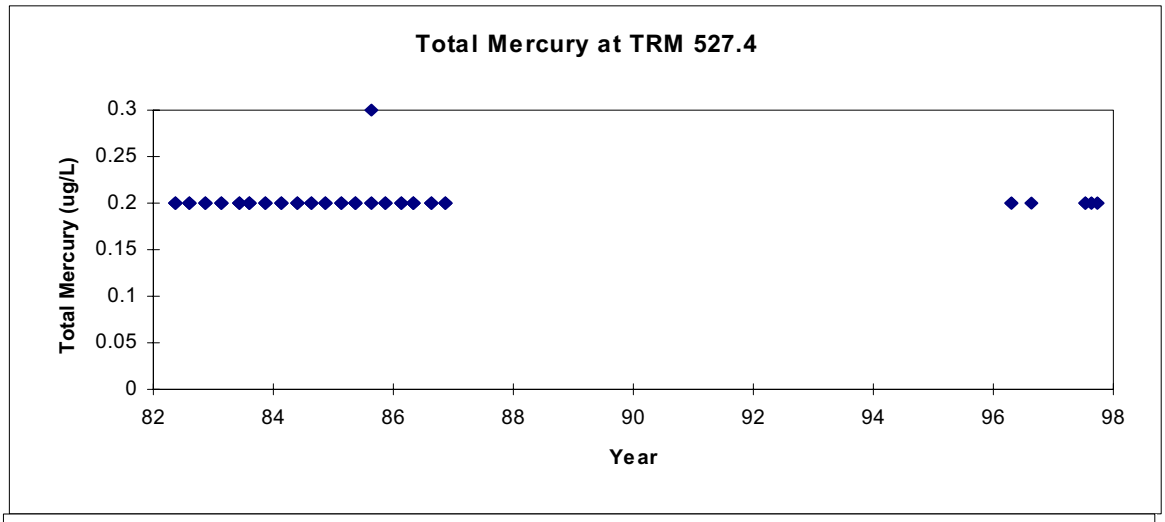
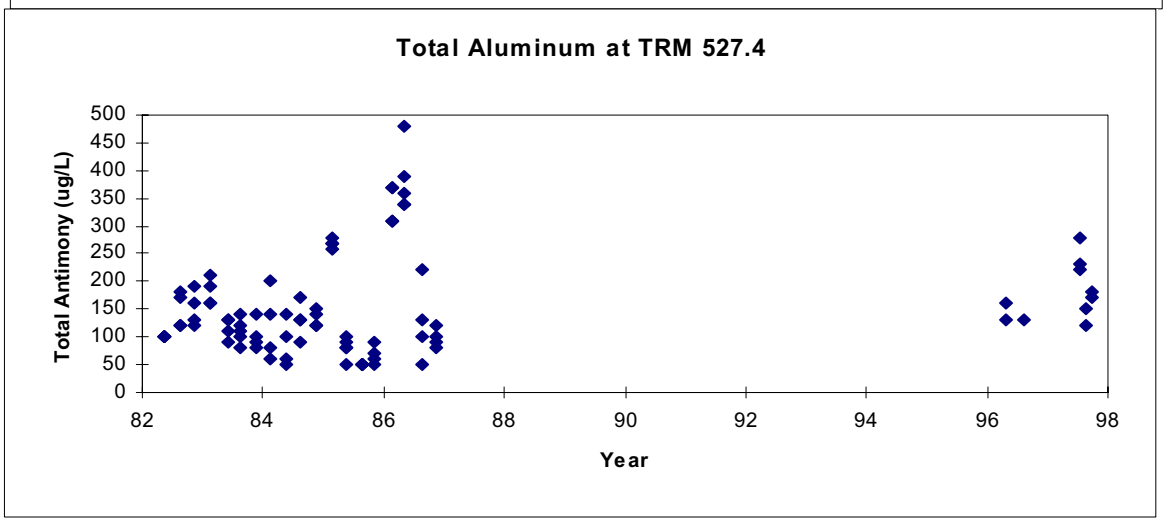
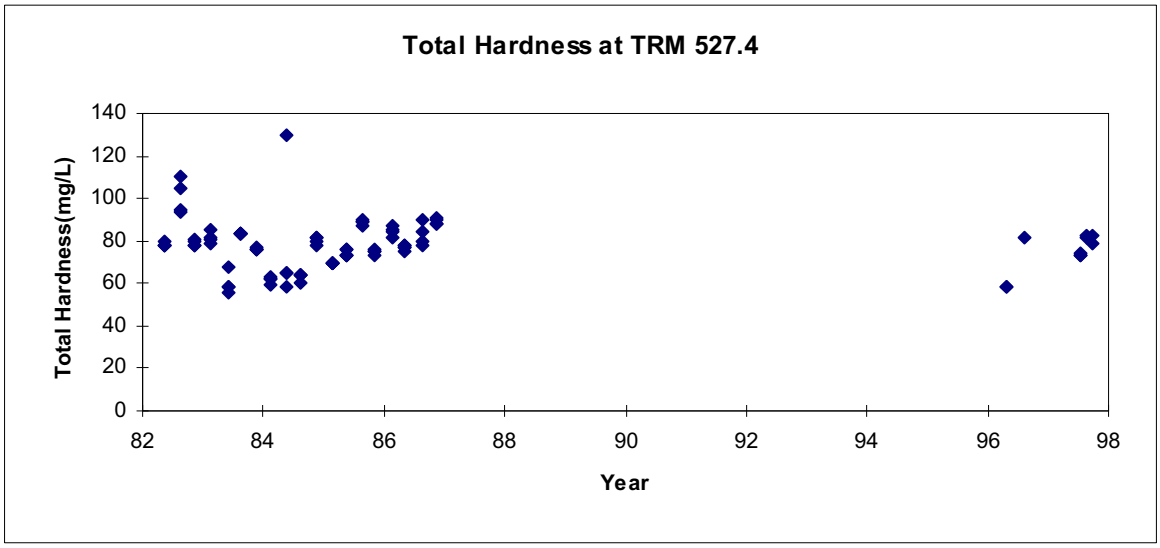

Total Aluminum at TRM 527.4
Total Antimony (ug/L)
500
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year


Total Selenium at TRM 527.4
Total Selenium (ug/L)
3
2.5
2
1.5
1
0.5
0
82
84
86
88
90
92
94
96
98
Year

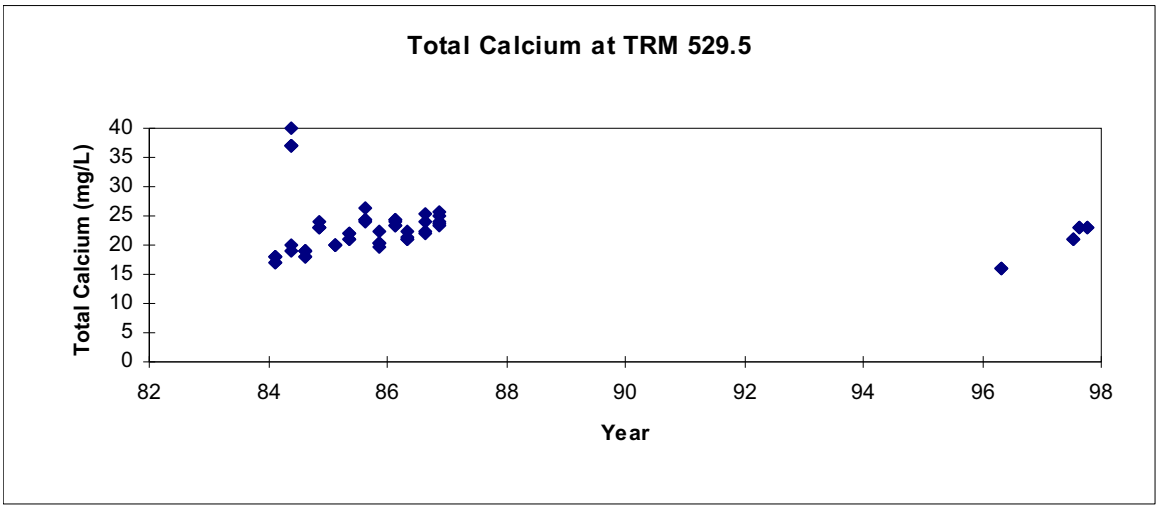

Total Mercury at TRM 527.4
Total Mercury (ug/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
82
84
86
88
90
92
94
96
98
Year

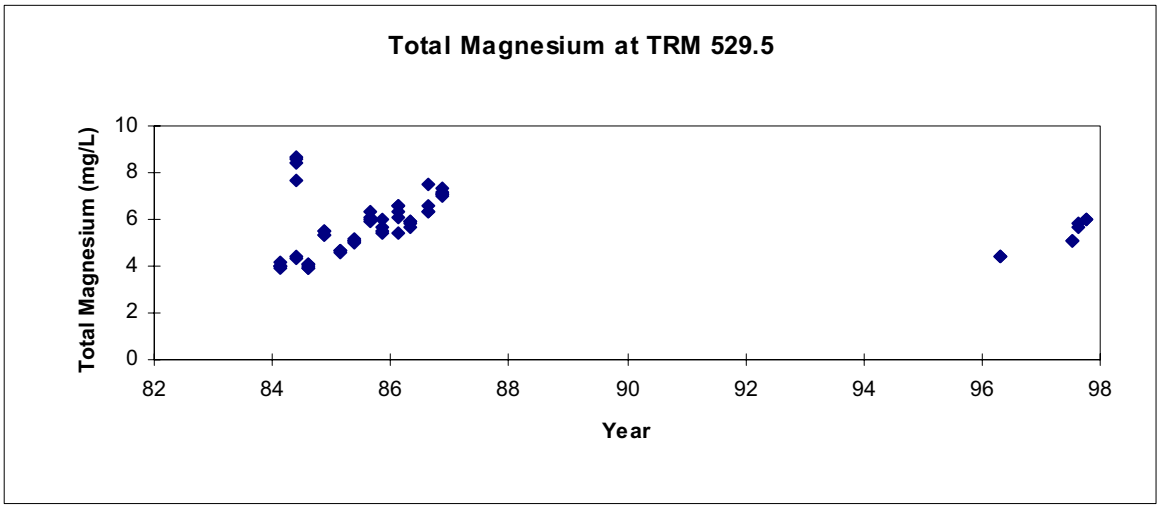

Total Aluminum at TRM 527.4
Total Antimony (ug/L)
500
450
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year

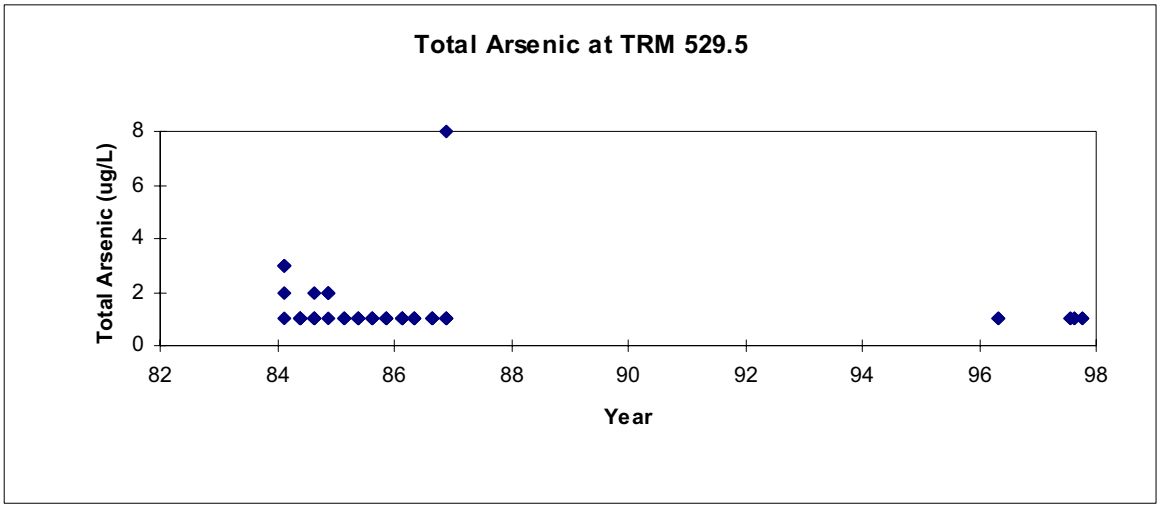
Appendix B-6 (Continued)

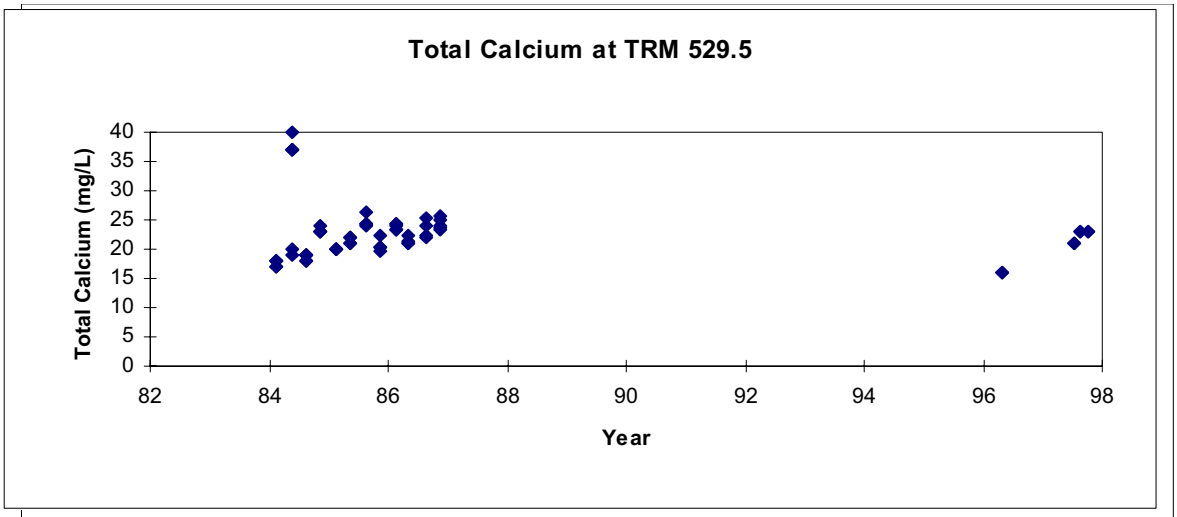


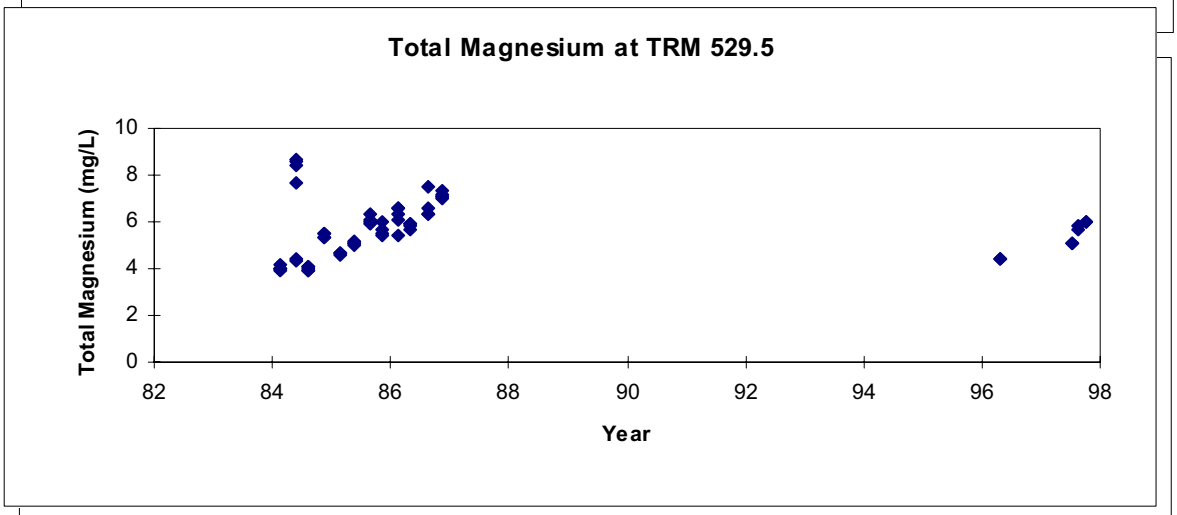
Appendix B-7. Concentrations of selected metals during preoperational (1984-1987) and operational (1996-1997) monitoring near Watts Bar Nuclear Plant at Tennessee River Mile 529.5



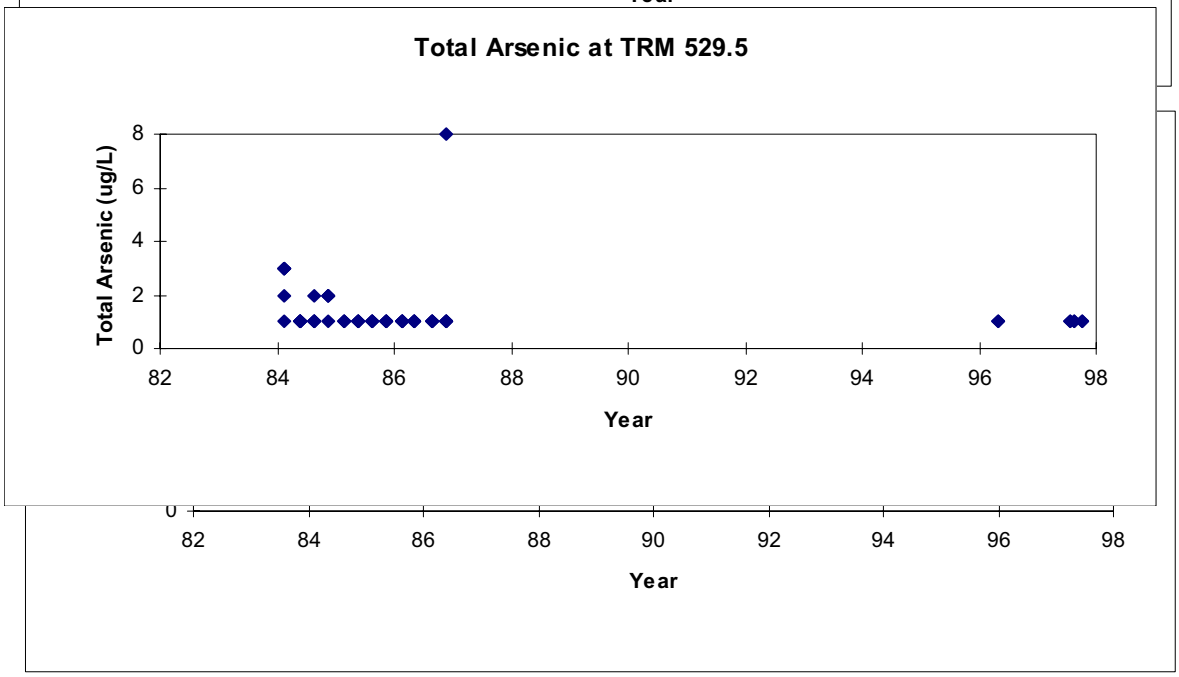




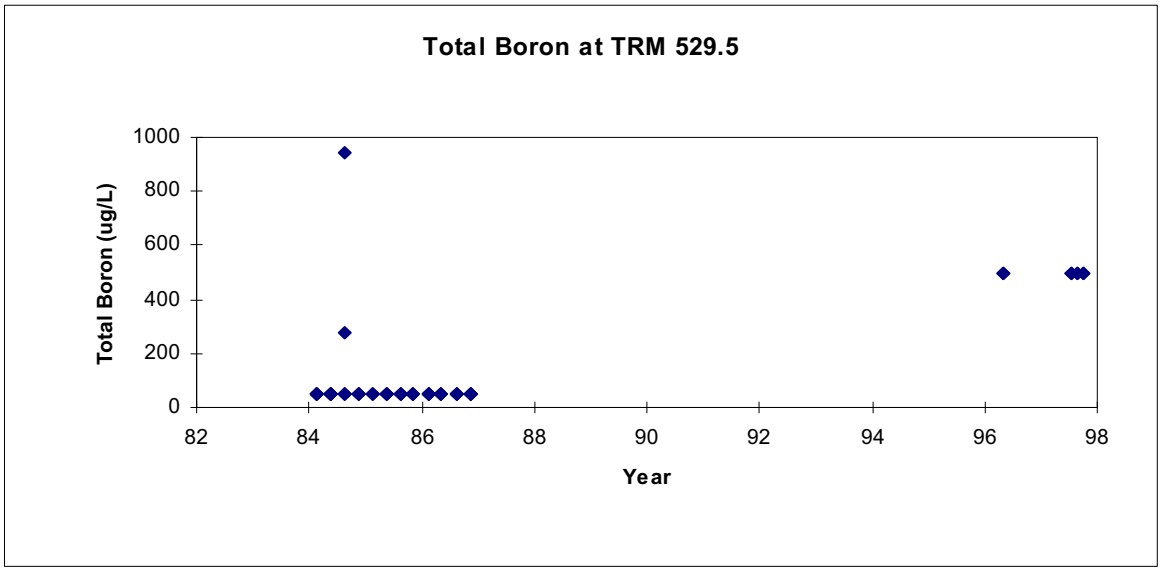

Total Calcium at TRM 529.5
Total Calcium (mg/L)
40
35
30
25
20
15
10
5
0
82
84
86
88
90
92
94
96
98
Year

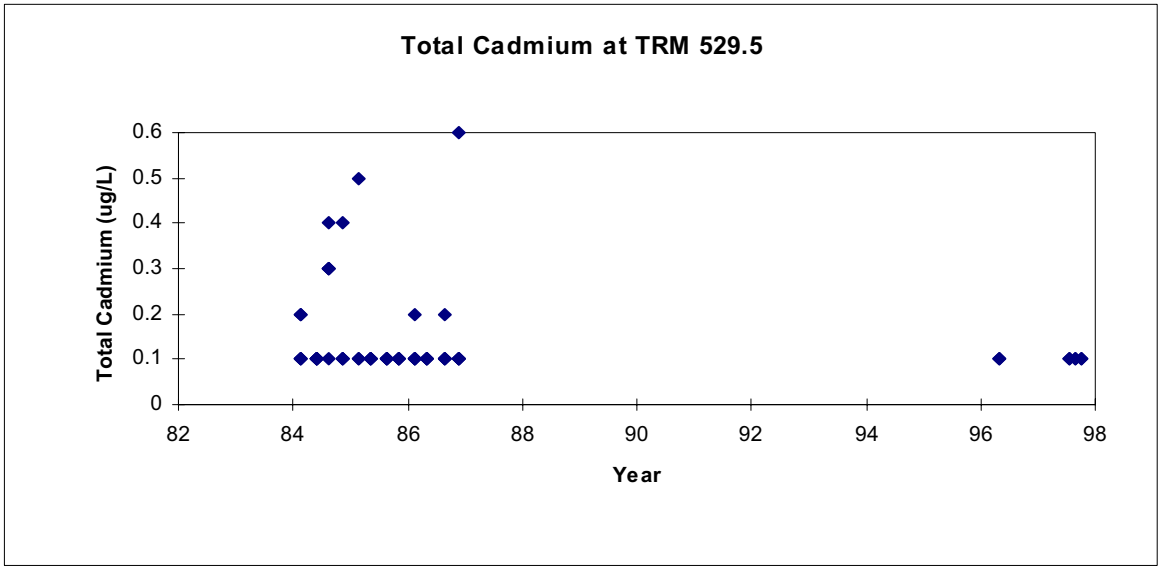

Total Magnesium at TRM 529.5
Total Magnesium (mg/L)
10
8
6
4
2
0
82
84
86
88
90
92
94
96
98
Year

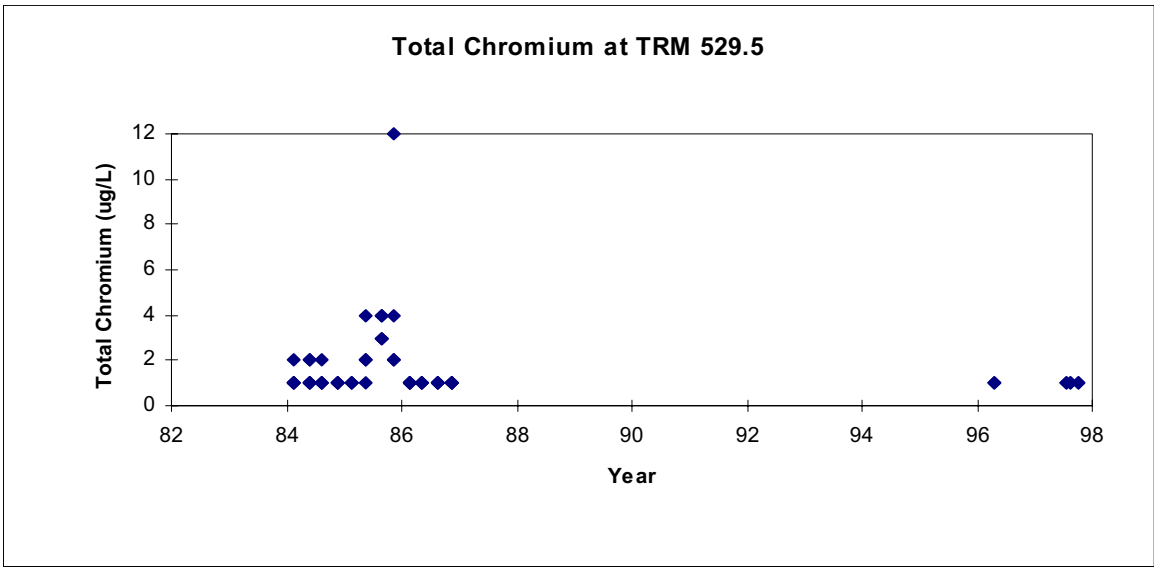
Year


Total Arsenic at TRM 529.5
Total Arsenic (ug/L)
8
6
4
2
0
82
84
86
88
90
92
94
96
98
Year

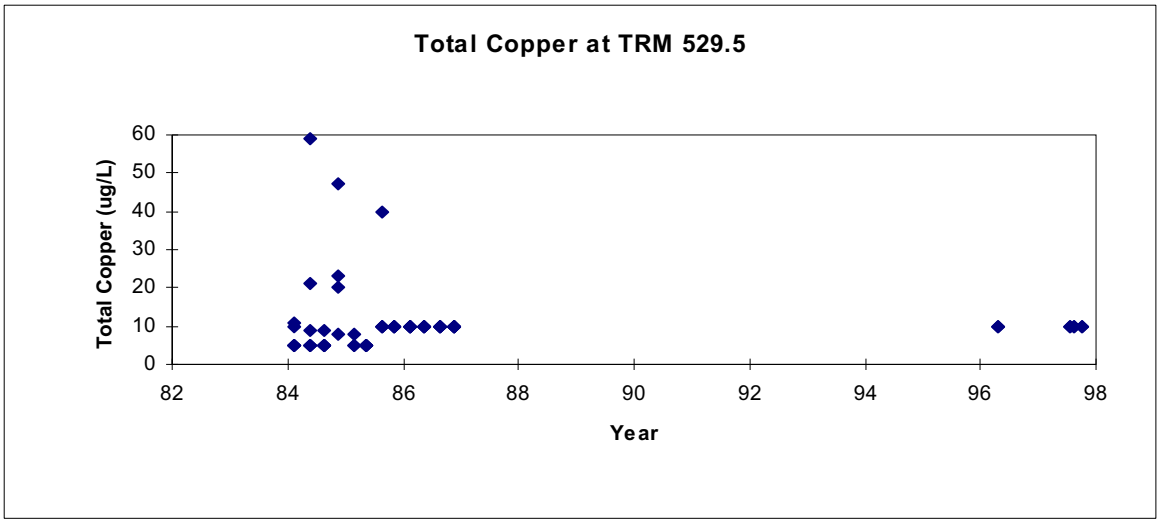
Appendix B-7 (Continued)

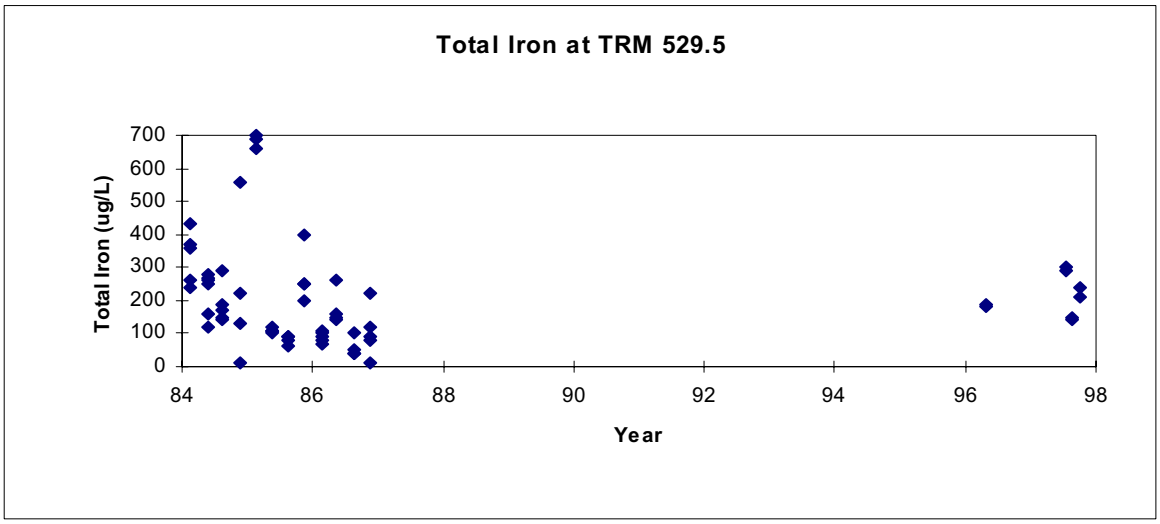


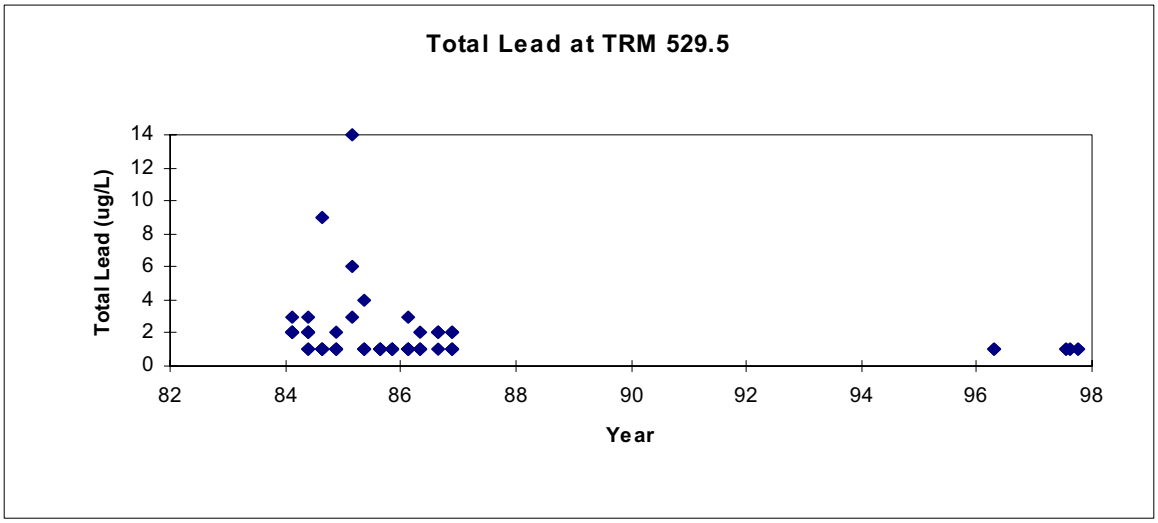


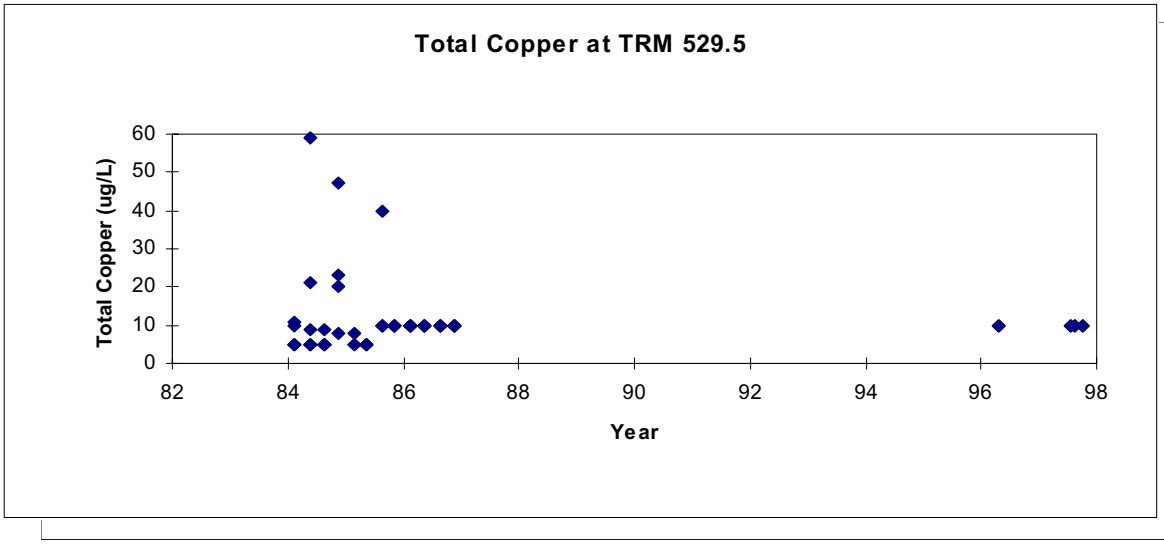


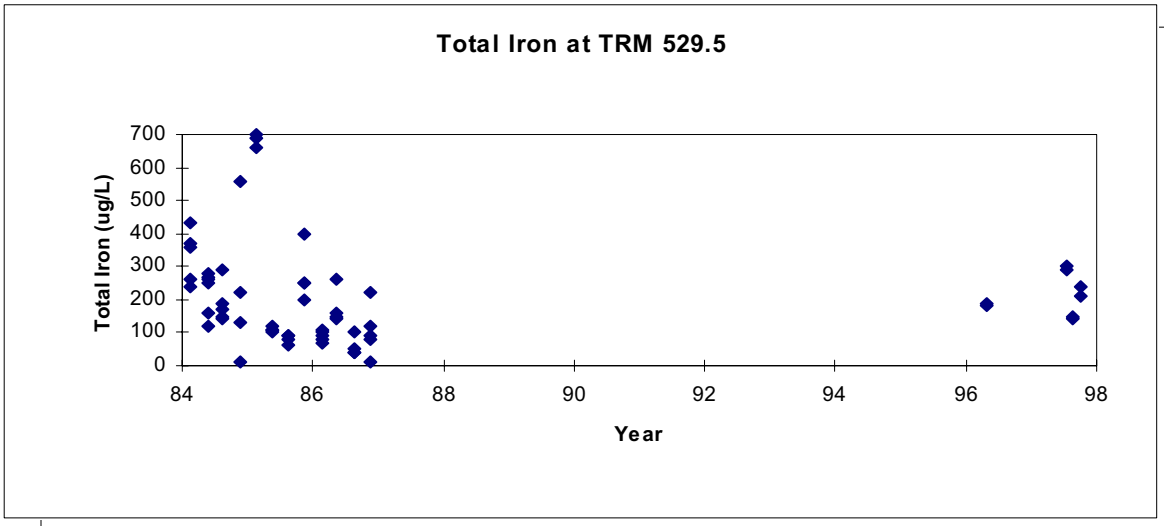
Appendix B-7 (Continued)

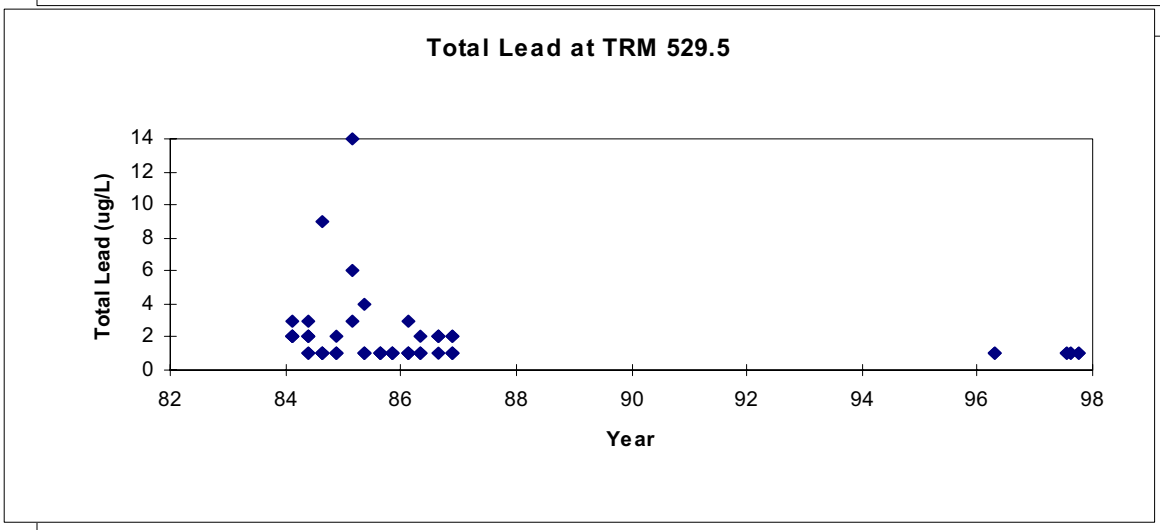




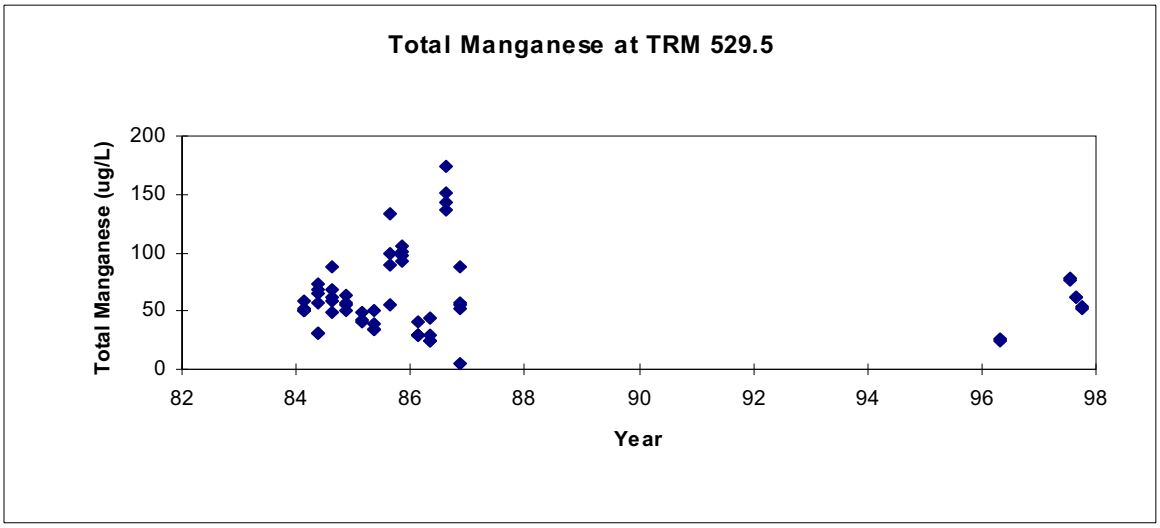


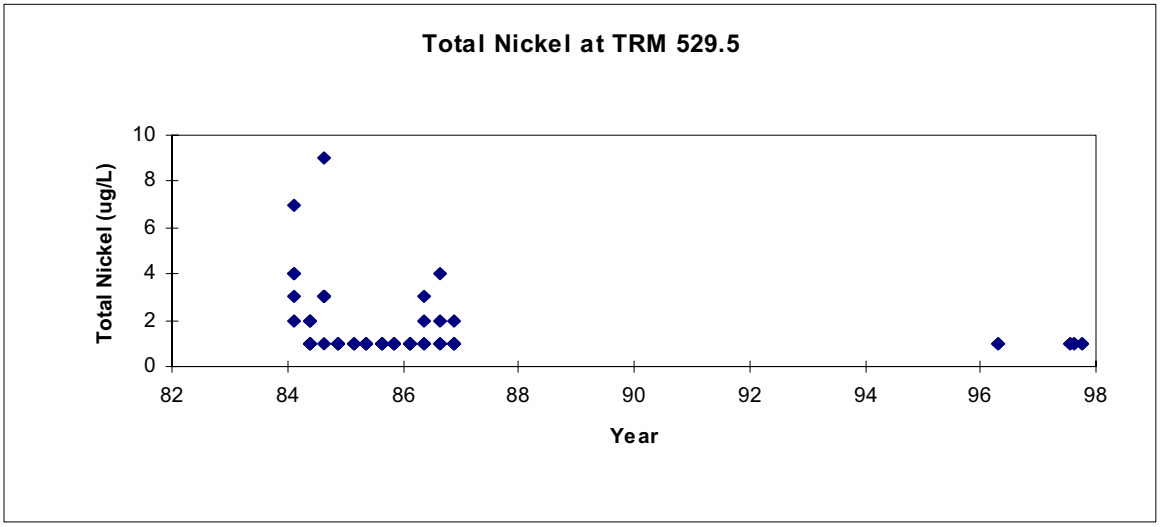

Total Copper at TRM 529.5
Total Copper (ug/L)
0
10
20
30
40
50
60
82
84
86
88
90
92
94
96
98
Year

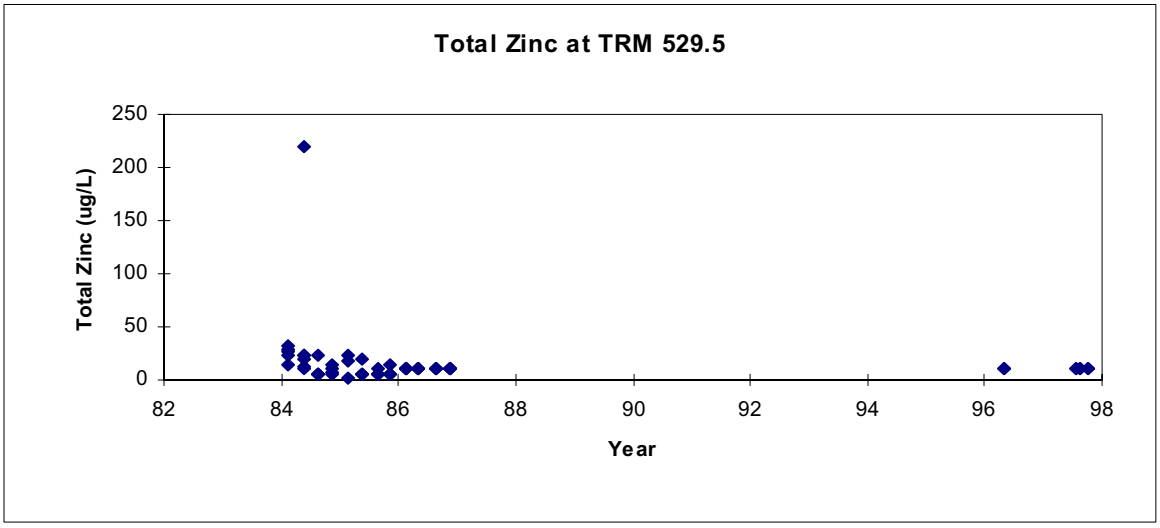

Total Iron at TRM 529.5
Total Iron (ug/L)
0
100
200
300
400
500
600
700
84
86
88
90
92
94
96
98
Year


Total Lead at TRM 529.5
Total Lead (ug/L)
0
2
4
6
8
10
12
14
82
84
86
88
90
92
94
96
98
Year

Appendix B-7 (Continued)







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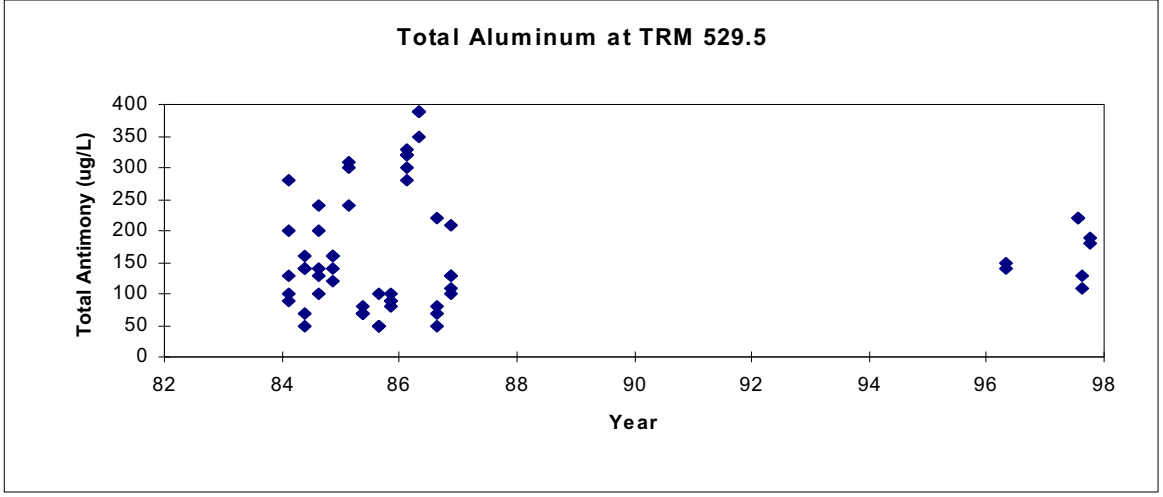
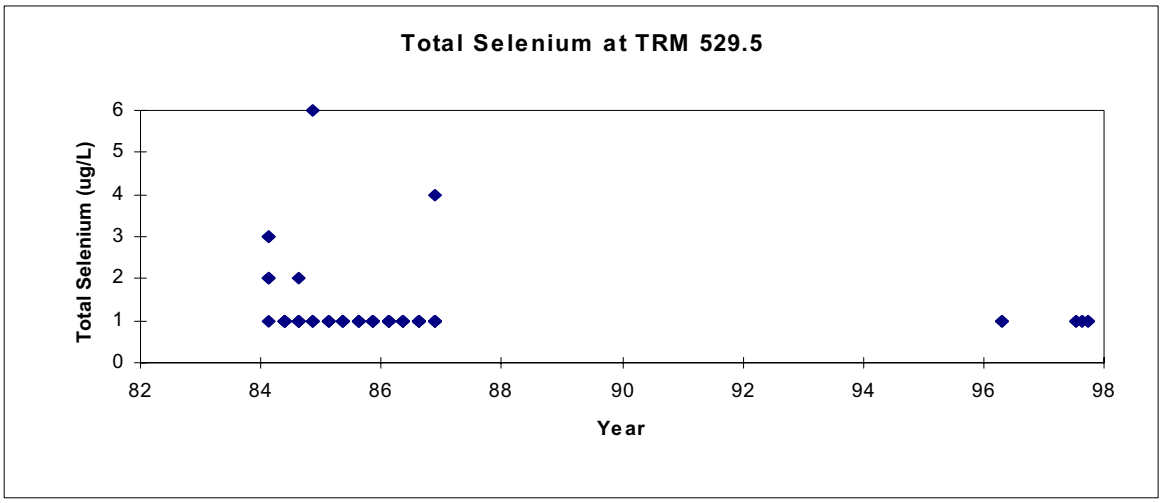
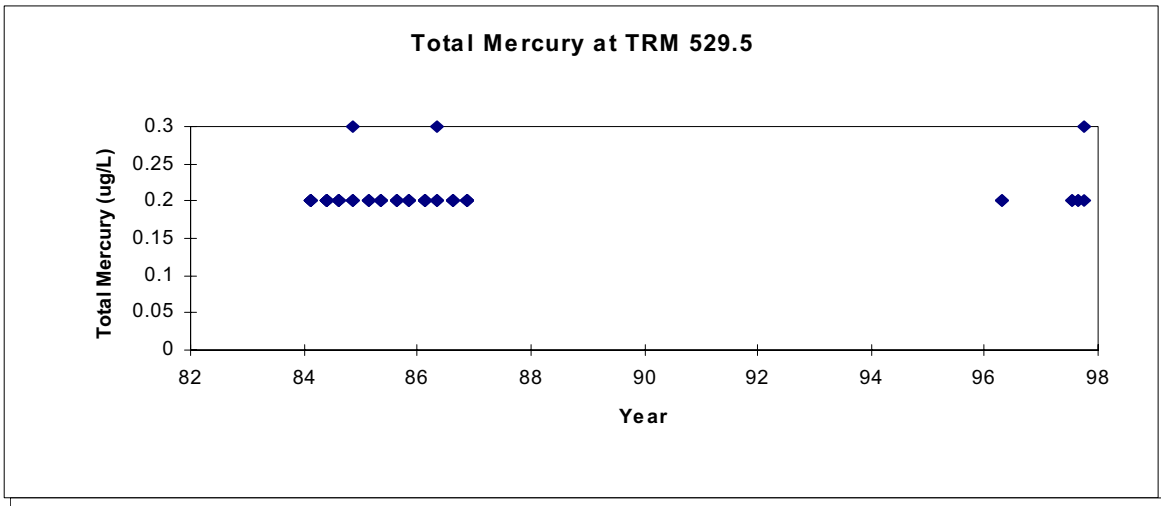
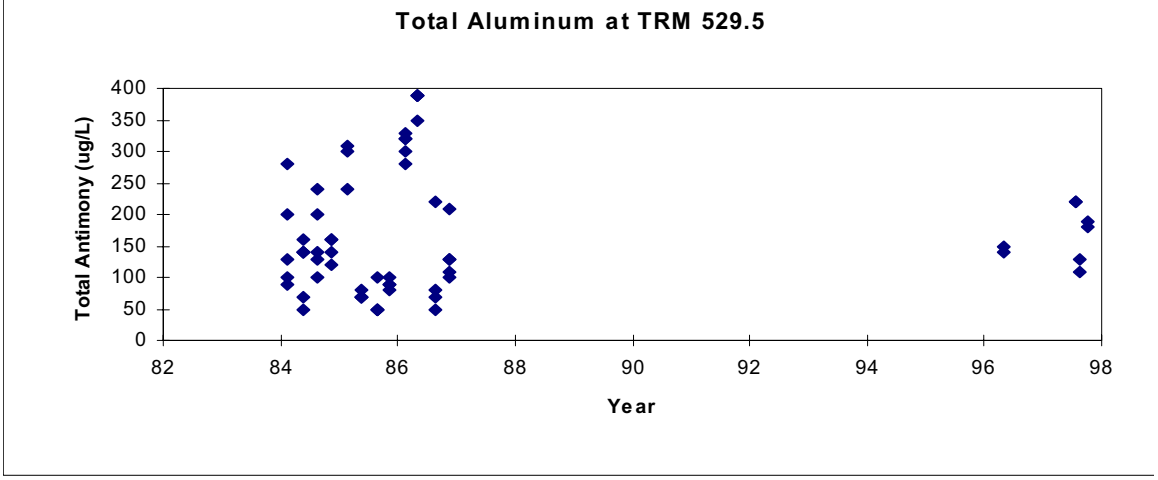
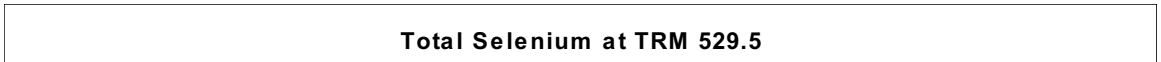

Total Aluminum at TRM 529.5
Total Antimony (ug/L)
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year

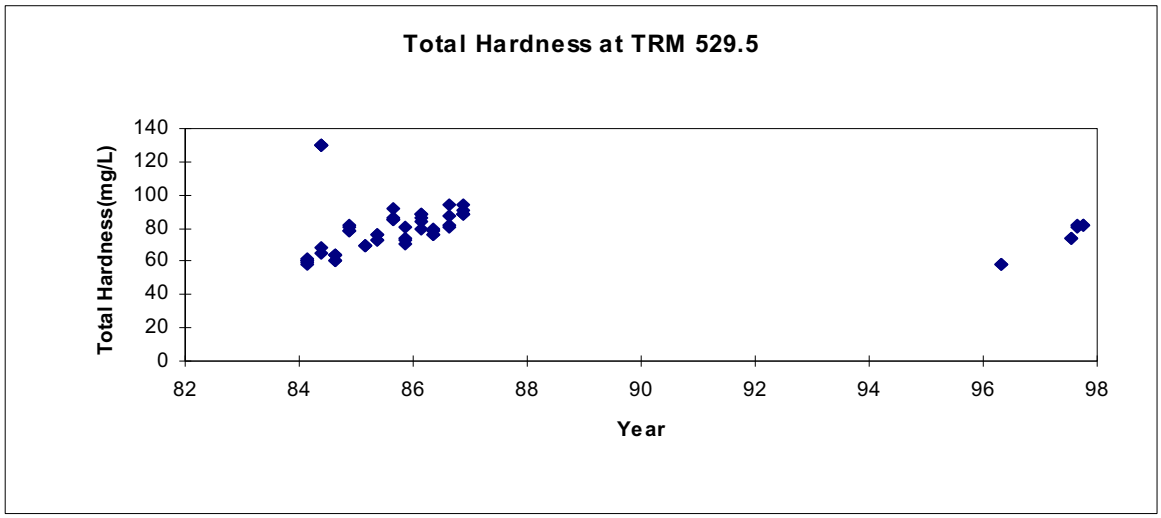

Total Selenium at TRM 529.5
Total Selenium (ug/L)
6
5
4
3
2
1
0
82
84
86
88
90
92
94
96
98
Year

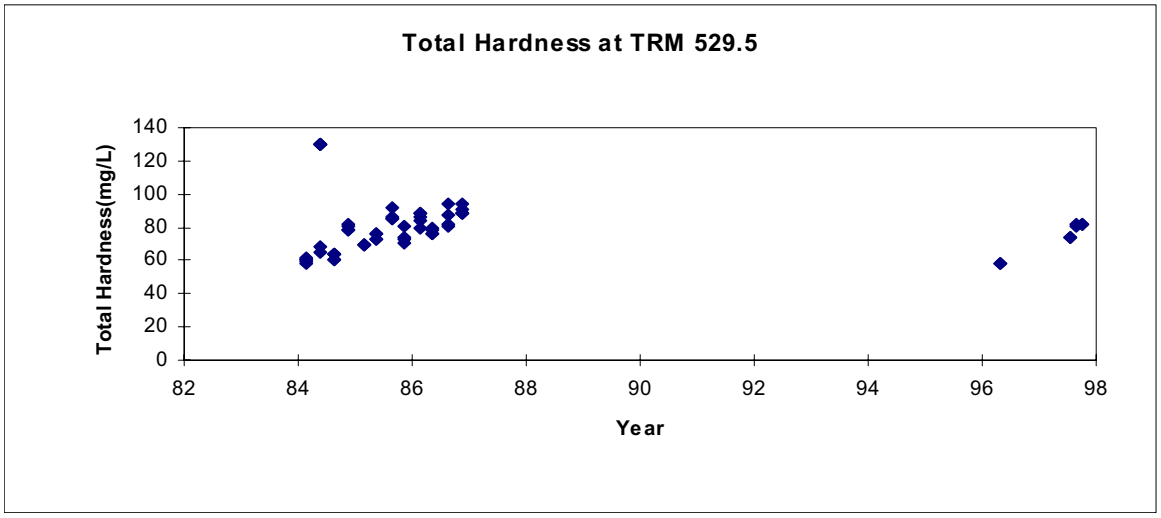

Total Mercury at TRM 529.5
Total Mercury (ug/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
82
84
86
88
90
92
94
96
98
Year


Total Aluminum at TRM 529.5
Total Antimony (ug/L)
400
350
300
250
200
150
100
50
0
82
84
86
88
90
92
94
96
98
Year


Total Selenium at TRM 529.5

Appendix B-7 (Continued)





ATTACHMENT 14

Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at Watts Bar Nuclear Plant at Tennessee River Mile 528 with Historical Densities during 1996 and 1997

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL SCIENCE AND RESOURCES

APRIL 2011

REVISED NOVEMBER 2011

Revisions (11/04/2011)
This revision confirms that the following conclusion regarding entrainment in the original April 2011 report remains valid.

While performing calculations for the annual report of the 2010-2011 WBN entrainment study (to be issued in December 2011), a clerical issue was discovered that prompted a thorough review of the raw data and calculations used to verify the density and entrainment rate estimates included in original report. Along with several more minor issues, this review disclosed that when using the "Sort" function in Excel on the raw data early in the data compilation and calculation processes, some columns of data were unintentionally excluded resulting in mismatched data. These data were then used to calculate the densities and entrainment estimates included in the April 2011 report. To remedy the issue, the original data were re-evaluated and density and entrainment estimates recalculated. Revised numbers collected and density and entrainment estimates are reflected in the following report. Changes in the revision include:

- **Table 2 and 3 -** Addition of Catostomidae egg and omission of gizzard shad and *Lepomis* eggs

- **Table 3 -** Changes in this revised table include higher numbers of freshwater drum eggs (+1,142), *Lepomis* larvae (+61), and unspecifiable Clupeidae larvae (+186) and lower numbers of gizzard shad (-19), *Pimephales* (-5), *Morone* (-76), white bass (-32), black bass (not smallmouth bass) (-15), *Pomoxis* (-237), white crappie (-12), freshwater drum (-199), and Atherinopsidae larvae (-20). Numbers collected of all other taxa remained the same. Total numbers of fish eggs increased (+583) while total numbers of fish larvae decreased (-364).

- **Table 4 -** Changes to densities of fish eggs were observed during fourth week of March (increases of 1/1000m^3 in reservoir and combined samples), first week of May (decrease of 1/1000m^3 in reservoir sample), third week of May (increase of 5/1000m^3 in intake sample and decreases of 1 and 2/1000m^3 in reservoir and combined samples, respectively), first week of June (increases of 43, 672, and 407/1000m^3 in intake, reservoir, and combined samples, respectively), second week of June (decrease of 1/1000m^3 in reservoir sample), and fifth week of June (increases of 2, 9, and 5/1000m^3 in intake, reservoir, and combined samples, respectively).

  Changes in densities of fish larvae were observed during the fourth week of April (decrease of 4/1000m^3 in intake sample and increase of 2/1000m^3 in reservoir sample), third week of May (increases of 32/1000m^3 in intake samples and decreases of 93 and 28/1000m^3 in reservoir and combined samples, respectively), first week of June 2010 (decreases of 111, 354, and 252/1000m^3 in intake, reservoir, and combined samples, respectively), and the fifth week of June (an increase of 6/1000m^3 in intake samples and decreases of 17 and 7/1000m^3 in reservoir and combined samples, respectively).

- **Table 5 -** There were increases in the average (+20) and peak densities (+312) of fish eggs and decreases in the average (-65) and peak densities (-460) of fish larvae.

- **Table 6 -** Changes to numbers collected are same as those listed above for Table 3. Occurrence by sample period was updated to reflect revised data.

- **Table 7 -** Because of the changes in densities, there were corresponding changes in estimated number entrained and estimated number transported. Percentages of fish eggs entrained increased during the weeks of May 16 (+0.54%), June 1 (+0.02%), and June 28 (+0.04%). Fish larvae densities increased the weeks of May 16th (+0.05%), June 1st (+1.32%), and June 28th (0.89%). Total estimated number of fish eggs entrained and total number fish eggs transported increased (+8.2 x 10^3 and +1.3 x 10^7, respectively), but total percent for the season decreased 0.02%. For fish larvae, total number entrained and total number transported decreased (-1.2 x 10^4 and -1.0 x 10^7, respectively), but total percent entrained increased 0.02%.

This revision confirms that the following conclusion regarding entrainment in the original April 2011 report remains valid. Overall, low entrainment percentages for fish eggs and larvae transported past WBN and minimal hydraulic entrainment by WBN, suggest no impact to the ichthyoplankton populations of Chickamauga Reservoir from the operation of WBN.

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Abbreviations and Acronyms

cfs	cubic feet per second
CTB	cooling tower blowdown
fps	feet per second
msl	mean sea level
SCCW	Supplemental Condenser Cooling Water
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
WBH	Watts Bar Hydroelectric Dam
WBN	Watts Bar Nuclear Plant

Introduction

Tennessee Valley Authority (TVA) is conducting additional monitoring during 2010–2011 in Chickamauga Reservoir to estimate entrainment mortality of fish in the vicinity of Watts Bar Nuclear Plant (WBN) due to the proposed operation of an additional nuclear reactor (Unit 2) at the Plant site. This monitoring began March 2010 and will serve to update and verify historical monitoring conducted in 1996 and 1997. This report will present taxonomic composition, densities and estimated entrainment during April through June 2010 and compare these data from the same period during 1996 and 1997.

Plant Description

WBN is located on the right descending (west) bank of upper Chickamauga Reservoir at Tennessee River Mile (TRM) 528 approximately 1.9 miles downstream of Watts Bar Hydroelectric Dam (WBH; TRM 529.9) and one mile downstream of the decommissioned Watts Bar Fossil Plant (Figure 1). Unit 1 went into commercial operation on May 27, 1996 and is designed for a net electrical output of 1,160 megawatts (gross electrical output of 1,218 megawatts).

Materials and Methods

Data Collection

Ichthyoplankton samples during 1996 and 1997 monitoring of Unit 1 were collected biweekly, on a diel schedule (day and night), during April through June. Reservoir samples were collected at five stations along a transect located at TRM 528.4, which was perpendicular to river flow just upstream of the cooling tower make-up water intake channel (Figure 1). Four intake samples were collected within the Intake Pumping Station (IPS) canal located at TRM 528 (Figure 1). Samples were taken with a beam net (0.5 m square, 1.8 m long, with 505 micron "nitex" mesh netting) towed upstream at a speed of 1.0 m/s for ten minutes. The volume of water filtered through the net was measured with a large-vaned General Oceanics Inc.® flowmeter. Approximately 150 m^3 of water were filtered per ten-minute sample. Water temperature was recorded using a mercury thermometer calibrated to the tenth degree. Ichthyoplankton samples during 2010 monitoring were collected using the same methods, diel schedule (day and night), sampling period (April through June), and at the same sampling locations as those used in 1996 and 1997 monitoring, with one exception. During 2010 monitoring, samples were collected weekly instead of biweekly. Detailed ichthyoplankton sampling procedures used during 1996, 1997, and 2010 monitoring are outlined in S&F OPS-FO-BR-23.5 (TVA, 2010a).

Laboratory Analysis

Laboratory analyses also followed the same procedures in 2010 as in 1996 and 1997. Larval fish were removed from the samples, identified to the lowest possible taxon, counted and measured to the nearest millimeter total length following procedures outlined in S&F OPS-FO-BR-24.1 (TVA, 2010b). Taxonomic decisions were based on TVA's "Preliminary Guide to the Identification of Larval Fishes in the Tennessee River," (Hogue et al., 1976) and other pertinent

literature (Wallus et al., 1990; Kay et al., 1994; Simon and Wallus, 2003; Simon and Wallus, 2006; Wallus and Simon, 2006; and Wallus and Simon, 2008).

The term "unidentifiable larvae" applies to specimens too damaged or mutilated to identify, while "unspecifiable" before a taxon implies a level of taxonomic resolution (i.e., "unspecifiable catastomids" designates larvae within the family *Catostomidae* that currently cannot be identified to a lower taxon). The category "unidentifiable eggs" applies to specimens that cannot be identified due to damage or lack of taxonomic knowledge. Taxonomic refinement is a function of specimen size and developmental stage. Throughout this report, the designation "unspecifiable clupeids" refers to clupeids less than 20 mm in total length and could include *Dorosoma cepedianum* (gizzard shad), *D. petenense* (threadfin shad), and/or *Alosa chrysochloris* (skipjack herring) (Table 2). Any clupeid specimen identified to species level represents a postlarva or juvenile 20 mm or longer in total length.

Developmental stage of moronids also determines level of taxonomic resolution. *Morone saxatilis* (striped bass) hatch at a larger size than either *M. chrysops* (white bass) or *M. mississippiensis* (yellow bass). Although it is currently impossible to distinguish between larvae of the latter two species, *M. saxatilis* can be eliminated as a possibility based on developmental characteristics of specimens 5 mm or less in total length (hence, the taxonomic designation "*Morone* not *saxatilis*"). Specimens identified as "*Morone* sp." are those greater than 5 mm total length that could be any of the three species.

Data Analysis

Temporal occurrence and relative abundance of eggs and larvae by taxon are presented and discussed for 1996, 1997, and 2010 monitoring periods. Densities of fish eggs and larvae were expressed as numbers per 1,000 m^3 and were calculated using the equation:

$$D = \frac{1{,}000(Number\ fish\ eggs\ or\ larvae\ collected)}{Sample\ volume}$$

Estimated entrainment of fish eggs and larvae was calculated by the following equation:

$$Ent = \frac{\sum DQ}{1000}$$

where *Ent* is estimated entrainment of fish eggs and larvae, *D* is the mean density (number/1,000 m^3) of fish eggs or larvae and *Q* is the flow (m^3/d). To calculate estimated entrainment of fish eggs and larvae that were transported past WBN (from reservoir samples), densities of fish eggs and larvae from all stations along reservoir transect at TRM 528 were averaged and multiplied by the corresponding 24-hour river flow past the plant. Entrainment estimates for intake samples were calculated using the same method, except densities of fish eggs and larvae from the intake samples and plant intake (IPS) water demand were used.

Percentage of transported ichthyofauna entrained by the plant was estimated using the formula:

$$E = \frac{100 D_i Q_i}{D_r Q_r},$$

where D_i is the mean density (number/1,000 m^3) of fish eggs or larvae in intake samples; D_r is the mean density (number/1,000 m^3) of fish eggs or larvae in the river transect at TRM 528; Q_i is the plant intake water demand (m^3/d); and Q_r is the river flow past WBN (m^3/d).

Results and Comparison with Historical Data (1996 through 1997)

During thirteen sample periods in 2010, the average volume of water filtered was 608 m^3 for intake samples and 781 m^3 for reservoir samples (Table 1). A list of families of fish eggs and larvae collected April through June during 1996, 1997, and 2010, including the lowest level of taxonomic resolution, is presented in Table 2.

Fish Eggs

A total of 1,585 fish eggs was collected in weekly sampling during April through June 2010. Composition was approximately 96 percent freshwater drum, 2.7 percent moronids (not striped bass), 1.3 percent clupeids (not skipjack herring), and 0.1 percent catostomids. During this same period in 1996 and 1997 (biweekly sampling), 2,929 and 1,605 fish eggs were collected, respectively (Table 3). Nearly 100 percent of eggs collected in 1996 and 1997 were mutilated and unidentifiable; this was most likely due to turbine passage through Watts Bar Dam. During 2010 monitoring, densities of eggs peaked on 05/16 at 117/1,000 m^3 in intake and on 06/01 at 1,356/1,000 m^3 in reservoir samples (Table 4). Average seasonal density for eggs was 75/1,000 m^3 in the intake and reservoir samples combined and peaked the week of 06/01 at 811/1,000 m^3 (Table 5; Figure 2).

Fish Larvae

A total of 5,885 larval fish was collected in weekly samples during April through June 2010, compared to 4,926 and 9,849 during the same period 1996–1997 (biweekly samples) respectively. Relative abundance for all taxa of larval fish collected during the thirteen weekly sample periods of 2010 was dominated by clupeids (68%) (gizzard and threadfin shad and skipjack), centrarchids (14%), and *Morone* (11%). Table 3 provides a comparison of relative abundance of eggs and larvae by taxon during April through June 1996, 1997, and 2010. Clupeids were the dominant family of larvae all three years. Occurrence by sample period for all taxa of eggs and larvae is presented for April through June 1996, 1997, and 2010 in Table 6. Larval *Morone* and percids (darters and sauger) were the first taxa to be collected all three years (Table 6).

Average densities (525, 924, 282), peak seasonal densities (1,387; 1,699; 828) and dates of peak densities (06/03, 05/15, 05/16) for larvae during April through June 1996, 1997, and 2010, respectively, are presented in Table 5. All of these values for samples collected during 2010 were slightly lower than the range of the two previous years (1996 and 1997) of monitoring. During 2010, average seasonal density for larvae was 282/1,000 m^3 in the intake and reservoir

samples combined and the peak density occurred on the week of 5/16 (Table 5; Figure 3). It should be noted that this peak density of fish larvae on 05/16 was coincidentally the date that there was no turbine flow through WBH to accommodate a hydrothermal survey of the WBN SCCW thermal plume under no-flow condition (TVA, 2011).

Estimated Entrainment

Entrainment estimates for fish eggs and larvae by sample period during April through June 1996, 1997, and 2010 and total percent entrainment for the period sampled are presented in Table 7. Highest seasonal entrainment recorded for eggs was 0.29% and for larvae 0.57% both in 1996. During April through June 2010, seasonal entrainment for fish eggs and larvae was estimated to be 0.12% and 0.40%, respectively. During one sample period (May 16) in 2010, density of fish eggs in intake samples (117/1,000 m^3) was significantly higher than in reservoir samples (13/1,000 m^3) and resulted in a higher entrainment estimate (4.1%) for that period. Similarly for fish larvae in 2010, during sample periods 9 through 12 (06/01 through 06/21) densities were higher in intake samples and entrainment estimates ranged from 0.79% to 8.65% (Table 7).

Conclusion

Seasonal entrainment percentages for both fish eggs and larvae during April through June 2010 were similar to those estimated for previous operational monitoring during the same period 1996 and 1997. It was concluded in the report on those data (TVA, 1998) that those entrainment levels would not be detrimental to the ichthyoplankton population of upper Chickamauga Reservoir. Therefore, the April through June 2010 ichthyoplankton population in upper Chickamauga Reservoir was not adversely affected due to entrainment by WBN.

Historically, adult fish communities measured by TVA's Reservoir Fish Assemblage Index in the vicinity of WBN have averaged a "Good" rating annually since monitoring began in 1999 (TVA, 2010c). This is further evidence that operations of WBN have not adversely affected the fish community in Chickamauga Reservoir.

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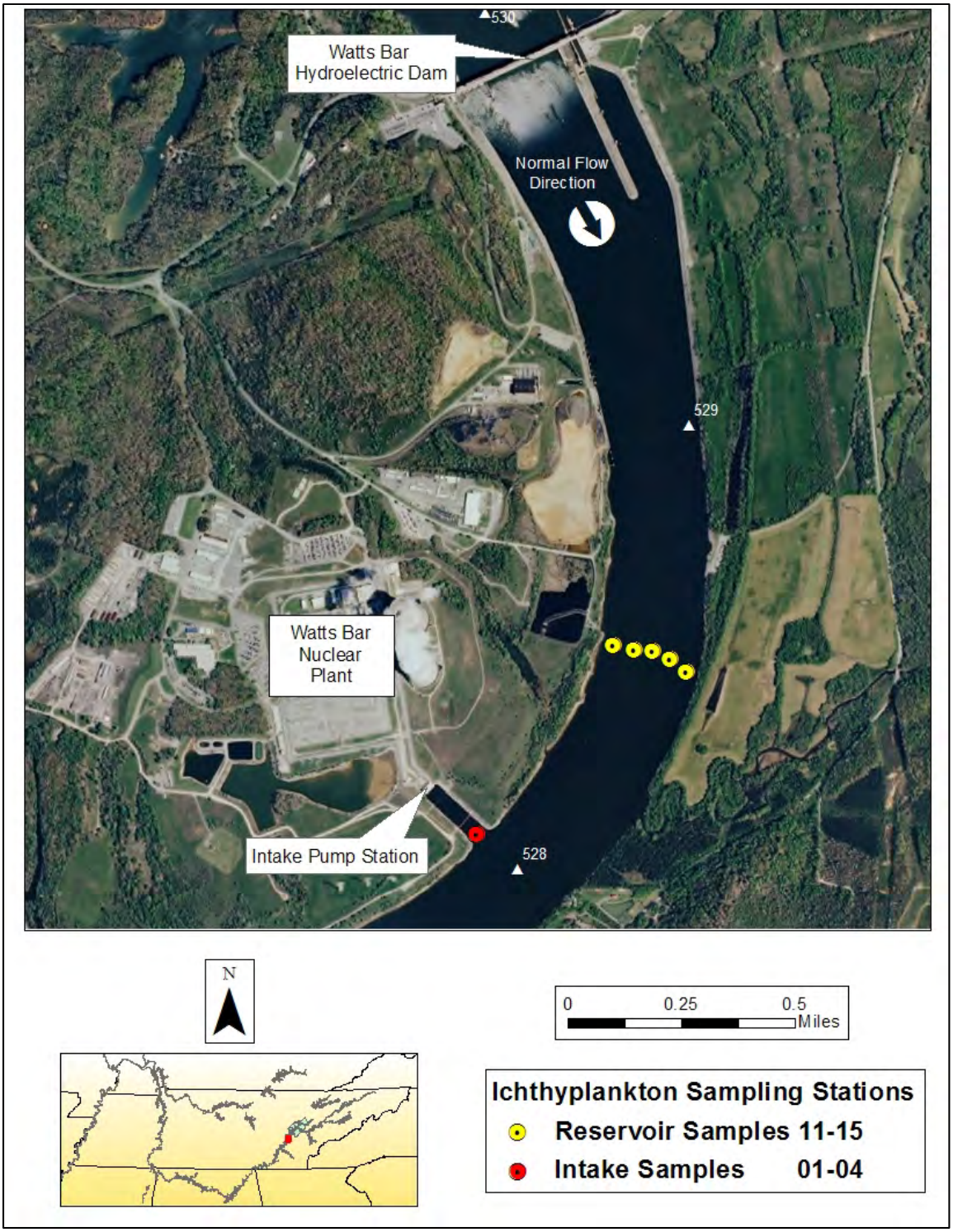

Figure 1. Locations of intake (Intake Pumping Station) and reservoir transects and sampling stations used to collect ichthyoplankton (fish eggs and larvae) during April through June 1996, 1997, and 2010 in the vicinity of Watts Bar Nuclear Plant, Chickamauga Reservoir, Rhea County, TN.

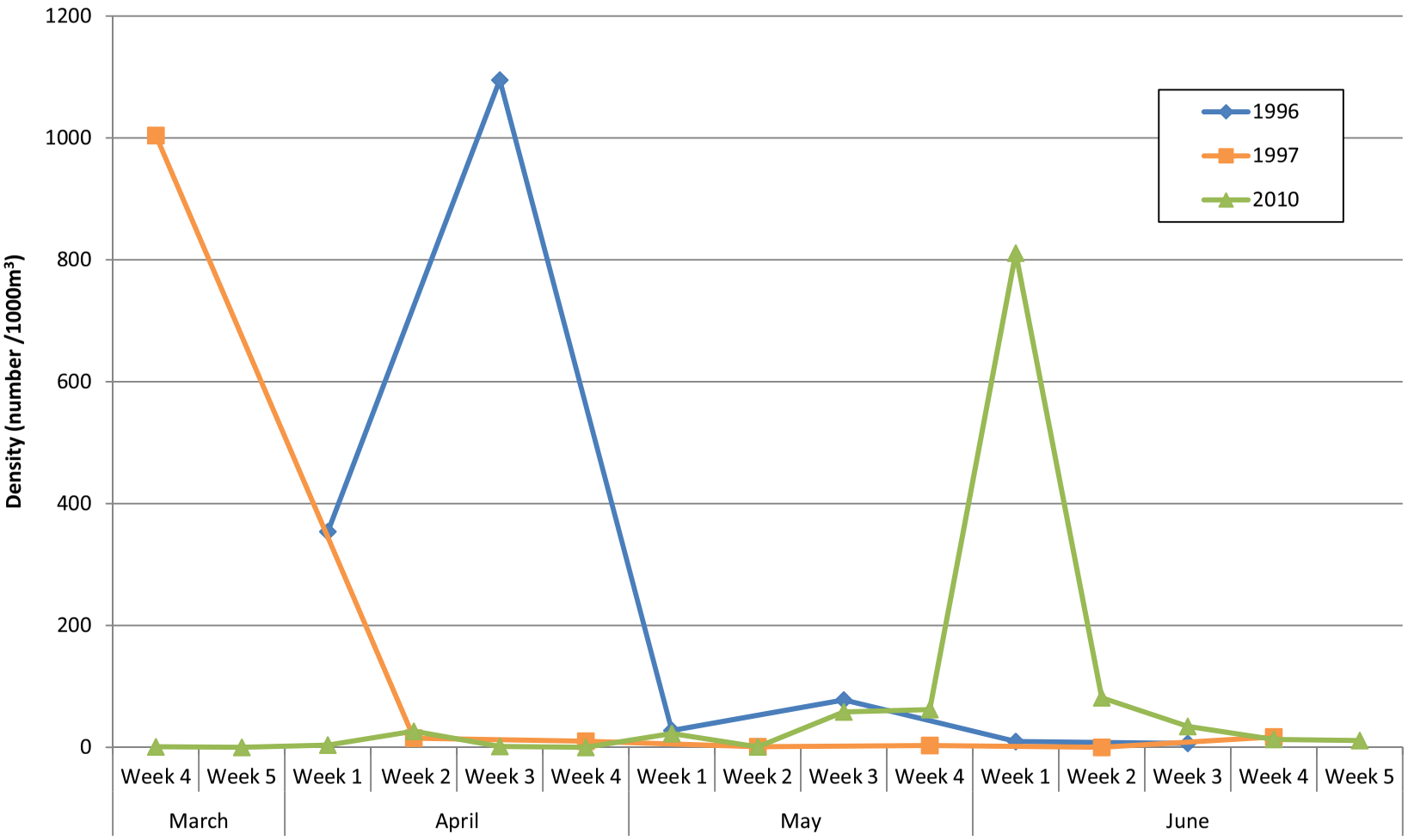

Figure 2. Weekly densities of fish eggs collected from sampling stations located in the Intake Pumping Station canal and in the Reservoir transect (combined) in the vicinity of Watts Bar Nuclear Plant, Rhea County, TN, during April through June 1996, 1997, and 2010.

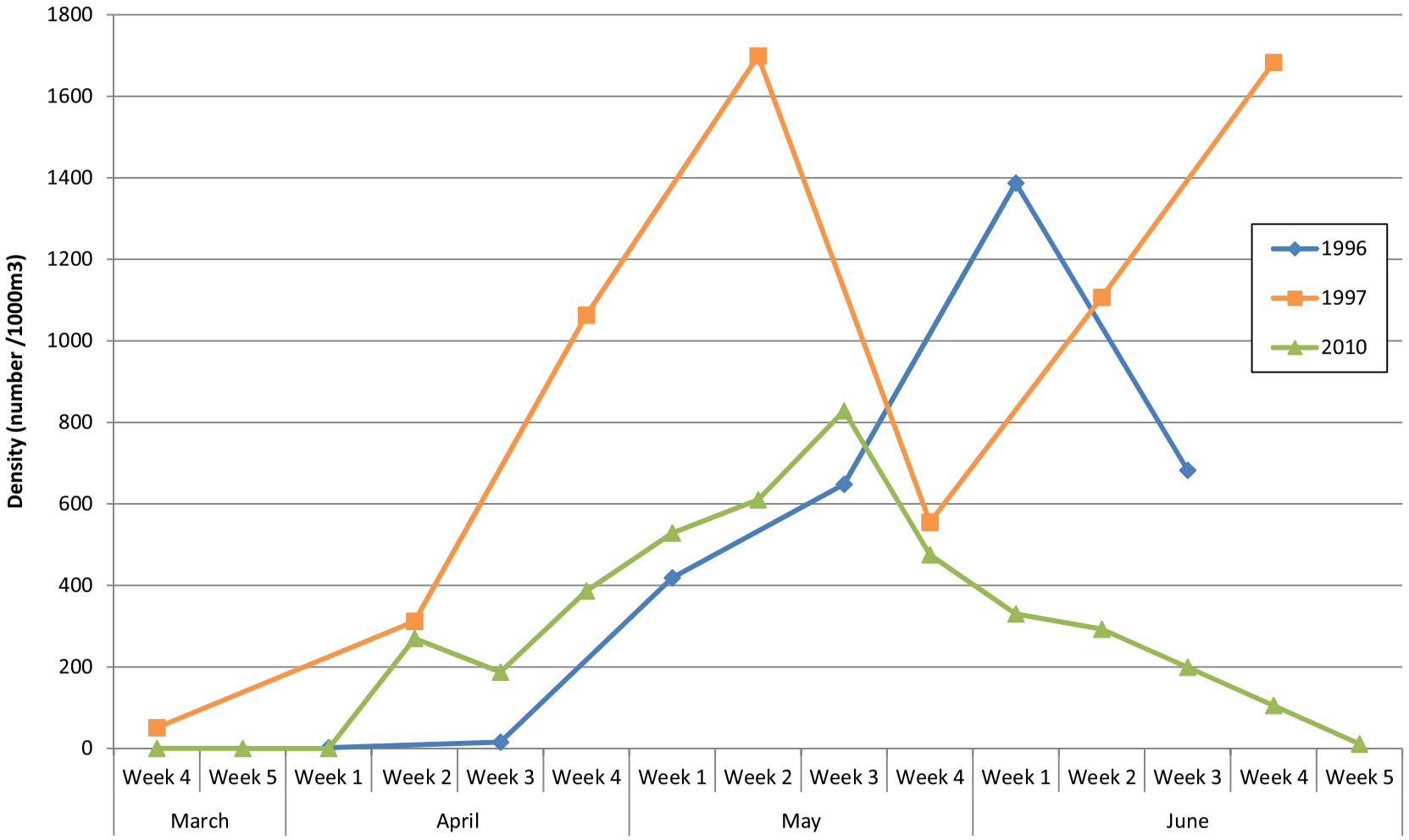

Figure 3. Weekly densities of larval fish collected from sampling stations located in the Intake Pumping Station (IPS) canal and in the Reservoir transect (combined) in the vicinity of Watts Bar Nuclear Plant, Rhea County, TN, during April through June 1996, 1997, and 2010.

Table 1. Total volume of water filtered weekly April through June 2010–2011 at stations at the Intake Pumping Station canal and the reservoir transect near Watts Bar Nuclear Plant to estimate densities and entrainment of fish eggs and larvae.

		2010		
Month	**Week**	**Intake**	**Reservoir**	**Total**
March	4	577	729	1,306
	5	588	744	1,332
April	1	595	744	1,339
	2	612	751	1,363
	3	623	760	1,383
	4	609	809	1,418
May	1	618	801	1,419
	2	588	774	1,362
	3	588	771	1,359
	4	621	798	1,419
June	1	594	816	1,410
	2	587	814	1,401
	3	628	799	1,427
	4	647	813	1,460
	5	647	787	1,434
	Total	**9,122**	**11,710**	**20,832**
	Average	**608**	**781**	**1,389**

Table 2. List of fish eggs and larvae by family collected near Watts Bar Nuclear Plant during April through June 1996, 1997, and 2010, and lowest level of taxonomic resolution for each family.

1996		1997		2010	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**
Fish Eggs				**Eggs**	
				Catostomidae spp. eggs	Unidentifiable catostomid eggs
Unidentifiable fish eggs		Unidentifiable fish eggs		Clupeidae spp. eggs	Unidentifiable clupeid eggs
				Moronidae spp. eggs	Temperate bass eggs
Aplodinotus grunniens eggs	Freshwater drum eggs	*Aplodinotus grunniens* eggs	Freshwater drum eggs	*Aplodinotus grunniens* eggs	Freshwater drum eggs
Fish Larvae					
Clupeidae		**Clupeidae**		**Clupeidae**	
Unspecifiable clupeids	Unspecified shad and/or herring	Unspecifiable clupeids	Unspecified shad and/or herring	Unspecifiable clupeids	Unspecified shad and/or herring
		Alosa chrysochloris	Skipjack herring	*Alosa chrysochloris*	Skipjack herring
Dorosoma cepedianum	Gizzard shad	*Dorosoma cepedianum*	Gizzard shad	*Dorosoma cepedianum*	Gizzard shad
Dorosoma petenense	Threadfin shad	*Dorosoma petenense*	Threadfin shad	*Dorosoma petenense*	Threadfin shad
Cyprinidae		**Cyprinidae**		**Cyprinidae**	
Unspecifiable cyprinids	Unspecified minnow or carp	Unspecifiable cyprinids	Unspecified minnow or carp		
Cyprinus carpio	Common carp	*Cyprinus carpio*	Common carp		
		Notropis volucellus	Mimic shiner		
				Cyprinella spp.	Various shiners
				Pimephales spp.	Fathead, bullhead or bluntnose minnow
Catostomidae				**Catostomidae**	
				Ictiobinae	Unspecified Ictiobines (buffalofish)
Minytrema melanops	Spotted sucker				
Ictaluridae				**Ictaluridae**	
Ictalurus punctatus	Channel catfish			*Ictalurus punctatus*	Channel catfish
Moronidae		**Moronidae**		**Mornidae**	
Morone sp.	Unspecified temperate bass	*Morone* sp.	Unspecified temperate bass	Morone sp.	Unspecified temperate bass
Morone chrysops	White bass	*Morone chrysops*	White bass	*Morone chrysops*	White bass
Morone mississippiensis	Yellow bass	*Morone mississippiensis*	Yellow bass		
Morone (not *saxatilis*)	Unspecified temperate bass(not striped bass)	*Morone* (not *saxatilis*)	Unspecified temperate bass(not striped bass)	*Morone* (not *saxatilis*)	Unspecified temperate bass (not striped bass)
Centrarchidae		**Centrarchidae**		**Centrarchidae**	
Lepomis sp.	Unspecified sunfish	*Lepomis* sp.	Unspecified sunfish	*Lepomis* sp.	Unspecified lepomid
		Micropterus sp.	Unspecified black bass		
				Micropterus (not *dolomieu*)	Unspecified black bass (not smallmouth bass)

Table 2. (Continued)

1996		1997		2010	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**
Pomoxis sp.	Unspecified crappie	*Pomoxis* sp.	Unspecified crappie	*Pomoxis* sp.	Unspecified crappie
				Pomoxis annularis	White crappie
Percidae		**Percidae**		**Percidae**	
Unspecifiable darter	Unspecified darter	Unspecifiable darter	Unspecified darter		
				Unidentifiable darter (not *Percina caprodes*)	Unidentifiable darter
				Unidentifiable darter (*Percina caprodes* type)	Unidentifiable darter, Logperch type
Perca flavescens	Yellow perch			*Perca flavescens*	Yellow perch
		Sander sp.	Walleye or sauger		
				Sander canadensis	Sauger
Sciaenidae		**Sciaenidae**		**Sciaenidae**	
Aplodinotus grunniens	Freshwater drum	*Aplodinotus grunniens*	Freshwater drum	*Aplodinotus grunniens*	Freshwater drum
				Atherinopsidae	
				Atherinopsidae spp.	Unspecified silverside (brook or inland)
				Menidia beryllina	Inland silverside

Table 3. Actual numbers and percent composition of fish eggs and larvae collected in impingement samples during April through June 1996, 1997, and 2010 in the vicinity of Watts Bar Nuclear Plant.

	1996		1997		2010	
Taxon	**Total Numbers Collected**	**% Comp**	**Total Numbers Collected**	**% Comp**	**Total Numbers Collected**	**% Comp**
EGGS						
Unidentifiable fish eggs	2,908	99.28%	1,591	99.13%		
Catostomidae eggs					1	0.06%
Clupeidae (not skipjack) eggs					20	1.26%
Moronidae (not *saxatilis*) eggs					43	2.71%
Aplodinotus grunniens eggs	21	0.72%	14	0.87%	1,521	95.96%
Total	**2,929**	**100%**	**1,605**	**100%**	**1,585**	**100%**
LARVAE						
Clupeidae						
Unspecifiable clupeids	4,132	83.88%	8,083	82.07%	3,991	67.86%
Alosa chrysochloris			8	0.08%	1	0.02%
Dorosoma cepedianum	74	1.50%	1	0.01%	197	3.35%
Dorosoma petenense	50	1.02%	2	0.02%	3	0.05%
Cyprinidae						
Unspecifiable cyprinids	2	0.04%	6	0.06%		
Cyprinidae (*Cyprinella* group)					1	0.02%
Cyprinidae (*Pimephales* group)					21	0.36%
Cyprinus carpio	2	0.04%	2	0.02%		
Notropis volucellus			2	0.02%		
Catostomidae						
Ictiobinae					2	0.03%
Minytrema melanops	3	0.06%				
Ictaluridae						
Ictalurus punctatus	2	0.04%			1	0.02%
Moronidae						
Morone sp.	41	0.83%	820	8.33%	51	0.87%
Morone chrysops	5	0.10%	2	0.02%	57	0.97%
Morone mississippiensis	16	0.32%	6	0.06%		
Morone (not *saxatilis*)	161	3.27%	382	3.88%	560	9.52%
Centrarchidae						
Lepomis sp.	95	1.93%	130	1.32%	583	9.91%
Micropterus sp.			3	0.03%		
Micropterus (not *dolomieu)*					4	0.07%
Pomoxis sp.	8	0.16%	125	1.27%	250	4.25%
Pomoxis annularis					3	0.05%
Percidae						
Unidentifiable darter	5	0.10%	8	0.08%		
Unidentifiable darter (not *Percina caprodes*)					1	0.02%
Unidentifiable darter (*Percina caprodes* type)					4	0.07%
Perca flavescens	6	0.12%			7	0.12%
Sander sp.			2	0.02%		
Sander canadensis					1	0.02%
Sciaenidae						
Aplodinotus grunniens	324	6.58%	267	2.71%	119	2.02%
Atherinopsidae						
Atherinopsidae sp.					23	0.39%
Menidia beryllina					1	0.02%
Total	**4,926**	**100%**	**9,849**	**100%**	**5,885**	**100%**

Table 4. Densities (number/1,000 m^3) by sample period of fish eggs and larvae collected at reservoir, intake, and reservoir and intake combined during April through June 1996 and 1997 (biweekly) and 2010 (weekly) at Watts Bar Nuclear Plant.

Fish Eggs		1996			1997			2010		
Month	**Week**	**Intake**	**Reservoir**	**Combined***	**Intake**	**Reservoir**	**Combined***	**Intake**	**Reservoir**	**Combined***
March	4	---	---	---	177	1,070	1,004	0	1	1
	5	---	---	---	---	---	---	0	0	0
April	1	17	382	354	---	---	---	0	7	4
	2	---	---	---	0	16	15	0	48	26
	3	109	1,528	1,095	---	---	---	0	3	1
	4	---	---	---	0	11	10	0	0	0
May	1	59	26	28	---	---	---	3	37	23
	2	---	---	---	0	1	1	0	1	1
	3	0	84	78	---	---	---	117	13	58
	4	---	---	---	0	3	3	6	105	62
June	1	9	10	10	---	---	---	62	1,356	811
	2	---	---	---	0	0	0	49	104	81
	3	0	7	7	---	---	---	43	28	34
	4	---	---	---	9	18	17	2	22	13
	5	---	---	---	---	---	---	2	19	11

Table 4. (Continued)

Fish Larvae		1996			1997			2010		
Month	**Week**	**Intake**	**Reservoir**	**Combined***	**Intake**	**Reservoir**	**Combined***	**Intake**	**Reservoir**	**Combined***
March	4	---	---	---	35	52	51	0	0	0
	5	---	---	---	---	---	---	0	0	0
April	1	0	1	1	---	---	---	0	0	0
	2	---	---	---	232	319	312	278	264	270
	3	0	22	15	---	---	---	151	217	187
	4	---	---	---	427	1,115	1,063	402	374	386
May	1	294	426	419	---	---	---	377	646	529
	2	---	---	---	1,822	1,689	1,699	663	570	610
	3	1,348	594	648	---	---	---	728	905	828
	4	---	---	---	625	550	555	488	465	475
June	1	5,575	1,065	1,387	---	---	---	516	195	330
	2	---	---	---	2,260	1,032	1,107	380	230	293
	3	2,354	551	682	---	---	---	358	74	199
	4	---	---	---	2,646	1,600	1,683	221	14	106
	5	---	---	---	---	---	---	15	8	11

--- denotes no sample collected during sample period.
***Values in the "Combined" column are not sums of corresponding values in "Reservoir" and "Intake" columns. Densities in "Combined" column were calculated using total (reservoir and intake combined) numbers of fish eggs and/or larvae collected and total volumes sampled (see "Data Analysis" section).**

Table 5. Average and peak density (number per 1,000 m^3) of fish eggs and larvae (reservoir and intake combined) with mean water temperatures collected in the vicinity of Watts Bar Nuclear Plant during April through June 1996, 1997, and 2010.

	1996	1997	2010
Fish Eggs			
Average Density	262	150	75
Peak Density	1,095	1,004	811
Date of Peak Density	4/22	3/21	6/01
Fish Larvae			
Average Density	525	924	282
Peak Density	1,387	1,699	828
Date of Peak Density	6/3	5/15	5/16
Mean Water Temperature (°C)	18.4	22.4	22.3

Table 6. Species list, total number collected, percent composition and occurrence spans of fish eggs and larvae collected during operational monitoring at Watts Bar Nuclear Plant, April through June 1996, 1997, and 2010.

1996									
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	OCCURRENCE BY SAMPLE PERIOD						
FISH EGGS			1	2	3	4	5	6	
Unidentifiable fish eggs	2,908	99.28%	X	X	X	X	X		
Aplodinotus grunniens eggs	21	0.72%				X	X	X	
Total	**2,929**	**100%**							
FISH LARVAE									
Clupeidae	4,132	83.88%			X	X	X	X	
Dorosoma cepedianum	74	1.50%					X	X	
Dorosoma petenense	50	1.02%					X	X	
Cyprinidae	2	0.04%						X	
Cyprinus carpio	2	0.04%				X	X		
Minytrema melanops	3	0.06%			X				
Ictalurus punctatus	2	0.04%						X	
Morone sp.	41	0.83%				X	X	X	
Morone chrysops	5	0.10%					X		
Morone mississippiensis	16	0.32%					X		
*Morone (*not *saxatilis)*	161	3.27%	X	X	X				
Lepomis sp.	95	1.93%					X	X	
Pomoxis sp.	8	0.16%			X	X	X		
Percidae *(*not *Sander)*	5	0.10%	X	X	X				
Perca flavescens	6	0.12%		X	X				
Aplodinotus grunniens	324	6.58%				X	X	X	
TOTAL	**4,926**	**100%**							

1997									
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	OCCURRENCE BY SAMPLE PERIOD						
FISH EGGS			1	2	3	4	5	6	7
Unidentifiable fish eggs	1,591	99.13%	X	X	X	X			X
Aplodinotus grunniens eggs	14	0.87%					X		X
Total	**1,605**	**100%**							
FISH LARVAE									
Clupeidae	8,083	82.07%	X	X	X	X	X	X	X
Alosa chrysochloris	8	0.08%					X	X	
Dorosoma cepedianum	1	0.01%							X
Dorosoma petenense	2	0.02%						X	X
Cyprinidae	6	0.06%						X	X
Cyprinus carpio	2	0.02%						X	
Notropis volucellus	2	0.02%		X	X				
Morone sp.	820	8.33%		X	X	X	X	X	X
Morone chrysops	2	0.02%				X	X		
Morone mississippiensis	6	0.06%					X	X	X
Morone (not *saxatilis*)	382	3.88%	X	X	X	X		X	
Lepomis sp.	130	1.32%					X	X	X
Micropterus sp.	3	0.03%					X		X
Pomoxis sp.	125	1.27%			X	X	X	X	X
Percidae (not *Sander*)	8	0.08%	X	X	X				
Sander sp.	2	0.02%	X						
Aplodinotus grunniens	267	2.71%				X	X	X	X
TOTAL	**9,849**	**100%**							

Table 6. (Continued)

2010															
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	OCCURRENCE BY SAMPLE PERIOD												
FISH EGGS			1	2	3	4	5	6	7	8	9	10	11	12	13
Catostomidae eggs	1	0.06%	X												
Clupeidae (not skipjack) eggs	20	1.26%							X	X	X	X			
Moronidae (not *M. saxatilis*) eggs	43	2.71%			X	X	X								
Aplodinotus grunniens eggs	1,521	95.96%							X		X	X	X	X	X
TOTAL	**1,585**	**100%**													
FISH LARVAE															
Unspecifiable clupeids	3,991	67.86%					X	X	X	X	X	X	X	X	X
Alosa chrysochloris	1	0.02%									X				
Dorosoma cepedianum	197	3.35%									X	X	X	X	X
Dorosoma petenense	3	0.05%										X	X	X	
Cyprinidae (*Cyprinella* group)	1	0.02%							X						
Cyprinidae (*Pimephales* group)	21	0.36%							X	X	X		X	X	X
Catostomidae (Ictiobinae)	2	0.03%						X							
Ictalurus punctatus	1	0.02%													X
Morone sp.	51	0.87%				X	X	X	X	X	X	X	X		
Morone chrysops	57	0.97%									X	X	X	X	X
Morone (not *saxatilis*)	560	9.52%				X	X	X	X						
Lepomis sp.	583	9.91%									X	X	X	X	X
Micropterus (not *dolomieu)*	4	0.07%						X	X				X	X	
Pomoxis sp.	250	4.25%						X	X	X	X	X	X	X	X
Pomoxis annularis	3	0.05%											X	X	X
Unidentifiable darter (not *Percina caprodes*)	1	0.02%							X						
Unidentifiable darter (*Percina caprodes* type)	4	0.07%				X	X		X						
Perca flavescens	7	0.12%						X	X		X			X	
Sander canadensis	1	0.02%				X									
Aplodinotus grunniens	119	2.02%							X		X	X	X	X	X
Atherinopsidae sp.	23	0.39%								X	X	X	X	X	
Menidia beryllina	1	0.02%													X
TOTAL	**5,885**	**100%**													

Table 7. Estimated entrainment results of fish eggs and larvae during April through June 1996, 1997, and 2010 at Watts Bar Nuclear Plant including intake and reservoir flow, sample periods, average densities, and total numbers and percent entrained and transported past WBN.

1996-Eggs								
		Intake			Reservoir			
Date	Sample Period	Density/ 1,000 m^3	Water Demand m^3/d	Estimated Number Entrained	Density/ 1,000 m^3	River Flow m^3/d	Estimated Number Transported	Percent Entrained
		D_i	Q_i		D_r	Q_r		
April 8	1	17.1	1.27E+05	2.18E+03	382.2	2.04E+07	7.80E+06	0.03%
April 22	2	108.9	7.10E+04	7.73E+03	1527.5	6.29E+07	9.61E+07	0.01%
May 6	3	58.8	1.62E+05	9.54E+03	25.7	2.41E+07	6.17E+05	1.55%
May 20	4	0.0	1.54E+05	0.00E+00	83.6	4.36E+07	3.64E+06	T
June 3	5	8.8	1.17E+05	1.03E+03	9.5	8.20E+07	7.80E+05	0.13%
June 17	6	0.0	2.26E+05	0.00E+00	7.0	6.94E+07	4.84E+05	T
			Total:	2.05E+04		**Total:**	1.09E+08	0.29%*

1996-Larvae								
		Intake			Reservoir			
Date	Sample Period	Density/ 1,000 m^3	Water Demand m^3/d	Estimated Number Entrained	Density/ 1,000 m^3	River Flow m^3/d	Estimated Number Transported	Percent Entrained
		D_i	Q_i		D_r	Q_r		
April 8	1	0.0	1.27E+05	0.00E+00	1.4	2.04E+07	2.93E+04	T
April 22	2	0.0	7.10E+04	0.00E+00	22.1	6.29E+07	1.39E+06	T
May 6	3	294.1	1.62E+05	4.77E+04	426.2	2.41E+07	1.03E+07	0.47%
May 20	4	1348.2	1.54E+05	2.08E+05	594.2	4.36E+07	2.59E+07	0.80%
June 3	5	5575.2	1.17E+05	6.51E+05	1065.3	8.20E+07	8.73E+07	0.75%
June 17	6	2354.0	2.26E+05	5.32E+05	550.6	6.94E+07	3.82E+07	1.39%
			Total:	1.44E+06		**Total:**	1.63E+08	0.57%*

1997-Eggs								
		Intake			Reservoir			
Date	Sample Period	Density/ 1,000 m^3	Water Demand m^3/d	Estimated Number Entrained	Density/ 1,000 m^3	River Flow m^3/d	Estimated Number Transported	Percent Entrained
		D_i	Q_i		D_r	Q_r		
March 21	1	177.0	1.03E+05	1.82E+04	1069.8	1.09E+08	1.17E+08	0.02%
April 14	2	0.0	1.24E+05	0.00E+00	16.0	2.38E+07	3.80E+05	T
April 28	3	0.0	1.01E+05	0.00E+00	10.5	5.43E+07	5.72E+05	T
May 15	4	0.0	1.04E+05	0.00E+00	0.7	4.96E+07	3.35E+04	T
May 27	5	0.0	1.10E+05	0.00E+00	2.7	4.63E+07	1.25E+05	T
June 9	6	0.0	1.19E+05	0.00E+00	0.0	7.49E+07	0.00E+00	T
June 23	7	9.1	1.23E+05	1.12E+03	18.1	9.99E+07	1.81E+06	0.06%
			Total:	1.94E+04		**Total:**	1.20E+08	0.02%*

1997-Larvae								
		Intake			Reservoir			
Date	Sample Period	Density/ 1,000 m^3	Water Demand m^3/d	Estimated Number Entrained	Density/ 1,000 m^3	River Flow m^3/d	Estimated Number Transported	Percent Entrained
		D_i	Q_i		D_r	Q_r		
March 21	1	35.4	1.03E+05	3.65E+03	52.1	1.09E+08	5.70E+06	0.06%
April 14	2	232.1	1.24E+05	2.89E+04	318.5	2.38E+07	7.59E+06	0.38%
April 28	3	427.4	1.01E+05	4.30E+04	1115.3	5.43E+07	6.05E+07	0.07%
May 15	4	1822.0	1.04E+05	1.89E+05	1688.9	4.96E+07	8.37E+07	0.23%
May 27	5	625.0	1.10E+05	6.88E+04	550.0	4.63E+07	2.55E+07	0.27%
June 9	6	2260.4	1.19E+05	2.70E+05	1032.2	7.49E+07	7.74E+07	0.35%
June 23	7	2645.5	1.23E+05	3.25E+05	1600.0	9.99E+07	1.60E+08	0.20%
			Total:	9.28E+05		**Total:**	4.20E+08	0.22%*

Table 7. (Continued)

2010-Eggs								
Fish Eggs		**Intake**			**Reservoir**			
Date	**Sample Period**	**Density/ 1,000 m^3**	**Water Demand m^3/d**	**Estimated Number Entrained**	**Density/ 1,000 m^3**	**River Flow m^3/d**	**Estimated Number Transported**	**Percent Entrained**
		D_i	**Q_i**		**D_r**	**Q_r**		
April 4	1	0.0	9.82E+04	0.00E+00	6.7	2.14E+07	1.44E+05	T
April 11	2	0.0	9.68E+04	0.00E+00	47.9	1.74E+07	8.34E+05	T
April 18	3	0.0	8.98E+04	0.00E+00	2.6	1.48E+07	3.89E+04	T
April 25	4	0.0	1.01E+05	0.00E+00	0.0	2.55E+07	0.00E+00	T
May 2	5	3.2	1.56E+05	5.05E+02	37.5	1.19E+08	4.47E+06	0.01%
May 9	6	0.0	1.59E+05	0.00E+00	1.3	3.08E+07	3.98E+04	T
May 16	7	117.3	1.64E+05	1.93E+04	13.0	3.65E+07	4.73E+05	4.08%
May 23	8	6.4	1.64E+05	1.06E+03	105.3	2.88E+07	3.03E+06	0.03%
June 1	9	62.3	1.62E+05	1.01E+04	1,356.1	1.85E+07	2.51E+07	0.04%
June 7	10	49.4	1.65E+05	8.13E+03	104.5	3.46E+07	3.62E+06	0.22%
June 14	11	43.0	1.66E+05	7.12E+03	27.5	3.04E+07	8.36E+05	0.85%
June 21	12	1.5	1.66E+05	2.57E+02	22.1	3.14E+07	6.96E+05	0.04%
June 28	13	1.5	1.65E+05	2.55E+02	19.1	3.11E+07	5.94E+05	0.04%
			Total:	4.67E+04		**Total:**	3.99E+07	0.12%*

2010-Larvae								
Fish Larvae		**Intake**			**Reservoir**			
Date	**Sample Period**	**Density/ 1,000 m^3**	**Water Demand m^3/d**	**Estimated Number Entrained**	**Density/ 1,000 m^3**	**River Flow m^3/d**	**Estimated Number Transported**	**Percent Entrained**
		D_i	**Q_i**		**D_r**	**Q_r**		
April 4	1	0.0	9.82E+04	0.00E+00	0.0	2.14E+07	0.00E+00	T
April 11	2	277.7	9.68E+04	2.69E+04	263.7	1.74E+07	4.58E+06	0.59%
April 18	3	150.9	8.98E+04	1.35E+04	217.2	1.48E+07	3.21E+06	0.42%
April 25	4	402.2	1.01E+05	4.06E+04	374.4	2.55E+07	9.55E+06	0.43%
May 2	5	376.9	1.56E+05	5.89E+04	645.7	1.19E+08	7.70E+07	0.08%
May 9	6	663.2	1.59E+05	1.05E+05	569.8	3.08E+07	1.76E+07	0.60%
May 16	7	727.7	1.64E+05	1.20E+05	905.0	3.65E+07	3.30E+07	0.36%
May 23	8	487.9	1.64E+05	8.00E+04	465.1	2.88E+07	1.34E+07	0.60%
June 1	9	515.5	1.62E+05	8.37E+04	195.0	1.85E+07	3.61E+06	2.32%
June 7	10	379.8	1.65E+05	6.25E+04	229.8	3.46E+07	7.96E+06	0.79%
June 14	11	358.4	1.66E+05	5.93E+04	73.8	3.04E+07	2.24E+06	2.65%
June 21	12	220.9	1.66E+05	3.68E+04	13.5	3.14E+07	4.25E+05	8.65%
June 28	13	15.5	1.65E+05	2.55E+03	7.6	3.11E+07	2.37E+05	1.08%
			Total:	6.90E+05		**Total:**	1.73E+08	0.40%*

T=less than 0.01 percent composition
***Total percent entrainment is calculated by dividing total Estimated Number Entrained by total Estimated Number Transported.**

ATTACHMENT 15

Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL STEWARDSHIP AND POLICY

Revised April 2011

Changes made from the previous version of this document:

In the previous version of this document, values provided for intake velocity (in front of screen), through-screen velocity, and average flow rate were derived using certain preliminary assumptions (e.g., summer and winter water levels, number of intake pumping station pumps in service) regarding operation of Units 1 and 2. Since issuance of the prior version, TVA recognized the need for consistency in these values and in response developed a standard set of assumptions for two-unit operation which will be used for the calculation of the velocities and flow rate in future relevant studies and documents. In addition, the updated values are more conservative in that they are representative of upper limit values rather than the nominal values typically used for such reports. Specifically, the average flow rates are based on the maximum number of intake pumping station pumps in service and Chickamauga Reservoir pool elevations are set at the lower bound for the time of year based on historical data. Because the differences between the preliminary and current standard assumptions were minor, use of the new standard values resulted in only small differences between resultant impingement values in the previous and updated versions of this report. Velocity and flow rate values derived using the current standard assumptions are reflected in this updated version.

Additional changes included in this updated version include:

- In the previous version, "Intake velocity (in front of screen)" was used to identify velocity at the entrance to the IPS. In the updated version, this was changed to "intake opening velocity (at entrance to IPS)" to more clearly describe the location being measured

- In this updated version, "Screen approach velocity (in front of screen)" and corresponding values were added to characterize the velocity in the IPS channel in front of the screen. These values had not been included in the previous version.

- In the previous version, values for intake opening velocity (at entrance to IPS), through-screen velocity, average flow rate, and percent hydraulic entrainment were separated by operation of Unit 1 only and both Units 1 and 2. In this updated version, the aforementioned values, along with screen approach velocity (in front of screen), were separated by summer and winter pool elevations and by operation of Unit 1 only and both Units 1 and 2.

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List of Acronyms and Abbreviations

CCW	**Condenser Cooling Water**
CWA	**Clean Water Act**
EPA	**Environmental Protection Agency**
EPRI	**Electric Power Research Institute**
FPS	**Feet Per Second**
GPM	**Gallons Per Minute**
IPS	**Intake Pumping Station**
MSL	**Mean Sea Level**
MW	**Megawatts**
NPDES	**National Pollutant Discharge Elimination System**
RFAI	**Reservoir Fisheries Assemblage Index**
TRM	**Tennessee River Mile**
TVA	**Tennessee Valley Authority**
VS	**Vital Signs**
WBH	**Watts Bar Hydroelectric Plant**
WBN	**Watts Bar Nuclear Plant**

Introduction

Tennessee Valley Authority (TVA) is conducting additional monitoring during 2010–2011 in Chickamauga Reservoir to estimate annual impingement mortality of fish in the vicinity of Watts Bar Nuclear Plant (WBN) due to the proposed operation of WBN Reactor Unit 2 at the Plant site. The National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for WBN is subject to compliance with the Federal Clean Water Act (CWA). Section 316(b) of the CWA requires the location, design, construction, and capacity of cooling water intake structures to reflect the best technology available for minimizing adverse environmental impacts. A potential impact associated with cooling water intake structures is impingement of aquatic organisms. Impingement occurs when fish and shellfish are trapped against intake screens by the force of cooling water withdrawal. Impingement data were collected during March 2010 through March 2011 to update baseline data collected during the same period 1996 through 1997 (both sampling periods during operation of Unit 1) and to assess potential impingement impacts from the proposed operation of WBN Unit 2. This report presents annual impingement data collected from the Condenser Cooling Water (CCW) intake screens during March 2010 through March 2011.

Plant Description

WBN is located on the right descending (west) bank of upper Chickamauga Reservoir at Tennessee River Mile (TRM) 528 approximately 1.9 miles downstream of Watts Bar Hydroelectric Dam (WBH; TRM 529.9) and one mile downstream of the idled Watts Bar Fossil Plant (Figure 1). Commercial operation of WBN Unit 1 began on May 27, 1996 and is designed for a net electrical output of 1,160 megawatts (MW; gross electrical output of 1,218 MW).

Cooling water flows from Chickamauga Reservoir through the plant intake channel to the intake pumping station (IPS) located approximately 1.9 miles downstream of Watts Bar Dam at TRM 528 (Figure 1). WBN Unit 1 and proposed Unit 2 use closed-cycle cooling such that the cooling water withdrawn at the intake pumping station is to make-up for evaporation of cooling tower blowdown. The intake channel leading to the pumping station has a cross-sectional area of approximately 1,650 ft^2 at a Chickamauga Reservoir summer pool elevation of 681 ft mean sea level (msl), and 3,150 ft^2 at a winter pool elevation of 677 ft msl. The IPS includes four gated openings containing a combined gross flow area of approximately 360 ft^2, producing an intake opening velocity (at entrance of IPS) of 0.17 fps at summer pool and 0.18 fps at winter pool. The approach screen velocity (in front of screen) at summer and winter pools is 0.40 and 0.37 fps, respectively. At the traveling water screens, the combined unobstructed through-screen area of the flow corresponding to the gated openings is reduced to approximately 140 ft^2, producing an average through-screen velocity of 0.62 fps at summer pool and 0.67 fps at winter pool. The average flowrate at the IPS for WBN Unit 1 only is approximately 73 cubic feet per second (cfs) at summer pool and 68 cfs at winter pool. Percent hydraulic entrainment for Unit 1 only at summer and winter pools is 0.3% of the long-term average river flow (about 27,000 cfs) past the plant. With the operation of both Unit 1 and proposed Unit 2, the average flow rate at the IPS at summer pool is expected to be 134 cfs, or 0.5% of the long-term average river flow past the plant. At winter pool, the average flow rate with operation of both Unit 1 and proposed Unit 2 is expected to be 113 cfs, or 0.4% of the long term average river flow (Table 1).

Methods and Analysis

Impingement

Impingement data presented in this report represent weekly samples collected from March 26, 2010 through March 17, 2011. Quality Assurance/Quality Control procedures for impingement sampling (TVA 2004) were followed to ensure sampling was consistent with historical impingement monitoring methods used during 1996 through 1997.

Impinged fish were collected after each routinely scheduled weekly 24-hour screen washes. TVA's Biological and Water Resources (B&WR) crew removed impinged fish that were washed into a fish collection basket (Figure 1). Fish were sorted from debris, identified, separated into 25-mm (1-in) length classes, enumerated, and weighed. Any fish collected alive were returned to the reservoir after processing. Incidental numbers of fish which appeared to have been dead for more than 24 hours (i.e., exhibiting pale gills, cloudy eyes, fungus, or partial decomposition) were not included in the sample. Data recorded by one member of the B&WR crew was checked and verified (signed) by the other for quality control.

Estimated weekly and annual impingement rates were calculated by extrapolating impingement rates from 24-hr samples [i.e., 24-hr sample x 7 days (weekly) x 52 weeks (annual)].

Fish Community Assessment - RFAI

The health of the fish community in the vicinity of WBN, with Unit 1 operating, was assessed using a standardized index. Prior to 2000, WBN was operating under a 316(a) Alternative Thermal Limit (ATL) that had been continued with each permit renewal based on studies conducted in the mid-1970s. In 1999, EPA Region IV began requesting additional data in conjunction with NPDES permit renewal applications to verify that a "Balanced Indigenous Population" (BIP) of fish and shellfish was being maintained at TVA's thermal plants with ATLs. TVA proposed that its existing Vital Signs (VS) monitoring program, supplemented with additional fish and benthic macroinvertebrate community monitoring upstream and downstream of thermal plants with ATLs, was appropriate for that purpose. The VS monitoring program began in 1990 in the Tennessee River System. This program was implemented to evaluate ecological health conditions in major reservoirs as part of TVA's stewardship role. One of five indicators used in the VS program to evaluate reservoir health is the Reservoir Fish Assemblage Index (RFAI) methodology. RFAI has been thoroughly tested on TVA and other reservoirs and published in peer-reviewed literature (Jennings, et al., 1995; Hickman and McDonough, 1996; McDonough and Hickman, 1999).

TVA initiated a study to evaluate fish communities in areas immediately upstream and downstream of WBN during 1999–2010 using RFAI multi-metric evaluation techniques. This report presents the results of autumn RFAI data collected in the vicinity and downstream of WBN during autumn 1999–2010 to illustrate the health and stability of the fish community in Chickamauga Reservoir (TVA, 2011).

Results and Discussion

Impingement

Weekly impingement sampling at WBN from March 26, 2010 through March 17, 2011, resulted in collection of 1,939 fish, comprising three species (Table 2). Gizzard shad were predominant in the samples (60.4%) followed by threadfin shad (39.5%) and inland silverside (0.1%). Historical impingement monitoring at WBN conducted during March 1996 through March 1997 resulted in the collection of 16 fish representing eight species. Gizzard shad, threadfin shad, bluegill, white crappie and freshwater drum comprised 81.3% of fish impinged during March 1996 through March 1997 monitoring (Table 2). The rate of impingement was highest during January through March 2011 (99.6%). The two largest samples were collected during the second and fourth weeks in February 2011 and contained 618 and 613 fish (extrapolated weekly estimates of 4,326 and 4,291), respectively, comprising 63.5% of the total fish collected for the year (Table 3, Figure 2). Gizzard shad comprised 61.8% and threadfin shad 38.2% of these two samples.

Annual extrapolated estimates of numbers impinged by species for 1996–1997 and 2010–2011 are presented in Table 4. Estimated annual impingement for 2010–2011 (13,573) was significantly higher than that estimated for 1996–1997 (161). The difference in numbers between years was due to larger numbers of gizzard and threadfin shad collected during cold-weather months of January through March 2011. Most (99.9%) of the fish impinged during this period were gizzard and threadfin shad. The timing of this peak impingement period and species composition of fish impinged suggests stress and cold-shock. This is a common and natural phenomenon observed during colder winter months at fossil and nuclear facilities in TVA and other southeastern reservoirs (Loar, 1978; McLean et al., 1980; McLean et al., 1985). Shad are noticeably affected by temperature becoming lethargic and moribund when temperatures fall below 50°F, making them more susceptible to impingement. Shad cannot tolerate drastic temperature changes and typically experience winter die-offs when water temperatures are between 40–55°F, particularly when the change in temperature is quick and drastic (Griffith, 1978 and Fost, 2006). Threadfin and/or gizzard shad typically comprise over 90% of fish impinged on cooling water intake screens of thermal power stations in the Southeastern United States (Loar, 1978). Referenced literature (McLean et al., 1980) has shown that climate-controlled events such as winter shad kills will occasionally occur but populations of the two affected species are able to recover in a relatively short time.

Water temperatures collected at WBN during November 2010 through March 2011 were compared to those during the same period 1996 through1997. Daily water temperatures for December 2010 and January, February, and March 2011 averaged 1.4, 2.3, 1.5 and 3.2°F lower, respectively, than corresponding months in 1996 and 1997. From November 2010 to January 2011, averages of daily water temperatures decreased 17.5°F compared to 11.9°F during the same period in 1996 through 1997 (Table 5; Figure 3). This large and rapid decrease in water temperatures during November 2010 to January 2011 could have stressed shad causing them to become lethargic and moribund. It is likely that cold-stressed shad would possibly require 2-3 weeks of regular exposure to low water temperatures before being collected in samples, as illustrated in Figure 2. Any lethargic or moribund shad in the forebay of Watts Bar Dam would

have been vulnerable to passage through the dam during generation. The continued decline of water temperatures into January, consistently low water temperatures in January and February (Figures 2 and 3), and/or passage through the dam could have caused further decline in condition and die-offs increasing their susceptibility to impingement at the WBN IPS. Some fish could actually be impinged after dying but cold temperatures could have delayed decomposition causing them to not be recognized as dead prior to impingement.

Fish Community Assessment - RFAI

In 2010, fish community RFAI scores of 44 ("Good"), 39 ("Fair") and 40 ("Fair") were observed at three sites in Chickamauga Reservoir: in the vicinity of WBN at TRM 529 (near-field), the Transition zone of the reservoir at TRM 490.5 and Forebay of Chickamauga Dam at TRM 482 (far-field), respectively (Table 6). Scores at these three sites were within 6 points of each other and met criteria to be considered similar (TVA, 2011). The RFAI was not used in 1996–1997 so there is not a direct comparison with 2010–2011, but average scores also rated "Good" for 1999–2010 and ranged from 44 to 45 (Table 6).

Summary and Conclusions

Proposed operation of Unit 2, given that both units would only withdraw water through the IPS to provide make-up for evaporation of cooling tower blowdown, would increase average flow rates and percent hydraulic entrainment to values shown in Table 1. It could be assumed that numbers of impinged fish could increase proportionally to average flowrates which would expand numbers impinged by the ratio of 73 to 134 cfs at summer pool or 68 to 113 cfs at winter pool (Table 1). Lethargic, moribund, or dead shad would be drifting without much, if any, maneuverability and could be passively drawn to the IPS. However, considering the unpredictability of the environmental factors which influence cold-shock in shad, it is nearly impossible to estimate numbers of fish that will be impinged at WBN after the addition of Unit 2. Therefore, it is suggested that impingement at the WBN IPS with two-unit operation would be driven more by the severity of cold-shock or winter-kills of shad rather than the projected increase in flow values, given the increased impingement observed during winter 2011 from that of winter 1997 with one-unit operation.

Historical impingement estimated from WBN during the winter of 1997 was extremely low compared to that observed during the winter of 2011. Colder climatic conditions and probable cold-shock events during winter 2010–2011 appear to be the major factors in the increased impingement. Aside from occasional and uncontrollable cold-shock events, estimated numbers and species composition of impinged fish, low projected maximum flow rate (134 cfs or 0.5% of average river flow) and through-screen velocity (0.67 fps), and "Good" ratings for the adult fish community in Chickamauga Reservoir suggest that proposed operation of two units at WBN will not affect the health and structure of the downstream reservoir fish community.

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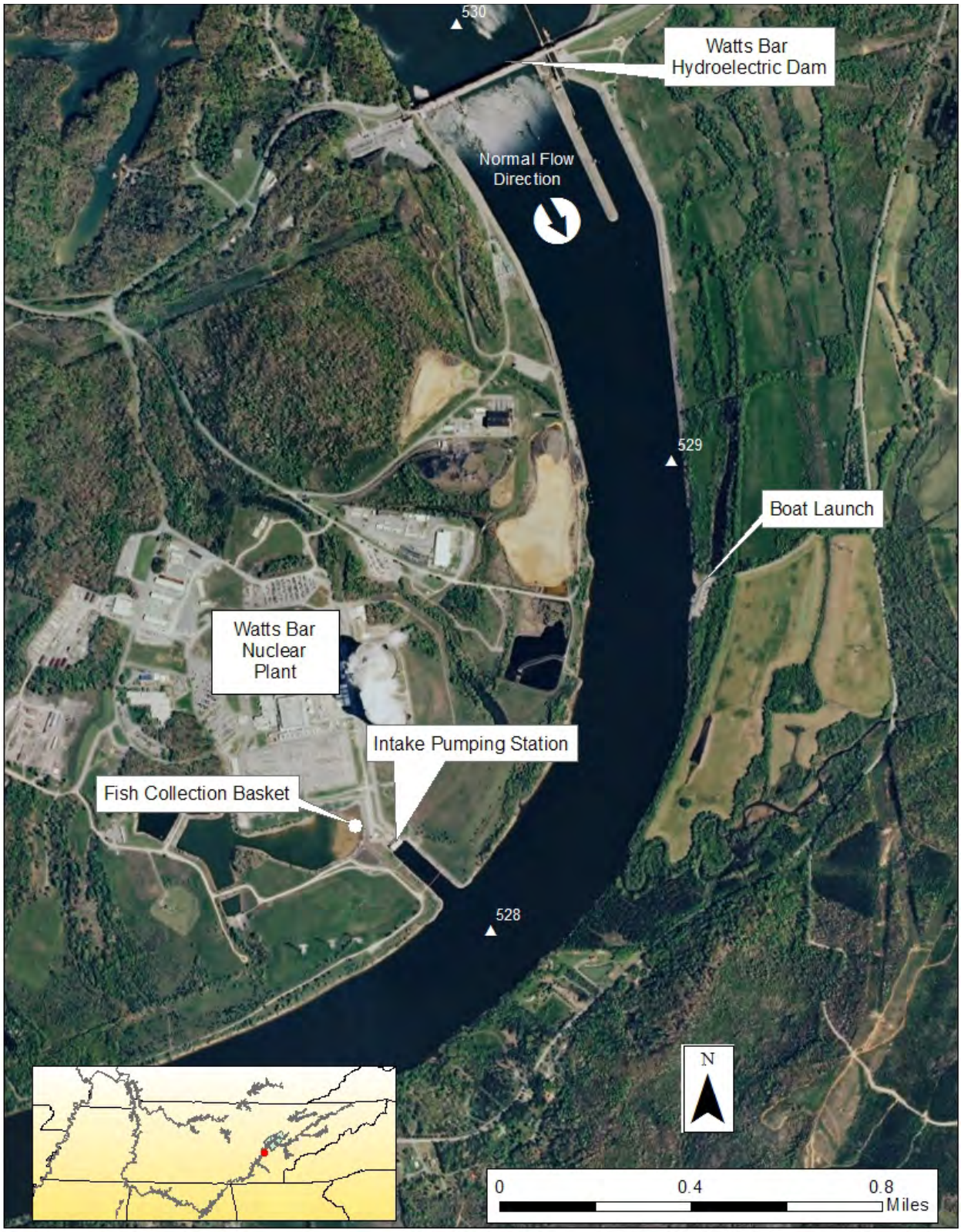
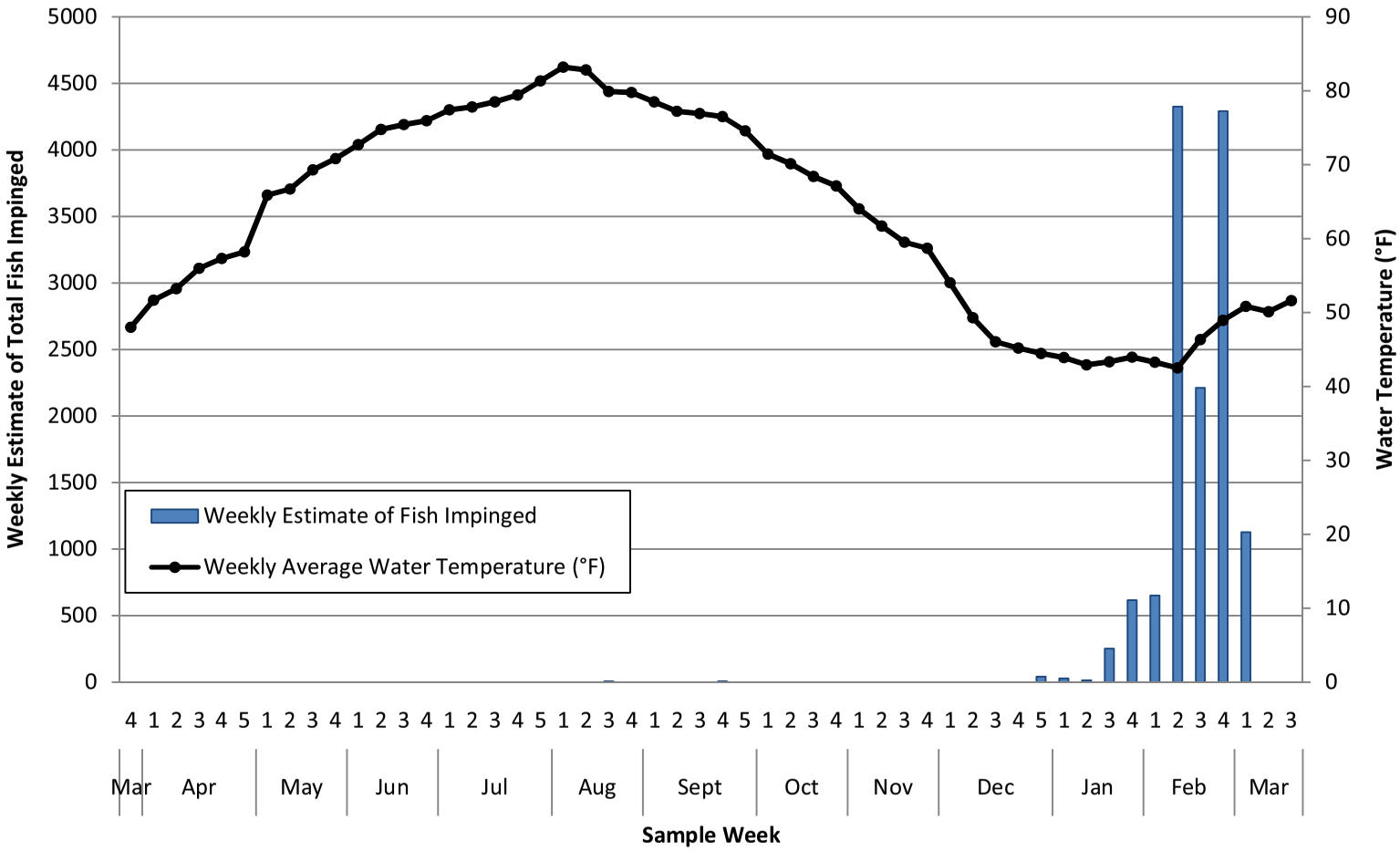


Figure 1. Location of Watts Bar Nuclear Plant, Watts Bar Hydroelectric Dam, Fish Collection Basket, and Intake Pumping Station.



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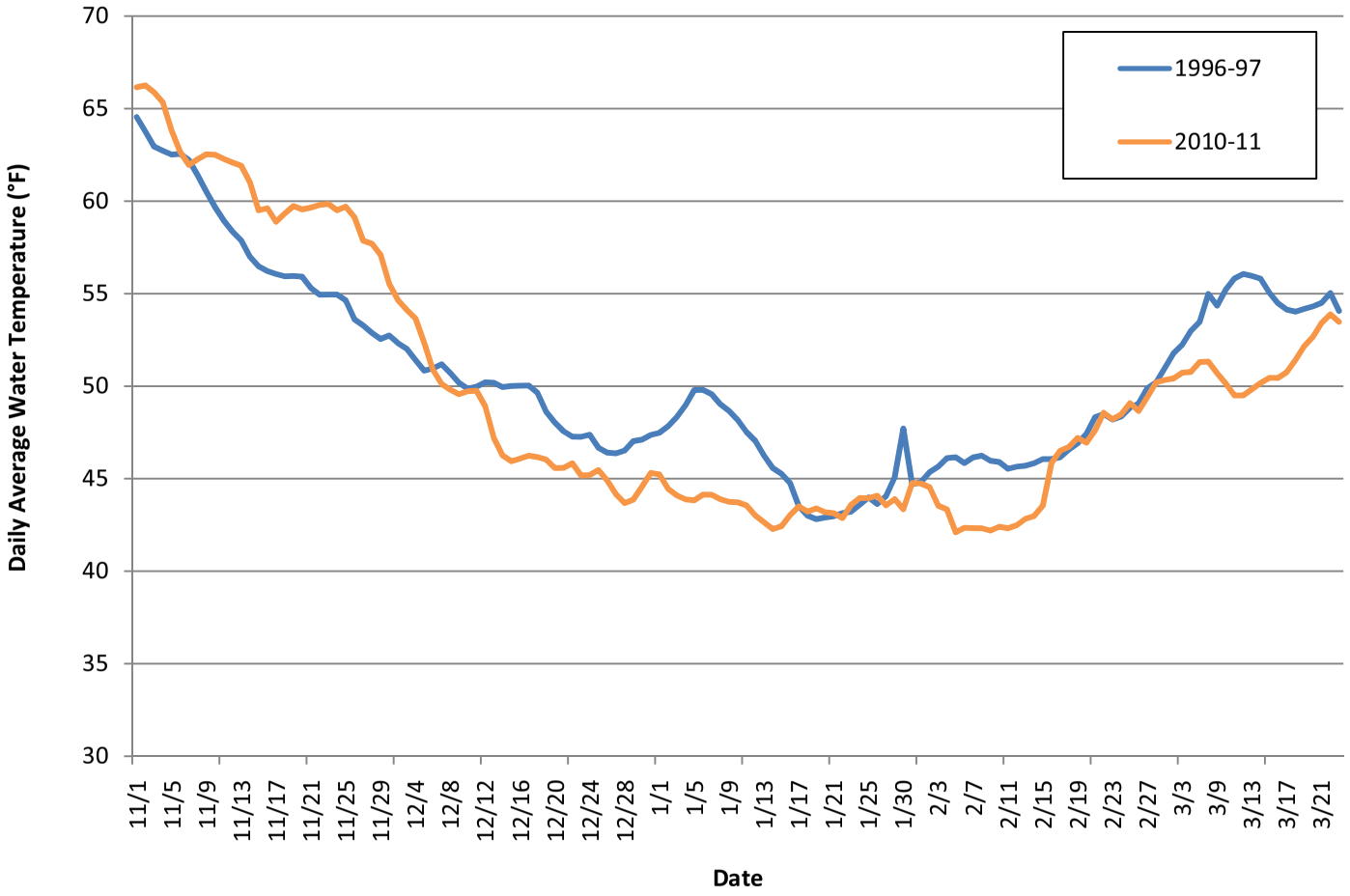

Figure 3. Daily Average Water Temperatures (°F) Collected from Chickamauga Reservoir in the Vicinity of WBN during November 1996 through March 1997 and November 2010 through March 2011.

Table 1. Comparison of Intake Opening, Screen Approach, and Through-Screen Velocities, Average Flow Rates, Percent Hydraulic Entrainment (Percent of River Flow) Past WBN's Intake Pumping Station at Summer and Winter Pool Elevations and during Operation of Unit 1 Only and Expected Values during Operation of Units 1 and 2 Combined.

	Summer Pool (681 msl)		Winter Pool (677 msl)	
	Unit 1 only	**Units 1 and 2 combined**	**Unit 1 only**	**Units 1 and 2 combined**
Intake opening velocity (at entrance of IPS)	0.17 fps	0.17 fps	0.18 fps	0.18 fps
Screen approach velocity (in front of screen)	0.40 fps	0.40 fps	0.37 fps	0.37 fps
Through-screen velocity	0.62 fps	0.62 fps	0.67 fps	0.67 fps
Average flow rates	73 cfs	134 cfs	68 cfs	113 cfs
***Percent hydraulic entrainment**	0.3%	0.5%	0.3%	0.4%

*Percent hydraulic entrainment based on long-term average river flow past WBN of 27,000 cfs.

Table 2. List of Fish Species by Family, Scientific, and Common Name Including Actual Numbers and Percent Composition Collected in Impingement Samples During March 1996 through March 1997 and March 26, 2010 Through March 17, 2011 at TVA's Watts Bar Nuclear Plant.

Family	Scientific Name	Common Name	3/1996 - 3/1997		3/26/2010 - 3/17/2011	
			Total Number Impinged	Percent Composition	Total Number Impinged	Percent Composition
Clupeidae	*Dorosoma cepedianum*	Gizzard shad	4	25.0%	1,172	60.4%
	Dorosoma petenense	Threadfin shad	2	12.5%	766	39.5%
Ictaluridae	*Ictalurus punctatus*	Channel catfish	1	6.3%	---	0.0%
	Pylodictus olivaris	Flathead catfish	1	6.3%	---	0.0%
Centrarchidae	*Lepomis macrochirus*	Bluegill	2	12.5%	---	0.0%
	Lepomis microlophus	Redear sunfish	1	6.3%	---	0.0%
	Pomoxis annularis	White crappie	2	12.5%	---	0.0%
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	3	18.8%	---	0.0%
Atherinopsidae	*Menidia beryllina*	Inland silverside	---	-	1	0.1%
		Total Number of Fish	**16**		**1,939**	
		Total Number of Species	**8**		**3**	
		Total Number of Sample Days	**52**		**52**	

Table 3. Actual Numbers and Weekly Estimates and Percent of Annual Total of Fish Impinged at Watts Bar Nuclear Plant by Month During March 26, 2010 Through March 17, 2011.

Year	Month	Week	Actual Numbers Impinged	Estimated Weekly Numbers Impinged	Percent of Annual Total
2010	March	4	0	0	0.0%
	April	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
		5	0	0	0.0%
	May	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	June	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	July	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
		5	0	0	0.0%
	August	1	0	0	0.0%
		2	0	0	0.0%
		3	1	7	0.1%
		4	0	0	0.0%
	September	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	1	7	0.1%
		5	0	0	0.0%
	October	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	November	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	December	1	0	0	0.0%
		2	0	0	0.0%

Table 3. (Continued)

Year	Month	Week	Actual Numbers Impinged	Estimated Weekly Numbers Impinged	Percent of Annual Total
		3	0	0	0.0%
		4	0	0	0.0%
		5	6	42	0.3%
2011	January	1	4	28	0.2%
		2	2	14	0.1%
		3	36	252	1.9%
		4	88	616	4.5%
	February	1	93	651	4.8%
		2	618	4,326	31.9%
		3	316	2,212	16.3%
		4	613	4,291	31.6%
	March	1	161	1,120	8.3%
		2	0	0	0.0%
		3	0	0	0.0%
Total (Annual)		**52**	**1,939**	**13,573**	**100%**

Table 4. Estimated Annual Numbers and Percent Composition of Fish Impinged by Species

at Watts Bar Nuclear Plant During March 1996 Through March 1997 and March 26, 2010 Through March 17, 2011.

Species	3/1996 - 3/1997		3/26/2010 - 3/17/2011	
	Estimated Number	**Percent Composition by Number**	**Estimated Number**	**Percent Composition by Number**
Gizzard shad	41	25.0%	8,204	60.4%
Threadfin shad	20	12.5%	5,362	39.5%
Channel catfish	30	18.8%		0.0%
Flathead catfish	10	6.3%		0.0%
Bluegill	10	6.3%		0.0%
Redear sunfish	20	12.5%		0.0%
White crappie	10	6.3%		0.0%
Freshwater drum	20	12.5%		0.0%
Inland silverside	---	**---**	7	0.1%
Total	**161**	**100%**	**13,573**	**100%**

Table 5. Comparison of Daily Average Water Temperatures (°F) Collected from Watts

Bar Reservoir in the Vicinity of WBN During November 1996 Through March 1997 and November 2010 Through March 2011.

	Daily Average Water Temperatures (°F)		
Period	**1996–1997**	**2010–2011**	**Difference**
November	57.9	61.2	3.3
December	49.2	47.8	-1.4
January	45.9	43.6	-2.3
February	46.8	45.3	-1.5
March	54.3	51.1	-3.2
November – March	50.6	49.7	-0.9
December – January	47.6	45.8	-1.8
December – February	47.4	45.6	-1.8
January – February	46.4	44.4	-2.0

Table 6. Summary of RFAI Scores from Fish Community Sample Sites Located Downstream of Watts Bar Nuclear Plant 1999-2010 as Part of the Vital Signs Monitoring Program in Chickamauga Reservoir.

Station	Location	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
Downstream Inflow (Near-Field)	TRM 529.0	42	44	46	48	48	42	42	42	42	44	44	44	**45 (Good)**
Transition (Far-Field)	TRM 490.5	45	46	45	51	42	49	46	47	44	34	41	39	**44 (Good)**
Forebay (Far-Field)	TRM 472.3	45	45	48	46	43	43	46	43	41	41	42	40	**44 (Good)**

RFAI Scores: 12-21 (“Very Poor”), 22-31 (“Poor”), 32-40 (“Fair”), 41-50 (“Good”), or 51-60 (“Excellent”).

ATTACHMENT 16

Hydrothermal Effects on the Ichthyoplankton from the Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Outfall in Upper Chickamauga Reservoir

Tennessee Valley Authority
Biological and Water Resources
Knoxville, Tennessee

January 2011

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INTRODUCTION

The National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for Watts Bar Nuclear Plant (WBN) identifies the discharge of water to the Tennessee River from the Supplemental Condenser Cooling Water (SCCW) System as Outfall 113. The permit states that when there is no flow released from Watts Bar Hydroelectric Dam (WBH), the effluent from Outfall 113 shall be regulated based on a Passive Mixing Zone (PMZ) extending in the river from bank-to-bank and 1,000 feet downstream from the outfall.

Current operation of WBN Unit One utilizes the SCCW system through constant gravity flow from above WBH. Completion and operation of Unit 2 will not significantly alter or increase the thermal effluent from the SCCW outfall.

Two hydrothermal surveys and one flow pattern survey were conducted in the vicinity of WBN during May and August 2010, when there were no releases from upstream WBH through generators or spillways to characterize attributes of the SCCW thermal plume. Water temperatures were recorded upstream and downstream of the SCCW discharge during this test to characterize the thermal aspects of the plume. Drogues, devices designed to drift with surface currents, were deployed at and near the SCCW outfall to track flow patterns and compare flow paths during normal and no generation from Watts Bar Dam.

The thermal plume was tracked and measured in conjunction with day and night ichthyoplankton sampling to describe temporal and spatial distribution of fish eggs and larvae and exposure rates to the thermal plume. This report presents the results of these surveys in relation to potential effects to ichthyoplankton from exposure to the thermal plume with no river flows being created by generation at the dam and constant SCCW discharge.

METHODS

The May survey was designed to coincide with the period of expected peak abundance of fish eggs and larvae in this area. The August survey was in turn scheduled to coincide with near maximum ambient water temperatures when most fish eggs have hatched and larvae matured and no longer drifting in the water column. Tests were conducted during the day on May 19, 2010 and during the night of May 20-21.

Characterization of the SCCW Thermal Plume

Flow Path Tracking with Drogues

Multiple drogue releases were necessary to capture the desired data. This is because drogues must move with the current in order to gather the desired data and they eventually leave the area

of interest making it necessary to gather and release them repeatedly, depending on the duration of the test. In this case, daytime and nighttime sessions each required four releases to capture the flow patterns over the low-flow periods. The drogues were equipped with Global Positioning Systems (GPS) to record and determine their position. These tests are considered representative of flow patterns that develop from WBH releases while the SCCW discharge remains constant.

River Temperature Collection with HOBOs

The hydrothermal surveys also included the collection of temperature data at twelve temporary monitoring stations using HOBO water temperature sensors deployed across the river channel from the SCCW discharge, upstream from the SCCW discharge, and across the downstream edge of the PMZ during periods of no release from WBH. Locations of HOBO stations are depicted in Figure 1. HOBO sensors were positioned at depths of 0.5, 3, 5, and 7 feet below the water surface and have an accuracy of about ±0.4°F and resolution of about 0.04°F. The HOBO devices include an internal data acquisition unit and were programmed to collect measurements once per minute. All the temperature probes used in the survey were calibrated by a quality program with equipment traceable to the National Institute of Standards and Technology (NIST). The temporary monitoring stations were deployed on August 18, several hours before the beginning of the survey, and were retrieved at the end of the survey. A GPS device was used to position the stations along the downstream edge of the PMZ. Detailed hydrothermal survey methods and explanation of the mixing zone boundaries can be found in Ruth and Hopping, 2010.

Ichthyoplankton Sampling

Abundance, distribution and taxonomic composition of ichthyoplankton was estimated during the two hydrothermal surveys (May 19-21 and August 25-27) by collecting samples at a transect below Watts Bar Dam (Figure 2). To estimate density and composition of fish eggs and larvae entrained at the SCCW intake above the dam, four samples (two each during day and night) were collected weekly immediately in front of the SCCW intake.

Ichthyoplankton samples below the SCCW outfall were collected during both day and night along a transect at TRM 528.0. One tow-net sample, approximately ten-minutes long was collected near each shoreline, at 40 and 60% of the distance across the transect and one bottom-drag sample towed near the bottom at mid-channel. Detailed ichthyoplankton sampling methodology is presented in TVA, 2010.

Ichthyoplankton data from samples collected at both locations (above and below dam) during the week prior to and the week after the hydrothermal survey were included in the analysis for comparison with normal generation conditions. A transect was also established at TRM 530.2 to characterize ichthyoplankton densities upstream of the dam using the same methods as the downstream transect. Data from the weeks prior to and following the surveys are included to determine if the May and August surveys represented the seasonal larval density and the seasonal maximum temperatures. Weekly sampling at these sites was initiated in March 2010 as part of preoperational monitoring for WBN Unit 2.

Larval fish (and egg) exposure rates (time exposed to increased temperatures) were compared to thermal limit data listed in Yoder et al., 2006 to evaluate species potentially affected. Upper incipient lethal temperature limits for each taxon collected were used to determine if these temperatures were exceeded.

It should be noted that densities of fish eggs and larvae from samples collected from five stations across the transect at TRM 528.0 are calculated from each sample during both day and night on the sample dates. At the SCCW intake above Watts Bar Dam, each density represents one sample (composited from two) each during both day and night. Therefore, samples frequently contained low actual numbers (occasionally only one individual) of eggs and larvae. These densities are presented primarily to compare taxonomic composition collected at the SCCW intake with that occurring at the downstream transect and to estimate densities of eggs and larvae which might be exposed to the SCCW outfall temperatures under low flow conditions.

RESULTS

Characterization of the SCCW Thermal Plume

Flow Path Tracking with Drogues

The first release of the daytime test began just after 6:00 AM (Figures 3 and 4), while Watts Bar Dam was still releasing water for generation. This discharge ceased at 7:05 AM. All drogues except the unit released closest to the SCCW discharge moved downstream rapidly (speed is shown by the length of the color bands, which represent distance traveled in 7.5 minutes) until the discharge was shut off. The SCCW drogue appeared to stay near the shoreline. All drogues slowed their drift immediately after generation ceased. They then were influenced by a sloshing effect of the reservoir caused by the rapid shutoff of Watts Bar Dam, some traveling upstream. After generation was stopped, the drogue released upstream of the SCCW and closest to the left descending bank was caught in an eddy that carried it upstream into the navigation lock.

The second array of drogues was released at 8:00 AM (Figure 5), 55 minutes after dam shutoff. During this period, most of the drogues track upstream. Water flow during this time interval was influenced by upstream slosh, along with turbine leakage from the dam and SCCW discharge. Though the flow rates of the turbine leakage and the SCCW discharge were similar (approximately 250 cubic feet per second [cfs] turbine leakage and an average of 284 cfs SCCW discharge), the turbine leakage was cooler and stayed near the bottom, while the SCCW discharge was warmer and spread out over the top of the water column. The SCCW discharge influenced drogue paths more since they tracked surface flows. The combination of these factors explained the tendency of the drogues to move upstream with slosh and/or away from the SCCW discharge as it spread out over the surface of the slowly moving river. The drogue unit released upstream of the SCCW discharge was pushed slowly downstream by leakage through the turbines at the dam.

By the time of the third release (Figure 6), the drogues released near the SCCW were carried across the river and moved downstream primarily along the opposite shoreline. They were joined in that cross-river flow by drogues released upstream of the SCCW.

The fourth release (2:00 PM, Figure 7) began by following the pattern of the third release with slow downstream flow modified by cross-channel flow created by the SCCW discharge. Near the end of the time period, dam releases increased and downstream flow accelerated making the SCCW discharge and resulting thermal stratification a much smaller influence on flow patterns.

The nighttime test began just after 8:00 PM on May 20 (Figures 8 and 9). As in the daytime test, water was released for generation at the beginning of the test and ceased partway through the first drogue release. For the first release, drogue paths were all downstream. All but one of the drogues had moved out of the test area by the time releases from WBH ceased.

During the second drogue release at midnight of May 21 (Figure 10), three hours after releases from WBH ceased, the drogues moved away from the SCCW discharge. Since this discharge was warmer than it was at this point in the daytime test, it is likely that the warm SCCW discharge spreading across the surface of the nearly stationary river was the principal determinant of surface flow patterns. Leakage from the turbines appeared to influence travel paths of those drogues released closest to the dam.

The third drogue release began at 1:52 AM (Figure 11). The SCCW discharge appeared to continue to be the primary influence on surface flow patterns and drogue paths, with all drogues moving away from this discharge point.

Drogue paths continued to be primarily determined by the SCCW discharge for the first part of the fourth drogue release at 3:30 AM (Figure 12). Dam discharge began increasing at 5:00 AM, whereupon all drogues began travelling downstream with the increased turbine flow and increased vertical mixing.

River Temperature Collection with HOBOs

Ambient river temperature released from Watts Bar Dam remained constant between 69° and 70°F during the May day and nighttime tests (Table 1). The ambient river temperature releases from Watts Bar Dam were warmer in August, beginning the tests at 79° to 80°F. River temperature decreased slightly after dam discharge was stopped. Cooler water from turbine leakage originating deeper in the reservoir reduces ambient temperatures after the dam discharge stops.

After the dam discharge ceased, warm water from the SCCW discharge was detected at the upstream stations, mostly near the surface. Maximum surface temperature in the upstream transect was 73°F in the May test, about 4°F above ambient. In the August daytime test, the upstream surface warmed to 81.5°F; the nighttime test showed minimal warming above ambient river temperature across the upstream stations.

HO-1, the station closest to the SCCW discharge, saw the highest surface temperatures in all tests and the highest bottom temperature in three of the four tests. May surface temperatures did

not exceed 76°F and bottom temperatures did not exceed 72°F. August surface temperatures remained under 83°F while bottom temperatures briefly exceeded 81°F.

After dam shutoff, all PMZ stations became warmer on the surface while staying at or near ambient at the bottom. PMZ stations stayed cooler than HO-1 except for H-PMZ1 in the August daytime test. Maximum temperature difference between the PMZ stations and ambient river temperature occurred just after dam discharge resumed, when a pulse of cooler water was seen at the upstream ambient sensor and before this cooler water reached the PMZ transect. Maximum difference between ambient and surface temperature reached 5°F during the May night test, 5.34°F during the May day test, and 5.36°F during the August day test. Temperature differences were smaller at greater depth and during the August night test.

Ichthyoplankton Sampling

Results of ichthyoplankton sampling conducted above and below Watts Bar Dam during May and August 2010 hydrothermal surveys are presented below. A list of larval fish and eggs by family and common name collected near WBN during May and August are listed in Table 2. . Identical families of both eggs and larvae were also represented in samples collected above Watts Bar Dam during the May and August surveys (Table 3).

May Survey

Tables 3 through 10 include data from the week of the survey and from corresponding samples collected during normal turbine generation/flow on May 11-12 and May 25-27, the weeks before and after the hydrothermal survey for comparison. All density values are number of eggs or larvae per 1000 m^3 with actual numbers of eggs and larvae collected in parentheses.

Above dam control transect (TRM 530.2) – Samples collected during May 19-21 from five stations across the transect above Watts Bar Dam were combined to provide total densities for fish eggs and larvae in the forebay upstream of the SCCW intake. Only one freshwater drum egg was collected in a night sample. Clupeid larvae dominated the samples with densities of 179 (70) and 1282 (495) per 1000m^3 during day and night, respectively. Centrarchid (sunfish) larvae were next in abundance with densities of 26 (10) and 47 (18) during day and night, respectively. Larval cyprinids (minnows) were less abundant at 3 (1) and 13 (5) per 1000 m^3 during day and night, respectively, as well as atherinopsids (silversides) at 3 (1) and 26 (10) per 1000 m^3. Larval *Moronidae* (white and yellow bass) and *Sciaenidae* (freshwater drum) were collected in night samples only at densities of 41 (16) and 10 (4) per 1000 m^3, respectively (Table 3).

SCCW Intake – Samples collected at the SCCW intake during the week of May 19-21 contained freshwater drum eggs and larvae representing four families. Drum eggs were collected in the night samples only at a density of 18 per 1000 m^3 (3 eggs). Clupeid larvae dominated the samples with densities of 253 (39 larvae) and 871 (144) per 1000 m^3 during the day and night samples, respectively. Centrarchid larvae were next in abundance with densities of 32 (5) and 18 (3) per 1000 m^3 during day and night samples, respectively. Two other families (*Cyprinidae* and *Sciaenidae*) were collected in night samples only at densities of 6 (1) each per 1000 m^3 (Table 4).

Below dam (TRM 528.0) – Samples collected from five stations across the downstream transect during May 19-21 are discussed below.

Right descending bank – Freshwater drum eggs were collected at 73 (6) per 1000 m^3 in the night sample only. Larval clupeid densities were 40 (3) and 813 (67) per 1000 m^3 during day and night, respectively. Centrarchids densities were 13 (1) and 36 (3) per 1000 m^3 during day and night, respectively. One specimen each (12 per 1000 m^3) of *Atherinopsidae* (silversides) and *Moronidae* (white and yellow bass) was collected during the night sample only (Table 5).

40% of reservoir width from right descending bank – No fish eggs were collected at this station. Larval clupeid densities were 180 (13) and 1,158 (91) per 1000 m^3 during day and night, respectively. Densities of freshwater drum larvae were collected at 25 (2) per 1000 m^3 during night only. Centrarchid densities were 14 (1) per 1000 m^3 and were collected during the day sample only, while *Moronidae* densities were 14 (1) per 1000 m^3 and were collected during night only. Freshwater drum densities were 25 (2) per 1000 m^3 during night sample only. Total larval density (1,390 per 1000 m^3) at this station was higher during the survey week than either the preceding or following week (Table 6).

60% of reservoir width from right descending bank – Freshwater drum eggs were collected at 38 (3) per 1000 m^3 during night only. Densities of clupeid larvae were 391 (30) and 1593 (127) per 1000 m^3 during day and night, respectively. Silverside densities were 13 (1) per 1000 m^3 during both day and night. The density of centrarchid larvae was 13 (1) per 1000 m^3 during day only. One each (13 per 1000 m^3) *Percidae* (darter) and *Sciaenidae* (drum) larva was collected during night only. Total larval density (2,137 per 1000 m^3) at this station was higher during the survey week than either the preceding or following week (Table 7).

Left descending bank – No fish eggs were collected at this station during the survey week. Clupeid larvae were collected at 526 (41) and 3,066 (244) per 1000 m^3; *Moronidae* densities were 26 (2) and 38 (3) per 1000 m^3 each during day and night, respectively. *Atherinopsidae* densities was 13 (1) per 1000 m^3 during both day and night samples. *Centrarchidae* density was 25 (2) per 1000 m^3 during night sample only. Total larval density at this station (3,707 per 1000 m^3) during the survey week was higher than either the preceding or following week (Table 8).

Bottom sample mid-channel – The density of freshwater drum eggs was 12 (1) per 1000 m^3 during night only. Clupeid larvae were collected at densities of 236 (17) and 347 (27) per 1000 m^3; *Centrarchidae* larvae at 14 (1) and 26 (2) per 1000 m^3; and *Moronidae* larvae at 14 (1) and 13 (1) per 1000 m^3, each during day and night, respectively. Total larval density at this station (728 per 1000 m^3) during

the survey week was higher than either the preceding or following week (Table 9).

Below Dam (TRM 528.0; five stations combined) – During the survey week of May 19-21, 114 total larvae (density of 306 per 1000 m^3) were collected during the day samples at the five stations below the dam, while 594 total larvae (1,819 per 1000 m^3) and 10 freshwater drum eggs (31 per 1000 m^3) were collected during the night sample. There were 85 (216 per 1000 m^3) and 357 (954 per 1000 m^3) total larvae collected during the day and night samples, respectively, in the week prior to the survey week. One hundred total larvae (259 per 1000 m^3) and 3 eggs (8 per 1000 m^3) were collected during the week following (May 25-27) in the day sample, while 355 (866 per 1000 m^3) total larvae and 81 freshwater drum eggs (197 per 1000 m^3) were collected during the night sample. The dominant taxon collected in the three weeks in May during both day and night samples was clupeids. Peak density at all stations combined below the dam was observed during the survey week of May 19-21; total density during the survey week (2,125 per 1000 m^3) was almost double that of the weeks prior to (1,161 per 1000 m^3) and following (1,125 per 1000 m^3) (Table 10).

August Survey

Tables 11 through 18 include data from the week of the survey and from corresponding samples collected during normal turbine generation/flow on August 17-18 and August 30-31, the weeks before and after the hydrothermal survey, for comparison. Most fish species have completed spawning by late August and most young fish have developed beyond the larval stage. The hydrothermal survey was conducted during this period to determine the maximum or near maximum temperatures to which any larval or juvenile fish would be exposed in the SCCW thermal plume under low flow conditions.

Above dam control transect (TRM 530.2) – Samples collected during August 25-27 from five stations combined across the upstream control transect contained no fish eggs and only eleven fish larvae (or juveniles). Densities of centrarchids were 10 (4) and 16 (6) per 1000 m^3 during day and night samples, respectively, and one clupeid was collected in the night samples for a density of 3 per 1000 m^3 (Table 9). During the previous week (August 17-18) under normal flow conditions, the day sample contained a density of 13 (5) per 1000 m^3. The night sample densities included silversides 3(1) per 1000 m^3, centrarchids 81 (32), clupeids 25 (10) and cyprinids 8 (3). Samples collected August 30-31 contained one centrarchid during both day and night samples for a density of 3 per 1000 m^3 and two clupeids (5 per 1000 m^3) in the night sample (Table 11).

SCCW Intake – No eggs and only one centrarchid larva was collected in the day samples during the August 25-27 survey (Table 10). No eggs or larvae were collected in the night sample. Samples collected August 17-18 contained only centrarchids with a density of 102 (15) in the day sample and 13 (2) in night sample. August 30-31 samples collected one centrarchid during both day and night samples for a density of 7 per 1000 m^3 each (Table 12).

Below dam (TRM 528.0) – Samples collected from five stations across the downstream transect during August 25-27 are discussed below.

Right descending bank – No fish eggs or larvae were collected during the week prior to (August 17-18) or during August 25-27 from this station sampled both day and night. During the following week (August 30-31), one larval fish (*Centrarchidae*; density of 12 per 1000 m^3) was collected during the night sample (Table 13).

40% of reservoir width from right descending bank – No fish eggs or larvae were collected during any of the three weeks from this station sampled both day and night (Table 14).

60% of reservoir width from right descending bank – One centrarchid larva (density of 13 per 1000 m^3) was collected during the day sample of August 17-18. No fish eggs or larvae were collected from this station during the weeks of August 25-27 or August 30-31 (Table 15).

Left descending bank – No fish eggs or larvae were collected from this station sampled both day and night during the first (August 17-18) and second (August 25-27) weeks of the study. During the third week one drum egg (density of 12 per 1000 m^3) was collected during the night sample. Two centrarchid larvae (density of 28 per 1000 m^3) were collected from this station during the night sample of the week following that of no generation (August 30-31) (Table 16).

Bottom sample mid-channel – No fish eggs or larvae were collected during any of the three weeks from this station sampled both day and night (Table 17).

Below Dam (TRM 528.0; five stations combined) – No fish eggs or larvae were collected August 25-27 from the five stations sampled both day and night at the transect below the dam at TRM 528.0 (Table 11). The day sample during August 17-18 collected one centrarchid (density of 3 per 1000 m^3). No fish eggs or larvae collected in the night sample. August 30-31 samples collected two centrarchids (8 per 1000 m^3) in the day sample and nothing in the night sample (Table 18).

CONCLUSIONS

Tracking and mapping the SCCW thermal plume with no release from WBH showed that the plume remained near the surface and spread across the river instead of being confined near the right descending bank, as observed under normal releases from WBH. Maximum temperatures recorded during the May and August no-flow surveys were 74.8ºF and 82.7ºF (both recorded at HOBO station nearest SCCW discharge), respectively. These maximum seasonal temperatures were lower than the Tennessee State Water Quality Criteria for Temperature of 86.9ºF (30.5ºC) which was developed to provide protection for aquatic resources.

During the May 19-21 survey, densities of larval fish were higher at the downstream transect (all stations combined) than the previous and following weekly samples. This indicated that the May survey was conducted either at or near the period of greatest ichthyoplankton abundance.

During the August survey week with no generation, no fish eggs or larvae were collected in the tailwater transect below the WBN SCCW discharge. This suggests that no ichthyoplankton would have been exposed to the thermal effluent during this period of peak (or near peak) seasonal temperatures.

Based on the taxa found from the ichthyoplankton collected, the thermal tolerance data in Yoder et al. (2006), river temperatures and exposure times measured in the study, there is essentially no risk of thermal damage to ichthyoplankton during no-flow conditions from WBH. This is true for both the high-density ichthyoplankton season (May) and the season with highest river temperatures (August).

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Ruth, B. L. and P. N. Hopping. 2010. Summer 2009 Compliance Survey for Watts Bar Nuclear Plant Outfall 113 Passive Mixing Zone. Tennessee Valley Authority River Operations, Knoxville, Tennessee, February, 2010. 63pp.

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Yoder, C.O., B.J. Armitage, and E.T. Rankin. 2006. Re-evaluation of the technical justification for existing Ohio River mainstem temperature criteria. Midwest Biodiversity Institute, Columbus, Ohio.

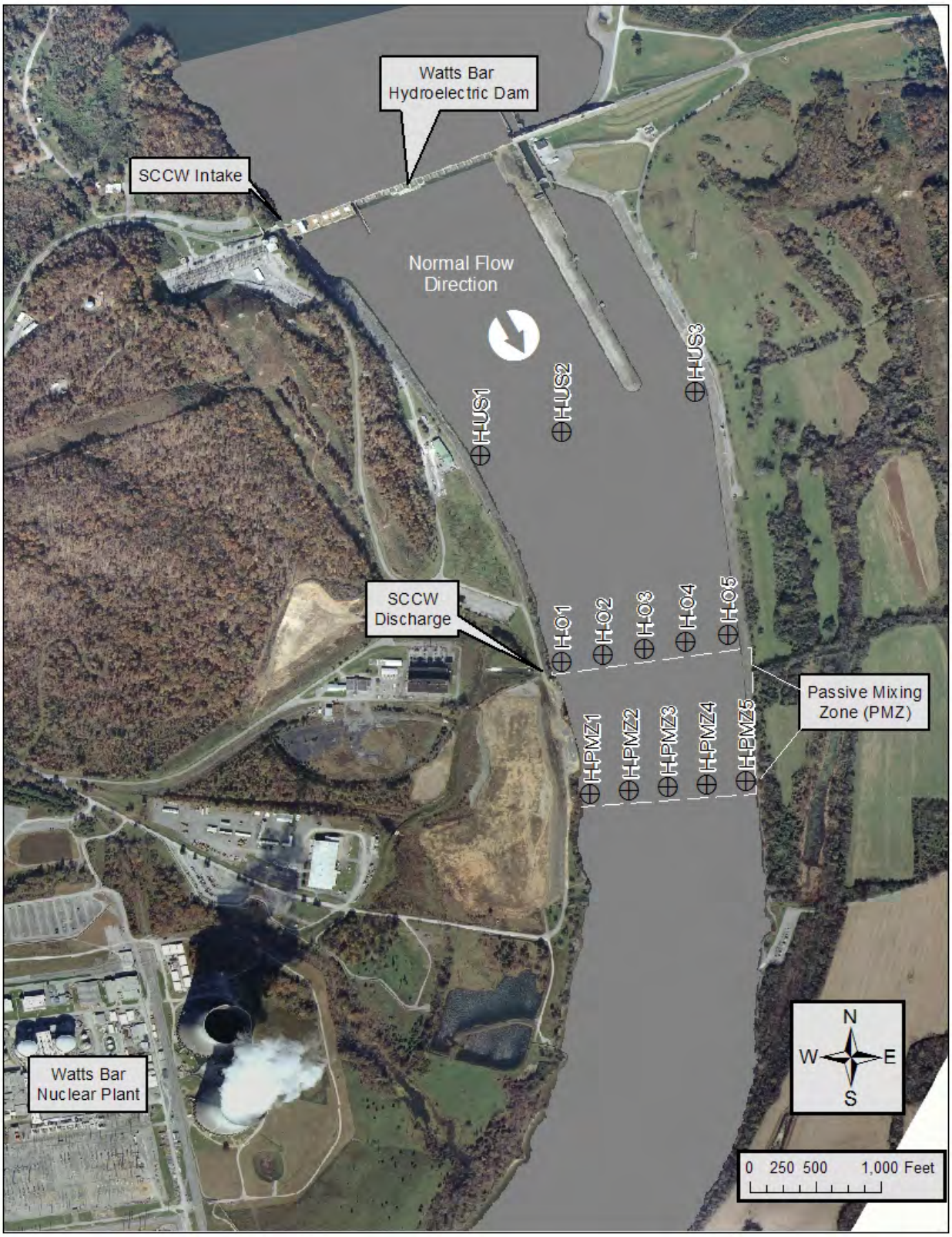

Figure 1. Locations of HOBO temperature recorders along transects across from (H-O1, H-O2, H-O3, H-O4, H-O5), upstream (H-US1, H-US2, H-US3) and downstream (H-PMZ1, H-PMZ2, H-PMZ3, H-PMZ4, H-PMZ5) of the SCCW discharge.

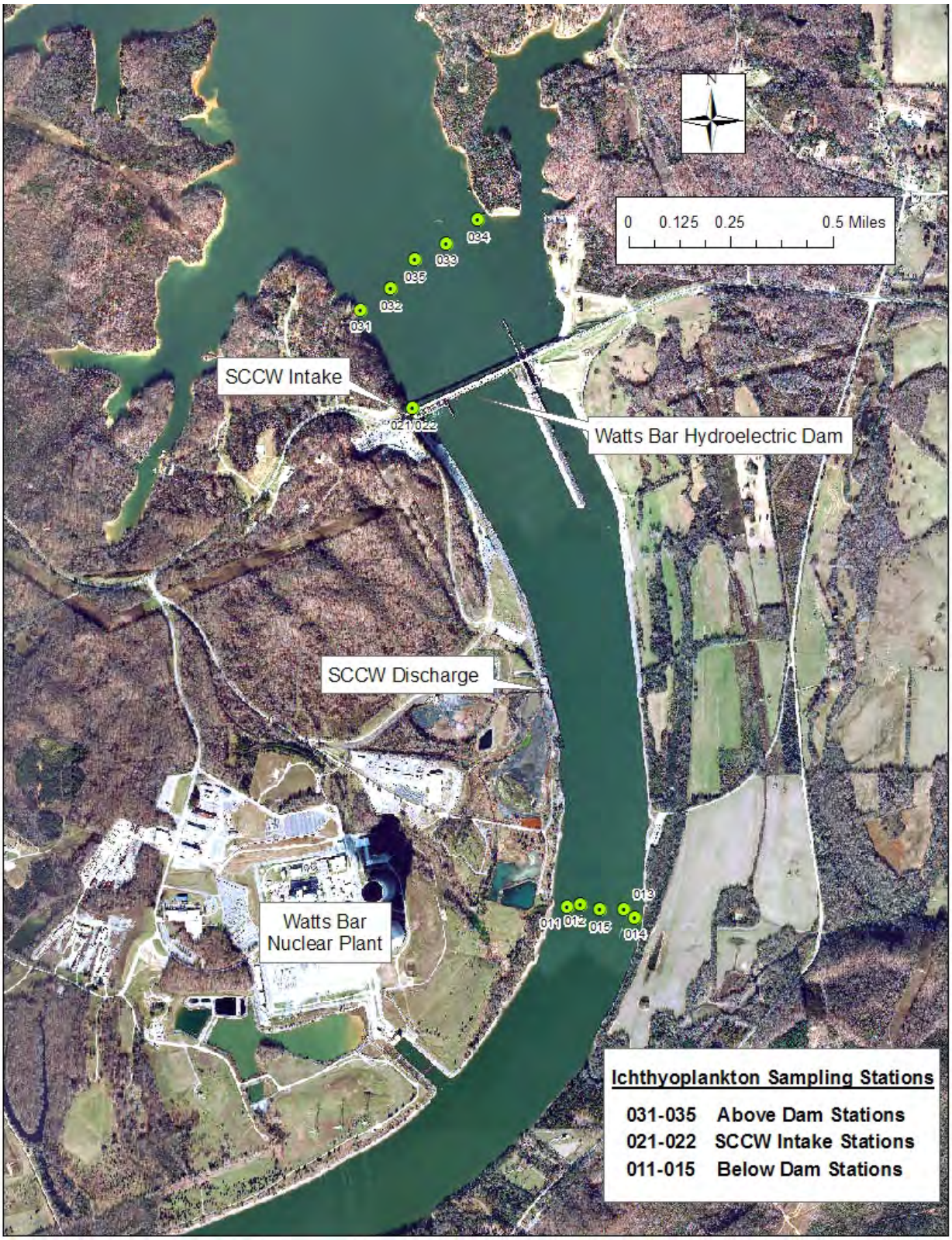

Figure 2. Locations of transects and sampling stations for larval fish and eggs upstream and downstream of Watts Bar Nuclear Plant, Chickamauga Reservoir, Rhea County, TN.

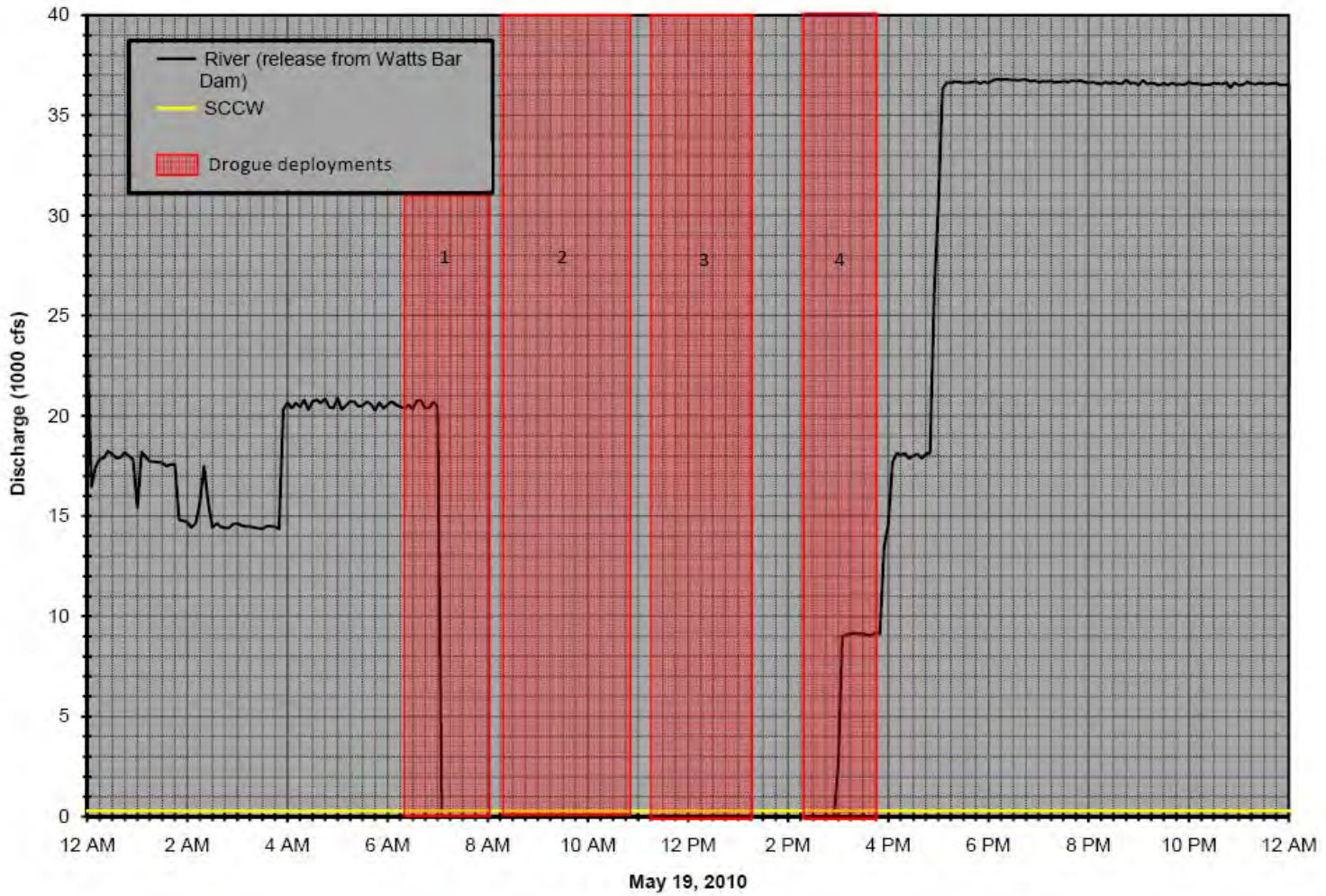

Figure 3. Drogue release times and flow at WBN for daytime test on May 19, 2010.

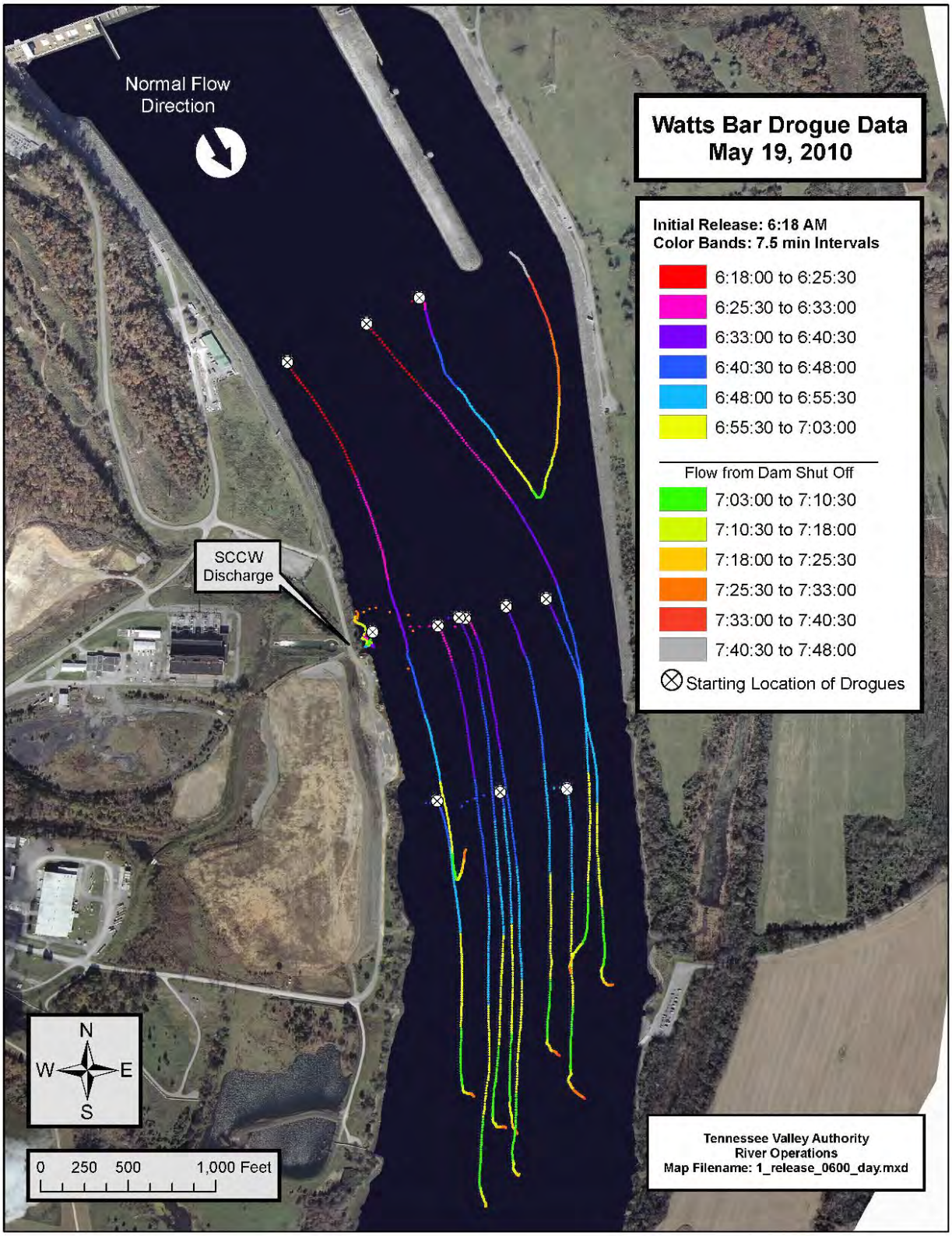

Figure 4. Drogue paths by time at WBN, 6:00 AM to 7:48 AM (first release of daytime test) May 19, 2010.

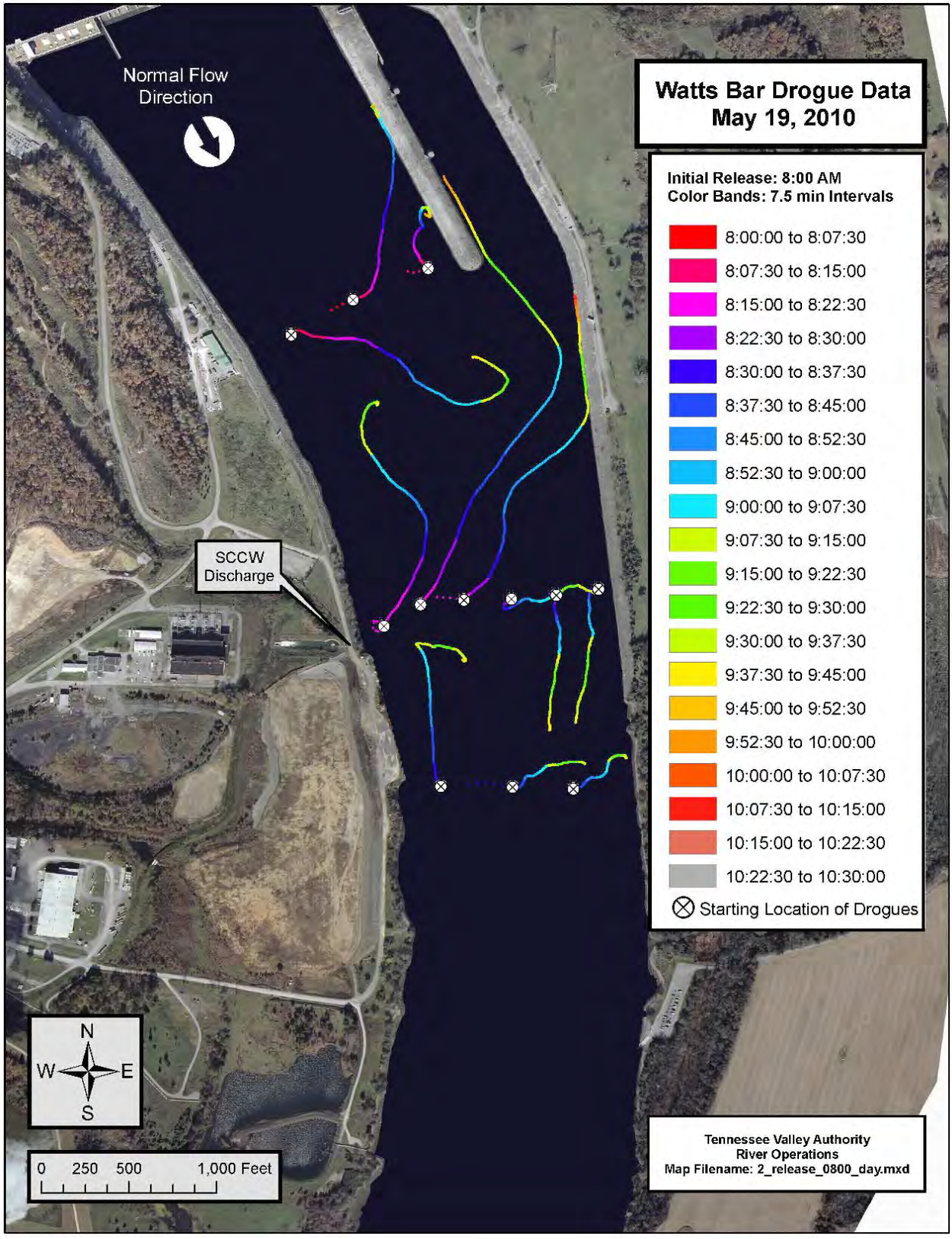

Figure 5. Drogue paths by time at WBN, 8:00 AM to 10:30 AM (second release of daytime test) May 19, 2010.

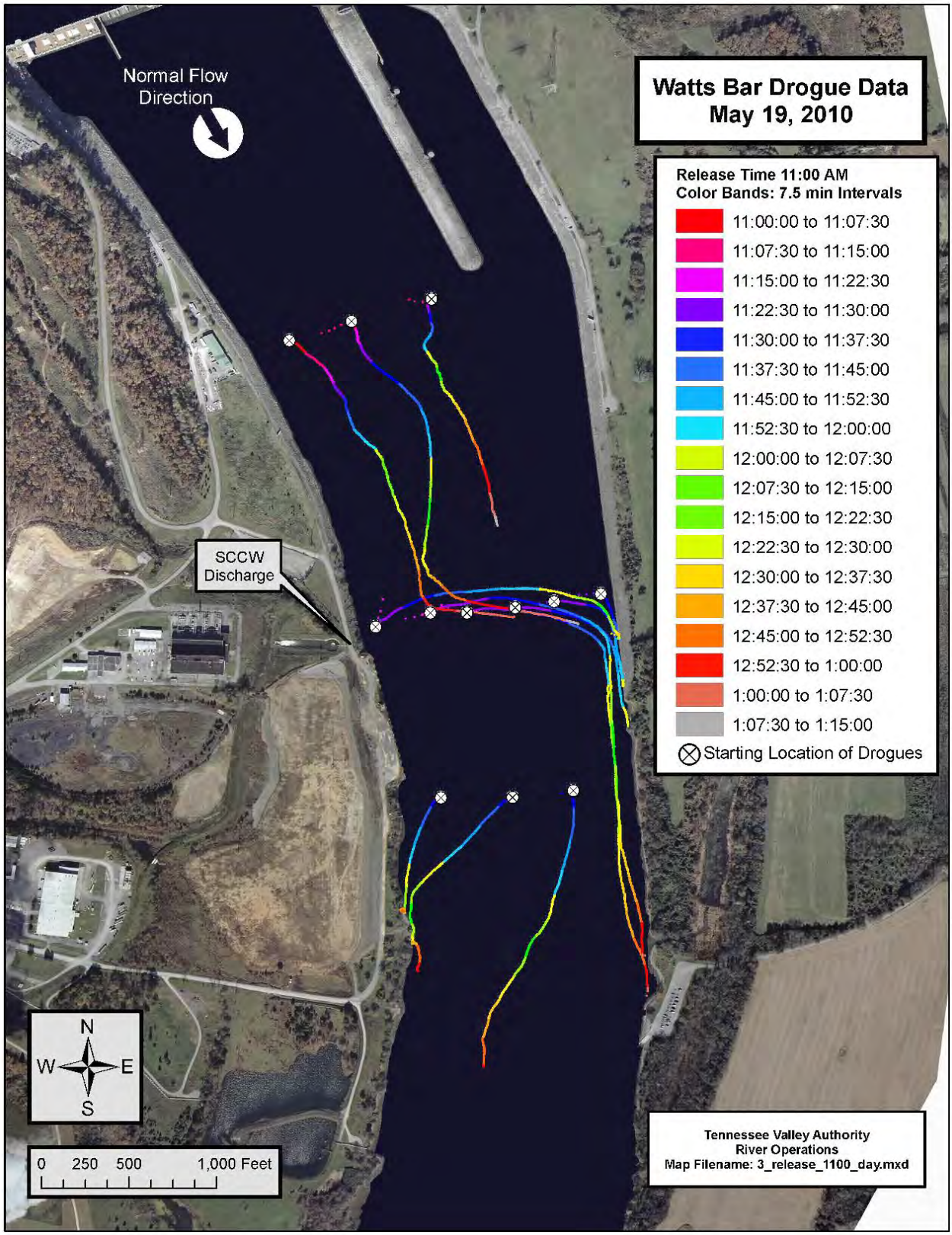

Figure 6. Drogue paths by time at WBN, 11:00 AM to 1:15 PM (third release of daytime test) May 19, 2010.

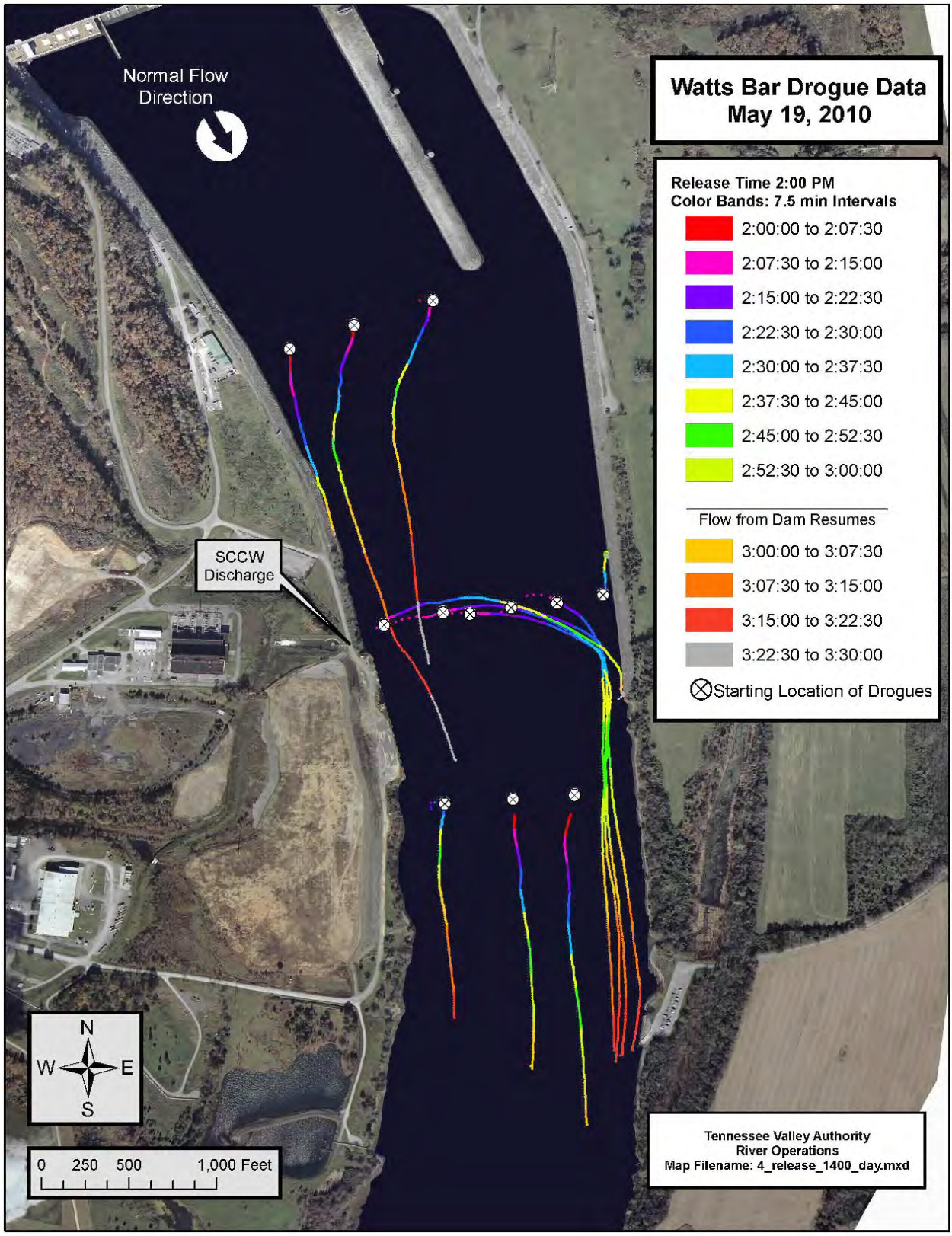

Figure 7. Drogue paths by time at WBN, 2:00 PM to 3:30 PM (fourth and final release of daytime test) May 19, 2010.

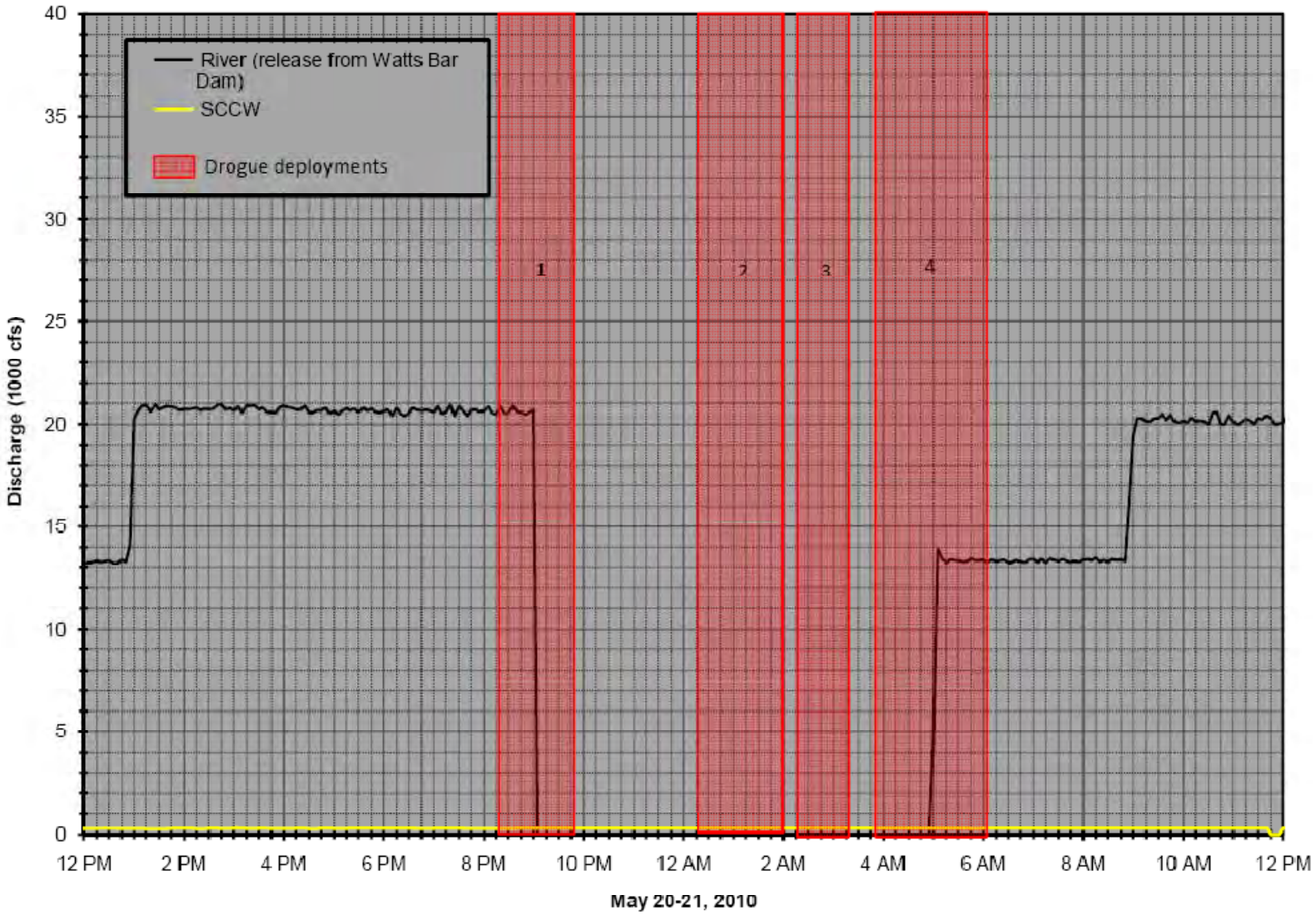

Figure 8. Drogue release times and flow for nighttime test, May 20-21 at WBN.

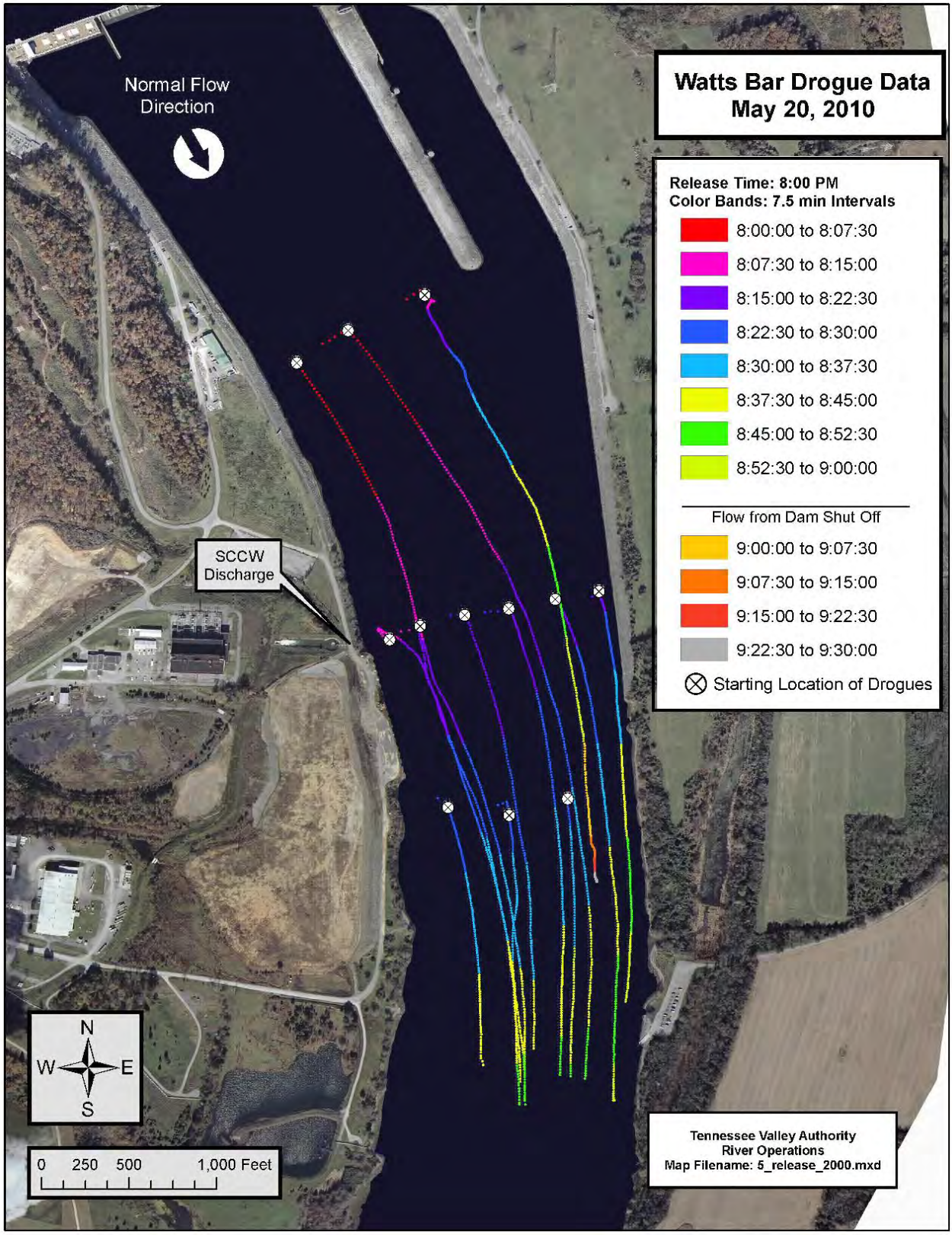

Figure 9. Drogue paths by time at WBN, 8:00 PM to 9:30 PM (first release of nighttime test) May 20, 2010.

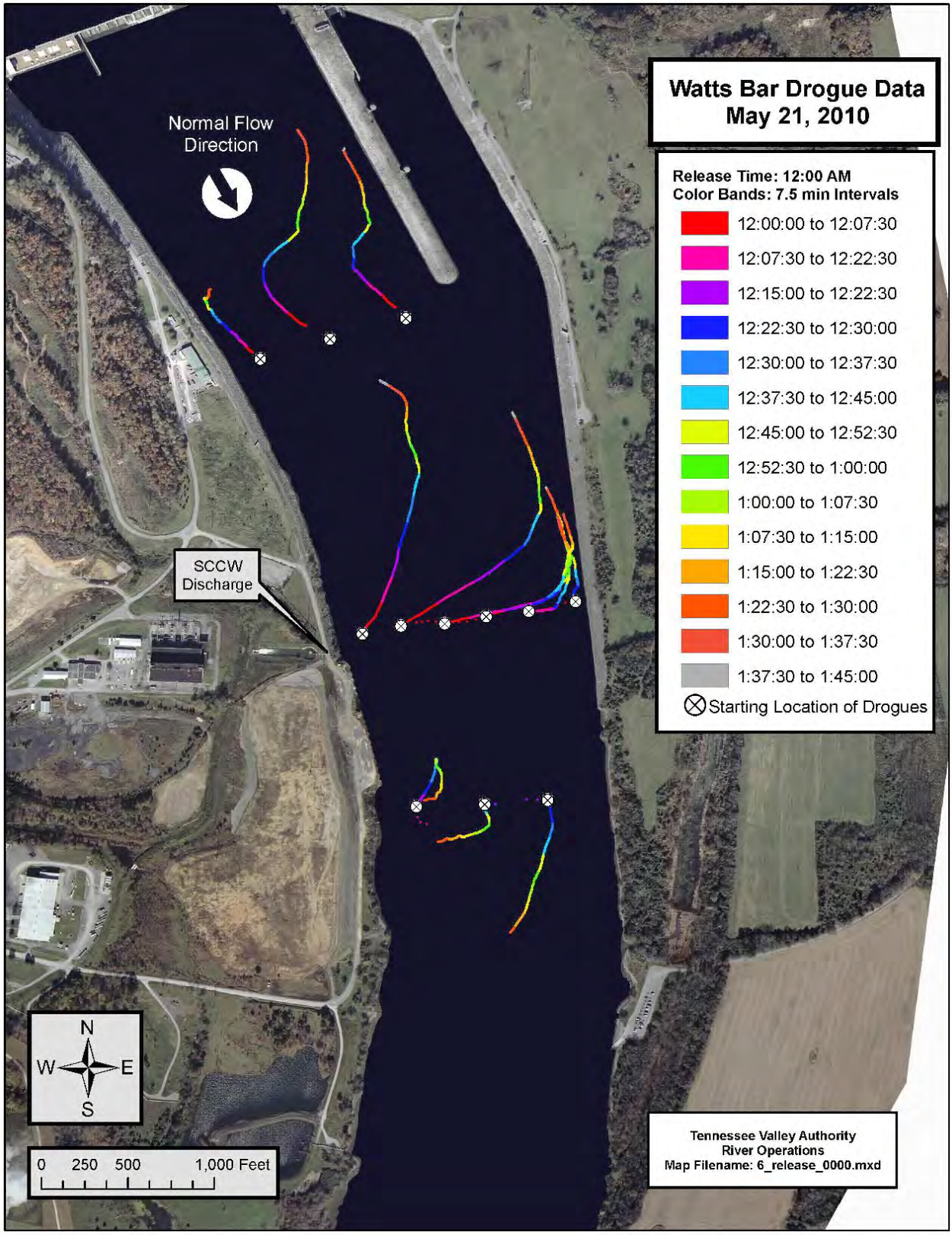

Figure 10. Drogue paths by time at WBN, midnight to 1:45 AM (second release of nighttime test) May 21, 2010.

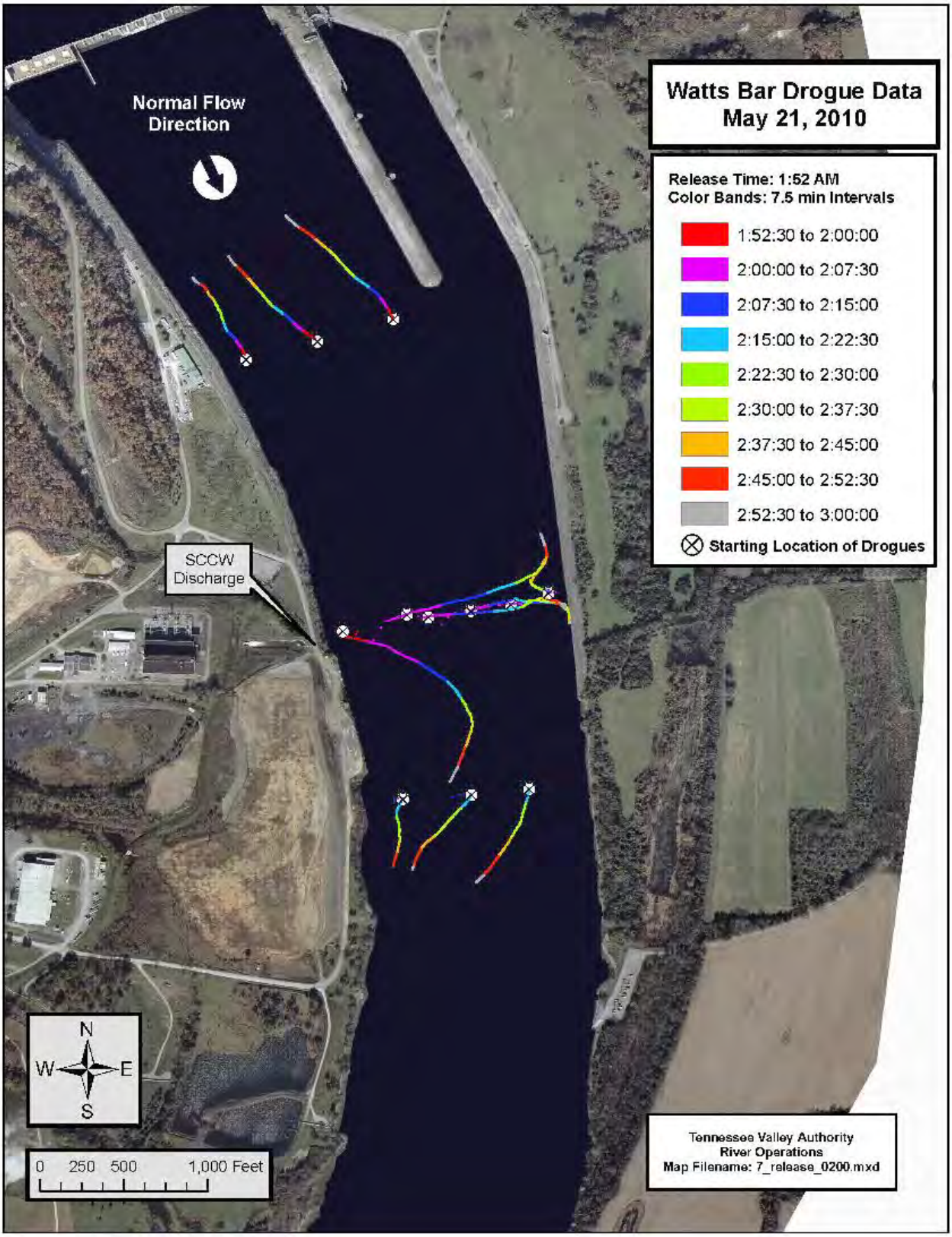

Figure 11. Drogue paths by time at WBN, 1:52 AM to 3:00 AM (third release of nighttime test) May 21, 2010.

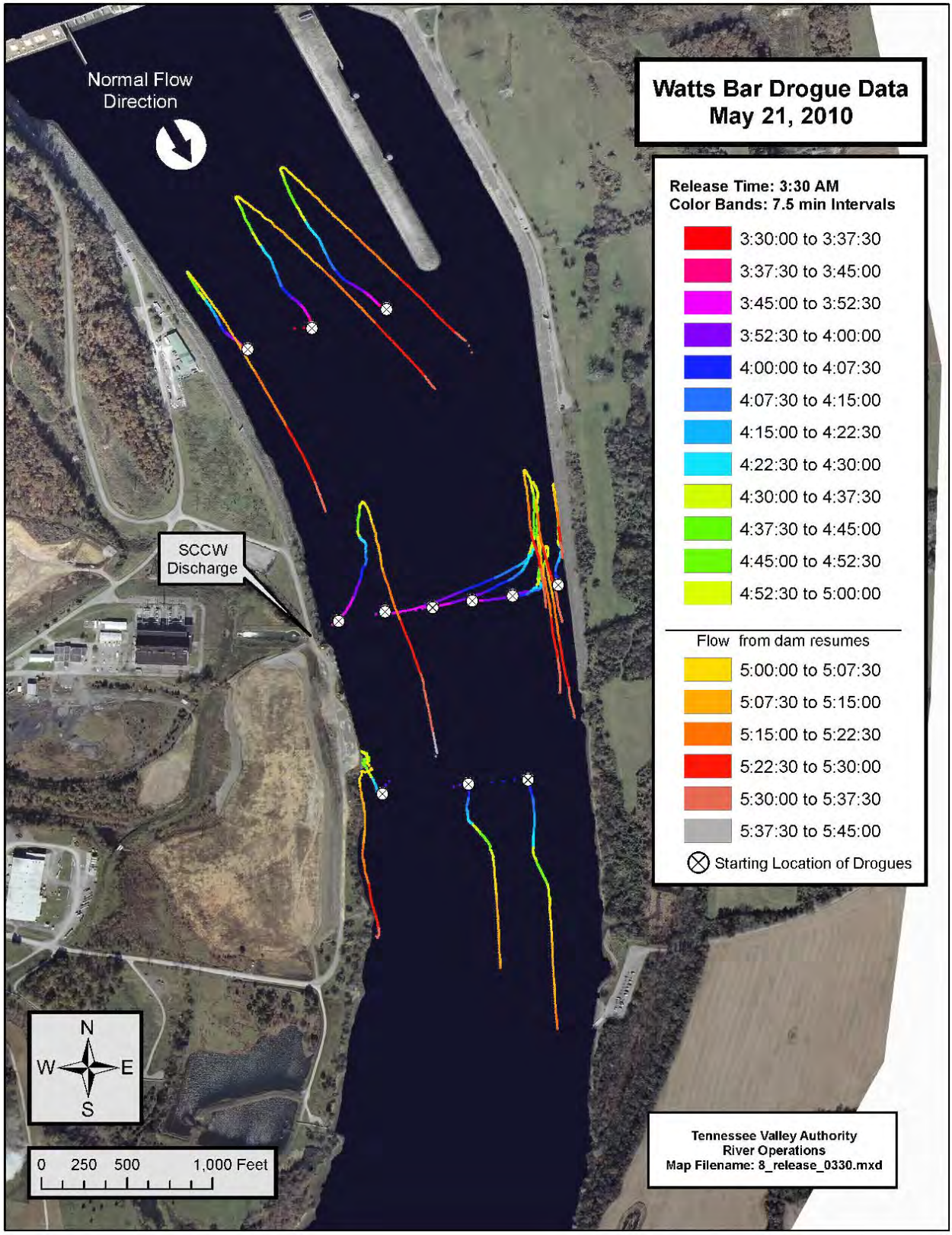

Figure 12. Drogue paths by time at WBN, 3:30 AM to 5:45 AM (fourth and final release of nighttime test) May 21, 2010.

Table 1. Ambient river temperatures, peak river temperatures at surface and bottom of water column, and river temperatures at four locations in the study area (Upstream of the SCCW, SCCW discharge, and the downstream Passive Mixing Zone transects) collected using HOBO temperature stations during day and nighttime tests in May and August 2010 near WBN.

	May		August	
Distribution	**Day**	**Night**	**Day**	**Night**
Ambient river temperature	68°-69°F, constant	69°-69.5°F, constant	79°F at dam shutdown, cooling to 76.5°F at restart of dam release	79.5° - 80°F at dam shutdown, cooling to 78°-78.5°F at restart of dam release
SCCW discharge temperature	73.5°F at start of test, warming to 79° at restart of dam	About 80°F through most of test	81°F at start, warming to 82.7° at end of test	82°F at start of test, 81°F at restart of dam release
Peak surface temperature	75°F at HO1	75.5°F at HO1	82.7°F at HO1 and PMZ1	82°F at beginning of test at HO1
Peak bottom temperature	71°F at HO1	72°F at HO1	80.2°F at HO2	81.2°F at HO1
Upstream transect	Surface warms to 73°F peak; little effect deeper	Up to 71°F at surface; some effect lower at US3	Surface warms to 81.5°F; less effect deeper.	Insignificant variation from ambient
Transect at SCCW discharge (HO)	HO1 is warmest; temperature increase dissipates across transect	HO1 is warmest; temperature increase dissipates across transect	HO1 is warmest; temperature increase dissipates across transect	HO1 is warmest but not much increase above ambient. Temperature increase dissipates across transect
Downstream passive mixing zone (PMZ) transect	Surface temperatures at all stations increase to up to 73°; little change at bottom	PMZ2 is warmest, up to 72.5°F at surface. Little or no change at bottom.	Surface temperature at all stations increase to up to 82.5°F	All stations have short 81.5°F peak at beginning; stable at 79°F for rest of test.

Table 2. List of fish and eggs by family collected near Watts Bar Nuclear Plant during May and August ichthyoplankton samples and lowest level of taxonomic resolution for each family.

	Scientific Name	Common Name	Lowest Level of Taxonomic Identification
Eggs			
		Unspecified	Identification to family was not possible. Limiting factors were size, stage of development, and condition (some are damaged).
	Clupeidae	**Shad**	Family.
	Sciaenidae	**Drum**	Species. freshwater drum
Larvae			
	Clupeidae	**Shad**	Family - all larvae < 20 mm TL. Genus or species -larger individuals to *Alosa* spp.- alewife, skipjack, *Dorosoma* spp. - gizzard and threadfin shad.
	Cyprinidae	**Minnows and Carps**	Family -most minnows, shiners, chubs, dace. Genus or species -common carp, golden shiner, and larger individuals to emerald shiner, mimic shiner, *Pimephales* spp.
	Moronidae	**Temperate basses**	Genus -most larval life phases Species - yolk-sac larvae $\geq$ 5 mm TL (striped bass), larger individuals to white, yellow, and striped bass.
	Centrarchidae	**Sunfishes**	Genus - crappie, lepomids (sunfishes), and black bass. Species - larger individuals to largemouth and smallmouth bass.
	Percidae	**Perches**	Family - darters (*Percina* or *Etheostoma*), yellow perch. No sauger were collected. Genus or species -larger individuals to logperch and *Percina* sp.
	Sciaenidae	**Drum**	Species. freshwater drum
	Atherinopsidae	**Silversides**	Family -most larvae (either brook or inland silverside).

Table 3. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation **upstream of Watts Bar Dam** (TRM 530.2) during three weeks in May 2010. Densities were derived using combined numbers of fish eggs and larvae and volumes sampled from all five stations along the reservoir transect upstream of the dam. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Watts Bar Forebay (Combined)	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	7 (3)	0	0	0	0	0
Sciaenidae	0	0	0	3 (1)	8 (3)	15 (6)
Total	**7 (3)**	**0**	**0**	**3 (1)**	**8 (3)**	**15 (6)**
Fish Larvae						
Atherinopsidae	3 (1)	0	3 (1)	26 (10)	13 (5)	2 (1)
Centrarchidae	39 (16)	23 (9)	26 (10)	47 (18)	120 (48)	88 (36)
Clupeidae	2188 (889)	358 (139)	179 (70)	1282 (495)	102 (41)	898 (367)
Cyprinidae	0	10 (4)	3 (1)	13 (5)	10 (4)	2 (1)
Moronidae	3 (1)	18 (7)	0	41 (16)	0	29 (12)
Percidae	0	3 (1)	0	0	0	0
Sciaenidae	0	0	0	10 (4)	8 (3)	27 (11)
Total	**2240 (910)**	**412 (160)**	**211 (82)**	**1422 (549)**	**261 (104)**	**1061 (434)**
24-hr Total	**2652 (1070)**		**1633 (631)**		**1322 (538)**	

Table 4. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at the **SCCW intake** (TRM529.9) during three weeks in May 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

SCCW Intake	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	0	0	0	0	0	0
Sciaenidae	0	0	0	18 (3)	0	0
Total	**0**	**0**	**0**	**18 (3)**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	0	21 (3)	32 (5)	18 (3)	79 (12)	63 (10)
Clupeidae	63 (10)	8204 (1181)	253 (39)	871 (144)	996 (152)	1814 (287)
Cyprinidae	0	0	0	6 (1)	0	0
Moronidae	6 (1)	0	0	0	0	6 (1)
Percidae	6 (1)	0	0	0	0	0
Sciaenidae	0	7 (1)	0	6 (1)	13 (2)	0
Total	**75 (12)**	**8232 (1185)**	**285 (44)**	**919 (152)**	**1088 (166)**	**1883 (298)**
24-hr Total	**8307 (1197)**		**1204 (196)**		**2971 (464)**	

Table 5. Densities (number per 1000 m3) of fish eggs and larvae by family collected during normal and no generation at a location **near the right descending bank** of the Tennessee River at TRM 528.0 below Watts Bar Dam during three weeks in May 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Right Bank	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	0	0	0	0	0	0
Sciaenidae	0	0	0	73 (6)	0	454 (36)
Total	**0**	**0**	**0**	**73 (6)**	**0**	**454 (36)**
Fish Larvae						
Atherinopsidae	0	0	0	12 (1)	0	0
Centrarchidae	0	13 (1)	13 (1)	36 (3)	128 (10)	76 (6)
Clupeidae	13 (1)	1509 (115)	40 (3)	813 (67)	344 (27)	1552 (123)
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	12 (1)	0	38 (3)
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	13 (1)	88 (7)
Total	**13 (1)**	**1522 (116)**	**53 (4)**	**946 (78)**	**485 (38)**	**2208 (175)**
24-hr Total	**1535 (117)**		**999 (82)**		**2693 (213)**	

Table 6. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **40% of reservoir width from right descending bank** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in May 2010. Numbers in parentheses represent actual numbers of fish eggs or larvae collected.

40% Right Bank	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	143 (12)
Total	**0**	**0**	**0**	**0**	**0**	**143 (12)**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	0	0	14 (1)	0	27 (2)	12 (1)
Clupeidae	99 (8)	714 (55)	180 (13)	1158 (91)	146 (11)	119 (10)
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	13 (1)	0	12 (1)
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	25 (2)	13 (1)	12 (1)
Total	**99 (8)**	**714 (55)**	**194 (14)**	**1196 (94)**	**186 (14)**	**298 (25)**
24-hr Total	**813 (63)**		**1390 (108)**		**484 (39)**	

Table 7. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **60% of reservoir width from right descending bank** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in May 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

60 % Right bank	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	13 (1)	0	0	0	0	0
Sciaenidae	0	0	0	38 (3)	13 (1)	145 (12)
Total	**13 (1)**	**0**	**0**	**38 (3)**	**13 (1)**	**145 (12)**
Fish Larvae						
Atherinopsidae	0	0	13 (1)	13 (1)	0	0
Centrarchidae	0	0	13 (1)	0	51 (4)	24 (2)
Clupeidae	423 (33)	564 (43)	391 (30)	1593 (127)	51 (4)	374 (31)
Cyprinidae	0	0	0	0	0	0
Moronidae	0	13 (1)	0	50 (4)	0	48 (4)
Percidae	0	0	0	13 (1)	0	0
Sciaenidae	0	0	0	13 (1)	25 (2)	36 (3)
Total	**436 (34)**	**577 (44)**	**417 (32)**	**1720 (136)**	**140 (11)**	**627 (52)**
24-hr Total	**1013 (78)**		**2137 (168)**		**767 (63)**	

Table 8. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **near the left descending bank** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in May 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Left bank	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	25 (2)	249 (21)
Total	**0**	**0**	**0**	**0**	**25 (2)**	**249 (21)**
Fish Larvae						
Atherinopsidae	0	0	13 (1)	13 (1)	0	0
Centrarchidae	0	0	0	25 (2)	13 (1)	36 (3)
Clupeidae	497 (40)	1715 (131)	526 (41)	3066 (244)	266 (21)	736 (62)
Cyprinidae	0	0	0	0	0	0
Moronidae	12 (1)	0	26 (2)	38 (3)	0	36 (3)
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**509 (41)**	**1715 (131)**	**565 (44)**	**3142 (250)**	**304 (24)**	**1057 (89)**
24-hr Total	**2224 (172)**		**3707 (294)**		**1361 (113)**	

Table 9. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation in samples near **bottom of the main channel** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in May 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Near Bottom	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	0	0	0	0	0	0
Sciaenidae	0	0	0	12 (1)	0	0
Total	**0**	**0**	**0**	**12 (1)**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	13 (1)	0	14 (1)	26 (2)	93 (7)	38 (3)
Clupeidae	0	152 (11)	236 (17)	347 (27)	66 (5)	88 (7)
Cyprinidae	0	0	0	26 (2)	0	0
Moronidae	0	0	14 (1)	13 (1)	0	25 (2)
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	14 (1)	26 (2)	13 (1)	25 (2)
Total	**13 (1)**	**152 (11)**	**278 (20)**	**450 (34)**	**172 (13)**	**176 (14)**
24-hr Total	**165 (12)**		**728 (54)**		**348 (27)**	

Table 10. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation **downstream of Watts Bar Dam** (TRM 528.0) during three weeks in May 2010. Densities derived using combined numbers of eggs or larvae and volumes sampled from all five stations along the reservoir transect downstream of the dam. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Downstream of Dam (Combined)	Week 1 (May 11-12) Normal Generation		Week 2 (May 19-21) No Generation		Week 3 (May 25-27) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Clupeidae	3 (1)	0	0	0	0	0
Sciaenidae	0	0	0	31 (10)	8 (3)	197 (81)
Total	**3 (1)**	**0**	**0**	**31 (10)**	**8 (3)**	**197 (81)**
Fish Larvae						
Atherinopsidae	0	0	5 (2)	9 (3)	0	0
Centrarchidae	3 (1)	3 (1)	11 (4)	21 (7)	62 (24)	37 (15)
Clupeidae	207 (82)	939 (355)	279 (104)	1703 (556)	176 (68)	568 (233)
Cyprinidae	0	0	0	6 (2)	0	0
Moronidae	3 (1)	3 (1)	8 (3)	31 (10)	0	32 (13)
Percidae	0	0	0	3 (1)	0	0
Sciaenidae	0	0	3 (1)	15 (5)	13 (5)	32 (13)
Total	**216 (85)**	**945 (357)**	**306 (114)**	**1819 (594)**	**259 (100)**	**866 (355)**
24-hr Total	**1161 (442)**		**2125 (708)**		**1125 (455)**	

Table 11. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation **upstream of Watts Bar Dam** (TRM 530.2) during three weeks in August 2010. Densities were derived using combined numbers of eggs or larvae and volumes sampled from all five stations along the reservoir transect upstream of the dam. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Watts Bar Forebay	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	3 (1)	0	0	0	0
Centrarchidae	13 (5)	81 (32)	10 (4)	16 (6)	3 (1)	3 (1)
Clupeidae	0	25 (10)	0	3 (1)	0	5 (2)
Cyprinidae	0	8 (3)	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**13 (5)**	**117 (46)**	**10 (4)**	**19 (7)**	**3 (1)**	**8 (3)**
24-hr Total	**130 (51)**		**29 (11)**		**11 (4)**	

Table 12. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at the **SCCW intake** (TRM529.9) during three weeks in August 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

SCCW Intake	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	102 (15)	13 (2)	7 (1)	0	7 (1)	7 (1)
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**102 (15)**	**13 (2)**	**7 (1)**	**0**	**7 (1)**	**7 (1)**
24-hr Total	**115 (17)**		**7 (1)**		**14 (2)**	

Table 13. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **near the right descending bank** of the Tennessee River at TRM 528.0 below Watts Bar Dam during three weeks in August 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Right Bank	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	0	0	0	0	0	12 (1)
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**12 (1)**
24-hr Total	**0**		**0**		**12 (1)**	

Table 14. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **40% of reservoir width from right descending bank** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in August 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

40% Right Bank	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	0	0	0	0	0	0
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
24-hr Total	**0**		**0**		**0**	

Table 15. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **60% of reservoir width from right descending bank** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in August 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

60 % Right bank	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	13 (1)	0	0	0	0	0
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**13 (1)**	**0**	**0**	**0**	**0**	**0**
24-hr Total	**13 (1)**		**0**		**0**	

Table 16. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation at a location **near the left descending bank** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in August 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Left bank	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	12 (1)
Total	**0**	**0**	**0**	**0**	**0**	**12 (1)**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	0	0	0	0	28 (2)	0
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**28 (2)**	**12 (1)**
24-hr Total	**0**		**0**		**40 (3)**	

Table 17. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation in samples near **bottom of the main channel** of the Tennessee River at TRM 528.0 downstream of Watts Bar Dam during three weeks in August 2010. Numbers in parentheses represent actual numbers of eggs or larvae collected.

Near Bottom	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Fish larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	0	0	0	0	0	0
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
24-hr Total	**0**		**0**		**0**	

Table 18. Densities (number per 1000 m^3) of fish eggs and larvae by family collected during normal and no generation **downstream of Watts Bar Dam** (TRM 528.0) during three weeks in August 2010. Densities were derived using combined numbers of eggs or larvae and volumes sampled from all five stations along the reservoir transect downstream of the dam. Numbers in parentheses represent actual numbers of eggs and larvae collected.

Downstream of Dam (Combined)	Week 1 (Aug 17-18) Normal Generation		Week 2 (Aug 25-27) No Generation		Week 3 (Aug 30-31) Normal Generation	
Family	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Fish Eggs						
Sciaenidae	0	0	0	0	0	2 (1)
Total	**0**	**0**	**0**	**0**	**0**	**2(1)**
Fish Larvae						
Atherinopsidae	0	0	0	0	0	0
Centrarchidae	3 (1)	0	0	0	8 (2)	0
Clupeidae	0	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0
Moronidae	0	0	0	0	0	0
Percidae	0	0	0	0	0	0
Sciaenidae	0	0	0	0	0	0
Total	**3 (1)**	**0**	**0**	**0**	**8 (2)**	**0**
24-hr Total	**3 (1)**		**0**		**10 (3)**	