USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

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New York Power Authority

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

A fish study was conducted for the New York Power Authority during 2003 in Buckhorn Marsh Restoration Project (BMRP), Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek as part of the process for relicensing the Niagara Power Project. BMRP includes two distinct portions of the former Burnt Ship Creek channel: 1) Burnt Ship Creek - from the mouth of the creek to a weir located near I-190 (west weir) and 2) Buckhorn Marsh impoundment - from the west weir to a weir located about 1,720 feet farther east and on the west bank of Woods Creek. The objectives were to: 1) determine whether northern pike, largemouth bass, and yellow perch used BMRP for spawning and as a nursery, and if so, estimate how many used it and establish whether they traversed either of the two weirs in BMRP; 2) compare the use of BMRP by northern pike for spawning and as a nursery with that of Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek; 3) determine the relative abundance and composition of all fish species in BMRP and Woods Creek; and 4) evaluate the need to increase fish passage into or out of BMRP as an approach for promoting its use by northern pike for spawning and as a nursery while maintaining BMRP goals for wildlife species.

Based on the data collected during 2003, the following inferences and conclusions are reasonable:

- BMRP is used by northern pike and largemouth bass for spawning and as a nursery and by yellow perch as a nursery.
- Within BMRP, Buckhorn Marsh impoundment is used more extensively than Burnt Ship Creek by yearling and older northern pike for spawning and by YOY northern pike as a nursery; it is used less extensively than Burnt Ship Creek by YOY largemouth bass as a nursery.
- Within BMRP, Buckhorn Marsh impoundment was not used by yellow perch, and Burnt Ship Creek was lightly used by yellow perch YOY as a nursery.
- Northern pike do not migrate out of Buckhorn Marsh impoundment and rarely migrate into it.

- Largemouth bass and yellow perch do not migrate into or out of Buckhorn Marsh impoundment.
- Migration of northern pike, largemouth bass, and yellow perch into Burnt Ship Creek from the Niagara River and out of Burnt Ship Creek to the Niagara River is limited by dense cattail stands.
- Migration of northern pike and largemouth bass into Burnt Ship Creek from Buckhorn Marsh impoundment is limited by water elevations below the top of the weir separating Burnt Ship Creek and Buckhorn Marsh impoundment.
- Fewer yearling and older northern pike use Buckhorn Marsh impoundment than Woods Creek and Gun Creek but more used Buckhorn Marsh impoundment than Burnt Ship Creek, Big Six Mile Creek, and Spicer Creek.
- The species composition and relative abundance of fish in Buckhorn Marsh impoundment and in Burnt Ship Creek differ from those of fish in Woods Creek and appear to reflect limited access from the Niagara River and lower water quality than in Woods Creek.
- Increasing fish passage into Buckhorn Marsh impoundment is not needed to promote its use by northern pike for spawning and as a nursery if the objective is to maintain a self-sustaining population; doing so might increase competition among northern pike.
- Increasing passage of northern pike out of Buckhorn Marsh impoundment after spawning may be needed to reduce population density if the objective is to maintain a self-sustaining population in the impoundment with good growth rates.
- If the objective is to use Buckhorn Marsh impoundment as seasonal spawning and nursery habitat for northern pike, then increasing fish passage into and out of the impoundment annually would be needed.

- Increasing fish passage into or out of Buckhorn Marsh impoundment would likely involve lowering the stoplog height of at least one weir during the spring and summer.
- Lowering the stoplog height of either weir would lower the water level in Buckhorn Marsh impoundment and make it more susceptible to daily changes in the water level of the Niagara River, which would not help maintain BMRP goals for wildlife species or improve the spawning and nursery habitat of the impoundment.

ABBREVIATIONS

Agencies

NYSDEC	New York State Department of Environmental Conservation
USFWS	United States Fish and Wildlife Service

Units of Measure

C	Celsius, Centigrade
cm	centimeter
El.	elevation
m	meter
m	milli (prefix for one-thousandth)
µ	micro (prefix for one-millionth)
µmhos/cm	micromhos per centimeter
ml	milliliter
mm	millimeter
ppm	parts per million
psi	pounds per square inch

Environmental

DO	dissolved oxygen
EAV	emergent aquatic vegetation
SAV	submerged aquatic vegetation
YOY	young-of-the-year fish (i.e., less than one year old)

Miscellaneous

BMRP	Buckhorn Marsh Restoration Project
PIT	Passive Integrated Transponder

1.0 INTRODUCTION

The New York State Department of Environmental Conservation (NYSDEC), New York State Office of Parks, U.S. Army Corps of Engineers, and Town of Grand Island, New York jointly funded and implemented the Buckhorn Marsh Restoration Project (BMRP). BMRP was designed to restore and create a diversity of wetland habitat types in and near the former channel of Burnt Ship Creek. It entailed removing sediment from the former channel, creating new channels, and constructing weirs with removable stoplogs to establish more stable and higher water levels (Roblee 1998). The goals of the project were to provide nesting, brooding, escape, and resting habitat for marsh birds and to re-establish habitat that northern pike (*Esox lucius*) could use for spawning and as a nursery.

Buckhorn Marsh is located on the north end of Grand Island. It extends from the Chippawa Channel of the Niagara River on the west to the Tonawanda Channel of the Niagara River on the east, separating Buckhorn Island to the north from the remainder of Grand Island to the south (Anderson 1995). The marsh includes: 1) two distinct portions of the former Burnt Ship Creek channel; from the mouth of Burnt Ship Creek to a weir (the west weir) located just east of I-190 (Burnt Ship Creek) and from the weir just east of I-190 to a weir (the east weir) located about 1,720 feet east, on the west bank of Woods Creek (Buckhorn Marsh impoundment); and 2) Woods Creek from the east weir to the mouth at the Niagara River (Figure 1.0-1).

During the relicensing process for the Niagara Power Project, NYSDEC and the U.S. Fish and Wildlife Service (USFWS) expressed an interest in enhancing northern pike reproduction in BMRP. However, there were no systematically collected data available to assess the use of BMRP for reproduction by northern pike. As part of the alternative licensing process, the New York Power Authority (NYPA) agreed to conduct a study and collect data that could be used to inform settlement discussions. NYPA agreed to fund such a study in 2003. The initial objectives of the study were to:

- determine whether northern pike used BMRP for spawning and as a nursery, and if so,
- estimate how many northern pike used it,

- establish whether northern pike traversed the west weir or the east weir, and
- evaluate the need to increase fish passage into or out of BMRP as an approach for promoting its use by northern pike for spawning and as a nursery while maintaining BMRP goals for wildlife species.

NYSDEC and USFWS subsequently requested that the study be expanded. The objectives of the expanded study were to:

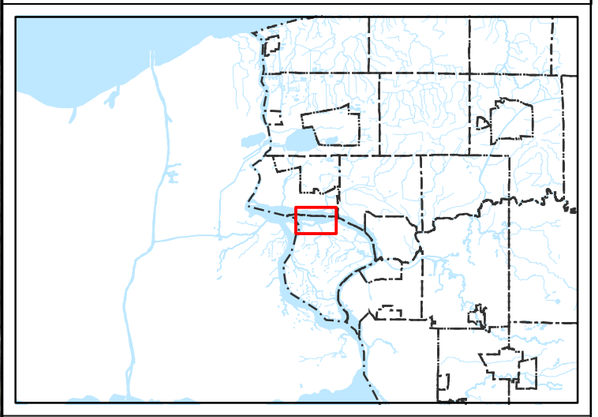
- determine whether largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*) used BMRP for spawning and as a nursery, and if so,
- estimate how many used it and whether they traversed the west weir or the east weir,
- determine the relative abundance and composition of all fish species in BMRP and Woods Creek,
- compare the use of BMRP by northern pike for spawning and as a nursery with that of Woods Creek, Big Six Mile Creek, Gun Creek, and Spicer Creek.

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Buckhorn Marsh Impoundment, Burnt Ship Creek, and Woods Creek

LEGEND

- Buckhorn Marsh Weir



0 300 600 1,200 Feet

N

FIGURE 1.0-1

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NIAGARA POWER PROJECT

2.0 METHODS

The Investigation Area for the study was BMRP, Woods Creek, Big Six Mile Creek, Gun Creek, and Spicer Creek (Figure 2.0-1).

2.1 Field Methods

The methods for conducting field sampling were detailed in a set of Standard Operating Procedures (Appendix A). They were developed jointly by the New York Power Authority, Gomez and Sullivan, and Stantec Consulting Services, Inc., which conducted field sampling.

2.1.1 Yearling and Older Fish

2.1.1.1 Sampling

Sampling for spawning northern pike, largemouth bass, and yellow perch was scheduled to occur in BMRP and Woods Creek weekly from the first week in February - or as soon after the first week in February that ice did not prevent sampling, through July 3. This period includes the reported spawning season for northern pike in the Niagara River – late-February to April (Harrison and Hadley 1983), yellow perch – mid-April to early-May, and largemouth bass – late-spring to early-summer (Scott and Crossman 1973). Sampling for spawning northern pike was scheduled to occur in Gun Creek, Spicer Creek, and Big Six Mile Creek from the first week in February - or as soon after the first week in February that ice did not prevent sampling, through May. Due to an unusually cold winter, fyke nets could not be set safely until ice melted during the last week in March and sampling for northern pike in Gun Creek, Spicer Creek, and Big Six Mile Creek was extended through the second week in June.

Fyke nets were selected as the primary collection gear for spawning fish and were scheduled to be set for 72 consecutive hours per week. Fyke nets collect northern pike, largemouth bass and yellow perch effectively when these fish are active during the spring; cause relatively little capture stress; can be fished

24 hours a day; could be deployed in all of the areas of interest in this study; and were used to collect fish during 2001 in Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek (NYPA 2002). Because fyke nets could not be set safely until the last week in March and the spawning season for northern pike is reported to be early March through early April (Harrison and Hadley 1983), it was possible that the spawning season for northern pike would be very short in 2003. Therefore, sampling was occasionally conducted seven days per week during late-March and April.

Electrofishing was selected to supplement collections of northern pike, largemouth bass, and yellow perch made using fyke nets with the intent of sampling in areas between and around fyke nets and was scheduled to be done one day per week. Limited electrofishing began in late-February.

A fyke net measuring 4 feet in diameter at the mouth, with a 9-inch diameter fyke opening, a 50-foot long by 4 feet high lead, and 20-foot long by 4 feet high wings was used where water depth was 4 feet or greater. A fyke net measuring 2.5 feet in diameter, with a 9-inch diameter fyke opening, a 50-foot long by 2.5 feet high lead, and 20-foot long by 2.5 feet high wings was used where water depth was less than 4 feet. Netting material was 1-inch bar mesh nylon with a dark coating to reduce net visibility and to keep algal growth to a minimum.

Electrofishing was done using a backpack electrofishing unit (Smith-Root model 15A) by wading in Spicer Creek and Gun Creek where the substrate was firm and from a 7-foot inflatable raft in Burnt Ship Creek where the substrate was extremely soft. Electrofishing was done using a boat-mounted unit (either a Honda or Smith-Root generator, and an electrofisher Type VI or 2.5 GPP control box) in Woods Creek, Big Six Mile Creek, and Buckhorn Marsh impoundment. The boat used for boat electrofishing was either 15 feet long or 18 feet long.

Six 4-foot fyke nets were set in Buckhorn Marsh impoundment (Figure 2.1-1). On the east end, one net was set in a channel with its mouth facing the weir and wings extending to shore so that it could intercept fish if they migrated into the marsh from Woods Creek and another net was set just west of the net facing the weir, with its mouth facing away from the weir and wings extending to shore so that it could intercept fish migrating from the marsh to Woods Creek. Two nets were set on the west end with

their respective leads extending to shore, one net was set in the north channel facing east, and one was set in the south channel facing east to provide sampling throughout the marsh between the weirs.

Three 4-foot fyke nets were set in Woods Creek (Figure 2.1-1). Between the east weir and the Niagara River, one net was set facing downstream to intercept fish entering the creek and one was set facing upstream to intercept fish leaving the creek. Upstream of the east weir, one net was set facing downstream to intercept fish swimming past the weir. On the first occasion that ice conditions permitted the setting of fyke nets (March 24, 2003), one of the three nets was set approximately 50 feet upstream of River Road, instead of immediately upstream of the east weir, for one twenty-four hour period. No nets were set at this location afterwards.

One 4-foot fyke net and one 2.5-foot fyke net were set in Burnt Ship Creek with their leads extending to shore in a direction intended to intercept fish entering the creek (Figure 2.1-1).

Two 2.5-foot fyke nets were set in both Gun (Figure 2.1-2) and Spicer Creeks (Figure 2.1-3), and two 4-foot fyke nets were set in Big Six Mile Creek (Figure 2.1-4).

2.1.1.2 Tagging and Handling

All yearling and older northern pike, yellow perch, largemouth bass and muskellunge (*Esox masquinongy*) were scanned for a PIT tag and a coded wire tag. Although it was not an objective of this study to determine the use of BMRP and the Grand Island tributaries by muskellunge, the species supports an important recreational fishery in the upper Niagara River and is known to be found in BMRP and the Grand Island tributaries. Therefore, muskellunge were measured and tagged opportunistically. If a tag was not detected and the fish was not healthy, it was measured and returned to the water without being tagged. If a PIT tag was detected, its number was recorded; if a coded wire tag was detected, its presence was recorded. PIT tag numbers were unique and were the principal source of information on when and where a fish was caught and tagged. Coded wire tags were used to help assess tag retention of PIT tags, along with visual observation of a scar at the insertion site for PIT tags.

In Buckhorn Marsh impoundment, Burnt Ship Creek, and Woods Creek, if no tag was detected in a northern pike, largemouth bass, yellow perch, or muskellunge and the fish was healthy and equal to or greater than a minimum size (which ranged from 150 mm to 200 mm depending on the species and when during the sampling program that the fish was caught), the fish was measured and implanted with a PIT tag and a coded wire tag, unless the coded wire tag injector malfunctioned. If the coded wire tag injector malfunctioned, a finclip was used. In Gun Creek, Spicer Creek, and Big Six Mile Creek only northern pike were measured and tagged.

A PIT tag was inserted into the isthmus using a 24-gage needle (Figure 2.1.1.2-1). Before implanting a PIT tag the tag number was recorded. A coded wire tag was inserted into either the left or right cheek. After tagging, the presence of the PIT tag and coded wire tag was verified using a PIT tag detector and a coded wire tag detector. If either tag could not be detected in the fish, a second tag was inserted into the fish. The fish were then returned to the water.

2.1.2 Young-of-the-Year Fish

2.1.2.1 Sampling

Seining was the primary method used for collecting young-of-the-year (YOY) fish. Electrofishing was selected to supplement collections of northern pike, largemouth bass, and yellow perch made by seining. Seining was done from the first week of June through the last week of September one day per week in Buckhorn Marsh impoundment, Burnt Ship Creek, and Woods Creek collectively and one day per week in Spicer Creek, Gun Creek, and Big Six Mile Creek collectively. Electrofishing was also done from the first week of June through the last week of September one day per week in Buckhorn Marsh impoundment, Burnt Ship Creek, and Woods Creek collectively and one day per week in Spicer Creek, Gun Creek, and Big Six Mile Creek collectively. Seines were made of ¼ inch mesh, were 6 feet deep, and were either 20 feet or 50 feet long. The 20-foot seine was used primarily in Gun Creek and Spicer Creek downstream of East River Road because the creeks are relatively narrow. The 50-foot seine was used in all other areas.

2.1.2.2 Marking and Handling

Those northern pike, largemouth bass, yellow perch and muskellunge caught with seines were immediately placed into 5 gallon plastic buckets. Young-of-the-year fish were marked according to Tables 2 and 3 in the Standard Operating Procedures in Appendix A. Marks (fin clips) were applied to the fish using sharp, blunt-ended scissors. Fish were not anesthetized.

2.1.3 Species Enumeration

In Buckhorn Marsh impoundment, Burnt Ship Creek, and Woods Creek all fish caught by fyke netting and seining were identified to species in the field where practicable and counted. In Gun Creek, Spicer Creek, and Big Six Mile Creek, only northern pike, largemouth bass, yellow perch, and muskellunge were routinely counted; the presence of other species was noted. Because electrofishing was used specifically to supplement the catch of northern pike, largemouth bass, and yellow perch, other species caught by electrofishing were not consistently enumerated (see Standard Operating Procedures in Appendix A).

2.1.4 Water Quality

Water quality measurements were taken at the surface immediately prior to seining, electrofishing, and tending fyke nets. Dissolved oxygen (DO) and temperature were measured using a YSI Oxymeter; conductivity was measured using an Oakton EC Tester, and pH was measured using a Oakton pH Tester2. All water quality equipment was calibrated according to the manufacturer's specifications at the beginning and end of each day. Specifications of the water quality meters are in Appendix A.

As part of another study, water surface elevations were collected on a 15-minute time step at 24 temporary locations during 2003 using In-Situ miniTROLL, Professional Model (30 psi) gauges. Data in the present report are for four locations: BSC-03 (in Burnt Ship Creek approximately 150 feet west of the west weir), BHM-01 (in Buckhorn Marsh impoundment approximately 100 feet east of the west weir),

BHM-02 (in Buckhorn Marsh impoundment approximately 150 feet west of the east weir), and WC-01 (in Woods Creek approximately 250 feet east of the east weir, Figure 2.1.4-1).

2.1.5 Habitat Characterization of the BMRP

To assess the fish spawning and nursery habitat in BMRP, data were collected along cross-sectional and longitudinal transects in Buckhorn Marsh impoundment and Burnt Ship Creek during late April 2003, before extensive growth of submerged aquatic vegetation (SAV) and emergent aquatic vegetation (EAV) was expected, and during August 2003, when SAV and EAV were expected to be at their peak.

In Buckhorn Marsh impoundment, sixteen cross-sectional transects were established (Figure 2.1.5-1). The cross-sectional transects were perpendicular to the centerline of the channel. Each cross-sectional transect traversed the bankfull width of the channel or up to a point where fish passage would be precluded. At approximately every 10 feet along each cross-sectional transect, water depth, substrate type, percent cover of each species of SAV and EAV (in 10% increments), approximate % decomposing vegetation (e.g., decomposing SAV, EAV or deciduous leaves) and instream and riparian cover were measured and recorded. The percent cover of SAV is presented as "sparse" (10, 20%), "moderately dense" (30, 40, 50%), "dense" (60, 70%) and "very dense" (80, 90, 100%).

In Burnt Ship Creek, a longitudinal transect was established along the channel centerline from the mouth at the Niagara River upstream to a foot path east of Route 190 (Figure 2.1.5-1). The start and end of open water areas, EAV, SAV, or other unique habitats along the channel's centerline were delineated. Water depths and substrates were recorded every 100 feet, and at least one measurement in each emergent vegetation stand if the stand was less than 100 feet long, in all habitat types in an effort to determine pathways for fish passage. Two cross-sectional transects were established in the open water channel of Burnt Ship Creek. These transects were located near fyke net sites. Data were collected as described for Buckhorn Marsh impoundment.

2.2 Analytical Methods

Analytical methods were developed by Dennis Dunning (Ph.D.) and John Magee (CFP), who also conducted the analyses and interpreted the results.

2.2.1 Population Estimates for Northern Pike

2.2.1.1 Buckhorn Marsh Impoundment

For Buckhorn Marsh impoundment, two multiple-census methods for closed populations were used for estimating the abundance of yearling and older northern pike: the Schumacher and Eschmeyer and the modified Schnabel (Ricker 1975). They will produce unbiased estimates if the following conditions are met: 1) marked fish suffer the same natural mortality as the unmarked fish, 2) marked fish are as vulnerable to capture as the unmarked ones, 3) marked fish do not lose their mark, 4) marked fish become randomly mixed with unmarked fish or the distribution of fishing effort in subsequent sampling is proportional to the number of fish present in different parts of the body of water, 5) all marks are recognized and reported on recovery, and 6) there is only a negligible amount of emigration or recruitment to the catchable population during the time the recaptures were being made (i.e., the population is closed). Additionally, to reduce the potential effects of angling, the population estimates covered the period from March 24, the first date that northern pike were tagged in Buckhorn Marsh impoundment through May 2, the day before the season for legally harvesting northern pike opened.

The best estimate of abundance N using the Schumacher and Eschmeyer method (equation 3.12 in Ricker 1975) is the reciprocal of:

$$1/N = \sum(M_t R_t) / \sum(C_t M_t^2)$$

where

N is the estimate of abundance,

M_t is the total marked fish at large at the start of the *t*th day (i.e., the number previously marked less any accidentally killed at previous recaptures),

M is the sum of M_t, the total number marked,

C_t is the total number caught on day *t*,

R_t is the number of recaptures in the sample $C_{t,,}$ and

R is the sum of R_t, the total recaptures during the period of the estimate.

The variance (equation 3.13 in Ricker 1975) is:

$$s^2 = (\sum (R^2{}_t / C_t) - (\sum R_t M_t)^2 / \sum (C_t M_t{}^2)) / m - 1$$

where m is the number of catches examined. Instead of computing confidence limits directly for N, it is better to compute them for the more symmetrically distributed 1/N (Ricker 1975). The variance of 1/N (equation 3.14 in Ricker 1975) is:

$$s^2 / (\sum C_t M_t^2)$$

For computing confidence limits for 1/N, *t*-values were used corresponding to m-1 degrees of freedom. Confidence limits for N were found by inverting those obtained for 1/N.

The best estimate of abundance N using the adjusted Schnabel method (equation 3.17 in Ricker 1975) is:

$$N = \sum(C_t M_t)/(R+1)$$

where approximate 95% confidence limits were calculated by considering R as a Poisson variable (from Appendix II in Ricker 1975):

$$N + 1.92 \pm 1.96\sqrt{N+1.0}$$

2.2.1.2 Woods Creek and Gun Creek

For Woods Creek and Gun Creek, two multiple-census methods for open populations were used: Bailey's triple catch method for small samples and the modified Jolly-Seber 4-catch method (Ricker 1975). They will produce unbiased estimates if the first five conditions listed for the closed population methods are met. The open population methods, unlike those for closed populations, allow the number of northern pike to change due to migration, mortality, recruitment or some combination of those. Northern pike typically migrate into and out of spawning areas during the spring.

Bailey's triple catch method uses fish caught during three time periods. During the first period (Time 1), fish are tagged. During Time 2, recaptures are noted, fish not previously tagged are tagged, and all fish are returned to the water. During Time 3, recaptures from fish tagged during Time 1 and Time 2 are noted. The best estimate of abundance N_2 using Bailey's triple catch method for small samples (equation 5.11 in Ricker 1975) is:

$$N_2 = M_2(C_2+1)(R_{13})/(R_{12}+1)(R_{23}+1)$$

where

N_2 is the abundance of fish during time 2,

M_2 is the number of fish tagged during time 2,

C_2 is the number of fish caught and examined for tags during time 2,

R_{12} is the number of fish recaptured during time 2 that were tagged during time 1,

R_{13} is the number of fish recaptured during time 3 that were tagged during time 1,

R_{13} is the number of fish recaptured during time 3 that were tagged during time 1,

R_{23} is the number of fish recaptured during time 3 that were tagged during time 2.

The variance of N_2 (equation 5.14 in Ricker 1975) is:

$$V = N_2^2 - [M_2^2 (C_2 + 1)(C_2 + 2)(R_{13})(R_{13} - 1)/(R_{12} + 1)(R_{12} + 2)(R_{23} + 1)(R_{23} + 2)]$$

The modified Jolly-Seber 4-catch method uses fish caught during four time periods. During the first period (Time 1), fish are tagged. During Time 2, the total catch and the recaptured fish are enumerated, fish not previously tagged are tagged, and all fish are returned to the water. During Time 3, recaptures from fish tagged during Time 1 and Time 2 are enumerated, fish not previously tagged are tagged, and all fish are returned to the water. During Time 4, recaptures from fish tagged during Time 1, Time 2, and Time 3 are enumerated. The best estimate of N_i using the modified Jolly-Seber 4-catch method (equation 5.22 in Ricker 1975) is:

$$N_i = \beta_i (C_i + 1)/m_i + 1$$

where (equation 5.21 in Ricker 1975)

$$\beta_i = [(M_i + 1)K_i/(R_i + 1)] + m_i + 1$$

and

M_i is the number of fish tagged during Time 1, Time 2, and Time 3,

C_i is the number of fish caught and examined for tags during Time 2, Time 3, and Time 4,

R_i is the number of fish recaptured during a recapture time period summed across all tagging periods,

m_i is the total number of fish recaptured during a tagging period summed across all recapture periods,

K_i is the number of fish recaptured during a recapture time period summed across all tagging periods minus the recaptures from first tagging period for each recapture period.

The variance (equation 5.23 in Ricker 1975) is:

$$S_i = \beta_{i+1}/(\beta_i - m_i + M_i)$$

2.2.2 Length Comparisons

The mean length of yearling and older northern pike in Buckhorn Marsh impoundment was compared to the mean lengths of yearling and older northern pike in Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek using the ANOVA approach in PROC GLM of SAS/STAT (SAS 1989). Two options were specified with the MEANS statement: DUNCAN and LSD. DUNCAN performs Duncan's multiple range test on all main effect means in the MEANS statement. LSD performs a pairwise *t*-test, equivalent to Fisher's least-significant-difference test in the case of equal cell sizes, for all main effect means in the MEANS statement. The lengths were also compared using the Chi-Square approach in PROC FREQ of SAS/STAT.

The mean length of YOY northern pike in Buckhorn Marsh impoundment was compared to the mean length of YOY in Woods Creek, Gun Creek, and Big Six Mile Creek combined using the GLM procedure of SAS/STAT.

The mean length of YOY largemouth bass in Buckhorn Marsh impoundment was compared to the mean lengths of YOY in Burnt Ship Creek and Woods Creek using the GLM procedure of SAS/STAT. One option was specified in the MEANS statement, DUNCAN.

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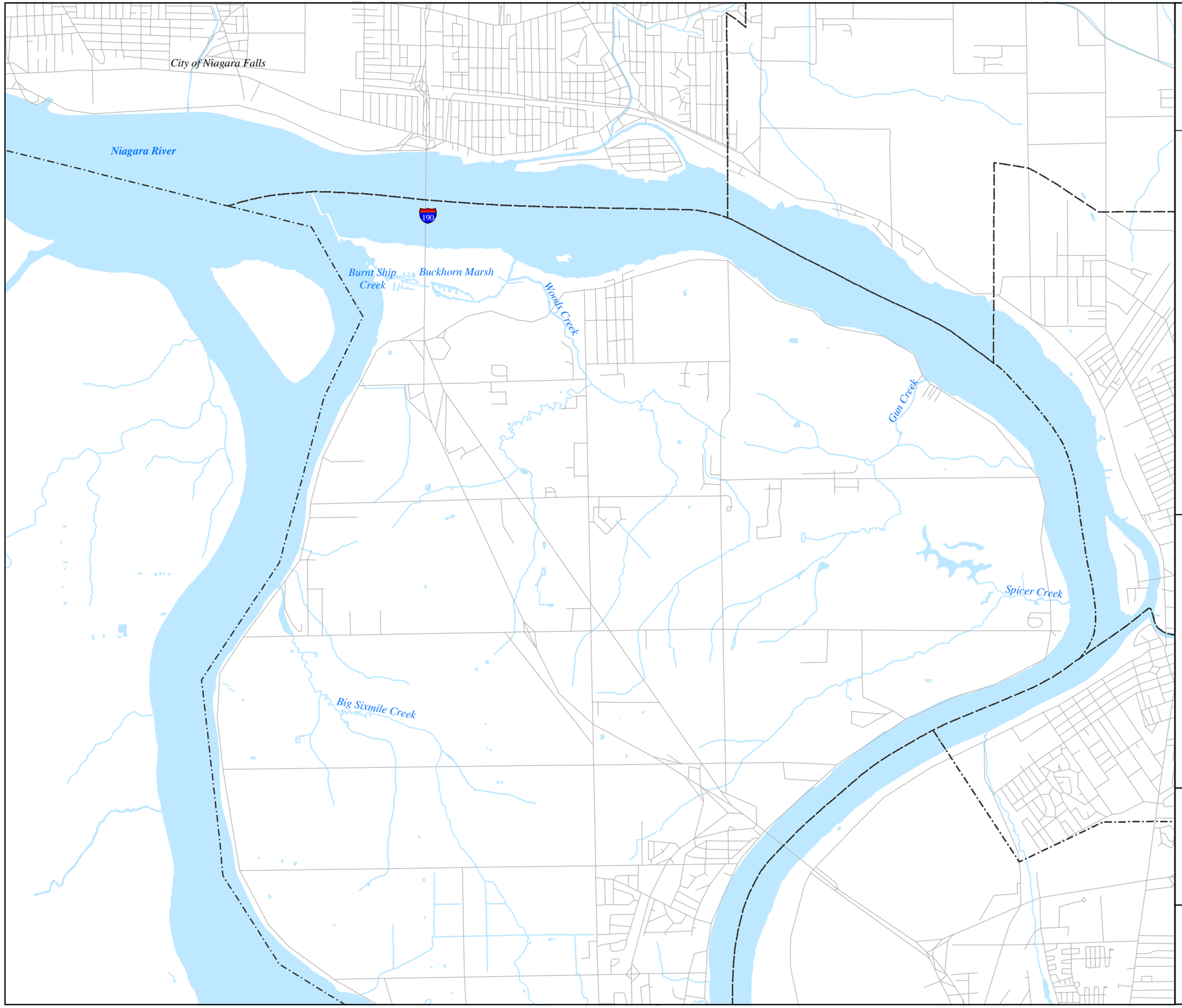
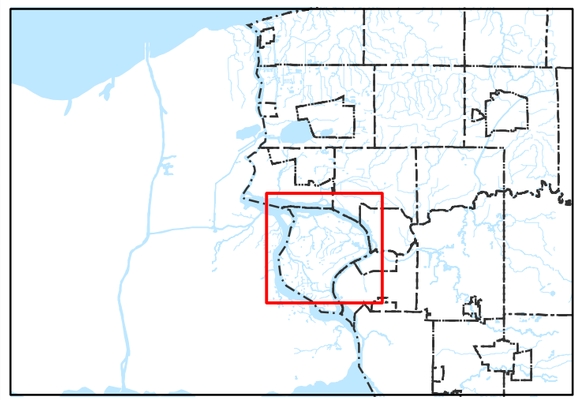
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Investigation Area



LEGEND

- Roads
- Streams
- Water Bodies
- Municipal Boundaries



0 2,000 4,000 8,000 Feet

N

FIGURE 2.0-1

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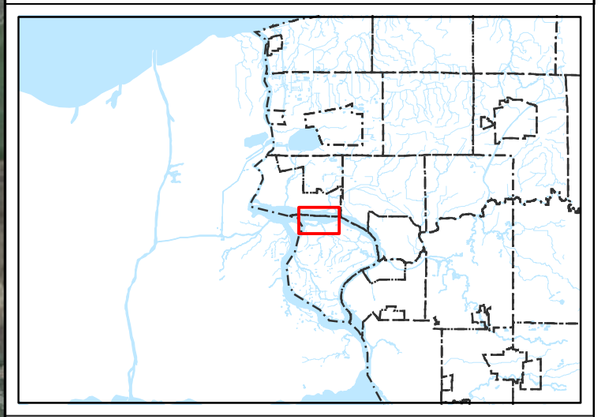
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY
Locations of Fyke Nets, Seining, and Electrofishing in Buckhorn Marsh Impoundment, Burnt Ship Creek and Woods Creek

LEGEND

- Fyke Net Location
- Seine Location
- Electrofishing Location



0 325 650 1,300 Feet

N

FIGURE 2.1-1

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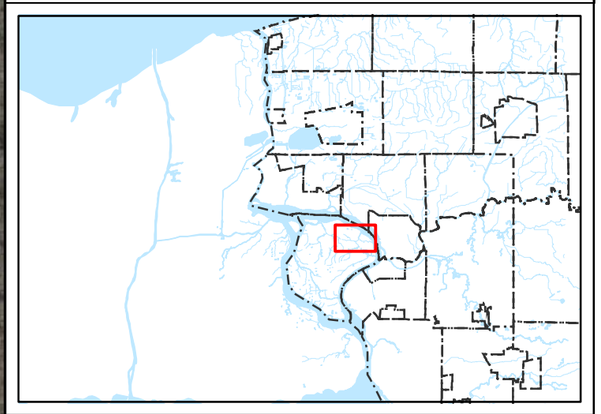
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Locations of Fyke Nets, Seining, and Electrofishing in Gun Creek

LEGEND

- Fyke Net Location
- Seine Location
- Electrofishing Location



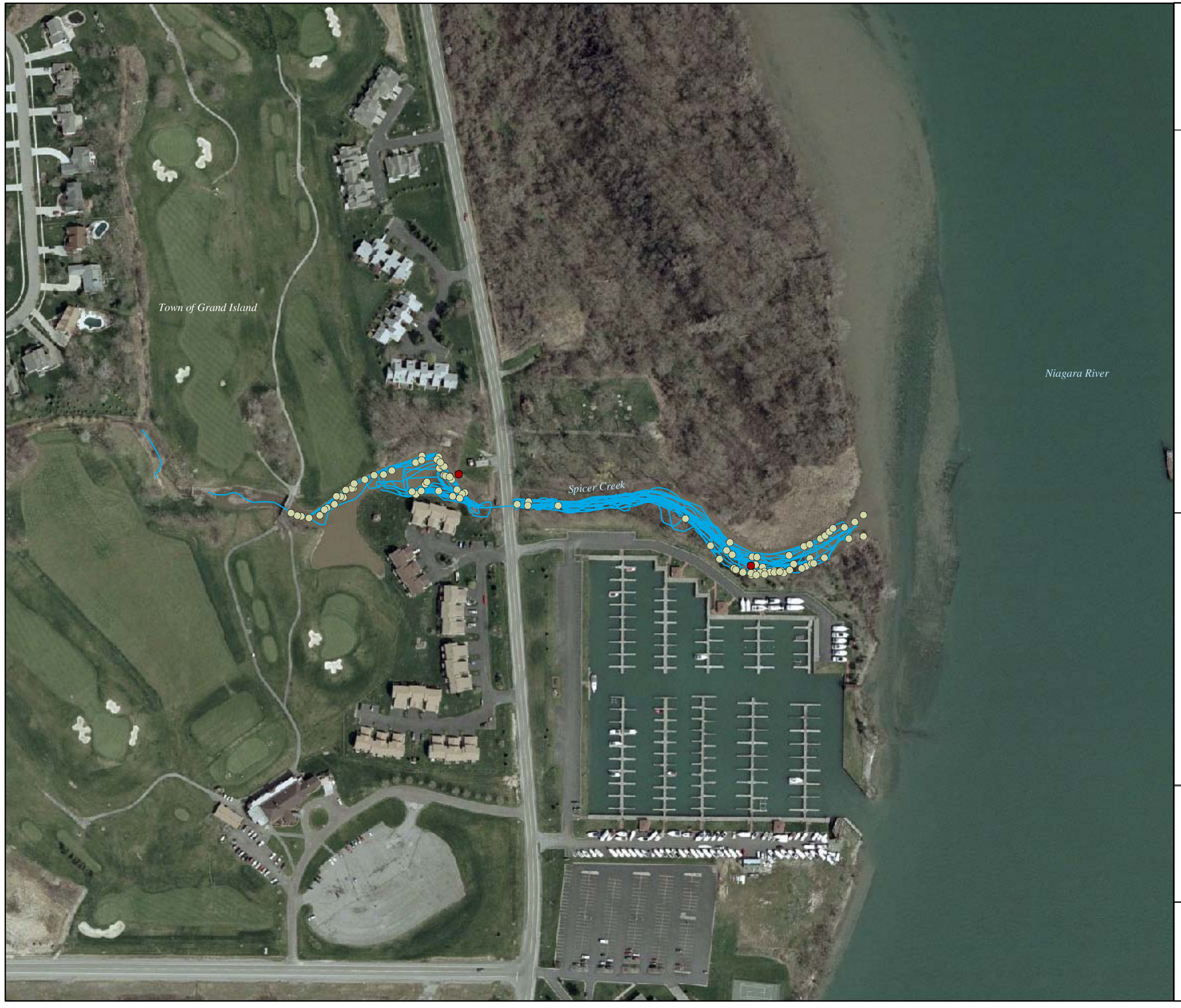
0 150 300 600 Feet

N

FIGURE 2.1-2

New York Power Authority

NIAGARA POWER PROJECT

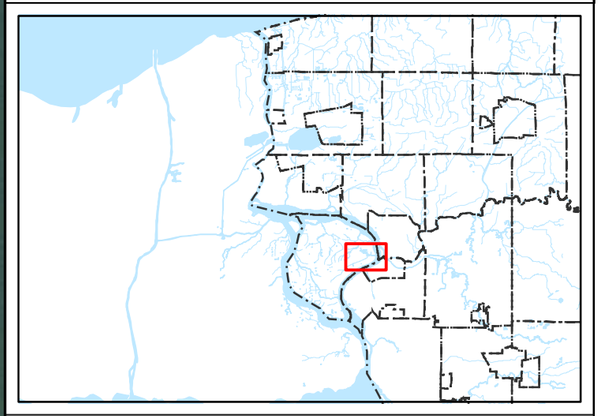


NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Locations of Fyke Nets, Seining, and Electrofishing in Spicer Creek

LEGEND

- Fyke Net Location
- Seine Location
- Electrofishing Location



0 125 250 500 Feet

N

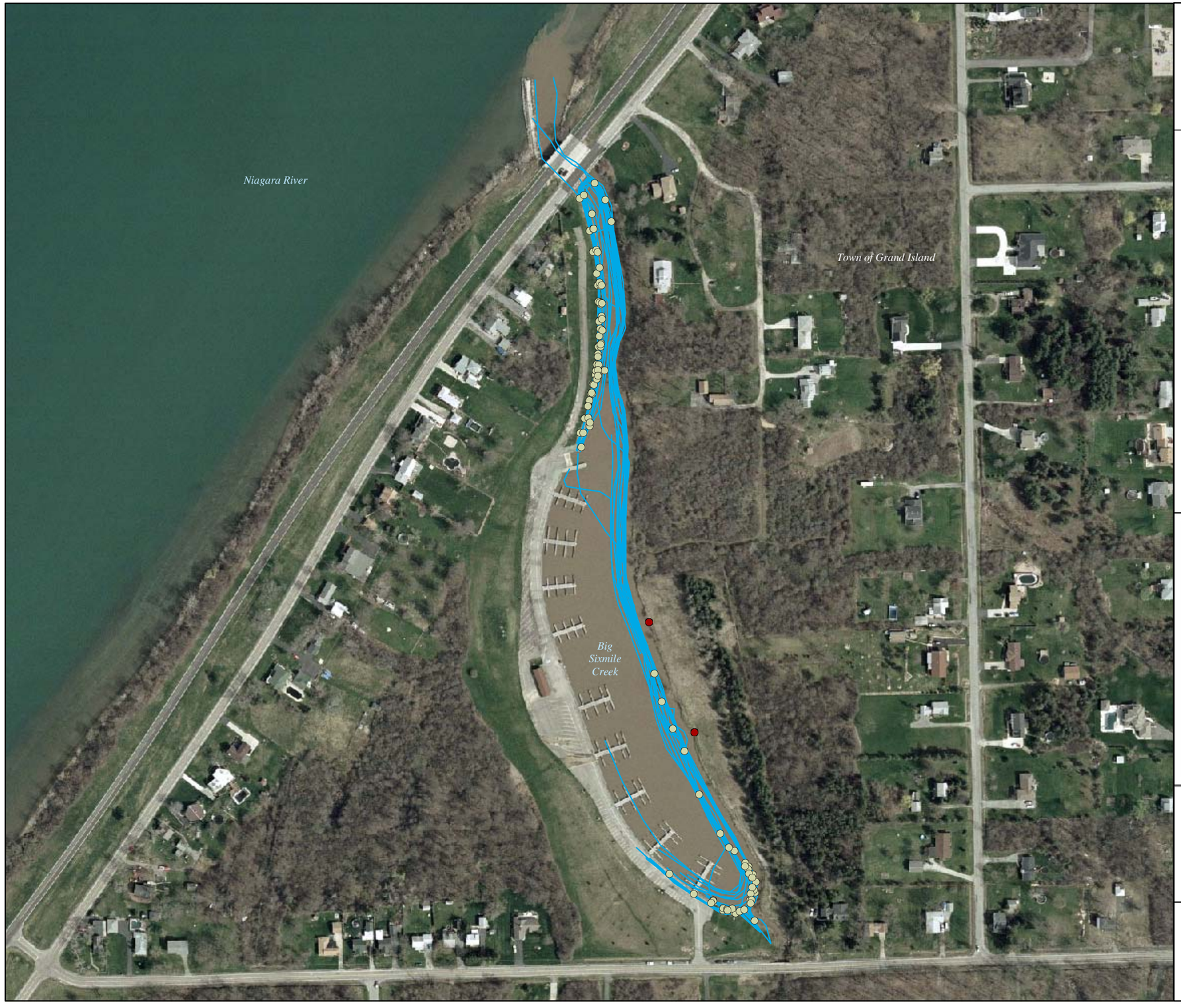
FIGURE 2.1-3

New York Power Authority

NIAGARA POWER PROJECT

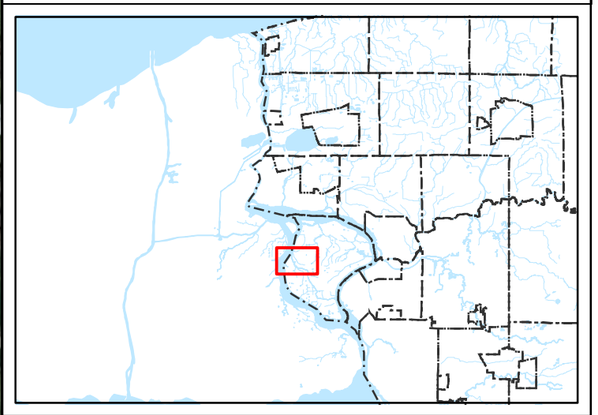
NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Locations of Fyke Nets, Seining, and Electrofishing in Big Sixmile Creek



LEGEND

- Fyke Net Location
- Seine Location
- Electrofishing Location



0 125 250 500 Feet

N

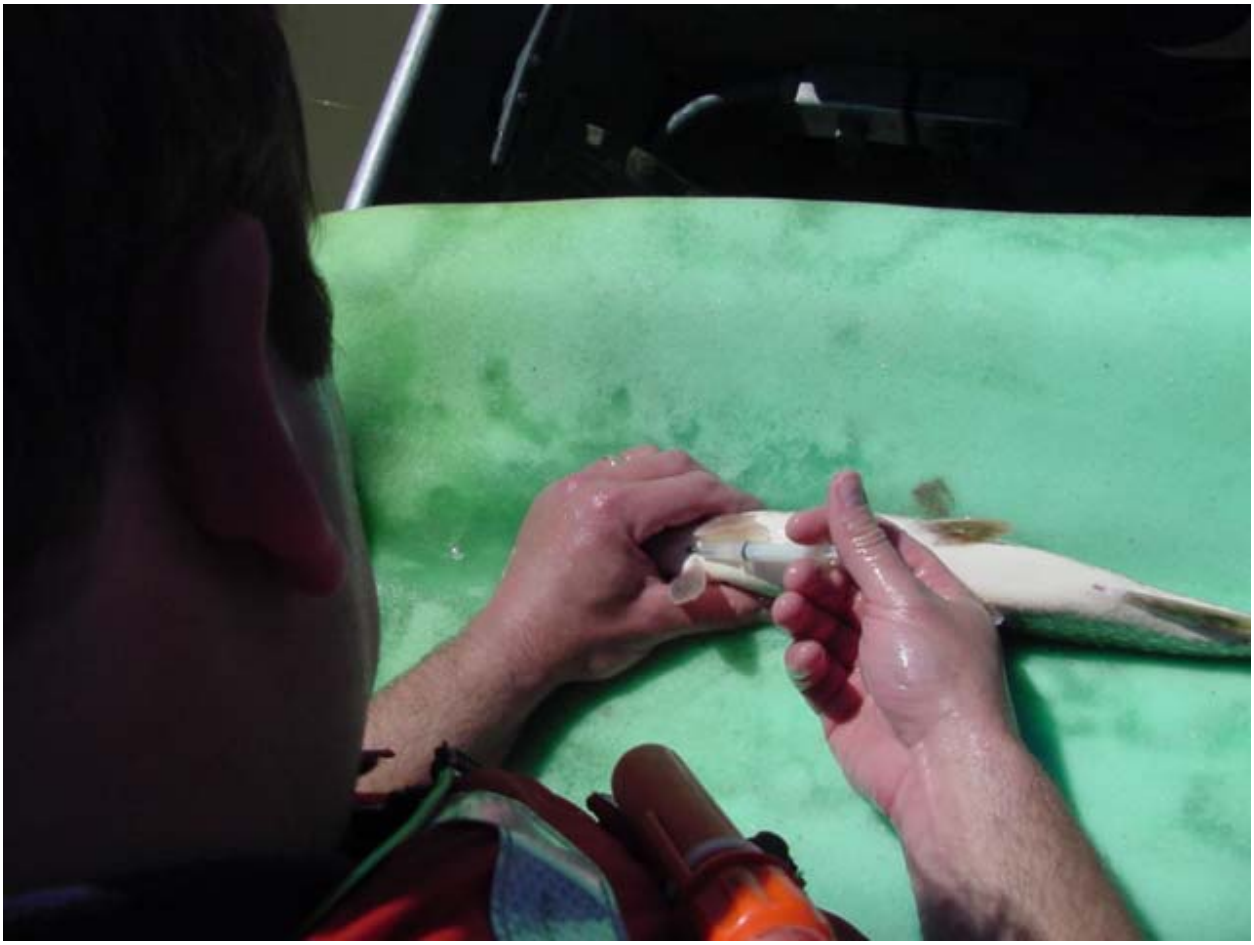
FIGURE 2.1-4

New York Power Authority

NIAGARA POWER PROJECT

FIGURE 2.1.1.2-1

INSERTION OF PIT TAG INTO THE ISTHMUS OF A NORTHERN PIKE

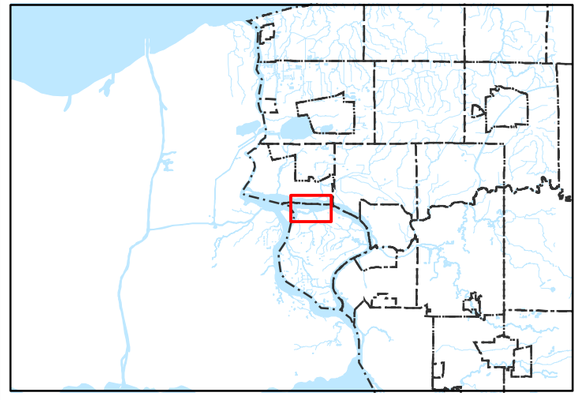


NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Location of Water Level Gauges

LEGEND

- Temporary Water Level Gauges - 2003



0 200 400 800 Feet

N

FIGURE 2.1.4-1

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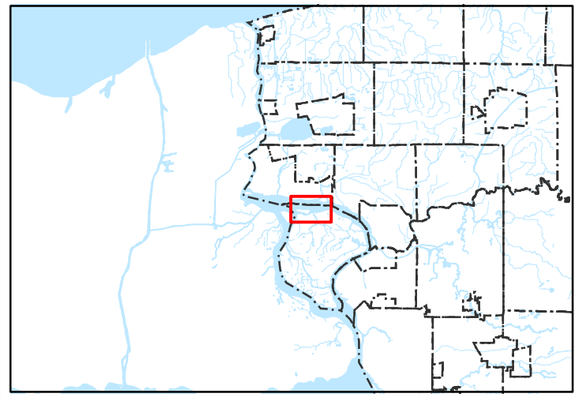
NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Locations of Habitat Transects

LEGEND

Habitat Transect



0 250 500 1,000 Feet

N

FIGURE 2.1.5-1

New York Power Authority

NIAGARA POWER PROJECT

3.0 RESULTS

3.1 Buckhorn Marsh Restoration Project

Northern pike and largemouth bass were caught in Buckhorn Marsh impoundment and in Burnt Ship Creek and one small yellow perch was caught in Burnt Ship Creek.

3.1.1 Buckhorn Marsh Impoundment

3.1.1.1 Yearling and Older Northern Pike

Fyke netting in Buckhorn Marsh impoundment caught 190 yearling and older northern pike; 48 in fyke nets BHM1 and BHM2 on the eastern end, 79 in fyke nets BHM4 and BHM5 on the western end, and 63 in fyke nets BHM3 and BHM6 in the central portion (Table 3.1.1.1-1). Of those, 20 were tagged from fyke nets BHM1 and BHM2, 27 from fyke nets BHM4 and BHM5, and 25 from BHM3 and BHM6 (Table 3.1.1.1-2). All fish were tagged during the period March 28 through April 18 except one, tagged on May 14. The tagged fish included 24 males, 9 females, and 39 whose sex could not be determined (Table 3.1.1.1-3). They ranged in length from 295 mm to 575 mm with a mean of 385 mm (Appendix B, Table B-1). Seining caught a 512 mm long northern pike on July 15. Only two tagged fish were recaptured without a tag; they were retagged.

Only one northern pike caught in Buckhorn Marsh impoundment was previously caught and tagged outside Buckhorn Marsh impoundment. It was a male, 647 mm long when tagged in Woods Creek on March 25 and 647 mm long when recaptured on May 7. No northern pike caught and tagged in Buckhorn Marsh impoundment were caught anywhere else sampled during this study.

The estimated number of yearling and older northern pike during the period March 28 through May 2, excluding the male initially caught in Woods Creek, was 85 using the Schumacher and Eschmeyer method and 87 using the adjusted Schnabel method (Appendix C, Table C-1). The 95% confidence

interval was 77 to 95 for the Schumacher and Eschmeyer estimate and 71 to 108 for the Schnabel estimate.

3.1.1.2 Young-of-the-Year Northern Pike

Seining in Buckhorn Marsh impoundment caught 77 YOY northern pike from June 11 to September 30. They ranged in length from 69 mm to 296 mm (Appendix B, Table B-1). The monthly mean length increased from 85 mm during June to 114 mm during July, 148 mm during August, and 166 mm during September. Of the 77 YOY caught, 72 were finclipped and 5 were recaptured. The estimated number of YOY northern pike based on fish marked and recaptured during August and September was 241 using the Schumacher-Eschmeyer method and 204 using the Schnabel method. The 95% confidence interval was 167 to 435 for the Schumacher-Eschmeyer estimate and 178 to 234 for the Schnabel estimate (Appendix C, Table C-2).

3.1.1.3 Yearling and Older Largemouth Bass

Fyke netting in Buckhorn Marsh impoundment caught eight yearling and older largemouth bass; all were tagged and none were recaptured. Two of the eight were females; the sex of the other six could not be determined. They ranged in length from 335 mm to 419 mm with a mean of 372 mm.

3.1.1.4 Young-of-the-Year Largemouth Bass

Seining in Buckhorn Marsh impoundment caught 92 YOY largemouth bass. Of those, 73 were measured and finclipped; they ranged in length from 39 mm to 132 mm with a mean of 64 mm. No finclipped YOY largemouth bass were recaptured.

3.1.1.5 All Fish Species

Seining, electrofishing, and fyke netting in Buckhorn Marsh impoundment caught 21 species of fish (Table 3.1.1.5-1, Appendix F, Table F-1). Some fish caught were only identified as belonging to the sunfish genus, the minnow family, or the sunfish family.

Seining caught 2,355 fish. They were identified as belonging to 18 species and 1 genus (Table 3.1.1.5-2). Sunfish (those identified as *Lepomis sp*.) were the most abundant genera, comprising 40.4% of all fish caught, while brown bullheads was the most abundant species and comprised 17.1% of all fish caught. Northern pike comprised 3.3% of all fish caught and largemouth bass comprised 3.9%. No yellow perch were caught.

Fyke netting caught 993 fish of 14 species (Table 3.1.1.5-3). Pumpkinseeds were most abundant, comprising 30.3% of all fish caught. Largemouth bass comprised 0.8% and northern pike 19.1% of all fish caught. No yellow perch were caught.

Electrofishing caught 10 fish species; some fish were only identified as belonging to the minnow family or the sunfish family (Table 3.1.1.5-4, Appendix F, Table F-2). Four largemouth bass and no northern pike or yellow perch were caught.

3.1.1.6 Aquatic Habitat Characterization

In the Buckhorn Marsh impoundment, the depth, profile, and substrate of the channel were relatively similar at all transects. The maximum depth was about 6 feet. The edge of the channel generally included a small shelf with water less than 2 feet deep (Figures 3.1.1.6-1 and 3.1.1.6-2). The substrate was generally mud, muck and silt with almost no sand (Figures 3.1.1.6-3 and 3.1.1.6-4). Muck substrates were characterized by soft, organic sediments with high water content.

3.1.1.6.1 April 2003

Very little decaying vegetation was present in the Buckhorn Marsh impoundment during April 2003 (Figure 3.1.1.6.1-1). The abundance of submerged aquatic vegetation (SAV) was generally sparse, moderately dense, or dense, although transects 14, 15 and 16, located in the western portion had very dense SAV (Figure 3.1.1.6.1-2). The SAV included nine species, three of which were common to most transects and made up the majority of the SAV coverage: coontail (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), and pondweed (*Potamogeton* species). Five species were found only in western transects (9-12); Eurasian milfoil (*Myriophyllum spicatum*) was found in transects 11-13. Seven species were only found in eastern transects (1-4) and water celery (*Vallisneria americana*) and water stargrass (*Zosterella dubia*) were found only in transects 1-6.

During April 2003, emergent aquatic vegetation (EAV) in the Buckhorn Marsh impoundment was present at the edges of the channel in all transects (Figure 3.1.1.6.1-2). The most pervasive species of EAV, and often the only one present, was cattail (*Tyhpa latifolia*). Purple loosestrife (*Lythrum salicaria*), cat greenbriar (*Smilax glauca*), yellow pond lily (*Nuphar lutea)*, green arrow arum (*Peltandra virginica)*, and upright sedge (*Carex stricta*) were occasionally present in isolated patches comprising 20% or less of the EAV. Transect 16 had the greatest number of EAV species (5), and cattail dominated the EAV along it.

3.1.1.6.2 August 2003

Very little decaying vegetation was present in the Buckhorn Marsh impoundment during August 2003 (Figure 3.1.1.6.2-1). SAV was generally very dense in all open water areas along the transects (Figure 3.1.1.6.2-2). Thirteen species of SAV were found along the transects. Most of the SAV was sparse to moderately dense and non-uniformly distributed. Coontail was common along all transects and often made up the majority of the SAV present, while stargrass was common in transects 1-4, but found in isolated patches elsewhere. Pondweed was sparse to moderate in coverage at all transects. Waterweed was present along most transects and its abundance was sparse to very dense.

During August 2003, cattail was generally the most abundant EAV along all the transects in the Buckhorn Marsh impoundment. Several transects (1, 3, 5-9, 11, and 16) had species other than cattail that made up 20% to 50% of the total EAV. These species were purple loosestrife, swamp verbena (*Verbena hastata*), pickerelweed (*Pontederia cordata*), earth loosestrife (*Lysimachia terrestris*), common rush (*Juncus effusus*), and common reed (*Phragmites australis*).

3.1.1.7 Water Quality

In Buckhorn Marsh impoundment, pH averaged 7.9 and ranged from 7.3 to 8.8; DO averaged 6.4 ppm, and ranged from 2.6 to 11.1 ppm, temperature averaged 15.8° C and ranged from 1.2° C to 27.8° C, and conductivity averaged 320 *u*mhos/cm and ranged from 270 *u*mhos/cm to 1,034 *u*mhos/cm (Appendix D, Table D-1).

3.1.2 Burnt Ship Creek

3.1.2.1 Yearling and Older Northern Pike

Fyke netting in Burnt Ship Creek caught two yearling and older northern pike; both were caught on March 29 and tagged. One of the two fish was a female 505 mm long. The other was 363 mm long; its sex could not be determined.

3.1.2.2 Young-of-the-Year Northern Pike

Seining in Burnt Ship Creek caught four YOY northern pike and electrofishing caught one from June 26 through August 28; all were finclipped. They ranged in length from 109 mm to 192 mm. None of the YOY were recaptured.

3.1.2.3 Yearling and Older Largemouth Bass

Fyke netting in Burnt Ship Creek caught five yearling and older largemouth bass and electrofishing caught one. Of those, one was tagged. They ranged in length from 140 mm to 446 mm with a mean of 252 mm. Seining caught a 179 mm long and a 199 mm long largemouth bass.

3.1.2.4 Young-of-the-Year Largemouth Bass

Seining in Burnt Ship Creek caught 114 YOY largemouth bass and electrofishing caught 16. They ranged in length from 39 mm to 112 mm with a mean of 59 mm. Of the 130 YOY caught, 73 were finclipped and none were recaptured.

3.1.2.5 All Fish Species

Seining, electrofishing, and fyke netting in Burnt Ship Creek caught 25 species of fish (Table 3.1.2.5-1, Appendix F, Table F-3). Some fish caught were only identified as belonging to the sunfish genus, the minnow family, or stickleback family.

Seining caught 1,512 fish. They were identified as belonging to 21 species (Table 3.1.2.5-2). Some fish were only identified as belonging to the sunfish genus or stickleback family. Central mudminnow was the most abundant species, comprising 27% of all fish caught. Northern pike accounted for 0.3 % and largemouth bass 9.9%. Two muskellunge were also caught.

Fyke netting caught 222 fish of 13 species (Table 3.1.2.5-3). Pumpkinseeds were the most abundant, comprising 59.9 % of all fish caught. Northern pike comprised 0.9% and largemouth bass 2.3% of all fish caught. One small yellow perch was caught but escaped through the mesh of the fyke net before it could be measured.

Electrofishing caught 19 species, 1 family, and 1 genus (Table 3.1.2.5-4, Appendix F, Table F-4). One northern pike, 17 largemouth bass, and no yellow perch were caught.

3.1.2.6 Aquatic Habitat Characterization

Water depth along the longitudinal Transect in Burnt Ship Creek ranged from 0.6 to 3.8 feet, with most being about 1.5 feet deep (Figures 3.1.2.6-1 and 3.1.2.6-2). Only two points along this Transect were about 3.6 and 3.8 feet; the next deepest point along it was about 2 feet. At Transect 1, there was a distinct east-west channel approximately 30 feet wide (north to south) and about 2 to 3 feet deep. North of this channel, the water was about 1.5 to 2 feet deep, becoming shallower only within about 10 feet of the north shore. Transect 2 was generally about 1 foot deep except for a very small section about 2.5 feet deep that was about 5 feet wide. From the mouth of Burnt Ship Creek to a distance approximately 600 feet southeast, the creek was completely occluded by very dense stands of cattail (Figures 3.1.2.6-1 and 3.1.2.6-2). Substrates were entirely mud and muck along the longitudinal transect and Transect 1, with only a small amount of silt at the very end of the longitudinal transect at the mouth of Burnt Ship Creek, and were entirely muck along Transect 2 (Figures 3.1.2.6-3 and 3.1.2.6-4).

3.1.2.6.1 April 2003

During April 2003, little or no decaying vegetation was present along the longitudinal transect except for a section about 100 to 500 feet west of Route I-190, where about 70% or more of the decaying vegetation was present. The water depth in this area was ~1 to 1.5 feet. Little or no decaying vegetation was present along the cross sectional transects (Figure 3.1.2.6.1-1).

SAV was sparse to moderately dense in the open water areas along the longitudinal transect and Transect 1 (Figure 3.1.2.6.1-2) and composed of coontail and waterweed. No SAV was present along Transect 2.

EAV was present at nearly every point along the longitudinal transect, was generally dense to very dense, and comprised mostly of cattail. A small amount of purple loosestrife and duckweed was present in two small areas, around the Route I-190 bridges and along the south side of the open water area approximately 400 feet west of cross section Transect 1. The most abundant species of EAV was cattail; purple loosestrife, American lotus (*Nelumbo lutea*), duckweed, and yellow pond lily were also present.

The area from the mouth to approximately 550 feet upstream was comprised of cattail that was moderately dense to very dense.

3.1.2.6.2 August 2003

During August 2003, about 70% or more of the decaying vegetation was present along the longitudinal transect approximately 100 to 500 feet west of Route I-190, the same locations at which decaying vegetation was present in April 2003 (Figure 3.1.2.6.2-1). Very little decaying vegetation was present along most of the rest of the longitudinal and cross section transects.

SAV was moderately dense to very dense in open water areas along the longitudinal transect and very dense along Transect 1 (Figure 3.1.2.6.2-2). The species of SAV were coontail, waterweed, common bladderwort, American white waterlily, stargrass, and pondweed. No SAV was present along Transect 2.

EAV was present at nearly every point along the longitudinal transect, was generally dense to very dense, and comprised mostly of cattail. The very dense stand of cattail that had grown in since April 2003 from the mouth to approximately 600 feet upstream made it impossible for the habitat survey crew to traverse through it (Figure 3.1.2.6.2-2). A small amount of purple loosestrife and duckweed was present in two small areas, around the Route I-190 bridges and along the south side of the open water area approximately 400 feet west of Transect 1. The most abundant species of EAV were purple loosestrife, jewelweed (*Impatiens capensis*), and broadleaf arrowhead (*Sagittaria latifolia*). The species of EAV present along the Transect 1 were cattail, reed canary grass (*Phalaris arundinacea*), joepyeweed (*Eupatorium maculatum*), purple loosestrife and jewelweed. Along Transect 2, the species of EAV were primarily cattail on the northern and southern ends and broadleaf arrowhead and arrowhead elsewhere.

3.1.2.7 Water Quality

In Burnt Ship Creek, pH averaged 7.9 and ranged from 6.9 to 9.6; DO averaged 6.7 ppm and ranged from 0.57 to 12.6 ppm, temperature averaged 14.1° C and ranged from 0.7° C to 23.7° C, and

conductivity averaged 1,085 *u*mhos/cm and ranged from 475 *u*mhos/cm to 1,990 *u*mhos/cm (Appendix D, Table D-2).

3.2 Woods Creek

3.2.1 Yearling and Older Northern Pike

Fyke netting in Woods Creek caught 217 yearling and older northern pike and electrofishing caught 5 from March 25 to July 3. Of those, 163 were tagged in Woods Creek and 54 were recaptured; 42 males, 33 females, and 88 whose sex could not be determined. The tagged fish ranged in length from 306 mm to 808 mm with a mean of 542 mm (Appendix B, Table B-1). Seining caught a 392 mm long and a 402 mm long northern pike. Only one tagged fish was recaptured without a tag. No northern pike caught in Woods Creek were previously caught and tagged elsewhere.

The estimated number of yearling and older northern pike in Woods Creek during the peak period March 30 through April 13 was 612 using the Jolly-Seber 4-catch method and 528 using the Bailey triple-catch method (Appendix C, Tables C-3 and C-4). The 95% confidence interval was 103 to 1,121 for the Jolly-Seber estimate and 0 to 1,208 for the Bailey estimate.

3.2.2 Young-of-the-Year Northern Pike

Seining in Woods Creek caught eight YOY northern pike and electrofishing caught one from June 25 to September 5. They ranged in length from 87 mm on June 25 to 277 mm on September 22 (Appendix B, Table B-2). The monthly mean length increased from 89 mm during June, to 150 mm during July, 172 mm during August, and 257 mm during September. Of the nine YOY caught, 7 were finclipped and one was recaptured.

3.2.3 All Fish Species

Seining, electrofishing, and fyke netting in Woods Creek caught 32 species of fish (Table 3.2.3-1, Appendix F, Table F-5). Some fish caught were only identified as belonging to the sunfish genus, the redhorse genus, the minnow family, or the sunfish family.

Seining caught 994 fish (Table 3.2.3-2). They were identified as belonging to 19 species, one family, and one genus. Pumpkinseeds were the most abundant, comprising 39.1 % of all fish caught. Northern pike comprised 1% of all fish caught and largemouth bass comprised 15.5%. No yellow perch were caught. Five muskellunge were also caught. Fyke netting caught 7,875 fish of 27 species, one family and one genus (Table 3.2.3-3). Rock bass were most abundant, comprising 25.9% of all fish caught. Northern pike comprised 2.8% and largemouth bass 8.6% of all fish caught. Fifteen muskellunge were also caught.

Electrofishing caught 18 species, two families, and one genus (Table 3.2.3-4, Appendix F, Table F-6). Six northern pike, 179 largemouth bass, and 5 yellow perch were caught.

3.2.4 Water Quality

In Woods Creek, pH averaged 8.1 and ranged from 7.4 to 9.2; DO averaged 8.9 ppm and ranged from 3.2 to 13.9 ppm, temperature averaged 13.5°C and ranged from 0.9°C to 25.1°C, and conductivity averaged 515 *u*mhos/cm and ranged from 220 *u*mhos/cm to 1,085 *u*mhos/cm (Appendix D, Table D-3).

3.3 Gun Creek

3.3.1 Yearling and Older Northern Pike

Fyke netting in Gun Creek caught 160 yearling and older northern pike and electrofishing caught 2 from March 25 to June 10. Of those, 129 were tagged: 47 males, 23 females, and 59 whose sex could not be determined. The tagged fish ranged in length from 104 mm to 770 mm with a mean of 542 mm

(Appendix B, Table B-1). No tagged fish were recaptured without a tag. No northern pike caught in Gun Creek were previously caught and tagged elsewhere.

The estimated number of yearling and older northern pike in Woods Creek during the peak period March 30 through April 13 was 255 using the Jolly-Seber 4-catch method and 159 using the Bailey triple-catch method (Appendix C, Tables C-5 and C-6). The 95% confidence interval was 0 to 530 for the Jolly-Seber estimate and 0 to 410 for the Bailey estimate.

3.3.2 Young-of-the-Year Northern Pike

Seining in Gun Creek caught 19 YOY northern pike and electrofishing caught 1 from June 9 to September 4. They ranged in length from 62 mm on June 25 to 202 mm on September 4 (Appendix B, Table B-2). The monthly mean length increased from 91 mm during June, to 106 mm during July, 162 mm during August, and 196 mm during September. Of the 20 YOY caught, 14 were finclipped and one was recaptured.

3.3.3 All Fish Species

Seining, electrofishing, and fyke netting in Gun Creek caught 29 species, one family, and two genera (Table 3.3.3-1, Appendix F, Table F-7). Some fish caught were only identified as belonging to the sunfish genus, the redhorse genus, or the minnow family. Among the fish caught were 107 largemouth bass, 20 yellow perch, and 3 muskellunge.

3.3.4 Water Quality

In Gun Creek, pH averaged 8.1 and ranged from 7.1 to 9.2; DO averaged 7.1 ppm and ranged from 2.3 to 12.1 ppm, temperature averaged 13.4° C and ranged from 0.3° C to 24.2° C, and conductivity averaged 425 *u*mhos/cm and ranged from 240 *u*mhos/cm to 800 *u*mhos/cm (Appendix D, Table D-4).

3.4 Big Six Mile Creek

3.4.1 Yearling and Older Northern Pike

Fyke netting in Big Six Mile Creek caught 14 yearling and older northern pike and electrofishing caught 1 from April 2 to June 4; all were tagged and none were recaptured. The tagged fish ranged in length from 363 mm to 817 mm long with a mean of 604 mm (Appendix B, Table B-1). Five of the tagged fish were males and six were females; the sex of the other four could not be determined. Seining caught three yearling and older northern pike; the first on June 9 was 268 mm long, the second on June 25 was 448 mm long, and the third on July 23 was 552 mm long.

3.4.2 Young-of-the-Year Northern Pike

Seining in Big Six Mile Creek caught 17 YOY northern pike from June 2 to September 5 and all but one were finclipped. The finclipped fish ranged in length from 109 mm to 192 mm (Appendix B, Table B-2). The monthly mean length increased from 77 mm during June, to 183 mm during August, and 236 mm during September; none were caught during August. None of the YOY were recaptured.

3.4.3 All Fish Species

Seining, electrofishing, and fyke netting caught 34 species of fish in Big Six Mile Creek (Table 3.4.3-1, Appendix F, Table F-8). Some fish caught were only identified as belonging to the sunfish genus, the redhorse genus, the minnow family, or the sunfish family. Among the fish caught were 742 largemouth bass, 48 yellow perch, and 14 muskellunge.

3.4.4 Water Quality

In Big Six Mile Creek, pH averaged 8.1 and ranged from 7.0 to 9.2; DO averaged 8.5 ppm and ranged from 5.4 to 15.9 ppm, temperature averaged 15.7° C and ranged from 1.0° C to 25.1° C, and

conductivity averaged 373 *u*mhos/cm and ranged from 240 *u*mhos/cm to 600 *u*mhos/cm (Appendix D, Table D-5).

3.5 Spicer Creek

3.5.1 Yearling and Older Northern Pike

Fyke netting in Spicer Creek caught 25 yearling and older northern pike and electrofishing caught 1 from April 12 to June 3; 24 were tagged and 2 were recaptured. The tagged fish ranged in length from 335 mm to 754 mm long with a mean of 542 mm (Appendix B, Table B-1). Eleven were males and 2 were females; the sex of the other 11 could not be determined.

3.5.2 Young-of-the-Year Northern Pike

No YOY northern pike were caught in Spicer Creek.

3.5.3 All Fish Species

Seining, electrofishing, and fyke netting in Spicer Creek caught 34 species of fish (Table 3.5.3-1, Appendix F, Table F-9). Some fish caught were only identified as belonging to the sunfish genus or the minnow family. Among the fish caught were 200 largemouth bass, 3 yellow perch and 17 muskellunge.

3.5.4 Water Quality

In Spicer Creek, pH averaged 8.1 and ranged from 7.1 to 9.2; DO averaged 8.6 ppm and ranged from 3.2 to 18.1 ppm, temperature averaged 14.0° C and ranged from 0.3° C to 27.6° C, and conductivity averaged 770 *u*mhos/cm and ranged from 220 *u*mhos/cm to 2,200 *u*mhos/cm (Appendix D, Table D-6).

3.6 Northern Pike Length Data

The mean lengths of yearling and older northern pike caught by fyke netting and electrofishing and tagged in Buckhorn Marsh impoundment, Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek were significantly different ($F=31.80$, $df=4$, $P<0.0001$). Yearling and older northern pike in Buckhorn Marsh impoundment were significantly smaller than those in Woods Creek, Gun Creek, and Spicer Creek and those in Woods Creek, Gun Creek, and Spicer Creek were significantly smaller than those in Big Six Mile Creek ($MSE=11{,}771.36$, $df=388$, $Alpha=0.05$). Buckhorn Marsh impoundment was unique in that no yearling and older northern pike ≥600 mm were caught and tagged there (Table 3.6-1). The number of yearling and older northern pike ≥600 mm in Buckhorn Marsh impoundment was significantly smaller than expected when compared with yearling and older northern pike from Woods Creek, Gun Creek, and Spicer Creek combined based on a Chi-Square analysis of fish <600 mm and those ≥600 mm ($Chi\text{-}Square=29.422$, $df=1$, $P<0.001$).

The mean length of YOY northern pike caught by seining in Buckhorn Marsh impoundment differed from that of Woods Creek, Gun Creek, and Big Six Mile Creek combined by month ($F=4.10$, $df=3$, $P<0.0084$). The difference in lengths became progressively larger from June through September (Table 3.6-2).

TABLE 3.1.1.1-1

NUMBERS OF NORTHERN PIKE CAUGHT BY FYKE NETTING IN BUCKHORN MARSH IMPOUNDMENT BY DATE AND FYKE NET LOCATION DURING 2003

Date	BHM1[1]	BHM2[1]	BHM3[2]	BHM4[2]	BHM5[2]	BHM6[2]	Total
3/28/2003	1	1					2
3/29/2003	2	1					3
3/30/2003	2						2
3/31/2003	1	2					3
4/1/2003	4	6		4	6		20
4/2/2003			11	4		3	18
4/3/2003			6	4	4		14
4/4/2003		1			8		9
4/10/2003				7	5	5	17
4/11/2003			1		3	2	6
4/12/2003	1			3	1	2	7
4/13/2003				1	5	4	10
4/14/2003				2		5	7
4/15/2003				1		4	5
4/16/2003			1	2	1	5	9
4/17/2003				2	4	2	8
4/18/2003			2		2	2	6
4/25/2003				1			1
4/30/2003	1	1	1		1	1	5
5/1/2003	1			1			2
5/2/2003		1					1
5/7/2003	1						1
5/8/2003	2						2
5/9/2003	2						2
5/14/2003		4					4
5/15/2003					2		2
5/16/2003		1					1
5/21/2003				1			1
5/22/2003		2			1	1	4
5/23/2003		1			1		2
6/4/2003			1				1
6/6/2003						1	1
6/13/2003				1			1
6/18/2003		1	2				3
6/19/2003		1	1	1			3

TABLE 3.1.1.1-1 (CONT.)

NUMBERS OF NORTHERN PIKE CAUGHT BY FYKE NETTING IN BUCKHORN MARSH IMPOUNDMENT BY DATE AND FYKE NET LOCATION DURING 2003

Date	BHM1[1]	BHM2[1]	BHM3[2]	BHM4[2]	BHM5[2]	BHM6[2]	Total
6/20/2003		2					2
6/26/2003	1	1					2
6/27/2003	1						1
7/1/2003	1						1
7/3/2003		1					1
Total	21	27	26	35	44	37	190

[1]Nets were set on March 27.

[2]Nets were set on March 30.

TABLE 3.1.1.1-2

NUMBERS OF NORTHERN PIKE CAUGHT BY FYKE NETTING IN BUCKHORN MARSH IMPOUNDMENT AND TAGGED BY DATE AND FYKE NET LOCATION, DURING 2003

Date	BHM1[1]	BHM2[1]	BHM3[2]	BHM4[2]	BHM5[2]	BHM6[2]	Total
3/28/2003	1	1					2
3/29/2003	2	1					3
3/30/2003	2						2
3/31/2003	1	2					3
4/1/2003	4	5		4	5		18
4/2/2003			9	4		2	15
4/3/2003			4	2	3		9
4/4/2003					5		5
4/10/2003					1	2	3
4/11/2003						1	1
4/12/2003				1			1
4/13/2003					1	1	2
4/14/2003							
4/15/2003						2	2
4/16/2003						3	3
4/17/2003							
4/18/2003			1		1		2
4/25/2003							
4/30/2003							
5/1/2003							
5/2/2003							
5/7/2003							
5/8/2003							
5/9/2003							
5/14/2003		1					1
Total	10	10	14	11	16	11	72

[1]Nets were set on March 27.

[2]Nets were set on March 30.

TABLE 3.1.1.1-3

NUMBERS OF NORTHERN PIKE CAUGHT BY FYKE NETTING AND TAGGED IN BUCKHORN MARSH IMPOUNDMENT BY DATE AND SEX DURING 2003

Date	Numbers of Northern Pike			
	Female	Male	Unknown	Total
3/28/2003			2	2
3/29/2003	1		2	3
3/30/2003			2	2
3/31/2003			3	3
4/1/2003	2	8	8	18
4/2/2003	2	8	5	15
4/3/2003	1	3	5	9
4/4/2003	1		4	5
4/10/2003			3	3
4/11/2003	1			1
4/12/2003			1	1
4/13/2003			2	2
4/14/2003				
4/14/2003				
4/15/2003		2		2
4/16/2003	1		2	3
4/17/2003				
4/18/2003		2		2
4/25/2003				
4/30/2003				
5/1/2003				
5/2/2003				
5/7/2003				
5/8/2003				
5/9/2003				
5/14/2003		1		1
Total	9	24	39	72

TABLE 3.1.1.5-1

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING AND ELECTROFISHING IN BUCKHORN MARSH IMPOUNDMENT DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bluntnose minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brook stickleback	*Culaea inconstans*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Common shiner	*Luxilus cornutus*
Emerald shiner	*Notropis atherinoides*
European rudd	*Scardinius erythrophtalmus*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Minnow	Cyprinidae
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Rock bass	*Ambloplites rupestris*
Spottail shiner	*Notropis hudsonius*
Sunfish	*Lepomis spp.*
Sunfish family	Centrarchidae
Tadpole madtom	*Notorus gyrinus*

TABLE 3.1.1.5-2

THE COMMON NAMES AND NUMBERS OF FISHES CAUGHT BY SEINING IN BUCKHORN MARSH IMPOUNDMENT DURING 2003

Common Name	Number Caught
Sunfish	951
Brown bullhead	403
Golden shiner	244
Bluegill	232
Pumpkinseed	174
Central mudminnow	127
Largemouth bass	92
Northern pike	78
Unidentified	14
Brook stickleback	11
Rock bass	11
Black crappie	4
Tadpole madtom	4
Common shiner	3
Bowfin	2
Banded killifish	1
Emerald shiner	1
Goldfish	1
Green sunfish	1
Spottail shiner	1

TABLE 3.1.1.5-3

THE COMMON NAMES AND NUMBERS OF FISHES CAUGHT BY FYKE NETTING IN BUCKHORN MARSH IMPOUNDMENT DURING 2003

Common Name	Number Caught
Pumpkinseed	301
Bowfin	205
Northern pike	190
Brown bullhead	186
Bluegill	51
Carp	17
European rudd	15
Goldfish	8
Largemouth bass	8
Black crappie	6
Golden shiner	2
Green sunfish	2
Bluntnose minnow	1
Rock bass	1

TABLE 3.1.1.5-4

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY ELECTROFISHING IN BUCKHORN MARSH IMPOUNDMENT DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Bluegill	*Lepomis macrochirus*
Bowfin	*Amia calva*
Brown bullhead	*Ameiurus nebulosus*
Central mudminnow	*Umbra limi*
Emerald shiner	*Notropis atherinoides*
Golden shiner	*Notemigonus crysoleucas*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Minnows	Cyprinidae
Pumpkinseed	*Lepomis gibbosus*
Sunfish family	Centrarchidae

TABLE 3.1.2.5-1

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BURNT SHIP CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bluntnose minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brook stickleback	*Culaea inconstans*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Common shiner	*Luxilus cornutus*
Creek chub	*Semotilus atromaculatus*
Emerald shiner	*Notropis atherinoides*
European rudd	*Scardinius erythrophtalmus*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Minnows	Cyprinidae
Muskellunge	*Esox masquinongy*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Rock bass	*Ambloplites rupestris*
Spottail shiner	*Notropis hudsonius*
Sticklebacks	Gasterosteidae
Sunfish	*Lepomis spp.*
Tadpole madtom	*Notorus gyrinus*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

TABLE 3.1.2.5-2

THE COMMON NAMES AND NUMBERS OF FISHES CAUGHT BY SEINING IN BURNT SHIP CREEK DURING 2003

Common Name	Number Caught
Central mudminnow	408
Brown bullhead	241
Sticklebacks	194
Largemouth bass	149
Golden shiner	137
Pumpkinseed	82
Common shiner	69
Brook stickleback	56
Spottail shiner	48
White sucker	27
Banded killifish	19
Black crappie	12
Green sunfish	11
Sunfish	10
Emerald shiner	10
Carp	10
Bluegill	8
Creek chub	5
Northern pike	4
Tadpole madtom	3
Bowfin	3
Unidentified	2
Rock bass	2
Muskellunge	2

TABLE 3.1.2.5-3

THE COMMON NAMES AND NUMBERS OF FISHES CAUGHT BY FYKE NETTING IN BURNT SHIP CREEK DURING 2003

Common Name	Number Caught
Pumpkinseed	124
Bowfin	32
Creek chub	13
Brown bullhead	10
Carp	9
European rudd	8
Bluegill	7
Common shiner	7
Largemouth bass	5
Rock bass	3
Northern pike	2
Black crappie	1
Yellow perch	1

TABLE 3.1.2.5-4

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY ELECTROFISHING IN BURNT SHIP CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bluntnose minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brook stickleback	*Culaea inconstans*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Common shiner	*Luxilus cornutus*
Emerald shiner	*Notropis atherinoides*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Minnow family	*Cyprinidae*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Spottail shiner	*Notropis hudsonius*
Sunfish	*Lepomis spp.*
White sucker	*Catostomus commersoni*

TABLE 3.2.3-1

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY ALL GEAR TYPES IN WOODS CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bowfin	*Amia calva*
Brook silverside	*Labidesthes sicculus*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Channel catfish	*Ictalurus punctatus*
Common shiner	*Luxilus cornutus*
Creek chub	*Semotilus atromaculatus*
Emerald shiner	*Notropis atherinoides*
European rudd	*Scardinius erythrophtalmus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Greater redhorse	*Moxostoma valenciennesi*
Largemouth bass	*Micropterus salmoides*
Minnows	Cyprinidae
Muskellunge	*Esox masquinongy*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Carpiodes cyprinus*

TABLE 3.2.3-1 (CONT.)

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY ALL GEAR TYPES IN WOODS CREEK DURING 2003

Name	
Common	**Scientific**
Rainbow trout	*Oncorhynchus mykiss*
Redhorse	*Moxostoma spp.*
River redhorse	*Moxostoma carinatum*
Rock bass	*Ambloplites rupestris*
Spottail shiner	*Notropis hudsonius*
Sunfish	*Lepomis spp.*
Sunfish family	Centrarchidae
Tadpole madtom	*Notorus gyrinus*
White crappie	*Pomoxis annularis*
White sucker	*Catostomus commersoni*
Yellow bullhead	*Ameiurus natalis*
Yellow perch	*Perca flavescens*

TABLE 3.2.3-2

THE COMMON NAMES AND NUMBERS OF FISHES CAUGHT BY SEINING IN WOODS CREEK DURING 2003

Common Name	Number Caught
Pumpkinseed	389
Largemouth bass	154
Rock bass	126
Brown bullhead	77
Sunfish	73
Carp	46
Bluegill	43
Goldfish	20
Golden shiner	16
Northern pike	10
Banded killifish	7
Spottail shiner	6
Minnows	6
Muskellunge	5
Black crappie	4
White sucker	3
Tadpole madtom	3
Central mudminnow	2
European rudd	2
Common shiner	1
Brook silverside	1

TABLE 3.2.3-3

THE COMMON NAMES AND NUMBERS OF FISHES CAUGHT BY FYKE NETTING IN WOODS CREEK DURING 2003

Common Name	Number Caught
Rock bass	2041
Pumpkinseed	1799
Brown bullhead	1346
Largemouth bass	680
European rudd	520
White sucker	347
Northern pike	217
Black crappie	205
Carp	168
Bluegill	150
Yellow perch	97
Redhorse	87
Goldfish	71
Common shiner	29
Spottail shiner	25
Bowfin	24
Muskellunge	15
Creek chub	12
Golden shiner	9
Gizzard shad	7
White crappie	7
Greater redhorse	4
Freshwater drum	3
River redhorse	3
Yellow bullhead	3
Minnows	2
Quillback	2
Channel catfish	1
Rainbow trout	1

TABLE 3.2.3-4

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY ELECTROFISHING IN WOODS CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Bluegill	*Lepomis macrochirus*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Emerald shiner	*Notropis atherinoides*
European rudd	*Scardinius erythrophtalmus*
Freshwater drum	*Aplodinotus grunniens*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Largemouth bass	*Micropterus salmoides*
Minnows	Cyprinidae
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Rock bass	*Ambloplites rupestris*
Spottail shiner	*Notropis hudsonius*
Sunfish	*Lepomis spp.*
Sunfish family	Centrarchidae
White crappie	*Pomoxis annularis*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

TABLE 3.3.3-1

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN GUN CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bluntnose minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brook stickleback	*Culaea inconstans*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Common shiner	*Luxilus cornutus*
Creek chub	*Semotilus atromaculatus*
Emerald shiner	*Notropis atherinoides*
European rudd	*Scardinius erythrophtalmus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Minnows	Cyprinidae
Muskellunge	*Esox masquinongy*
Northern hog sucker	*Hypentelium nigricans*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Redhorse	*Moxostoma spp.*
Rock bass	*Ambloplites rupestris*
Spottail shiner	*Notropis hudsonius*

TABLE 3.3.3-1 (CONT.)

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN GUN CREEK DURING 2003

Name	
Common	**Scientific**
Sunfish	*Lepomis spp.*
Tadpole madtom	*Notorus gyrinus*
White crappie	*Pomoxis annularis*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

TABLE 3.4.3-1

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BIG SIX MILE CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bluntnose minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brook silverside	*Labidesthes sicculus*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Common shiner	*Luxilus cornutus*
Creek chub	*Semotilus atromaculatus*
European rudd	*Scardinius erythrophtalmus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Johnny darter	*Etheostoma nigrum*
Largemouth bass	*Micropterus salmoides*
Longnose gar	*Lepisosteus osseus*
Minnows	Cyprinidae
Muskellunge	*Esox masquinongy*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Carpiodes cyprinus*

TABLE 3.4.3-1 (CONT.)

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BIG SIX MILE CREEK DURING 2003

Name	
Common	**Scientific**
Rainbow trout	*Oncorhynchus mykiss*
Redhorse	*Moxostoma spp.*
River redhorse	*Moxostoma carinatum*
Rock bass	*Ambloplites rupestris*
Round goby	*Neogobius melanostomus*
Smallmouth bass	*Micropterus dolomieui*
Spottail shiner	*Notropis hudsonius*
Sunfish	*Lepomis spp.*
Sunfish family	Centrarchidae
White bass	*Morone chrysops*
White crappie	*Pomoxis annularis*
White perch	*Morone americana*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

TABLE 3.5.3-1

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN SPICER CREEK DURING 2003

Name	
Common	**Scientific**
Banded killifish	*Fundulus diaphanus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bluntnose minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brindled madtom	*Noturus miurus*
Brook silverside	*Labidesthes sicculus*
Brown bullhead	*Ameiurus nebulosus*
Carp	*Cyprinus carpio*
Central mudminnow	*Umbra limi*
Common shiner	*Luxilus cornutus*
Creek chub	*Semotilus atromaculatus*
Emerald shiner	*Notropis atherinoides*
European rudd	*Scardinius erythrophtalmus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Hornyhead chub	*Nocomis biguttatus*
Largemouth bass	*Micropterus salmoides*
Minnows	Cyprinidae
Muskellunge	*Esox masquinongy*
Northern hog sucker	*Hypentelium nigricans*

TABLE 3.5.3-1 (CONT.)

THE COMMON AND SCIENTIFIC NAMES OF FISHES CAUGHT IN SPICER CREEK BY SEINING, FYKE NETTING, AND ELECTROFISHING

Name	
Common	**Scientific**
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Carpiodes cyprinus*
Rock bass	*Ambloplites rupestris*
Spottail shiner	*Notropis hudsonius*
Sunfish	*Lepomis spp.*
Tadpole madtom	*Notorus gyrinus*
White crappie	*Pomoxis annularis*
White perch	*Morone americana*
White sucker	*Catostomus commersoni*
Yellow bullhead	*Ameiurus natalis*
Yellow perch	*Perca flavescens*

TABLE 3.6-1

NUMBERS OF YEARLING AND OLDER NORTHERN PIKE CAUGHT BY FYKE NETTING AND ELECTROFISHING AND TAGGED IN BUCKHORN MARSH IMPOUNDMENT, WOODS CREEK, GUN CREEK, SPICER CREEK, AND BIG SIX MILE CREEK DURING 2003 BY LENGTH CATEGORY

Location	Number in each Length Category				
	<399 mm	400-499 mm	500-599 mm	600-699 mm	≧700 mm
Buckhorn Marsh impoundment	45	19	4	0	0
Woods Creek	10	39	71	30	12
Gun Creek	26	23	25	33	17
Spicer Creek	3	4	10	6	1
Big Six Mile Creek	2	4	4	4	4

TABLE 3.6-2

MEAN LENGTHS OF YOUNG-OF-THE-YEAR NORTHERN PIKE CAUGHT BY SEINING IN BUCKHORN MARSH IMPOUNDMENT AND IN WOODS CREEK, GUN CREEK, AND BIG SIX MILE CREEK COMBINED DURING JUNE, JULY, AUGUST, AND SEPTEMBER 2003

Month	Mean length (mm)*	
	Buckhorn Marsh impoundment	Tributaries
June	85	84
	(9)	(25)
July	114	125
	(13)	(7)
August	148	172
	(34)	(8)
September	166	229
	(21)	(6)

*Numbers of YOY are in parentheses.

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Water Depths
April 2003

LEGEND

Water Depths (ft)
- 0
- 1
- 2
- 3
- 4
- 5
- 6

0 150 300 600 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.1.6-1

New York Power Authority

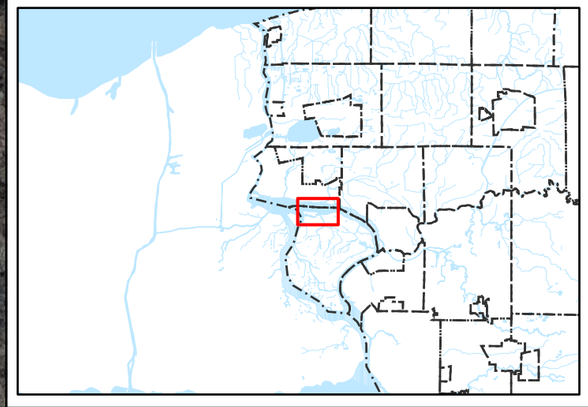
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Water Depths
August 2003

LEGEND

Water Depths (ft)
- 0
- 1
- 2
- 3
- 4
- 5
- 6



0 150 300 600 Feet

Scale for Insets
0 37.5 75 Feet

N

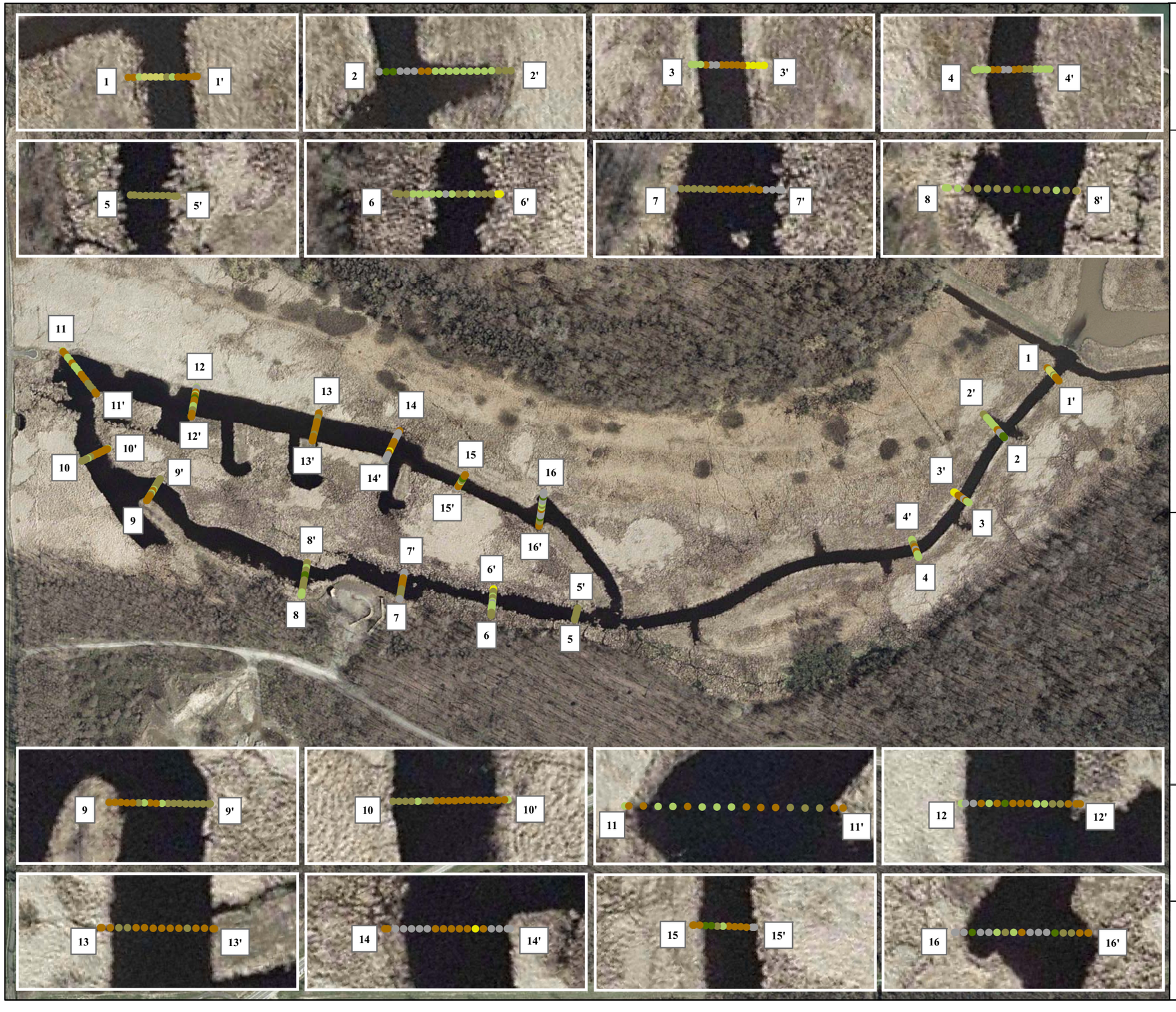
FIGURE 3.1.1.6-2

New York Power Authority

NIAGARA POWER PROJECT

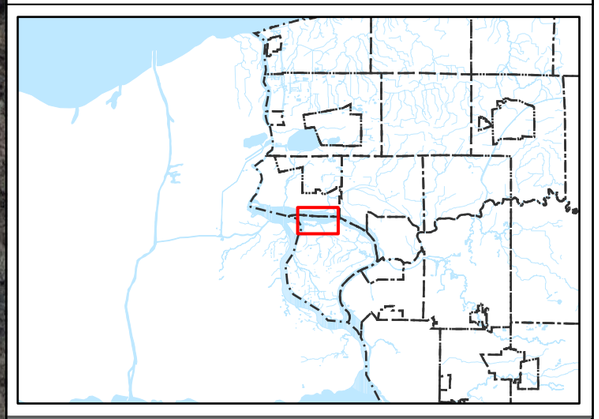
NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Substrates
April 2003



LEGEND

Substrates
- Mud Clay
- Muck
- Muck, Mud Clay
- Silt
- Silt, Hard Clay
- Silt, Mud Clay
- Silt, Muck
- Silt, Sand



0 150 300 600 Feet

Scale for Insets
0 37.5 75 Feet

N

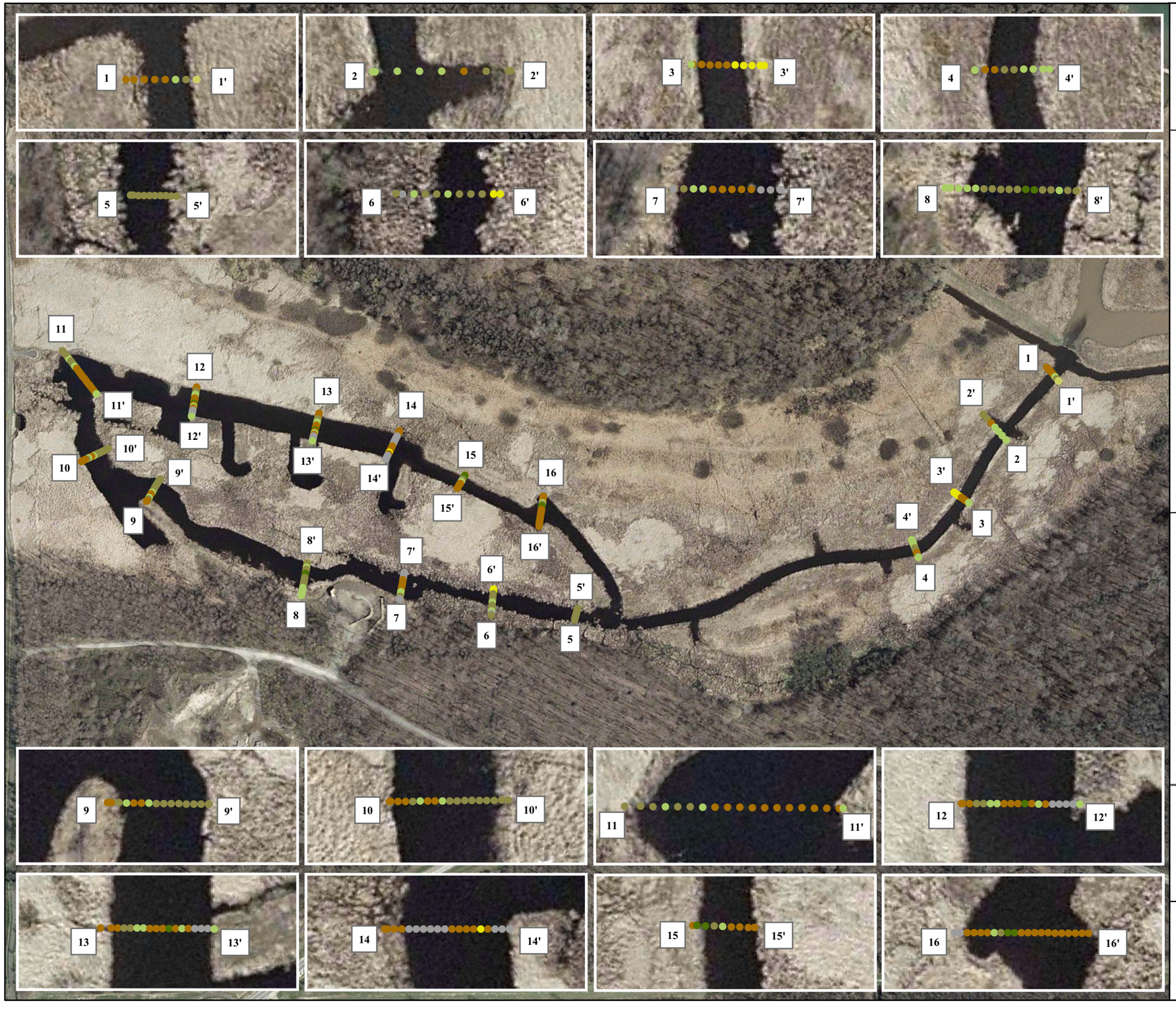
FIGURE 3.1.1.6-3

New York Power Authority

NIAGARA POWER PROJECT

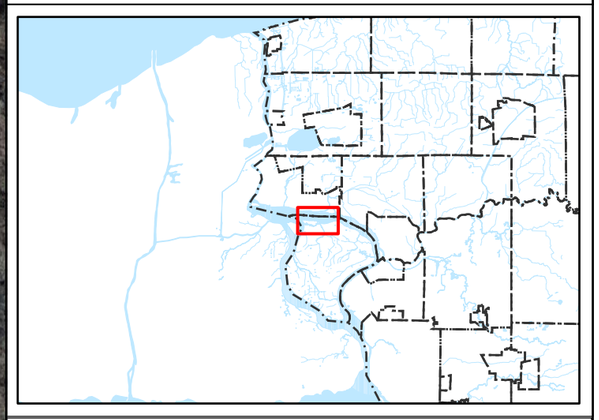
NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Substrates
August 2003



LEGEND

Substrates
- Mud Clay
- Muck
- Muck, Mud Clay
- Silt
- Silt, Hard Clay
- Silt, Mud Clay
- Silt, Muck
- Silt, Sand



0 150 300 600 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.1.6-4

New York Power Authority

NIAGARA POWER PROJECT

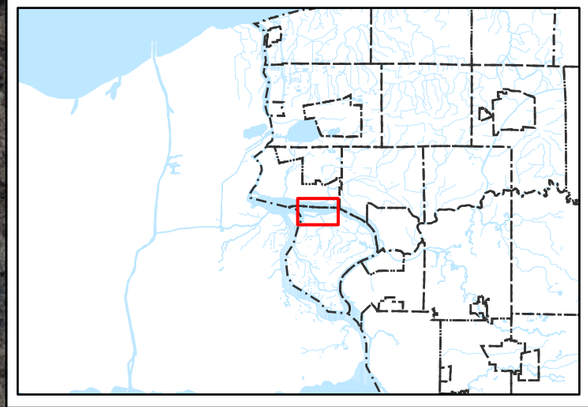
NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Percent Decaying Vegetative Matter
April 2003

LEGEND

Decaying Vegetative Matter (%)

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100



0 150 300 600 Feet

Scale for Insets

0 37.5 75 Feet

N

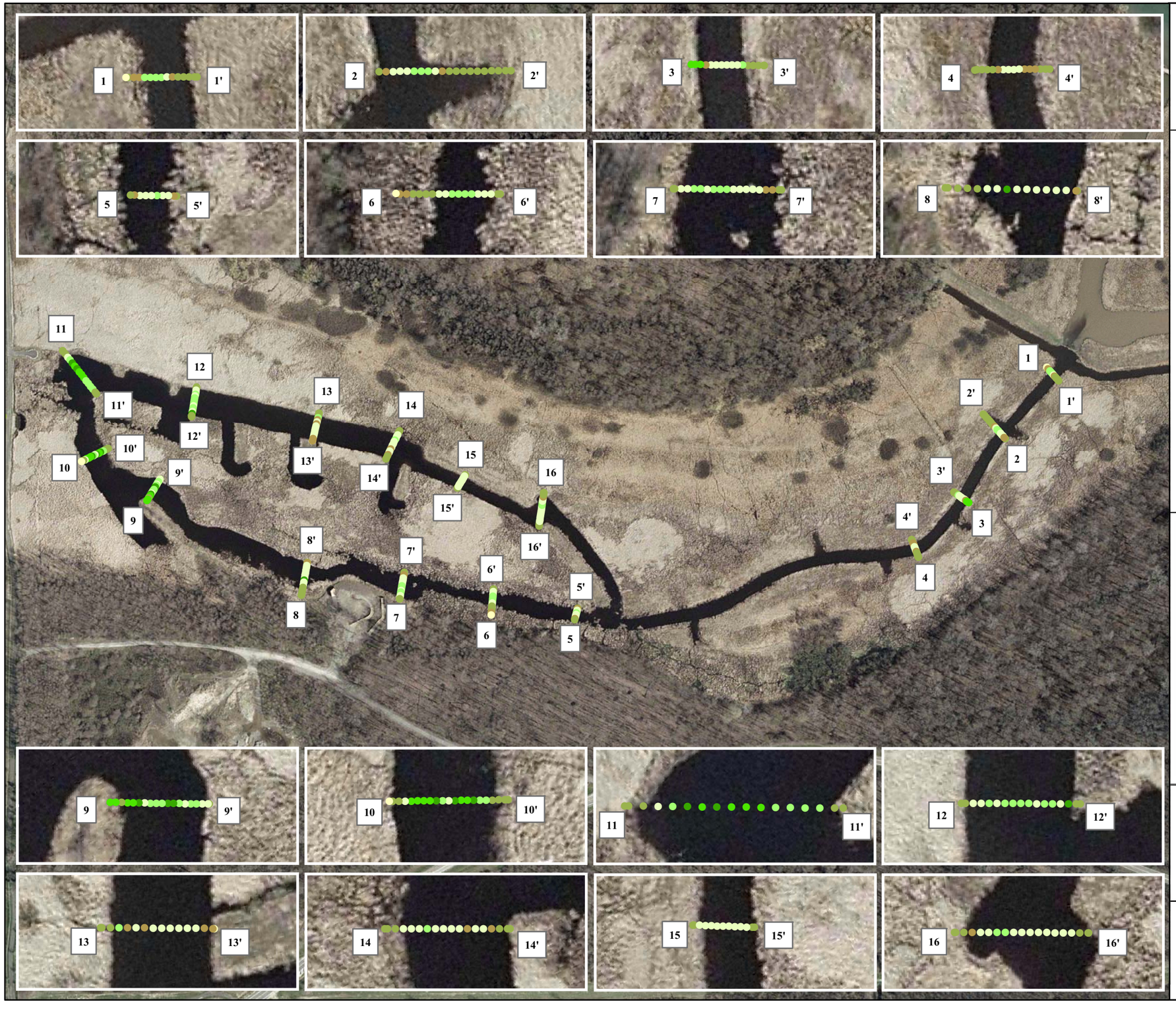
FIGURE 3.1.1.6.1-1

New York Power Authority

NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Submerged and Emergent Aquatic Vegetation
April 2003

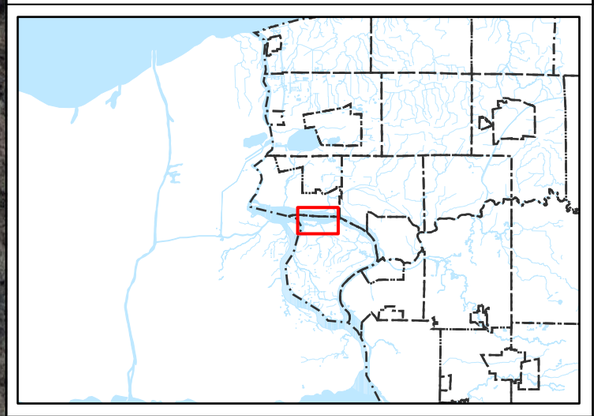


LEGEND

- Emergent Aquatic Vegetation

Submerged Aquatic Vegetation Density

- Bare Shore
- None
- Sparse
- Moderately Dense
- Dense
- Very Dense



0 150 300 600 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.1.6.1-2

New York Power Authority

NIAGARA POWER PROJECT

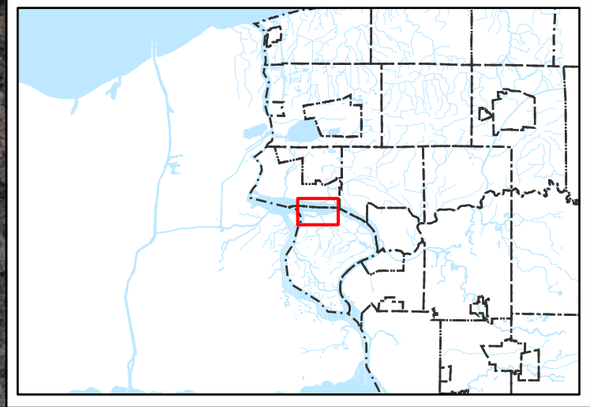
NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Percent Decaying Vegetative Matter
August 2003

LEGEND

Decaying Vegetative Matter (%)

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100



0 150 300 600 Feet

Scale for Insets

0 37.5 75 Feet

N

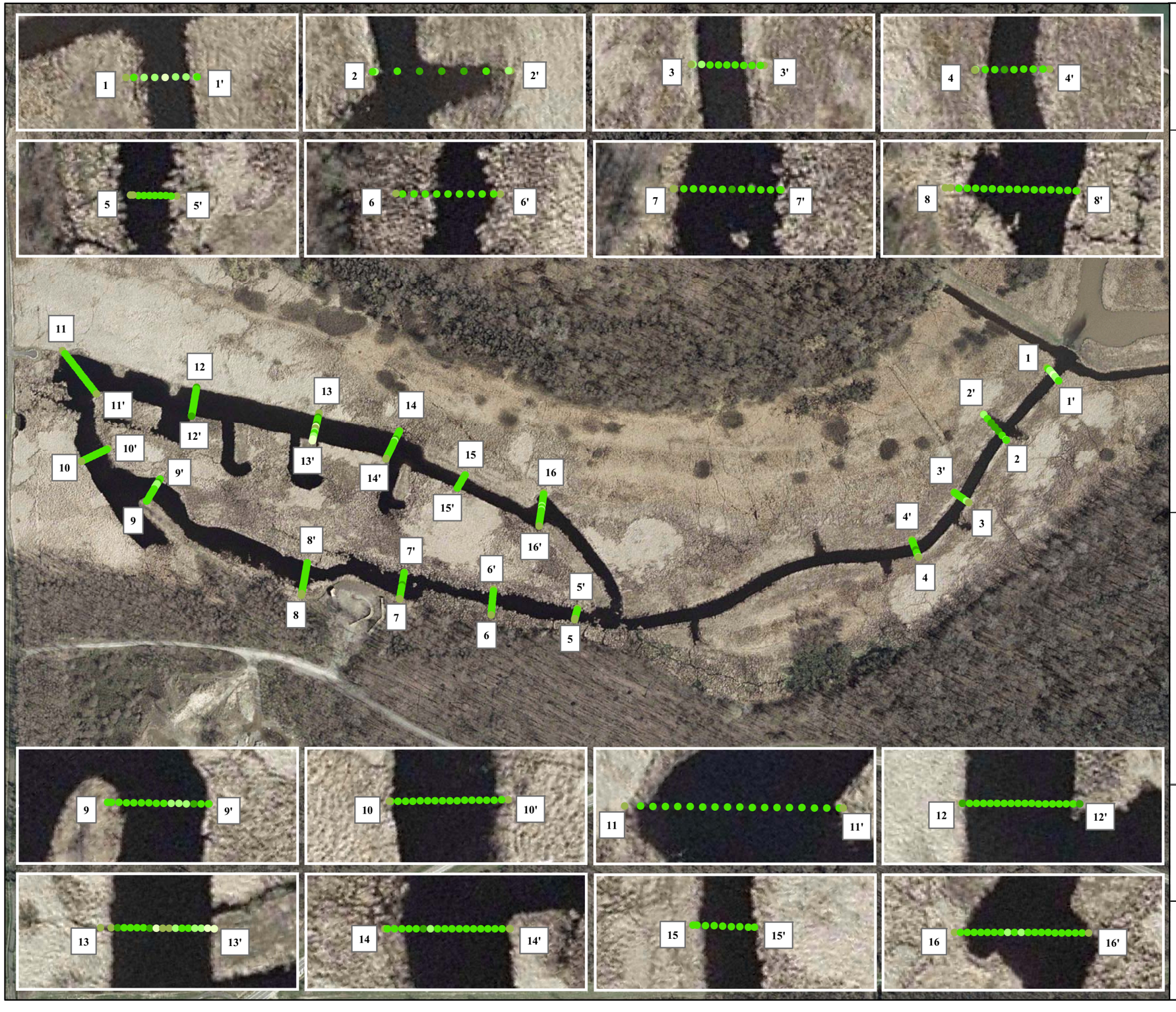
FIGURE 3.1.1.6.2-1

New York Power Authority

NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Submerged and Emergent Aquatic Vegetation
August 2003

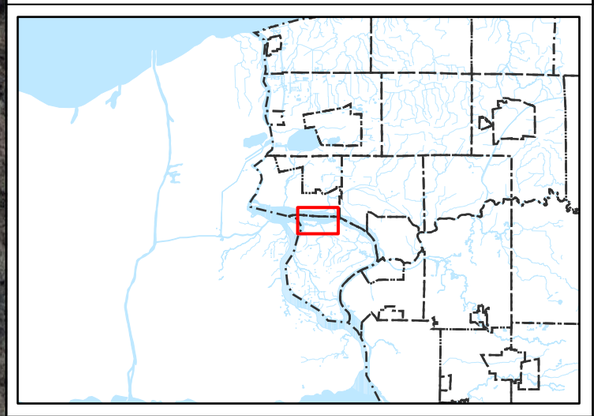


LEGEND

- Emergent Aquatic Vegetation

Submerged Aquatic Vegetation Density

- Bare Shore
- None
- Sparse
- Moderately Dense
- Dense
- Very Dense



0 150 300 600 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.1.6.2-2

New York Power Authority

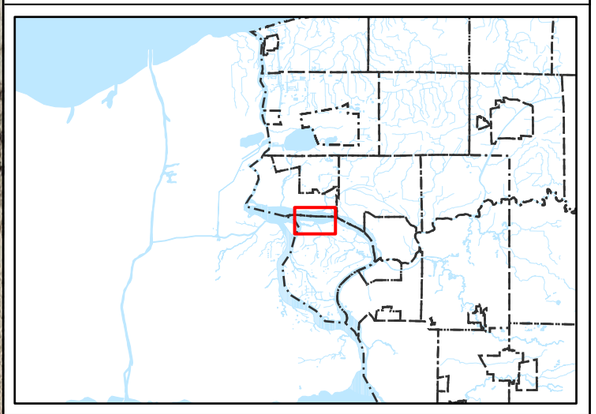
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Water Depths
April 2003

LEGEND

Water Depths (ft)
- 0
- 1
- 2
- 3
- 4
- 5
- 6



0 125 250 500 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.2.6-1

New York Power Authority

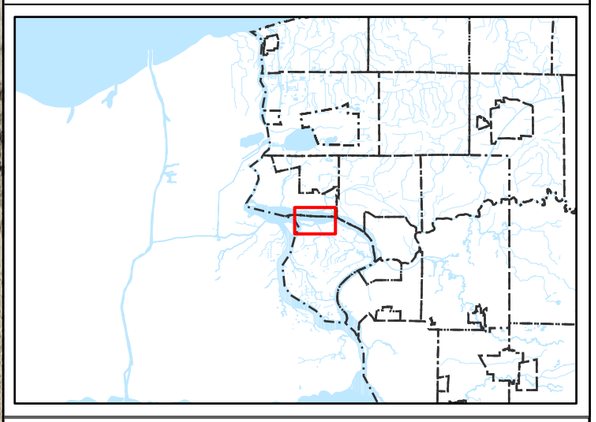
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Water Depths
August 2003

LEGEND

Water Depths (ft)
- 0
- 1
- 2
- 3
- 4
- 5
- 6



0 125 250 500 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.2.6-2

New York Power Authority

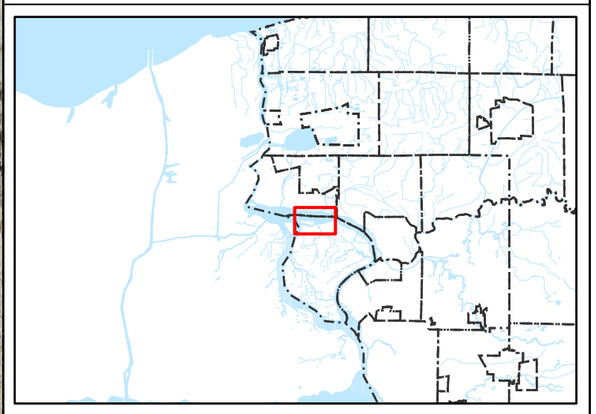
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Substrates
April 2003

LEGEND

Substrates
- Mud Clay
- Muck
- Muck, Mud Clay
- Silt
- Silt, Hard Clay
- Silt, Mud Clay
- Silt, Muck
- Silt, Sand



0 125 250 500 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.2.6-3

New York Power Authority

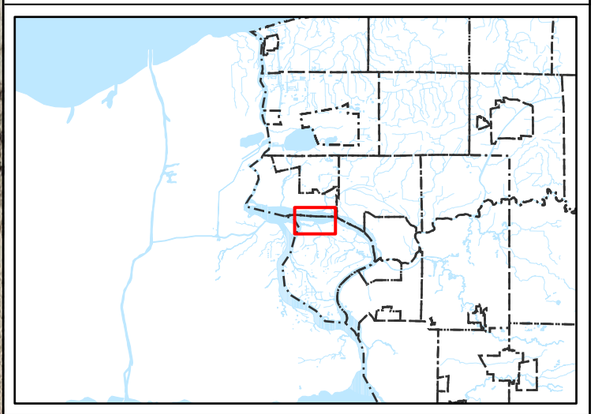
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Substrates
August 2003

LEGEND

Substrates
- Mud Clay
- Muck
- Muck, Mud Clay
- Silt
- Silt, Hard Clay
- Silt, Mud Clay
- Silt, Muck
- Silt, Sand



0 130 260 520 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.2.6-4

New York Power Authority

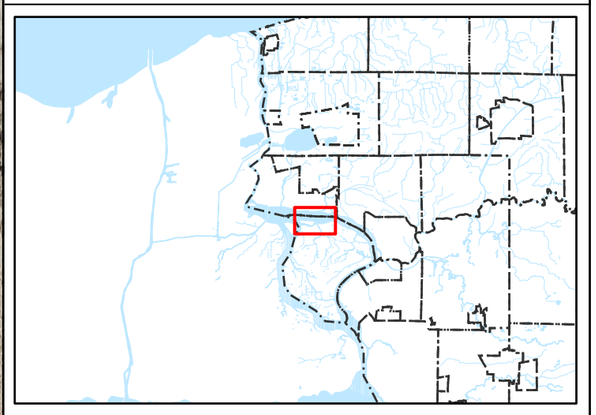
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Percent Decaying Vegetative Matter
April 2003

LEGEND

Decaying Vegetative Matter (%)
- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100



0 125 250 500 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.2.6.1-1

New York Power Authority

NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

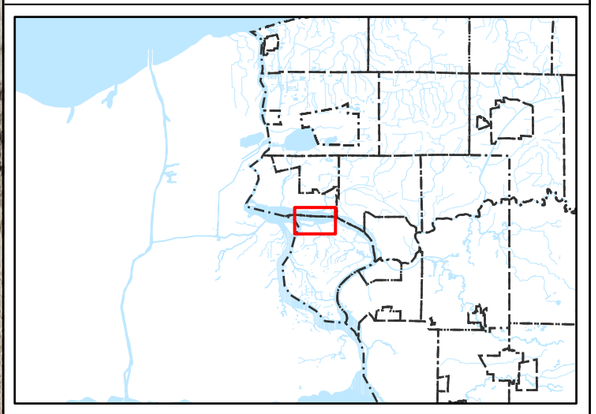
Submerged and Emergent Aquatic Vegetation
April 2003

LEGEND

- Emergent Aquatic Vegetation

Submerged Aquatic Vegetation Density

- Bare Shore
- None
- Sparse
- Moderately Dense
- Dense
- Very Dense



0 125 250 500 Feet

Scale for Insets

0 37.5 75 Feet

N

FIGURE 3.1.2.6.1-2

New York Power Authority

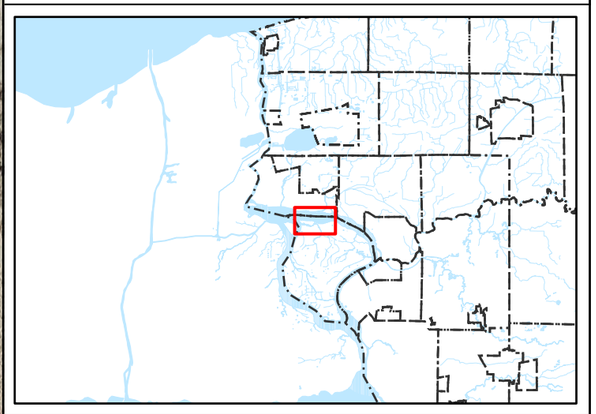
NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

Percent Decaying Vegetative Matter
August 2003

LEGEND

Decaying Vegetative Matter (%)
- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100



0 125 250 500 Feet

Scale for Insets
0 37.5 75 Feet

N

FIGURE 3.1.2.6.2-1

New York Power Authority

NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY

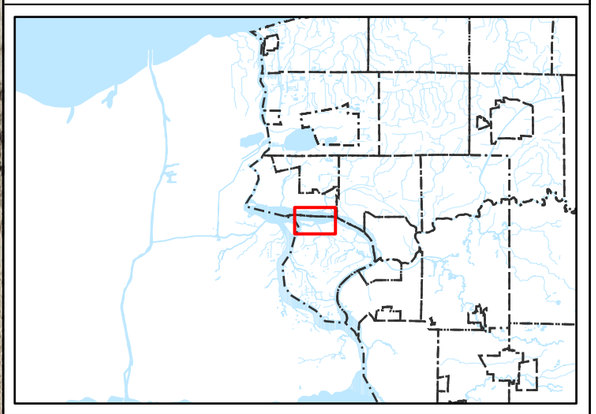
Submerged and Emergent Aquatic Vegetation
August 2003

LEGEND

- Emergent Aquatic Vegetation

Submerged Aquatic Vegetation Density

- Bare Shore
- None
- Sparse
- Moderately Dense
- Dense
- Very Dense



0 125 250 500 Feet

Scale for Insets

0 37.5 75 Feet

N

FIGURE 3.1.2.6.2-2

New York Power Authority

NIAGARA POWER PROJECT

4.0 DISCUSSION

4.1 Use of BMRP as a Nursery and for Spawning

4.1.1 Northern Pike

The capture of 77 YOY northern pike in Buckhorn Marsh impoundment and 5 YOY in Burnt Ship Creek during the period from June through September is evidence that BMRP was used as a nursery by northern pike. Although spawning by northern pike was never observed in BMRP during 2003, there is little doubt that it occurred based on the capture of YOY northern pike and the capture of yearling and older northern pike during the spring before the capture of YOY. From March through May, the period when northern pike are known to spawn in tributaries of the Niagara River, almost half of the 72 yearling and older northern pike caught and tagged in Buckhorn Marsh impoundment and 1 of 2 yearling and older northern pike caught and tagged in Burnt Ship Creek were capable of spawning, based on the presence of eggs or milt extruded by field technicians.

It is unlikely that the 77 YOY caught by seining in Buckhorn Marsh impoundment migrated from Burnt Ship Creek or Woods Creek. The elevation of Burnt Ship Creek was lower than the elevation at the top of the stoplogs in the west weir from March through September during those days when the gauge in Burnt Ship Creek recorded data that were deemed reliable. The gauge began recording data that were deemed unreliable on May 16 and continued to do so until July 1. The water elevation in Burnt Ship Creek both before and after the period of unreliable data was about a foot, on average, below the elevation at the top of the stoplogs in the west weir (Appendix E, Figures E-1 – E-7). During the period of unreliable data collection, there is no reason to believe that the water elevation in Burnt Ship Creek was above the top of the stoplogs in the west weir, based on the water elevations recorded from the period March through September in Woods Creek. If the water elevation in Burnt Ship Creek was always below the elevation at the top of the stoplogs in the west weir, it should have been physically impossible for YOY northern pike to enter Buckhorn Marsh impoundment from Burnt Ship Creek. Although the elevation of Woods Creek was higher than the top of the stoplogs in the east weir during 470 hourly

periods from May through September, it is unlikely that YOY northern pike in Woods Creek entered Buckhorn Marsh impoundment (Appendix E, Figures E-10 – E-14). YOY northern pike emigrate from spawning marshes into rivers about three weeks after hatching, when they are an average of 20 mm long (Becker 1983). Furthermore, their preferred water depth increases with length (Casselman and Lewis 1996). The length of YOY caught in Buckhorn Marsh impoundment starting in June was greater than or equal to 69 mm. Additionally, none of the 8 YOY northern pike that were finclipped in Woods Creek from June through September were among the 77 YOY northern pike caught in Buckhorn Marsh impoundment. This is in contrast to the recapture of one YOY northern pike on July 23 in Woods Creek from among four YOY northern pike that were finclipped in Woods Creek during late June and early July.

Based on data collected during 2003, the population of northern pike in Buckhorn Marsh impoundment is essentially self-sustaining. Passage of yearling and older northern pike into Buckhorn Marsh impoundment was a rare event. Only one yearling and older northern pike caught outside Buckhorn Marsh impoundment (a 647 mm long male) was among the 190 fyke net captures inside Buckhorn Marsh impoundment. That one fish was caught on March 25 in Woods Creek and recaptured in Buckhorn Marsh impoundment on May 7. From March 25 through May 7 the elevation of Woods Creek was equal to or higher than the elevation at the top of the stoplogs in the east weir for only 8 hours on April 5, and 10 hours on May 5-6 (Appendix E, Figures E-8 – E-10). If passage of yearling and older northern pike into Buckhorn Marsh impoundment was limited to those times, the low frequency of passage is not surprising.

The five YOY northern pike caught in Burnt Ship Creek could have been spawned there or in Buckhorn Marsh impoundment. If passage of YOY from Buckhorn Marsh impoundment into Burnt Ship Creek was possible when the water elevation in Buckhorn Marsh impoundment was higher than the top of the stop logs in the west weir by 0.25 inches or more, then passage could have occurred during 10 hours on May 5-6 and 1 hour on May 11 (Appendix E, Figure E-3). However, it is more likely that the YOY caught in Burnt Ship Creek were spawned there based on the limited time available for passage and the absence of any YOY finclipped in Buckhorn Marsh impoundment among the five YOY caught in Burnt Ship Creek.

4.1.2 Largemouth Bass

The capture of 73 YOY largemouth bass in Buckhorn Marsh impoundment and 130 YOY in Burnt Ship Creek during the period from late-July through September is evidence that BMRP was used as a nursery by largemouth bass. Although spawning by largemouth bass was never observed in BMRP during 2003, there is little doubt that it occurred based on the capture of YOY largemouth bass and the capture of yearling and older largemouth bass during the spring before the capture of YOY. From mid-May through mid-June, the period when largemouth bass are known to spawn, two of the 7 yearling and older largemouth bass caught and tagged in Buckhorn Marsh impoundment were capable of spawning, based on the presence of eggs or milt extruded by field technicians. During the same time period, four yearling and older largemouth bass were caught and tagged in Burnt Ship Creek.

Although it is possible that YOY largemouth bass migrated from Woods Creek into Buckhorn Marsh impoundment because the water elevation of Woods Creek was frequently higher than the top of stoplogs in the east weir starting in June, it seems unlikely based on the absence of any recaptures in Buckhorn Marsh impoundment of YOY finclipped in Woods Creek. It is also unlikely that the 73 YOY caught by seining in Buckhorn Marsh impoundment migrated from Burnt Ship Creek for the same reasons it was unlikely for YOY northern pike and largemouth bass -- low water elevations.

4.2 Use of BMRP by Northern Pike Compared with Grand Island Tributaries

The estimated population size of yearling and older northern pike in Buckhorn Marsh impoundment during 2003 (85 – 87) was about six to seven times smaller than that in Woods Creek and about two to three times smaller than that in Gun Creek during the period of peak abundance. A comparison of population size could not be made between Buckhorn Marsh impoundment and Burnt Ship Creek, Spicer Creek, and Big Six Mile Creek because the number of yearling and older northern pike tagged and recaptured in those creeks was not sufficient to reliably estimate population size. However, more yearling and older northern pike appeared to use Buckhorn Marsh impoundment than Burnt Ship Creek, Spicer Creek, and, perhaps, Big Six Mile Creek based on the greater number caught in Buckhorn Marsh impoundment and the fact that the estimated population size of yearling and older northern pike in

Buckhorn Marsh impoundment was considerably greater than the number of yearling and older northern pike caught by fyke netting and electrofishing in Burnt Ship Creek, Spicer Creek, and Big Six Mile Creek. The number caught in Big Six Mile Creek may not be directly comparable to the numbers caught in Burnt Ship Creek and Spicer Creek because: 1) a fyke net was not set near the mouth of Big Six Mile Creek although one net was set near the mouth of the other two creeks and 2) the area of Big Six Mile Creek sampled is a boat basin, making it considerably wider than the other two creeks. The mouth of Big Six Mile Creek is the entrance to Big Six Mile Marina and setting a fyke net there would have interfered with boat traffic. Instead of setting a fyke net near the mouth of Big Six Mile Creek, two nets were set on the east shore, opposite the boat slips where the probability of a yearling and older northern pike encountering a net was most likely lower than the probability of a yearling and older northern pike encountering a net set in Burnt Ship Creek and Spicer Creek.

The greater number of YOY northern pike in Buckhorn Marsh impoundment compared with the creeks sampled in this study was probably due to a difference in emigration rates and a real difference in abundance. During most of the summer, the water elevation in Buckhorn Marsh impoundment was below the top of the stoplogs in both the west weir and the east weir, limiting the opportunity for YOY northern pike to emigrate. In Woods Creek, Gun Creek, Big Six Mile Creek, and Spicer Creek there were no barriers preventing YOY northern pike from emigrating, a movement pattern that YOY northern pike undertake starting three weeks after hatching (Becker 1983). Additionally, the numbers of YOY northern pike in Burnt Ship Creek, Spicer Creek, and Big Six Mile Creek before emigration were probably smaller than the number in Buckhorn Marsh impoundment based on the smaller numbers of yearling and older northern pike caught in the creeks.

4.3 Species Composition and Relative Abundance of Fish in BMRP

The species composition of fish in Buckhorn Marsh impoundment and Burnt Ship Creek differed from those of Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek (Table 4.3-1, Appendix F, Table F-10). Fewer fish species were caught and observed in Buckhorn Marsh impoundment (21) and Burnt Ship Creek (25) than in Gun Creek (30), Woods Creek (33), Spicer Creek (34), and Big Six Mile Creek (35). Eleven fish species, typically found in the Niagara River, were caught in Woods Creek but

not in either Buckhorn Marsh impoundment or Burnt Ship Creek. The species composition of fish in Gun Creek, Spicer Creek, and Big Six Mile Creek was more similar to that of Woods Creek than either that of Buckhorn Marsh impoundment or Burnt Ship Creek. Fourteen fish species caught in Gun Creek, Spicer Creek, and Big Six Mile Creek were not caught in Buckhorn Marsh impoundment and Burnt Ship Creek.

Among the fish species common to Buckhorn Marsh impoundment, Burnt Ship Creek, and Woods Creek, those typically associated with Niagara River were relatively more abundant in Woods Creek. For example, rock bass comprised 24.4% of all fish caught in Woods Creek but only 0.3% of all fish caught in Buckhorn Marsh impoundment and 0.4% of those caught in Burnt Ship Creek. Among the fish species common to Buckhorn Marsh impoundment, Burnt Ship Creek, and Woods Creek, those tolerant of higher water temperatures and lower DO were more abundant in Buckhorn Marsh impoundment and Burnt Ship Creek. For example 408 central mudminnows were caught in Burnt Ship Creek and 127 were caught in Buckhorn Marsh impoundment compared with only 2 caught in Woods Creek.

4.4 Need to Increase Fish Passage into or out of BMRP

The need to increase fish passage into or out of BMRP as an approach for promoting its use by northern pike for spawning and as a nursery while maintaining BMRP goals for wildlife species differed for Buckhorn Marsh impoundment and Burnt Ship Creek depending upon whether the objective for Buckhorn Marsh impoundment is to maintain a self-sustaining population with good growth rates or to use it as seasonal spawning or nursery habitat.

4.4.1 Buckhorn Marsh Impoundment

The smaller mean length of YOY northern pike caught by seining in Buckhorn Marsh impoundment during July, August, and September compared with YOY caught in Woods Creek, Gun Creek, and Big Six Mile Creek combined could reflect emigration of larger fish from Buckhorn Marsh impoundment, higher mortality of larger fish, stunting, or a combination of the three. These factors, and winterkill, could also be responsible for the smaller mean length of yearling and older northern pike

caught and tagged in Buckhorn Marsh impoundment compared with those caught and tagged in Woods Creek, Gun Creek, Big Six Mile Creek, and Spicer Creek and the absence of northern pike ≥600 mm long in Buckhorn Marsh impoundment.

There is no direct evidence that yearling and older northern pike or YOY emigrated from Buckhorn Marsh impoundment; none of the pike finclipped or tagged inside Buckhorn Marsh impoundment were caught outside of it. If emigration did not occur, then the emigration rate for larger northern pike could not be higher than that for smaller fish.

The lower than expected number of northern pike ≥600 mm long in Buckhorn Marsh impoundment does not appear to be due to winterkill. On March 27, the day before ice melted enough so that fyke nets could be set in Buckhorn Marsh impoundment near the east weir for the first time, 24 dead fish were found floating there including 8 northern pike, 2 bluegill, 11 carp, 1 black crappie, 1 bullhead, and 1 largemouth bass. The following day when more ice melted, 88 fish were found floating in Buckhorn Marsh impoundment including 7 northern pike, 33 pumpkinseed, 12 carp, 5 crappie, 1 bullhead, 25 rock bass, and 5 white sucker. It is reasonable to believe that these fish died due to winterkill. The eight northern pike found on March 27, although not measured, were estimated to range in length from 250 mm to 500 mm. If they were representative of the northern pike that died and their estimated lengths were accurate, then winterkill could not have produced the lower than expected number of northern pike ≥600 mm long.

Higher mortality of larger YOY northern pike in Buckhorn Marsh impoundment, due to a combination of limited food availability and cannibalism, could have produced the smaller mean length of those fish. Cannibalism among northern pike is not unusual and occurs more frequently in waters with few fish species (Inskip 1982). Buckhorn Marsh impoundment had the fewest species among all of the areas sampled during 2003. If the fewer species reflected limited food availability, limited food availability caused yearling and older northern pike to become cannibalistic, and the cannibalistic yearling and older northern pike fed selectively on larger YOY northern pike -- because they represented the larger food items preferred by larger northern pike, then the mean length of the remaining YOY would be

smaller. However, this does not appear to be the case because the length distribution of YOY northern pike was not truncated.

Higher mortality of larger yearling and older northern pike could have occurred simply due to selective harvest of larger fish by anglers. Alternatively, selective harvest of larger fish could have caused stunting. Stunting (i.e., a reduction in juvenile growth and a near cessation of growth in adulthood) is known to occur in northern pike populations (Diana 1987). In three Michigan lakes, high fishing mortality on larger fish resulted in an earlier age at first maturation and increased total allocation for gonadal growth at the expense of somatic growth (Diana 1983). However, it is unlikely that selective harvest of larger fish by anglers accounts for the smaller mean length of yearling and older northern pike in Buckhorn Marsh impoundment because field technicians never saw anyone fishing there although they did see people fishing in other areas sampled during 2003.

Two environmental factors that could have caused stunting of YOY northern pike in Buckhorn Marsh impoundment are temperature and DO. Casselman (1978) reported that growth rates of YOY northern pike peaked at 21^{o} C and decreased quickly at higher temperatures. Adelman and Smith (1970) reported that growth rates of YOY northern pike decreased gradually as DO decreased from 7 ppm to 3 or 4 ppm and then decreased more quickly, due to reduced food consumption and conversion efficiency (gain in weight/weight of food consumed). During the period when the highest water temperatures occurred in Buckhorn Marsh impoundment, June 16 through September 4, the mean was 23.3^{o} C and 86% of the daily mean water temperature values were greater than 21^{o} C; three of those exceeded 25^{o} C. During the same period, the mean DO in Buckhorn Marsh impoundment was 6.7 ppm and 57% of the daily mean DO values were below 7 ppm.

If high water temperature caused stunting, then stunting should have been more pronounced in Buckhorn Marsh impoundment because the mean water temperature from June 16 through September 4 in Buckhorn Marsh impoundment (23.3^{o} C) was higher than that in Woods Creek (21.3^{o} C), Gun Creek (20.8^{o} C), and Big Six Mile Creek (21.7^{o} C) and the three highest water temperatures among all of these water bodies occurred in Buckhorn Marsh impoundment. As expected, the mean length of YOY northern pike caught by seining in Buckhorn Marsh impoundment was significantly smaller than the mean length

of YOY northern pike caught by seining in Woods Creek, Gun Creek, and Big Six Mile Creek combined during July, August, and September. The lower mean DO in Buckhorn Marsh impoundment from June 16 through September 4 compared with Woods Creek (8.0 ppm) and Big Six Mile Creek (7.5 ppm) is also consistent with the significant length differences for YOY northern pike. However, the mean DO in Gun Creek (6.2 ppm) was lower than that in Buckhorn Marsh impoundment. Initially, this appeared to be inconsistent with the significantly smaller mean length of YOY northern pike caught by seining in Buckhorn Marsh impoundment compared with those caught by seining in Woods Creek, Gun Creek, and Big Six Mile Creek collectively. The YOY northern pike caught by seining in Woods Creek, Gun Creek, and Big Six Mile Creek were combined because the number caught in each of these creeks individually was not large enough for a statistical comparison. Based on a non-statistical comparison, the mean length of YOY northern pike caught by seining in Gun Creek during July was smaller than that for YOY northern pike in Buckhorn Marsh impoundment, Woods Creek, and Big Six Mile Creek; during August and September, the mean length was larger than that for Buckhorn Marsh impoundment but smaller than those for Woods Creek and Big Six Mile Creek. DO and temperature could have caused stunting in yearling and older northern pike in Buckhorn Marsh impoundment during the same time period considered for YOY because DO and temperature requirements of yearling and older fish are similar to those of YOY (Casselman 1978). DO may have caused stunting before that period as well. From April 1 through June 15 -- a time period during which growth of yearling and older northern pike was likely to occur, the mean DO in Buckhorn Marsh impoundment was 6.3 ppm and about 67% of the daily mean DO values were below 7 ppm. The mean DO in Buckhorn Marsh impoundment during that period was lower than that in Woods Creek (9.2 ppm), Gun Creek (7.1 ppm), Big Six Mile Creek (8.8 ppm), and Spicer Creek (8.5 ppm) and the percent of the daily mean DO values <7 ppm was higher than that for Woods Creek (22%), Gun Creek (56%), Big Six Mile Creel (15%), and Spicer Creek (34%). If the number of days when DO was <7 ppm was important, then the difference in growth between northern pike caught in Buckhorn Marsh impoundment and those caught in Woods Creek, Gun Creek, Big Six Mile Creek, and Spicer Creek may have been greater than expected based on the 2003 data because most yearling and older northern pike appear to leave the creeks after spawning. Although DO was not measured in the Niagara River during 2003, it was measured during 2001. The minimum DO at three different locations in the Niagara River during May 2001 was ≥8.2 ppm and was consistently higher than that in Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek during the same period.

Another factor that could have caused stunting of northern pike in Buckhorn Marsh impoundment is intraspecific competition. Reductions in food intake due to intraspecific competition or limited prey size resulted in large reductions in growth rate of a simulated population of northern pike (Diana 1987). Similarly, reduced growth rates of yearling and older northern pike in Escanaba Lake occurred as population density and competition for food increased (Kempinger and Carline 1978). In 12 Minnesota lakes and 17 Wisconsin lakes, lower growth rates occurred when the density of yearling and older northern pike exceeded 13 per hectare (Pierce and Tomcko. 2003). The open water area of Buckhorn Marsh impoundment is approximately 3.5 hectares. Therefore, based on a population estimate of 85 yearling and older northern pike, the density in Buckhorn Marsh impoundment (24 fish/ha) exceeds the value at which a density dependent reduction in growth is expected by almost a factor of two. Therefore, it is likely that intraspecific competition was an important factor contributing to the smaller mean length of yearling and older northern pike tagged in Buckhorn Marsh impoundment compared with those tagged in Woods Creek, Gun Creek, Big Six Mile Creek, and Spicer Creek.

If intraspecific competition was also an important factor contributing to the smaller mean length of YOY northern pike caught in Buckhorn Marsh impoundment compared with those tagged in Woods Creek, Gun Creek, and Big Six Mile Creek, then the density in Buckhorn Marsh impoundment should have been higher. As expected, the catch per seine haul of YOY northern pike in Buckhorn Marsh impoundment was 10 times higher than that in Woods Creek and over three times higher than that in Gun Creek and in Big Six Mile Creek.

If low DO and high temperature along with intraspecific competition caused stunting under current conditions, they would still cause stunting if passage into Buckhorn Marsh impoundment were increased. To alleviate stunting, northern pike passage out of Buckhorn Marsh impoundment would need to be provided after spawning. If that were done, passage into the marsh during the next spawning season might be needed. This would be equivalent to using the impoundment as seasonal spawning and nursery habitat.

Increasing passage for spawning northern pike into Buckhorn Marsh impoundment from Woods Creek would likely require lowering the stoplog height of the east weir during the spring. From March

through May 2003, when the spawning migration of northern pike was at it its peak, the water level in Woods Creek infrequently exceeded the stoplog height. Keeping the lower stoplog height during the spring and the summer would be needed to increase northern pike passage out of Buckhorn Marsh impoundment into Woods Creek after spawning. From March through mid-June 2003 the water level in Buckhorn Marsh impoundment was higher than the stoplog height of the east weir. Yet, no northern pike appeared to leave the impoundment. Lowering the stoplog height during 2003 would have lowered the water level in Buckhorn Marsh impoundment and increased the influence of daily water fluctuations in the Niagara River. Both of those changes in water level would not be consistent with management of the Buckhorn Marsh impoundment for wildlife, which includes maintaining stable and higher water levels – approximating historic levels (Anderson 1995).

Even if lowering the stoplog height in the east weir were acceptable, it would probably do little to improve the relatively poor habitat of Buckhorn Marsh impoundment for spawning and as a nursery. The most abundant EAV was cattail, the poorest vegetation type for spawning (Casselman and Lewis 1996), which formed a dense, almost monotypic stand. One of the most abundant SAV species was pondweed, also a poor vegetation type for spawning (Casselman and Lewis 1996). Additionally, the banks of Buckhorn Marsh impoundment were steeply sloped, which do not provide expansive shallow water areas that characterize relatively good spawning habitat for northern pike (Casselman and Lewis 1996).

Increasing passage for spawning northern pike into Buckhorn Marsh impoundment from Burnt Ship Creek would likely provide little benefit unless access to Burnt Ship Creek was improved and the stoplog height of the west weir were lowered. Lowering the stoplog height of the west weir would cause the same concerns as lowering the stoplog height of the east weir.

4.4.2 Burnt Ship Creek

The relatively small number of yearling and older northern pike caught in Burnt Ship Creek may be due to its relatively poor spawning habitat, limited access from the Niagara River, homing behavior, or a combination of these. A large, dense, almost monotypic cattail stand appears to limit the migration of northern pike both into Burnt Ship Creek from the Niagara River and out of the creek. Based on an aerial

photo from 1951, Burnt Ship Creek was an open channel from its mouth, east to beyond the I-190. Since then, the aerial extent of cattails in Burnt Ship Creek has expanded to the point that there is little open water in a large portion of the creek. The most abundant EAV in Burnt Ship Creek was cattail, the poorest vegetation type for northern pike spawning (Casselman and Lewis 1996).

Removing cattails to create a channel from the Niagara River would increase access to Burnt Ship Creek but may not initially produce a large increase in the number of yearling and older northern pike that use it. Harrison (1978) suggested that yearling and older northern pike from the Niagara River either have a strong homing tendency or they do not move far from the creek in which they spawned. If so, then the number of northern pike that currently return to Burnt Ship Creek may be low and it may take years to re-establish a larger population.

Removing cattails from Burnt Ship Creek should also improve water quality by increasing the exchange of water with the Niagara River. During the period June 16 through September 4, which includes the period when YOY northern pike were caught in Burnt Ship Creek, the mean DO (4.1 ppm) was much lower than that in Woods Creek (8.0 ppm), Gun Creek (6.1 ppm), Big Six Mile Creek (7.5 ppm), Spicer Creek (7.0 ppm), and even Buckhorn Marsh impoundment (6.7 ppm). Conductivity was also higher in Burnt Ship Creek during the period June 16 through September 4 and during the period from April 1 through June 15.

4.5 Conditions for Unbiased Population Estimates

Results from this study were used to examine the conditions that must be met for unbiased population estimates of yearling and older northern pike in Buckhorn Marsh impoundment, Woods Creek, and Gun Creek and an unbiased estimate of YOY northern pike in Buckhorn Marsh impoundment.

The first condition for unbiased estimates is that marked fish suffered the same natural mortality as unmarked fish. The tags used for yearling and older fish and the fin clips for YOY were minimally invasive and did not make the fish more visible to predators. Additionally, no recaptured fish were

observed to have infected or ulcerated tag wounds or fins. Therefore, it is reasonable to believe that marked fish suffered the same natural mortality rate as unmarked fish.

The second condition for unbiased estimates is that marked fish were as vulnerable to capture as the unmarked ones. The fish marked in our study were those that occurred naturally, i.e., they were not transported from other locations nor were they hatchery fish. The tags and finclips did not cause fish to become entangled in fyke nets and seines nor make them more visible during electrofishing. Therefore, it is reasonable to believe that marked fish were as vulnerable to capture as the unmarked ones.

The third condition for unbiased estimates is that marked fish did not lose their mark. Retention of PIT tags, the principal tag used, in yearling and older fish was greater than 98%. The maximum period of time between a fish being finclipped and recaptured was relatively short, reducing the likelihood that a fin would regenerated enough that a field technician would not recognize a clipped fin. Therefore, loss of marks was considered negligible and no adjustment to population estimates was needed for lost of marks.

The fourth condition for unbiased estimates is that either the marked fish or the total fishing effort was randomly distributed over the population being sampled. In Buckhorn Marsh impoundment: 1) yearling and older northern pike migrated from the eastern end to the western end and back, increasing the likelihood of mixing with unmarked fish and 2) seining for YOY northern pike was conducted at the eastern end, the western end, and in between. In Woods Creek and Gun Creek, sampling for yearling and older northern pike occurred over a protracted period of time. Coupled with the placement of fyke nets near the mouth of both creeks and the active movement of yearling and older fish during the spring, there was a high probability that random mixing occurred. Additionally, the two fyke nets in Gun Creek were separated by about 0.5 miles. Therefore, it is reasonable to believe that marked fish became randomly mixed with unmarked fish or the distribution of fishing effort in subsequent sampling was proportional to the number of fish present in different parts of the areas sampled.

The fifth condition for unbiased estimates is that all marks were recognized and reported on recovery. Recaptures of marked fish were based exclusively on collections made by field crews who

marked the fish and who followed standard operating procedures. Therefore, it is very likely that all marks were recognized and reported.

The sixth condition, which must be met for unbiased estimates for closed populations, is negligible recruitment to the catchable population during the time the recaptures were being made. In Buckhorn Marsh impoundment, only one yearling and older northern pike tagged outside Buckhorn Marsh impoundment was subsequently recaptured inside. Therefore, it is reasonable to believe that only negligible recruitment occurred.

The sixth condition for unbiased estimates for closed populations is not required for open populations. It appears that the populations of yearling and older northern pike in Woods Creek and Gun Creek were open. Yearling and older northern pike were caught in a physiological condition where they could spawn from March through June 2003. It is unlikely that the same fish remained in spawning condition for this length of time because northern pike spawning has been reported to occur over a two to five day period (Scott and Crossman 1973). More likely, northern pike were probably migrating into Woods Creek and Gun Creek over the 4-month period to spawn. This is not surprising from the perspective of life history theory because it allows northern pike to spread the risk of poor conditions during spawning over a longer period of time, assuring that at least some fish will spawn when conditions are good. The variable catch over the four-month period from March through June probably reflects northern pike migrating out of Woods Creek and Gun Creek after spawning at the same time that northern pike are migrating in to spawn. Therefore, the use of methods for open populations to estimate abundance in Woods Creek and Gun Creek during this study was more appropriate than the use of methods for closed populations.

The rule for assuring an unbiased estimate of abundance using the Jolly-Seber 4-catch method is that the total recaptures during the period of the estimate should be larger than 3 or 4 (Ricker 1975). This rule was not met for Woods Creek and Gun Creek during every recapture time period. The accuracy of abundance estimates using Bailey's triple-catch method also depends principally upon the numbers recaptured during subsequent time periods and particularly the number during the last time period. For both Woods Creek and Gun Creek the number recaptured during the last time period using Bailey's triple-

catch method was only one. The extent of the bias in these estimates, if bias exists, cannot be determined from the existing data.

As a result of migration, it also appears that the numbers of yearling and older northern pike in Woods Creek and Gun Creek were not constant over time. The open population methods provide estimates of abundance for distinct time periods during the study but not for the entire study. Those estimates for Woods Creek and Gun Creek are directly comparable to one another but are not to the population estimates for Buckhorn Marsh impoundment, which are estimates of the entire population. Nonetheless, it is reasonable to conclude that the number of yearling and older northern pike in Buckhorn Marsh impoundment was less than the number that used Woods Creek and Gun Creek.

The open population estimates for Woods Creek and Gun Creek are not directly comparable with the closed population estimates calculated by Harrison (1978), who did not have enough recaptures to calculate open population estimates. However, the estimated number of yearling and older northern pike was greater in Woods Creek compared with Gun Creek regardless of whether closed or open population methods were used.

TABLE 4.3-1

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003

Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Banded killifish	X	X	X	X	X	X
Black crappie	X	X	X	X	X	X
Bluegill	X	X	X	X	X	X
Bluntnose minnow	X	X		X	X	X
Bowfin	X	X	X	X	X	X
Brindled madtom						X
Brook silverside			X		X	X
Brook stickleback	X	X		X		
Brown bullhead	X	X	X	X	X	X
Carp	X	X	X	X	X	X
Central mudminnow	X	X	X	X		X
Channel catfish			X			
Common shiner	X	X	X	X	X	X
Creek chub		X	X	X	X	X
Emerald shiner	X	X	X	X	X[1]	X
European rudd	X	X	X	X	X	X
Freshwater drum			X	X	X	X
Gizzard shad			X	X	X	X
Golden shiner	X	X	X	X	X	X

TABLE 4.3-1 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003

Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Goldfish	X	X	X	X	X	X
Greater redhorse			X			
Green sunfish	X	X		X	X	X
Hornyhead chub						X
Johnny darter					X	
Largemouth bass	X	X	X	X	X	X
Logperch				X[1]		
Longnose gar					X	
Minnow family	X	X	X	X	X	X
Muskellunge		X	X	X	X	X
Northern hog sucker				X		X
Northern pike	X	X	X	X	X	X
Pumpkinseed	X	X	X	X	X	X
Quillback			X		X	X
Rainbow trout			X		X	
Redhorse			X	X	X	
River redhorse			X		X	
Rock bass	X	X	X	X	X	X
Round goby					X	
Smallmouth bass			X[1]		X	

TABLE 4.3-1 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003

Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Spottail shiner	X	X	X	X	X	X
Sticklebacks		X				
Sunfish	X	X	X	X	X	X
Sunfish family	X		X	X[1]	X	
Tadpole madtom	X	X	X	X		X
White bass					X	
White crappie			X	X	X	X
White perch					X	X
White sucker		X	X	X	X	X
Yellow bullhead			X			X
Yellow perch		X	X	X	X	X
Total Number of Species[2] Caught and Observed	21	25	33	30	35	34

[1] Observed but not caught.

[2] Does not include a count of family or genera.

5.0 CONCLUSIONS

The objectives of this study were to: 1) determine whether northern pike, largemouth bass, and yellow perch used the Buckhorn Marsh Restoration Project (BMRP) for spawning and as a nursery, and if so, estimate how many used it and establish whether they traversed either of the two weirs in BMRP; 2) compare the use of Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek by northern pike for spawning and as a nursery with that of BMRP; 3) determine the relative abundance and composition of species other than northern pike, largemouth bass, and yellow perch in BMRP and Woods Creek; and 4) evaluate the need to increase fish passage into or out of BMRP as an approach for promoting its use by northern pike for spawning and as a nursery while maintaining BMRP goals for wildlife species. Based on the data collected during 2003, the following inferences and conclusions are valid.

5.1 Use of BMRP for Spawning and as a Nursery

- BMRP is used by northern pike and largemouth bass for spawning and as a nursery and by yellow perch as a nursery.
- Within BMRP, Buckhorn Marsh impoundment is used more extensively than Burnt Ship Creek by both YOY and yearling and older northern pike but less extensively than Burnt Ship Creek by YOY largemouth bass.
- Within BMRP, Buckhorn Marsh impoundment was not used by yellow perch, and Burnt Ship Creek was lightly used by yellow perch YOY as a nursery.
- Northern pike do not migrate out of Buckhorn Marsh impoundment and rarely migrate into it.
- Largemouth bass did not migrate into or out of Buckhorn Marsh impoundment.

- Migration of northern pike and largemouth bass into Burnt Ship Creek from the Niagara River and out of Burnt Ship Creek to the Niagara River is limited by dense cattail stands.
- Migration of northern pike and largemouth bass into Burnt Ship Creek from Buckhorn Marsh impoundment is limited by water elevations lower than the top of the weir separating Burnt Ship Creek and Buckhorn Marsh impoundment.

5.2 Use of BMRP by Northern Pike Compared with Grand Island Tributaries

- Fewer yearling and older northern pike use Buckhorn Marsh impoundment than Woods Creek and Gun Creek but more used Buckhorn Marsh impoundment than Burnt Ship Creek, Big Six Mile Creek, and Spicer Creek.

5.3 Species Composition and Relative Abundance of Fish in BMRP

- The species composition and relative abundance of fish in Buckhorn Marsh impoundment and in Burnt Ship Creek differ from those of fish in Woods Creek and appear to reflect limited access from the Niagara River and lower water quality.

5.4 Need to Increase Fish Passage into or out of BMRP

- Increasing fish passage into Buckhorn Marsh impoundment is not needed to promote its use by northern pike for spawning and as a nursery if the objective is to maintain a self sustaining population; doing so might increase competition among northern pike.
- Increasing fish passage out of Buckhorn Marsh impoundment after spawning may be needed to reduce population density if the objective is to maintain a self sustaining population in the impoundment with good growth rates.

- If the objective were to use Buckhorn Marsh impoundment as seasonal spawning and nursery habitat for northern pike, then increasing fish passage into and out of the impoundment annually would be needed.
- Increasing fish passage into or out of Buckhorn Marsh impoundment would likely involve lowering the stoplog height of at least one weir during the spring and summer.
- Lowering the stoplog height of either weir would lower the water level in Buckhorn Marsh impoundment and make it more susceptible to daily changes in the water level of the Niagara River, which would not help maintain BMRP goals for wildlife species or improve the spawning and nursery habitat of the impoundment.
- Increasing fish passage into and out of Burnt Ship Creek would likely involve creating a more open channel, which should promote use of the creek by northern pike for spawning and as a nursery because relatively few northern pike use it now and access appears to be limited by dense stands of cattails.

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APPENDIX A – STANDARD OPERATING PROCEDURES

Standard Operating Procedures

USE OF BUCKHORN MARSH AND GRAND ISLAND TRIBUTARIES BY NORTHERN PIKE FOR SPAWNING AND AS A NURSERY: STANDARD OPERATING PROCEDURES

Niagara Power Project

(FERC No. 2216)

Prepared for:

New York Power Authority

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September 2003

TABLE OF CONTENTS

TABLES

1.0 INTRODUCTION

The objectives of this investigation are to: 1) determine whether northern pike, largemouth bass, and yellow perch used Buckhorn Marsh Restoration Project (BMRP) for spawning and as a nursery, and if so, estimate how many used it and establish whether they traversed either of the two weirs in BMRP; 2) compare the use of BMRP by northern pike for spawning and as a nursery with that of Woods Creek, Gun Creek, Spicer Creek, and Big Six Mile Creek; 3) determine the relative abundance and composition of all fish species in BMRP and Woods Creek; and 4) evaluate the need to increase fish passage into or out of BMRP as an approach for promoting its use by northern pike for spawning and as a nursery while maintaining BMRP goals for wildlife species. This document describes the standard operating procedures for the field tasks associated with this investigation.

2.0 LICENSE TO COLLECT AND POSSESS SPECIMENS

All fish collections will be made in accordance with the License to Collect and Possess Specimens for this project. Each field crew will carry a copy the License to Collect and Possess Specimens during all activities for which it is required and display it upon request.

3.0 SAMPLING APPROACH

3.1 Investigation Area

The investigation area for the study is in the upper Niagara River and is subdivided into zones, sites and stations. The zones (tributaries and the marsh) are contained within Grand Island. Specific sites within the marsh zone are the portion of Buckhorn Marsh between the two water control structures, Burnt Ship Creek, and portions of Woods Creek within and adjacent to Buckhorn Marsh. The sites in the tributaries zone are: Big Six Mile Creek from the mouth to the east end of the marina, Gun Creek from the mouth to a large pool located approximately 2,500 feet upstream, and Spicer Creek from the mouth to approximately 3,000 feet upstream of East River Road. Stations will be identified as appropriate within

each site. Table 1 outlines the zones and sites, and the sampling gear and schedule used at selected stations.

3.2 Sampling Strategy and Schedule

Sampling will take place from February through September 2003. Within each zone, sampling will be conducted at sites selected to accommodate fyke nets, electrofishing (high voltage boat shockers or portable/back-pack shockers) and seines.

Fyke nets will be deployed four days/week at all sites from ice-out through the first week of July. Seining will occur two days/week such that each site will be visited once per week from June through September. Electrofishing will occur two days/week such that each site will be visited once per week for the entire study period.

3.2.1 Evaluation of Ice Conditions in the Buckhorn Marsh and Grand Island Tributaries Relative to Initiation of Sampling and Ice-Condition Procedure

Ice-cover on a tributary more than a few millimeters thick and/or shoreline ice, could jeopardize crew safety during deployment/retrieval of fyke nets, especially if air temperatures will return to, or remain at/below freezing. Also, net-catch-characteristics could be affected by ice formation on or near the nets. Also of importance, fish survival could be affected if reformation of ice causes delays in access to, and processing of the catch. Similarly, should pieces of shoreline ice or shelf ice upstream of a net release for any reason it could foul nets resulting in net collapse, damage or loss, and mortalities of entrapped fish. Considering the above, fyke nets will not be set in a tributary or Buckhorn Marsh until that water body is clear of large sheets of ice and air temperatures are not likely to cause anything other than skim-ice to re-form overnight.

Electrofishing will be conducted as ice begins to recede before conditions are suitable for fyke netting. Sampling will be conducted when a tributary or Buckhorn Marsh can be safely accessed on foot by field crews carrying a back-pack shocker and equipment needed for tagging fish and recording data.

Ice conditions on the tributaries will be monitored at least once a week (with emphasis on Spicer and Gun Creeks) when ice is present to determine if sampling can occur. When air temperatures are above freezing, the creeks will be monitored five times a week. The electrofishing effort will be distributed among all tributaries in the study as soon as an opening can be safely accessed and efforts will be completed for up to two days a week across all sites conditions permitting. This ice-condition procedure will continue until it is safe to set fyke nets.

4.0 METHODS

4.1 General Considerations for Specimen Handling

4.1.1 Fish Handling

The following procedures will be followed to keep fish alive and reduce stress and injury:

- Personnel handling live fish will have wet hands, use wet chamois, or wear wet gloves. All surfaces that come in contact with live fish must be wet, including the measurement board. Wet open-cell foam covered with a wet chamois on which fish will rest and be held will be used during tagging operations, as appropriate.
- The head/eyes of struggling fish, especially large fish, will be covered with a wet cloth if this action aids in tagging or measuring tasks.
- All collected fish should be returned to the water as quickly as possible.
- Fish may be held in a tank(s) with sufficient volume to ensure that oxygen is not depleted or reduced to unacceptable levels when a fyke net is being checked, a seine haul is completed or during an electrofishing transect.
- Water in the tank(s) will be changed or replenished as necessary before each fyke net is checked, seine haul is made and before each electrofishing transect is done.

- All fish collected by electrofishing or seine netting will be released in the vicinity of collection.
- Fish collected from fyke nets in spawning or pre-spawning condition will be released upstream of the net in which it was captured except for fish collected in the fyke net in Woods Creek with the net mouth facing upstream, in which case fish will be released downstream.
- Spent fish collected from fyke nets will be released on the downstream side.
- Northern pike, muskellunge, largemouth bass or yellow perch in good condition in a holding tank will be released immediately after tagging.
- Northern pike, muskellunge, largemouth bass or yellow perch not in good condition will be released prior to tagging.
- Dead fish in tanks or (target species) recovered from the water after release will be returned to the water at the site of capture in Buckhorn Marsh or the site of capture elsewhere if the water is at least four feet deep and the fish will not be visible from the surface. The swim bladder/gut of a dead fish will be punctured to cause the specimen to sink. This procedure will be done discreetly to minimize the potential for upsetting the public.

If a specimen cannot be positively identified in the field, a representative will be preserved for later identification. Alcohol will be used for preserving specimens that must be kept.

All preserved samples will be the property of Stantec Consulting Services Inc. They will be retained in Stantec's laboratory for one year beyond the end of project field sampling.

4.1.2 Rare, Threatened, Endangered or Species of Concern

If a fish that is a rare, threatened, endangered species (RTE) or species of concern (SOC) is collected, it will be returned to the river alive immediately after a positive identification is made. All dead RTE and SOC will be frozen and saved. The New York Power Authority will be notified of such

capture as soon as possible (within 24 hours). Stantec will inform the New York State Department of Environmental Conservation (NYSDEC) of such capture at the end of the sampling season as required by the License to Collect and Possess Specimens. A list of all RTE & SOC species for New York State is shown in Table 2.

4.2 Fishing Procedures

Three fishing gears will be used for sampling during this study: fyke nets, seines and electrofishing equipment. Two crews, of two persons each, will be used for all efforts with each gear type. Fish sampling gear will be maintained/repaired as necessary, and water quality equipment will be calibrated to manufacturers' specifications prior to entering the field each day.

4.2.1 Fyke Nets

Two sizes of fyke nets will be used; the size of net at a given site will be appropriate to for the water depth at the site. The net will be deployed where water depth is equal to or greater than the diameter/height of the largest hoop in the fyke net used. The fyke nets to be used have hoops with a maximum diameter of either 4 feet at the mouth or 2.5 feet. The leads for all nets are 50 feet and wings are 20 feet long, the leads and wings 4 foot or 2.5 feet high as appropriate to the hoop size. The funnel openings are all 9 inches. Netting material is 1-inch bar mesh nylon with a dark coating to reduce net visibility and to keep algal growth to a minimum.

The maximum number of fyke nets set on any given day will be 17.

4.2.1.1 Precautions

- Fyke nets will be set in shallow depths of 2.5, or 4 feet deep at the mouth of the net (possibly deeper). Given the shallow sets, care will be exercised to avoid danger to other marine activities, boaters, and anglers.
- All fyke nets will be marked by buoys at the opening and wings.

- Fyke nets will never be set in navigation channels.
- The general location and duration of fishing activities will be reported to the U.S. Coast Guard, NYSDEC local conservation officer, and Buckhorn State Park Ranger.

4.2.1.2 Procedures

Fyke nets will be set for four consecutive days each week. Depending on site they will be set Monday through Thursday, or Tuesday through Friday (~72 hours/week/site) from ice-out through the first week of July 2003. Each fyke net will be checked approximately every 24-hours and fish processed. The net, leader and wings will be set tight using poles or anchors. If anchors are used, buoys will mark the distal end of wings and the net opening. Only properly mended nets will be used.

Deployment/retrieval procedures:

- In tributaries, fyke nets will generally be set in water of appropriate depth with the mouth facing downstream unless otherwise noted. The leader will be directed downstream along the course of the creek and the wings will be opened as much as possible. Two, 2.5 foot nets will be set at Spicer Creek, net 1 near the first bend above the mouth of the Creek, net 2 in pond just above the culverts under East River Road. Two, 2.5 foot nets will be set in Gun Creek, net 1 above the boat docks, net 2 at the outlet to the pond. At Big Six Mile Creek two, four foot nets will be set such that they do not interfere with boat traffic near shore opposite the boat slips, net 1 facing the River, net 2 facing upstream.
- In Woods Creek three, four-foot nets will be set. Net 1 will be deployed below the east weir and above the bridge facing the River. Net 2 will be set just above net 1 but below the east weir facing upstream. Net 3 will be set facing the River at a distance above the east weir that is similar to the distance between the weir and net 2.

- In the Marsh six, 4-foot fyke nets will be set between the water control structures. One net (Marsh net #1) will be set in the main channel upstream of the eastern structure located at Woods Creek and west of the first pair of side-cuts to the main channel. This net will be set facing Woods Creek. The wings for this and all nets will be spread at an angle close to a perpendicular to the lead. Net 2 will be deployed, west of Net 1 facing west. Net 3 will be set about half way up the channel on the south of the large bog-like island and facing Woods Creek. Net 4 will be set near the western end of the island facing a small cove on the south shore of the channel. The mouth of net 4 will face towards, and lead directed into the cove. Net 5 will be set on the western end of the island near its north channel, the net generally facing Woods Creek. Net 6 will be set in the North channel facing Woods Creek approximately parallel to net 3.
- For deployment from a boat, the fyke net will be set from the bow, with the pot on top and the leader and wings underneath.
- The pot will be anchored or staked first and the net with the float line of the leader upright will be played out as the boat is moved in reverse (if a boat is used). Once the net is deployed, the wings and the leader will be played out.
- When the gear is fully extended, the wings will be anchored or staked with a maximum opening. The leader will be fully extended and anchored or staked firmly to support the mouth of the net.
- For retrieval, the above procedure will be reversed.

Net locations will be determined once at each net location (using a standard location, horizontal coordinates, NAD 27 state plain west). The nets will be set at approximately the same coordinates, respective to each net as conditions permit. The coordinates are listed in Table 3.

The following information will be gathered for each deployment/retrieval when applicable:

- The depth at the mouth of the net (±0.3 m).

- Date and time of deployment/retrieval (Date: dd/mm/yy; hour: hh:mm)
- Conditions of the net (clogging, tears, etc.).
- All fish collected will be identified to the species level and counted (see below).

4.2.2 Seining

Two bag seines will be available for this project, and used as appropriate. A large (50 ft x 6 ft x ¼ in) or a small (20 ft x 6 ft x ¼ in) seine will be deployed depending on field conditions.

4.2.2.1 Precautions

- The bag seines will be used in shallow depths, close to shore. Great care must be exercised so that the seine does not catch and rip on bottom protrusions.
- The use of the bag seine might represent a danger to the field crew because of slippery substrate, sudden change in depths, especially if waders are worn. The field crew member handling the bag seine will always wear a personal floating device (PFD) when seining.

4.2.2.2 Procedures

At least two seine hauls will be made at or near each of the sampling sites. The bag seine will be manually dragged along the bottom using a two-person crew. Seining will be conducted as possible in shallow waters with smooth bottom where it is most effective.

- The lead line must remain in contact with the bottom to prevent fish from escaping under the net. If the lead line gets snagged, the bag section will be lifted just enough so that the obstacle is cleared.

- Snags as discussed above will be noted on the comment section of the field datasheet.
- If target species are observed escaping, the seine haul will be redone in a different location that has not been disturbed by the first pull. A haul will still be acceptable if the net gets snagged as long as fish are not observed escaping.

One end of the bag seine will be kept close to shore while the other person moves offshore to extend the net. Both ends of the seine will then be moved simultaneously over a distance moving in an upstream direction.

When the haul is completed, the offshore end will be brought back to shore so that both ends are rejoined. The seine will be brought back onto shore by having one person hauling both lead lines together as close to the bottom as possible while the other person pulls on the floating top line on either side. If more appropriate to a station, and as an alternative to the above, the offshore pole (brail) will be swept upstream to shore making an arc with the shore-brail as the fixed center of the arc.

Seine information will be placed on site specific maps and/or data sheets, as appropriate and include the following:

- The approximate location of each seine haul will be noted (drawn) on a map of the site sampled on each day of sampling (there are specific maps for each tributary and for the area between the weirs).
- One map will be used for each site, each day it is sampled.
- The fish caught on each haul will be noted on the fisheries data sheet and the catch related to the appropriate haul/transect number on a map.
- The date (dd/mm/yy), gear type and haul (transect) and time (hh:mm) as appropriate will be entered on the map.
- Conditions of the net (clogging, tears, etc.).

Seine locations can vary with each site visit unless the areas suitable for seining at a site are limited. The objective is to seine suitable areas, and cover as much of the area designated as the study area/site as possible, considering the catch and processing time, and within the time frame allotted.

All fish collected will be identified to the species level and individually counted or sub-sampled (see below). During largemouth bass spawning season try to avoid shallows where it is obvious males are guarding nests.

4.2.3 Electrofishing

Electrofishing will be conducted using a Smith-Root type VI-A, 2.5 GPP, model 15A backpack shocker or model 12 back-pack shocker as appropriate.

High Voltage Electrofishing

- The electrofishing gear will be mounted on a motorized 18 or a 15-foot aluminum boat.
- The electrofishing equipment in the 18 foot boat will comprise the following:
  - An array of anodes mounted at the bow
  - The boat acting as the cathode
  - A Honda or Smith-Root generator depending on gear used
  - A Smith Root Type VI Electrofisher
  - A holding tank for captured specimens
  - Appropriate dip nets
  - A holding tank
  - Tagging equipment/readers

Portable Electrofishing

- A backpack electroshocker (model 15A or 12 from Smith-Root)
- A dip net either provided with the shocker or as appropriate to conditions
- A holding tank for captured fish
- Tagging equipment/readers

4.2.3.1 Precautions

Electrofishing is hazardous work. Batteries and generator can produce enough energy to injure or kill a person.

- Currents applied at 20-500 Hz and as low as 0.0002 amps can cause serious injury or death. Death is usually a result of respiratory arrest, asphyxia or ventricular fibrillation.
- Cardiopulmonary resuscitation (CPR) can restore breathing but for ventricular fibrillation, CPR is only a stalling technique – a defibrillator must be used to restore normal heart rhythm.
- All members of the electrofishing crew will have received orientation on equipment and procedures. The crew will be constituted of at least one experienced operator (personnel are urged to attend CPR and first aid courses provided specifically for Stantec).
- The electrofishing equipment will be routinely inspected to check for and eliminate loose or frayed wires and connectors.
- All crew members must wear the following protective equipment:
  - PFD
  - Rubber soled shoes/boots and rubber gloves
  - Ear plugs/muff as appropriate

- Mammals, birds, reptiles, amphibians and mollusks are to be avoided when possible.
- During largemouth bass spawning season try to avoid shallows where it is obvious that males are guarding nests.

High Voltage Electrofishing

- A fire extinguisher (ABC type) will be available and placed near the generator.
- Gasoline will be stored in approved containers;
- When electrofishing begins, the most experienced person will take charge of the operation and complete electrofisher settings.
- The crew will be composed of only the required members with one person collecting fish at the bow.
- When the equipment is ready and personnel prepared, a pre-arranged signal will be used to commence electrofishing activities.
- A control pedal in good operating order will be available to the crewmembers.
- Equipment will be set so that there are no obstacles between the crew collecting the specimens with the dip nets and the holding tank.
- Electrofishing will not be done during heavy rain, thunderstorms or rough waters conditions. Regardless of these weather conditions, at the discretion of the crew leader, electrofishing can be discontinued for any safety reason.
- The equipment will be shut down when replacement, repairs or refueling (after generators cool) is taking place.
- The boat operator will proceed slowly and will deliberately avoid fish chasing.

- Fish will always be captured using dip nets with fiberglass handles or covered by an insulating material (electrical tape), never by hand.

Portable Electrofishing

- The small/shallow tributaries, will be accessed on foot and using a portable/back-pack electroshocker.
- The same general safety precaution stated above will be followed.
- All personnel while using the portable electroshocker will wear waders.
- No electrofishing will be attempted if the health, safety or welfare of the public may be endangered.

4.2.3.2 Procedures

High Voltage Electrofishing

Depending on the site, electrofishing will be conducted on either a Monday or a Friday each week of the study during daylight. Electrofishing will occur in all appropriate reaches of a site, as possible (electrofishing will generally not occur while fyke nets are in place). Fishing will be carried out as much as possible in a downstream direction if water flow is strong (so stunned fish will drift with the boat) and in habitats suitable to the electrofishing gear and retrieval of stunned fish. Electrofishing transects can vary with each site visit unless transects suitable for electrofishing at a site are limited. The primary objective during electrofishing is to catch northern pike, muskellunge, largemouth bass, and yellow perch. Therefore, the field crews will traverse suitable transects, and cover as much of the water body as possible, considering the catch and processing time, and within the time frame allotted. Fish do not need to be captured and enumerated if they can be identified as species other than northern pike, muskellunge, largemouth bass and yellow perch before being captured.

The apparatus will run on DC current using appropriate settings so as to avoid injuring fish. As gear permits, the duration of time during which current is supplied to the electrodes will be noted. An area to be electrofished will typically be traversed at a uniform slow boat or walking speed, slowing or

stopping near structures if appropriate, and as necessary to net fish affected by the electric field. The electrofisher controls will be set to produce a field that is effective for capture of target species, but avoids injury. Target species will be netted in preference to non-targets when multiple species are observed, though all fish will be captured as possible.

Electrofishing information will be placed on maps and/or data sheets, as appropriate and include the following:

- The approximate location of each electrofishing transect will be noted (drawn and numbered) on a map of the site sampled on each day of sampling (there are specific maps for each tributary and for the area between the weirs).
- One map will be used for each site, each day it is sampled.
- The fish caught on each transect will be noted on the fisheries data sheet and the catch related to the appropriate transect number on a map.
- The date (dd/mm/yy), gear type and transect and time (hh:mm) as appropriate will be entered on the map.
- The duration of electrofishing as indicated by the gear timer or other devise as appropriate will be noted on data sheets.
- Fish will be handled as soon as possible at the completion of a transect. RTE species, if identified prior to landing, will not be brought on board. If found, release immediately and be certain the RTE is clear of the area before continuing with electrofishing.
- Only northern pike, muskellunge, largemouth bass, and yellow perch collected will be identified to the level of species and counted.

The presence of tagged fish (including tag numbers for PIT tags, presence-absence for coded wire tags) or other tags, clips and anomalies in the condition of fish will be recorded, as appropriate.

Portable Electrofishing

Backpack or portable electrofishing will be conducted during daylight. No electrofishing will be conducted while the fyke nets are in the water.

Fishing will be carried out as much as possible in an upstream direction in shallow habitats, corresponding to habitats in small streams, along shorelines. Moving in an upstream direction will avoid silt suspended by electrofishing activities and optimize visibility. The primary objective during electrofishing is to catch northern pike, muskellunge, largemouth bass, and yellow perch. Therefore, the field crews will traverse suitable transects, and cover as much of the water body as possible, considering the catch and processing time, and within the time frame allotted. Fish do not need to be captured and enumerated if they can be identified as species other than northern pike, muskellunge, largemouth bass and yellow perch before being captured.

The transect will be established so as to cover relatively homogenous habitats.

Electrofishing information will be placed on maps and/or data sheets, as appropriate and include the following:

- The approximate location of each electrofishing transect will be noted (drawn and numbered) on a map of the site sampled on each day of sampling (there are specific maps for each tributary and for the area between the weirs).
- One map will be used for each site, each day it is sampled.
- The fish caught on each transect will be noted on the fisheries data sheet and the catch related to the appropriate transect number on a map.
- The date (dd/mm/yy), gear type and transect and time (hh/:mm) as appropriate will be entered on the map.
- The duration of electrofishing as indicated by the gear timer or other devise as appropriate will be noted on data sheets.

- Fish will be handled as soon as possible at the completion of a transect. RTE species, if they are identified prior to landing, will not be brought on board. If found release immediately and be certain the RTE is clear of the areas before continuing with electrofishing.
- Only northern pike, muskellunge, largemouth bass, and yellow perch collected will be identified to the level of species and counted.

The presence of tagged fish (including tag numbers for PIT tags, presence-absence for coded wire tags) or other tags, clips and anomalies in the condition of fish will be recorded, as appropriate.

4.3 Fish Species to be Monitored Tagged Clipped or Measured

Refer to _Table_4 and _Table_5_1 for site-specific directions on fish tagging and clipping for targeted young of year (YOY) and yearling and older (YAO) fish. These tables also provide procedures for counting and recording information on non-target fish.

4.3.1 General Procedures for Monitoring for Coded-Wire (CWT) and Passive Integrated Transponder (PIT) Tags

1. Complete all fish handling/tagging procedures as rapidly as possible and in a manner to limit stress to fish (see fish handling section).
2. Remove a fish from the holding tank using a dip net and place the fish on a wet measuring board with a wet chamois and determine/record its total-length to the nearest mm
3. If a target species is collected (northern pike, muskellunge, largemouth bass, or yellow perch 150 mm or greater) the fish will be checked for fin clips, non-project tags (e.g., Floy dart tags) (noted if present), and scanned for a passive integrated transponder (PIT) tag. The scan will be completed using a 134.2 kHz Biomark-Destron's Pocket Reader* slowly passed along and around the body of the fish
4. If a PIT tag is detected, the number will be recorded and the fish returned to the source water
5. If a PIT tag is not detected, the fish will be scanned around the head for a coded wire tag (CWT) using a CWT NMT Handheld "Wand" Detector**
6. If a CWT is detected, it will be so noted and the fish re-scanned for PIT tag

7. If again a PIT tag is not detected, the fish's abdominal area will be examined for evidence of a scar consistent with that caused by insertion of a PIT tag, and the scar noted if observed (this fish will be a candidate for re PIT tagging following the appropriate procedure below)

8. If a PIT tag is detected in the second scan the number will be noted, an asterisk placed at the end of the data-line on the data sheet, and also in the comments section after which "false negative" will be written, and the fish released

9. If neither a PIT or CWT are detected, and the fish is healthy, and is the appropriate length it will tagged using the PIT-CWT tagging procedure

   * The Reader will be maintained in an airtight, heavy duty, zip-lock type bag. If appropriate they will also be maintained in a bag while being used in the field, as these readers are not waterproof. Additionally, the reader must accurately report the number of the acrylic-encased, verification PIT tag chip to confirm that the reader operating satisfactorily.

   ** The detector must be checked before it is used at the first fyke net, haul location or transect of the day, before it is used after moving to a now location, and if a malfunction is suspected to determine that it detects a magnetized, 1.1 mm long CWT. Also, be certain that it is not falsely detecting a ferrous material such as a belt buckle, watch or boat component.

4.3.2 Passive Integrated Transponder (PIT) Tagging Procedures

1. Prior to retrieving a fish from a holding tank for processing, verify that the 134.2 kHz Biomark-Destron's Pocket Reader is operating properly* and scan/record the number of the rice-shaped, 11.5 mm glass PIT tag that is to be injected.

2. Place the tag into a Biomark MK6 Injector.

3. Place a target-fish (of 150 mm or greater length yellow perch and largemouth bass, 175 mm and greater northern pike and muskellunge, or as is considered safe for the fish by the crew leader), abdomen-up in a length of wet, open-cell foam as appropriate such that the foam partially wraps around, gently supports, and partially restrains the fish (a wet chamois may also be used)

4. Place the foam and fish on the fish measuring board to complete the tagging procedure.

5. Typically fish are PIT tagged with the tail pointing away from the biologist, however, this can be altered based on the preference of the biologist, and might be different based on species.

6. For largemouth bass and yellow perch, the needle of the MK6 injector should be inserted posterior to the tips of the pectoral fins, when the fins are laid along the side of the fish (or where the fin tips should be if the fins are eroded or missing). The objective is to have the tag lie between the pyloric caeca and the pelvic girdle after the tag is inserted.

7. Insert the needle into the abdomen to the right or left of the mid-ventral line and between the tips of the pleural ribs. (The spleen lies on the right side of the body so insertion on the left side will reduce chance of injury to the organ, though relative position will vary slightly among target species)

8. For northern pike or muskellunge, the needle of the MK6 injector should be inserted as shown in the photo below. The objective is to have the tag lie between and just anterior to the pelvic fins after the tag is inserted.

1. Insert the needle in just enough to penetrate the subcutaneous layer – the heart is close to this area, therefore, inserting the needle too far may kill the fish.

2. Direct the needle anteriorly (bevel down) with the needle tip under the scales; note the insertion must avoid the heart and other vital organs.

3. The needle must penetrate deep enough to inject the tag into the body cavity, injection into the cavity reduces the potential for tag rejection through the needle-hole; note the depth of needle penetration is of the needle will vary depending on the size/species of fish being tagged.

4. Scan the fish and confirm the number on the data form matches that on the reader and if so, proceed to applying a CWT,

5. The needle should be sharpened or replaced as necessary and disinfected between nets/hauls/transects as needed.

4.3.3 Coded Wire Tag (CWT) Tagging Procedures

1. Prior to retrieving a fish from a holding tank for processing, verify that the CWT NMT Handheld “Wand” Detector is operating properly.

2. Determine that a CWT Handheld “Multishot” Injector is set to magnetize and that the 1.1 mm CWT and the injector needle is sharp.

3. Maintain the previously PIT tagged target-fish in the wet, open-cell foam such that the foam partially wraps around, gently supports, and partially restrains the fish though the fish will be shifted to a dorsal-up orientation.

4. Place the foam with fish on the fish measuring board, as appopriate.

5. Typically a CWT is inserted while the fish's tail is pointing away from the biologist, however, this can be altered based on the preference of the biologist, and might be different among species.

6. The needle of the Multishot Injector should be inserted subcutaneously in the left cheek muscle at a 45o angle to the vertical.

7. The needle need only penetrate to a shallow depth, but check that it is securely implanted to avoid tag rejection.

8. Scan the fish following the monitoring procedure and release into the source water if a detection is registered, if not, check equipment to insure proper operation and re-inject a CWT on the opposite side, rescan and release. Record the side into which the CWT was injected and whether one or two CWTs were injected into the fish.

9. The equipment will be rinsed with clean water as necessary between sampling locations.

4.3.4 Fish Fin Clipping Procedures

Following the directions outlined in Table 4 and Table 5, the designated fin will be partially clipped (e.g., a half to ¾ clip) fish scales are not to be affected or bleeding caused. Sharp, blunt-ended scissors will be used. The fish will be held in wet chamois as discussed for CWT and PIT tagging.

4.4 Water Quality

Water quality data are to be collected at each fyke net each time they are set or tended except for nets that are in close proximity (e.g., back to back) where water quality would not be measurably different. Water quality data will be collected for seine hauls and electrofishing transects at each site, though the objective is to use time to collect fish and not necessarily to collect water quality for all hauls/transects each day at a site except as conditions suggest reasonable to do so. Table 6 lists the parameters and equipment for the water quality parameters that will be measured.

TABLE 1

AREAS, ZONES, SITES, AND STATIONS/GEAR/SCHEDULE WHERE FISH COLLECTIONS WILL BE MADE DURING THE 2003 FISHERIES SURVEY OF THE BUCKHORN MARSH AND TRIBUTARIES OF THE NIAGARA RIVER ON GRAND ISLAND

Area	Zone	Site	Stations
Upper Niagara	Grand Island Tributaries	Woods Creek	3 Fyke nets for 72 hrs/week, Feb-Jul; Electrofishing 1 day/wk, Feb-Sept; Seine netting 1 day/wk, Jun-Sept
		Gun Creek	2 Fyke nets for 72 hrs/week, Feb-Jul; Electrofishing 1 day/wk, Feb-Sept; Seine netting 1 day/wk, Jun-Sept
		Burnt Ship Creek	2 Fyke nets for 72 hrs/week, Feb-Jul; Electrofishing 1 day/wk, Feb-Sept; Seine netting 1 day/wk, Jun-Sept
		Spicer Creek	2 Fyke nets for 72 hrs/week, Feb-Jul; Electrofishing 1 day/wk, Feb-Sept; Seine netting 1 day/wk, Jun-Sept
		Big Six Mile Creek	2 Fyke nets for 72 hrs/week, Feb-Jul; Electrofishing 1 day/wk, Feb-Sept; Seine netting 1 day/wk, Jun-Sept
	Buckhorn Marsh (between water control Structures)		6 Fyke nets for 72 hrs/week, Feb-Jul; Electrofishing 1 day/wk, Feb-Sept; Seine netting 1 day/wk, Jun-Sept

TABLE 2

COMMON AND SCIENTIFIC NAMES OF ENDANGERED, THREATENED AND SPECIAL CONCERN FISH SPECIES IN NEW YORK STATE

Species	Latin Name
Endangered	
Shortnose sturgeon	*Acipenser brevirostrum*
Silver chub	*Macrhybopsis storeriana*
Pugnose shiner	*Notropis anogenus*
Round whitefish	*Prosopium cylindraceum*
Bluebreast darter	*Etheostoma camurum*
Gilt darter	*Percina evides*
Spoonhead sculpin	*Cottus ricei*
Deepwater sculpin	*Myoxocephalus thompsoni*
Threatened	
Lake sturgeon	*Acipenser fulvescens*
Mooneye	*Hiodon tergisus*
Lake chubsucker	*Erimyzon sucetta*
Gravel chub	*Erimystax x-punctata*
Mud sunfish	*Acantharchus pomotis*
Banded sunfish	*Enneacanthus obesus*
Longear sunfish	*Lepomis megalotis*
Longhead darter	*Percina macrocephala*
Eastern Sand darter	*Ammocrypta pellucida*
Swamp darter	*Etheostoma fusiforme*
Spotted darter	*Etheostoma maculatum*
Special Concern	
Mountain brook lamprey	*Ichthyomyzon greeleyi*
Black redhorse	*Moxostoma duquesnei*
Streamline chub	*Erymystax dissimilis*
Redfin shiner	*Lythrurus umbratilis*
Ironcolor shiner	*Notropis chalybaeus*

TABLE 3

FYKE NET LOCATIONS

Net	NORTHING	EASTING
Big Six Mile 1	1101521.401	385704.563
Big Six Mile 2	1101796.201	385592.385
Buckhorn 1	1115048.406	394364.264
Buckhorn 2	1114971.471	394294.410
Buckhorn 3	1114412.089	392604.018
Buckhorn 3 new*	1114510.063	393693.132
Buckhorn 4	1114735.185	391562.849
Buckhorn 5	1115074.433	391510.600
Buckhorn 6	1114732.017	392621.411
Burntship 1	1115259.414	390552.498
Burntship 1 Orig**	1115221.568	390679.970
Burntship 2	1115335.867	389732.726
Gun 1	1110452.980	410645.283
Gun 2	1109173.383	410060.737
Spicer 1	1102295.057	416519.007
Spicer 2	1102523.046	415789.406
Woods 1	1115727.135	394599.209
Woods 2	1115552.821	394559.792
Woods 3	1115237.955	394733.768
Woods 1 orig.***	1113801.374	396352.663

* Location where net 3 was moved due to SAV

** Original location of net 1

*** Original location of net 1

TABLE 4

PROCEDURE FOR MARKING FISH IN BIG SIX MILE, GUN, AND SPICER CREEKS

Fyke Nets	Northern Pike	Largemouth Bass	Yellow Perch	Muskellunge
Identify, count, and record all fish collected.	All fish species			
Measure and record total length (TL, mm), sex if possible	X			X
Examine YAO for PIT tag & record number	X	X	X	
Insert PIT tag on all YAO > 175 mm if doesn't have one1	X			X
Insert PIT tag on all YAO > 200 mm if doesn't have one1		X	X	
Insert a coded wire tag into any fish receiving PIT tag	X	X	X	X
Check every yellow perch that does not have a PIT/Coded wire tag for fin clip and record any present			X	
Electrofishing and Seining	**Northern Pike**	**Largemouth Bass**	**Yellow Perch**	**Muskellunge**
Identify, count, and record fish collected.	X	X	X	X
Measure and record total length (TL, mm), sex if possible	X			X
Examine YAO for PIT tag & record number	X	X	X	X
Insert PIT tag on all YAO > 175mm if doesn't have one1	X			X
Check every YOY fish for fin clips and record	X	X	X	
Clip lower caudal fin on every YOY not previously clipped (Big Sixmile)	X			X
Clip upper caudal fin on every YOY not previously clipped (Gun Creek)	X			X
Clip upper and lower fin on every YOY not previously clipped (Spicer Creek)	X			X

Estimate number of fish other than northern pike, muskellunge, largemouth bass and yellow perch caught by species (if possible) by category:

Very low	<10
Low	>10 and <100
Moderate	>100 and <1000
High	>1000

[1] Prior to April 3, 2003, all northern pike, muskellunge, largemouth bass, and yellow perch that were >150mm total length were to receive a PIT and coded wire tag. On April 3, 2003, the SOP changed such that only those northern pike, muskellunge, largemouth bass, and yellow perch >175mm were to receive a PIT and coded wire tag. On April 10, 2003, the SOP changed such that only those largemouth bass >200mm were to receive a PIT and coded wire tag. On April 11, 2003 the SOP was changed such that only those yellow perch >200mm were to receive a PIT and coded wire tag.

TABLE 5

PROCEDURE FOR MARKING FISH IN BUCKHORN MARSH, WOODS AND BURNT SHIP CREEKS

Fyke nets	**Northern Pike**	**Largemouth Bass**	**Yellow Perch**	**Muskellunge**
Identify, count, and record **all** fish collected.	All fish species			
Measure and record total length (TL, mm), sex if possible	X	X	X	X
Examine YAO for PIT tag & record number	X	X	X	
Insert PIT tag on all YAO > 175mm if doesn't have one[1]	X			X
Insert PIT tag on all YAO > 200mm if doesn't have one[1]		X	X (100/week max)	
Insert a coded wire tag into any fish receiving PIT tag	X	X	X	
Check every yellow perch that does not have a PIT/Coded wire tag for fin clip and record any present			X	
Electrofishing	**Northern Pike**	**Largemouth Bass**	**Yellow Perch**	**Muskellunge**
Measure and record total length (TL, mm), sex if possible	X	X	X	X
Examine YAO for PIT tag & record number	X	X	X	
Insert PIT tag on all YAO > 175mm if doesn't have one[1]	X			X
Insert PIT tag on all YAO > 200mm if doesn't have one[1]		X	X (100/week max)	
Check every YOY fish for fin clips and record	X	X	X	
Clip **right pelvic** on every YOY not previously clipped (**Buckhorn**)	X	X	X	
Clip **left pelvic** on every YOY not previously clipped (**Woods Creek**)	X	X	X	
Clip **anal fin** on every YOY not previously clipped (**Burnt Ship**)	X	X	X	

TABLE 5 (CONT.)
PROCEDURE FOR MARKING FISH IN BUCKHORN MARSH, WOODS AND BURNT SHIP CREEKS

Seining	Northern Pike	Largemouth Bass	Yellow Perch	Muskellunge
Identify, count, and record **all** fish collected (**Buckhorn Marsh only**)	All fish species			
Identify, count, and record fish collected (**Woods and Burnt Ship**)	X	X	X	X
Measure and record total length (TL, mm), sex if possible	X	X	X	X
Examine YAO for PIT tag & record number	X	X	X	
Insert PIT tag on all YAO > 175mm if doesn't have one[1]	X			X
Insert PIT tag on all YAO > 200mm if doesn't have one[1]		X	X (100/week max)	
Check every YOY fish for fin clips and record	X	X	X	
Clip **right pelvic** on every YOY not previously clipped (**Buckhorn**)	X	X	X	
Clip **left pelvic** on every YOY not previously clipped (**Woods**)	X	X	X	
Clip **anal fin** on every YOY not previously clipped (**Burnt Ship**)	X	X	X	

[1] Prior to April 3, 2003, all northern pike, muskellunge, largemouth bass, and yellow perch that were >150mm total length were to receive a PIT and coded wire tag. On April 3, 2003, the SOP changed such that only those northern pike, muskellunge, largemouth bass, and yellow perch >175mm were to receive a PIT and coded wire tag. On April 10, 2003, the SOP changed such that only those largemouth bass >200mm were to receive a PIT and coded wire tag. On April 11, 2003 the SOP was changed such that only those yellow perch >200mm were to receive a PIT and coded wire tag.

TABLE 6

WATER QUALITY PARAMETERS AND EQUIPMENT

Parameter	Method	Precision
Water temperature	YSI Oxymeter	±0.2ºC (±0.36 ºF)
Light penetration	*Secchi disk or NTU meter	Disk ±0.25m (± 9.8 in)
Dissolved oxygen	YSI Oxymeter	±0.3mg/L
Depth	Sounding line	±0.5m
Conductivity	EC Tester	±1% full scale
pH	PH Tester 2	±0.1 pH

* NTU meter used when available from URS, otherwise Secchi reading obtained.

APPENDIX B – LENGTHS OF YEARLING AND OLDER AND YOUNG-OF-THE-YEAR NORTHERN PIKE

TABLE B-1

LENGTHS (MM) OF YEARLING AND OLDER NORTHERN PIKE TAGGED IN WOODS CREEK, GUN CREEK, BUCKHORN MARSH IMPOUNDMENT, SPICER CREEK, AND BIG SIX MILE CREEK THROUGH JULY 3, 2003

Woods Creek	Gun Creek	Buckhorn Marsh	Spicer Creek	Big Six Mile Creek
306	144	295	335	363
310	305	309	359	480
320	332	320	397	482
327	338	324	406	490
327	343	325	424	510
330	349	327	436	572
351	354	328	484	590
392	363	330	510	606
396	366	330	513	628
397	368	331	514	629
402	370	331	533	652
405	376	332	570	711
407	377	334	580	731
407	378	335	589	802
413	378	336	590	817
414	379	338	591	
414	380	339	593	
417	381	339	615	
417	382	342	660	
424	388	343	670	
427	390	348	671	
428	391	348	680	
431	394	356	684	
432	396	356	754	
435	396	356		
436	398	358		
437	406	364		
438	407	366		
441	408	366		
444	410	368		
445	412	372		
452	420	374		
452	420	375		
459	421	375		
461	429	377		
461	437	381		
466	452	384		
469	452	385		

Woods Creek	Gun Creek	Buckhorn Marsh	Spicer Creek	Big Six Mile Creek
471	454	385		
474	455	385		
475	462	385		
476	466	385		
476	470	391		
481	471	392		
482	477	397		
482	478	405		
489	490	407		
490	495	407		
495	496	409		
500	502	410		
502	514	410		
502	517	413		
502	518	415		
502	520	420		
503	522	423		
506	522	424		
508	525	434		
509	527	434		
509	528	435		
510	532	444		
510	533	470		
514	535	472		
515	542	483		
516	545	485		
517	548	500		
517	557	505		
517	560	511		
518	562	575		
518	569			
520	572			
521	577			
522	585			
524	590			
525	598			
528	602			
533	612			
533	618			
533	620			
534	621			
534	621			
535	622			

Woods Creek	Gun Creek	Buckhorn Marsh	Spicer Creek	Big Six Mile Creek
537	625			
538	625			
539	631			
541	631			
542	632			
548	633			
550	637			
550	640			
552	642			
560	645			
560	660			
561	662			
562	668			
563	668			
565	669			
565	670			
569	671			
569	679			
570	680			
570	682			
572	684			
572	688			
573	690			
577	692			
579	693			
580	694			
580	700			
581	701			
582	706			
584	708			
585	710			
585	720			
589	726			
590	728			
591	729			
592	731			
595	737			
597	742			
599	752			
602	760			
605	767			
608	768			
617	770			

Woods Creek	Gun Creek	Buckhorn Marsh	Spicer Creek	Big Six Mile Creek
617				
618				
622				
625				
632				
632				
632				
634				
638				
641				
642				
643				
647				
649				
655				
657				
666				
667				
667				
672				
675				
682				
687				
691				
692				
695				
700				
704				
710				
712				
714				
715				
717				
722				
748				
749				
782				
808				

TABLE B-2

LENGTHS (MM) OF YOUNG-OF-THE-YEAR NORTHERN PIKE CAUGHT BY SEINING AND ELECTROFISHING IN BUCKHORN MARSH IMPOUNDMENT, GUN CREEK, BIG SIX MILE CREEK, AND WOODS CREEK, DURING 2003

Buckhorn Marsh	Gun Creek	Big Six Mile Creek	Woods Creek
69	62	54	87
74	80	74	91
78	81	75	133
80	81	76	135
80	84	68	152
82	86	63	163
87	89	73	211
91	90	89	237
97	93	77	277
97	99	86	
97	110	93	
100	112	98	
102	114	187	
105	115	174	
109	122	187	
110	151	207	
110	162	264	
110	174		
112	189		
112	202		
113			
113			
114			
114			
115			
117			
117			
117			
119			
123			
123			
124			
127			
130			
130			
133			
133			
133			

Buckhorn Marsh	Gun Creek	Big Six Mile Creek	Woods Creek
134			
136			
137			
137			
138			
140			
144			
146			
146			
148			
150			
151			
152			
153			
154			
155			
156			
156			
156			
157			
159			
160			
162			
162			
164			
165			
166			
172			
172			
174			
180			
183			
211			
211			
220			
235			
249			
285			
296			

APPENDIX C – VALUES USED FOR CALCULATING ABUNDANCE OF YEARLING AND OLDER AND YOUNG-OF-THE-YEAR NORTHERN PIKE

TABLE C-1

VALUES USED FOR CALCULATING THE ABUNDANCE OF YEARLING AND OLDER NORTHERN PIKE IN BUCKHORN MARSH IMPOUNDMENT DURING 2003 USING THE SCHUMACHER AND ESCHMEYER AND ADJUSTED SCHNABEL METHODS.

Date	Caught (C)	Recaptured (R)	Marked (M)	Cumulative marked	$C_t M_t$	$M_t R_t$	$C_t M_t^2$	R_t^2/C_t
28-Mar	2	0	2	0	0	0	0	0.0000
29-Mar	3	0	3	2	6	0	12	0.0000
30-Mar	2	0	2	5	10	0	50	0.0000
31-Mar	3	0	3	7	21	0	147	0.0000
1-Apr	20	2	18	10	200	20	2,000	0.2000
2-Apr	18	3	15	28	504	84	14,112	0.5000
3-Apr	14	4	9	43	602	172	25,886	1.1429
4-Apr	9	4	5	52	468	208	24,336	1.7778
10-Apr	17	14	3	57	969	798	55,233	11.5294
11-Apr	6	5	1	60	360	300	21,600	4.1667
12-Apr	7	6	1	61	427	366	26,047	5.1429
13-Apr	10	7	2	62	620	434	38,440	4.9000
14-Apr	7	7	0	64	448	448	28,672	7.0000
15-Apr	5	3	2	64	320	192	20,480	1.8000
16-Apr	9	6	3	66	594	396	39,204	4.0000
17-Apr	8	7	0	69	552	483	38,088	6.1250
18-Apr	6	4	2	69	414	276	28,566	2.6667
25-Apr	1	1	0	71	71	71	5,041	1.0000
30-Apr	5	5	0	71	355	355	25,205	5.0000
1-May	2	2	0	71	142	142	10,082	2.0000
2-May	1	1	0	71	71	71	5,041	1.0000
Sum	155	81	71	1003	7,154	4,816	408,242	59.95124

TABLE C-2

VALUES USED FOR CALCULATING THE ABUNDANCE OF YOUNG-OF-THE-YEAR NORTHERN PIKE IN BUCKHORN MARSH IMPOUNDMENT DURING 2003 USING THE SCHUMACHER AND ESCHMEYER AND ADJUSTED SCHNABEL METHODS

Date	Caught (C)	Recaptured (R)	Marked (M)	Cumulative marked	$C_t M_t$	$M_t R_t$	$C_t M_t^2$	R_t^2/C_t
8/1/2003	13	0	13	22	286	0	6,292	0.0000
8/4/2003	2	0	2	35	70	0	2,450	0.0000
8/14/2003	3	1	2	37	111	37	4,107	0.3333
8/21/2003	11	0	11	39	429	0	16,731	0.0000
8/29/2003	5	0	5	50	250	0	12,500	0.0000
9/5/2003	7	1	6	55	385	55	21,175	0.1429
9/9/2003	7	2	5	61	427	122	26,047	0.5714
9/16/2003	3	1	2	66	198	66	13,068	0.3333
9/22/2003	2	0	2	68	136	0	9,248	0.0000
9/30/2003	2	0	2	70	140	0	9,800	0.0000
Sum	77	5	72	550	2,619	280	123,907	1.380952

TABLE C-3

VALUES USED FOR CALCULATING THE ESTIMATED NUMBER OF YEARLING AND OLDER NORTHERN PIKE IN WOODS CREEK DURING 2003 USING THE JOLLY-SEBER METHOD

Time period	Newly marked fish	Examined for marks	Recaptures of fish marked at			Total	K_i[a]	Number
			March 25 - March 29	March 30 - April 13	April 14 - May 2			
March 25 - March 29	38	-	-	-	-	-	-	-
March 30 - April 13	73	75	6	-	-	6	6	612
April 14 - May 2	41	47	4	5	-	9	5	552
May 3 - June 10	-	45	2	3	1	6	-	-
Total			12	8	1	21		

*K_i is the sum of all recaptures made later than $Time_i$ of the fish marked before $Time_i$

TABLE C-4

VALUES USED FOR CALCULATING THE ESTIMATED NUMBER OF YEARLING AND OLDER NORTHERN PIKE IN WOODS CREEK DURING 2003 USING THE BAILEY METHOD

Time period	Newly marked fish	Examined for marks	Recaptures of fish marked at			Number
			March 25 - March 29	March 30 - April 13	April 14 - May 2	
March 25 - March 29	38	-	-	-	-	-
March 30 - April 13	73	75	6	-	-	538
April 14 - May 2	41	47	4	5	-	492
May 3 - June 10	-	45	2	3	1	-

TABLE C-5

VALUES USED FOR CALCULATING THE ESTIMATED NUMBER OF YEARLING AND OLDER NORTHERN PIKE IN GUN CREEK DURING 2003 USING THE JOLLY-SEBER METHOD

Time period	Newly marked fish	Examined for marks	Recaptures of fish marked at			Total	K_i*	Number
			March 25 - March 29	March 30 - April 13	April 14 - May 2			
March 25 - March 29	32	-	-	-	-	-	-	-
March 30 - April 13	39	50	4	-	-	4	3	255
April 14 - May 2	24	29	2	4	-	6	2	137
May 3 - June 10	33	43	1	1	1	3	-	-
Total			7	5	1	13		

*K_i is the sum of all recaptures made later than $Time_i$ of the fish marked before $Time_i$

TABLE C-6

VALUES USED FOR CALCULATING THE ESTIMATED NUMBER OF YEARLING AND OLDER NORTHERN PIKE IN GUN CREEK DURING 2003 USING THE BAILEY METHOD

Time period	Newly marked fish	Examined for marks	Recaptures of fish marked at			Number
			March 25 - March 29	March 30 - April 13	April 14 - May 2	
March 25 - March 29	32	-	-	-	-	-
March 30 - April 13	39	50	4	-	-	159
April 14 - May 2	24	29	2	4	-	72
May 3 - June 10	33	43	1	1	1	-

APPENDIX D – WATER QUALITY MEASUREMENTS

TABLE D-1

MEASUREMENTS OF pH, DO, CONDUCTIVITY, AND TEMPERATURE AT THE SURFACE IN BUCKHORN MARSH IMPOUNDMENT DURING 2003

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
3/21/2003	7.6	10.6	380	1.2
3/27/2003	8	6	613	7.6
3/28/2003	8	6.5	665	8.8
3/29/2003	7.8	5.6	650	5.9
3/30/2003	7.8	6.6	700	
3/31/2003	7.7	6.1	656	3.7
4/1/2003	7.6	6.6	714	5.3
4/2/2003	8	7.4	768	4.2
4/3/2003	8	8.9	936	2
4/4/2003	8.7	11.1	860	5.1
4/10/2003	8.2	10.5	866	5.3
4/11/2003	8.2	10.4	864	6.4
4/12/2003	8.3	10.2	850	7.1
4/13/2003	7.9	9.8	864	8.8
4/14/2003	8.1	9.2	852	12.1
4/15/2003	7.9	8.4	946	12.2
4/16/2003	7.8	8.6	802	7.4
4/17/2003	7.7	8.5	1034	8.3
4/21/2003	7.8	8.1	940	15.4
4/22/2003	7.6	5.8	976	10.8
4/23/2003	8	6.8	890	11.5
4/24/2003	8	7.4	826	10.8
4/28/2003	7.8	7.9	900	16
4/29/2003	7.7	6.4	890	14
4/30/2003	7.5	6.1	834	14.8
5/1/2003	7.4	6.5	876	14.8
5/5/2003	7.3	6.2	850	14.5
5/6/2003	7.9	5.7	869	15.2
5/7/2003	7.6	4.4	882	14.4
5/8/2003	7.6	4.4	884	14.3
5/13/2003	7.8	3.8	836	12.8
5/14/2003	8	5	868	14.5

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
5/15/2003	7.5	4.7	842	13.1
5/19/2003	7.6	5.5		19.7
5/20/2003	7.5	4.5	814	17.2
5/21/2003	7.6	4.9	810	16.1
5/22/2003	8	5.9	768	17.5
5/27/2003		4.7	660	18.1
5/28/2003	7.8	4.7	813	18.3
5/29/2003		4.3	838	18.8
5/30/2003		4.2	850	17.9
6/2/2003	7.8	6	720	19.5
6/3/2003	7.8	5.4	846	16.4
6/4/2003	7.8	5.2	856	16.1
6/5/2003	7.8	5.2	786	17.5
6/9/2003	8	6.9	740	20.8
6/10/2003	7.7	5.2	843	20.9
6/11/2003	7.7	5	873	20.5
6/12/2003	7.5	4.2	870	19.1
6/16/2003	7.3	7.2	870	25.3
6/17/2003	7.8	6.3	850	22.7
6/18/2003	8	5.2	822	20.7
6/19/2003	8.1	5.8	860	20.7
6/23/2003	8.1	4.6	765	23
6/24/2003		7.5	809	23
6/25/2003	8	8.3	798	27.8
6/26/2003	8.3	6.4	792	23.5
6/30/2003				23
7/1/2003	8	8.4	666	23.7
7/2/2003	8.3	7.3	640	23.7
7/9/2003	7.8	6.3	890	25.5
7/11/2003	8.3	2.6	440	20.7
7/15/2003	8.8	10.2	320	23.4
7/23/2003	8.5	8	500	23.3
7/28/2003	8.8	7.9	310	23.1
8/1/2003	8.6	5.1	400	23.8
8/4/2003	7.8	7.1	330	24.2
8/14/2003	8.5	5.3	420	24.4
8/21/2003	8.5	5.1	440	24.5

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
9/3/2003	8.5	5.3	290	21.4
9/5/2003	8.6	4.9	460	19
9/8/2003	8.6	7.8	300	21.9
9/9/2003	8	5.9	270	20.7
9/15/2003	8.5	7.7	280	21.1
9/16/2003	8.2	8	281	20.5
9/22/2003	8.4	6.1	280	18.7
9/24/2003				
9/25/2003	8.5	3.4	410	16.5
9/29/2003	8.2	3	790	13.7
9/30/2003	8.3	8.2	320	15.6

TABLE D-2

MEASUREMENTS OF pH, DO, CONDUCTIVITY, AND TEMPERATURE AT THE SURFACE IN BURNT SHIP CREEK DURING 2003

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
3/28/2003	8.2	9.1	1563	8.4
3/29/2003	8.2	9.7		5.5
3/30/2003	7.9	12.0		5.4
3/31/2003	8.1	11.7	1200	2.5
4/1/2003	8.2	11.1	1850	4.3
4/2/2003	7.9	12.0		3.3
4/3/2003	8.1	12.5		0.7
4/4/2003	7.4	10.7		3.4
4/7/2003	8.4	10.3		0.9
4/8/2003	8.3	12.0	490	1.6
4/9/2003	7.5	11.0	1720	2.3
4/10/2003	7.8	11.6	1850	3.7
4/11/2003	7.5	11.1	1650	6.2
4/12/2003	7.8	11.5		9.5
4/13/2003	8.3	12.6	1120	9.1
4/14/2003	8.0	11.1	570	7.8
4/15/2003	8.0	9.0	830	11.5
4/16/2003	7.7	8.8	1880	5.6
4/18/2003	7.7	11.7	510	5.5
4/21/2003	8.3	8.0	1128	10.6
4/22/2003	7.9	9.1	1595	7.3
4/23/2003	8.0	8.1	1740	7.4
4/25/2003	7.3	8.2	1475	10.1
4/28/2003	7.7	8.4	1030	11.5
4/29/2003	7.7	6.2	1265	12.3
4/30/2003	8.3	8.1	1065	12.1
5/2/2003	8.1	7.2	1110	12.8
5/5/2003	7.5	6.8	1285	12.2
5/6/2003	8.0	6.1	1315	12.5
5/7/2003	7.9	7.5	620	13.3
5/9/2003	8.0	5.4	1060	12.6
5/12/2003	7.7	6.4	1003	10.0
5/13/2003		5.2	1660	9.5
5/14/2003	7.7	5.6	1530	12.3
5/19/2003	7.9	7.0	855	16.8
5/20/2003	7.9	5.1	1110	13.9
5/21/2003	7.9	6.3	760	13.0
5/23/2003	7.9	5.1	1210	14.7

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
5/27/2003	8.0	6.6	560	16.9
5/28/2003	8.0	6.1	590	15.3
5/29/2003	8.3	6.2	560	18.3
6/2/2003	7.6	5.8	1070	14.4
6/3/2003	8.0	4.8	1320	14.8
6/4/2003	7.3	5.7	960	15.3
6/6/2003	7.9	6.2	640	15.4
6/9/2003	7.8	5.0	940	17.3
6/10/2003	7.3	4.2	1245	18.2
6/11/2003	7.9	4.0	1990	18.8
6/13/2003	8.3	5.1	580	17.7
6/23/2003	8.1	5.2	1140	20.3
6/24/2003		4.8	1160	22.0
6/25/2003	7.7	4.7	1065	23.3
6/26/2003	7.9	3.9	753	22.6
6/30/2003	8.1	7.3	535	21.1
7/7/2003	7.2	3.0	635	23.7
7/8/2003	6.9	2.4	1250	23.7
7/15/2003	8.5	3.2	660	21.8
7/16/2003	8.5	3.3	475	21.9
7/18/2003	8.4	5.9	785	22.1
7/24/2003	8.5	3.1	520	20.4
7/25/2003	8.3	4.2	1410	20.6
7/30/2003	7.1	4.8	875	21.4
7/31/2003	9.6	4.2	520	22.2
8/6/2003	8.3	4.8	1145	21.9
8/7/2003	7.7	1.5	1115	21.4
8/12/2003	6.9	0.6	1170	22.5
8/19/2003	8.7	3.8	1180	22.0
8/20/2003	8.5	3.5	1250	20.5
8/26/2003	8.7	2.8	1080	21.4
8/28/2003	6.9	2.4	1155	19.9
9/2/2003	8.2	3.1	1420	17.8
9/4/2003	8.5	8.8	1450	23.5
9/10/2003	7.4	3.3	835	18.5
9/11/2003	8.4	2.9	1350	18.7
9/17/2003	7.4	2.9	655	17.5
9/18/2003	8.2	2.5	1265	16.8
9/23/2003	8.2	4.7	1020	15.9
9/25/2003	8.1	6.0	950	16.9
9/29/2003	7.8	4.4	970	13.6

TABLE D-3

MEASUREMENTS OF pH, DO, CONDUCTIVITY, AND TEMPERATURE AT THE SURFACE IN WOODS CREEK DURING 2003

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
3/21/2003	7.6	11.8	550	3.0
3/24/2003	8.1	9.9	683	6.4
3/25/2003	7.6	9.3	713	6.7
3/26/2003	7.9	8.1	740	7.5
3/27/2003	8.5	8.7	713	9.9
3/28/2003	8.0	8.3	797	10.4
3/29/2003	8.3	9.0	845	5.6
3/30/2003	7.8	10.8	840	3.8
3/31/2003	7.8	11.1	680	2.9
4/1/2003	7.9	11.4	655	4.9
4/2/2003	8.1	12.2	535	3.0
4/3/2003	8.1	10.1	815	0.9
4/4/2003	8.3	13.0	965	0.9
4/7/2003	8.1	13.9	943	0.9
4/9/2003	8.8	13.1	1085	3.5
4/10/2003	8.1	10.0	587	6.2
4/11/2003	9.0	10.9	680	8.4
4/12/2003	8.2	11.3	710	8.6
4/13/2003	8.1	10.6	565	8.2
4/14/2003	8.4	12.2	350	9.1
4/15/2003	8.4	12.3	425	7.4
4/16/2003	7.9	9.7	645	7.6
4/17/2003	8.3	13.1	340	4.0
4/21/2003	8.3	10.5	515	9.1
4/22/2003	8.2	12.2	433	5.7
4/23/2003	8.1	11.3	340	5.9
4/24/2003	8.4	11.3	370	8.3
4/28/2003	8.1	11.5	503	9.8
4/29/2003	8.1	12.6	353	7.4
4/30/2003	8.1	12.5	280	7.7
5/1/2003	7.6	7.1	985	13.7
5/5/2003	7.8	7.2	1025	13.1
5/6/2003	7.9	6.9	840	14.8
5/7/2003	7.8	8.3	603	11.3
5/8/2003	7.8	9.3	490	10.0
5/13/2003	7.9	7.0	670	11.5

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
5/14/2003	8.2	7.2	775	14.1
5/15/2003	7.6	6.1	630	12.3
5/19/2003	8.0	6.8	490	17.1
5/20/2003	7.9	7.1	483	13.6
5/21/2003	7.5	6.1	575	15.0
5/22/2003	8.4	7.3	510	14.9
5/27/2003		5.9	550	17.2
5/28/2003	8.1	9.0	436	13.8
5/29/2003		7.7	475	14.8
5/30/2003		8.5	415	13.5
6/2/2003	7.7	6.9	600	18.0
6/3/2003	8.0	7.7	440	13.6
6/4/2003	8.2	8.6	380	13.5
6/5/2003	8.3	8.5	395	15.3
6/6/2003				14.2
6/9/2003		4.5	520	18.9
6/10/2003	7.9	5.9	403	17.3
6/11/2003	8.2	7.4	465	16.9
6/12/2003		3.2	765	18.5
6/13/2003		5.1	600	17.3
6/16/2003	7.4	3.2	700	22.6
6/17/2003	8.3	8.9	308	18.5
6/18/2003	8.4	8.4	303	16.6
6/19/2003	8.5	8.5	270	15.8
6/20/2003		6.7	415	17.5
6/23/2003	7.9	8.3	485	21.8
6/24/2003		9.3	310	19.6
6/25/2003	8.3	7.8	473	23.8
6/26/2003	8.5	8.1	300	20.9
6/29/2003				
6/30/2003	7.8	7.0	297	21.1
7/1/2003		8.3	275	22.9
7/2/2003	7.7	8.2	220	21.5
7/9/2003	7.9	6.3	280	24.7
7/10/2003	7.4	6.3	320	23.3
7/14/2003	8.3	7.3	610	20.5
7/15/2003	8.4	6.1	230	22.5
7/21/2003	8.9	5.0	580	21.0
7/23/2003	8.3	7.1	310	21.8
7/28/2003	8.8	9.7	430	22.3

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
8/1/2003	8.9	8.2	270	24.3
8/4/2003	7.8	7.2	520	24.1
8/5/2003	8.8	9.0	420	24.1
8/14/2003	8.0	7.1	360	24.1
8/16/2003				
8/18/2003	9.2	10.5	250	24.7
8/26/2003	8.6	8.0	240	24.0
8/27/2003	8.3	8.2	230	24.3
8/29/2003	9.0	11.9	220	25.1
9/3/2003		9.9	270	22.4
9/5/2003	9.0	12.7	270	22.4
9/8/2003	8.9	10.0	290	21.9
9/9/2003	8.6	9.9	230	24.5
9/15/2003		7.6	280	22.3
9/16/2003	8.5	10.4	270	21.4
9/22/2003		8.2	270	18.9
9/24/2003		8.6	340	17.8
9/30/2003	8.4	9.4	290	16.4

TABLE D-4

MEASUREMENTS OF pH, DO, CONDUCTIVITY, AND TEMPERATURE AT THE SURFACE IN GUN CREEK DURING 2003

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
3/21/2003	7.4	11.9	250	3.3
3/24/2003	7.7	9.9	260	8.0
3/25/2003	7.7	9.8	330	6.8
3/26/2003	8.1	8.9	315	6.5
3/27/2003	8.6	9.4	285	12.9
3/28/2003	8.4	6.6	330	9.6
3/29/2003	8.7	10.0	470	5.1
3/30/2003	8.7	10.9	390	3.2
3/31/2003	8.2	10.8	335	2.1
4/1/2003	7.9	9.8	390	5.0
4/2/2003	8.1	9.0	455	3.8
4/3/2003	8.5	12.0	490	0.9
4/4/2003	8.3	12.1	543	0.6
4/5/2003	8.0	11.4	555	0.3
4/7/2003	7.7	11.9	470	0.7
4/8/2003	8.5	11.8	470	1.4
4/9/2003	8.1	11.3	455	1.5
4/10/2003	8.0	10.4	355	5.0
4/11/2003	8.2	8.9	480	5.3
4/12/2003	8.2	7.8	320	6.2
4/13/2003	8.3	10.0	290	8.7
4/14/2003	8.1	7.8	390	11.6
4/15/2003	7.9	6.1	453	10.3
4/16/2003	8.0	8.7	460	5.3
4/18/2003	7.9	8.1	410	9.0
4/21/2003	8.2	4.2	493	12.4
4/22/2003	7.9	4.6	640	7.4
4/23/2003	8.1	5.8	515	7.0
4/25/2003	7.9	8.3		11.5
4/28/2003	7.8	8.3	563	13.2
4/29/2003	7.9	5.3	645	12.4
4/30/2003	8.2	7.6	470	13.7
5/2/2003	8.2	5.9	630	13.3
5/5/2003	8.0	7.4	493	13.0
5/6/2003	7.9	6.7	440	13.5
5/7/2003	7.9	5.8	415	13.2

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
5/9/2003	8.0	5.7	375	12.4
5/12/2003	7.9	6.0	395	11.4
5/13/2003		7.0	305	9.7
5/14/2003	7.8	6.0	305	13.3
5/19/2003	8.1	5.4	373	17.0
5/20/2003	8.2	7.5	320	13.2
5/21/2003	8.0	6.6	255	12.4
5/23/2003	8.6	8.2	280	16.1
5/27/2003	8.3	6.2	358	15.8
5/28/2003	8.2	5.1	410	15.0
5/29/2003	8.5	5.6	395	16.2
6/2/2003	8.0	6.0	293	13.7
6/3/2003	8.0	6.2	305	14.4
6/4/2003	8.0	4.3	375	14.9
6/6/2003	8.2	6.7	430	16.4
6/9/2003	7.9	3.1	477	18.3
6/10/2003	7.7	3.0	465	17.8
6/11/2003	7.9	2.6	510	17.8
6/12/2003	7.8	2.8		17.4
6/13/2003	8.0	3.8	535	17.0
6/16/2003	7.9	4.8	385	20.2
6/17/2003	8.0	2.3	400	18.6
6/23/2003				
6/24/2003	7.9	3.9	550	21.8
6/30/2003	7.8	4.4	555	22.4
7/1/2003	8.4	7.0	485	22.7
7/3/2003	8.6	10.5	250	23.1
7/7/2003	7.8	3.7	295	22.1
7/8/2003	7.4	5.4	555	22.6
7/15/2003	8.4	6.4	470	21.8
7/18/2003	8.1	4.5	575	21.4
7/24/2003	8.6	4.8	440	19.9
7/25/2003	8.1	6.9	695	20.1
7/30/2003	8.2	7.3	805	21.2
7/31/2003	9.1	11.6	800	23.8
8/6/2003	9.2	8.8	260	23.0
8/7/2003	8.2	3.5	360	21.0
8/12/2003	7.8	8.0	260	23.3
8/15/2003	8.9	8.4	685	23.5
8/19/2003	9.2	6.9	240	22.8

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
8/20/2003	9.0	5.9	250	23.8
8/26/2003	8.6	7.7	240	24.2
8/28/2003	8.4	5.7	415	20.8
9/2/2003	8.8	9.1	290	20.2
9/4/2003	8.9	5.7	280	21.8
9/10/2003	8.8	9.5	405	21.3
9/11/2003	9.0	7.3	260	21.7
9/16/2003	8.0	6.8	380	20.6
9/17/2003	8.0	5.5	280	20.4
9/18/2003	8.5	5.9	290	19.9
9/23/2003	8.4	6.4	305	18.0
9/25/2003	8.1	5.9	280	18.6
9/29/2003	7.9	3.8	370	13.8

TABLE D-5

MEASUREMENTS OF pH, DO, CONDUCTIVITY, AND TEMPERATURE AT THE SURFACE IN BIG SIX MILE CREEK DURING 2003

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
3/17/2003	8.2	14.1	340	1.0
3/21/2003	7.8	13.9	240	2.1
4/1/2003	8.3	10.5	290	4.5
4/2/2003	7.9	10.3	320	5.0
4/3/2003	8.2	11.0	380	3.0
4/4/2003	8.5	13.3	360	1.2
4/7/2003	8.0	13.6	340	1.2
4/8/2003	9.2	12.8	370	3.8
4/10/2003	8.2	10.9	330	6.3
4/11/2003	8.7	10.4	330	6.7
4/12/2003	8.5	10.6	290	9.2
4/13/2003	8.2	9.7	350	8.8
4/14/2003	8.4	9.7	330	11.3
4/15/2003	8.2	9.6	360	10.9
4/16/2003	7.8	8.4	440	7.7
4/17/2003	7.5	8.6	460	8.2
4/21/2003	8.4	8.4	430	12.2
4/22/2003	8.1	9.3	400	9.1
4/23/2003	8.0	8.5	360	8.4
4/24/2003	7.8	9.1	330	9.0
4/28/2003	7.5	9.5	390	11.1
4/29/2003	8.0	9.7	380	11.5
4/30/2003	8.3	10.5	390	12.4
5/1/2003	7.9	10.1	460	14.0
5/5/2003	8.7	15.9	410	12.8
5/6/2003	7.8	8.3	365	12.3
5/7/2003	7.9	7.5	370	13.6
5/8/2003	7.1	7.5	370	13.8
5/13/2003	7.5	7.9	295	11.3
5/14/2003	8.3	7.7	280	12.2
5/15/2003	7.8	7.4	340	12.6
5/19/2003	8.4	6.7	310	15.7
5/20/2003	7.7	7.4	300	14.1
5/21/2003	7.1	7.0	270	14.1
5/22/2003	8.6	7.7	270	15.4
5/27/2003		7.7	265	15.5

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
5/28/2003	8.1	7.5	320	15.1
5/29/2003		6.7	340	16.0
5/30/2003		7.1	350	16.3
6/2/2003	7.5	7.5	303	16.0
6/3/2003	8.1	7.8	295	14.9
6/4/2003	8.2	7.6	310	14.7
6/5/2003	8.3	7.5	310	14.6
6/6/2003	8.2	6.6	330	14.3
6/9/2003	8.4	6.8	360	18.0
6/10/2003	7.5	6.6	370	17.7
6/11/2003	8.4	6.7	390	18.9
6/12/2003	7.9	6.4	420	18.8
6/16/2003	7.2	6.4	360	20.1
6/17/2003	7.4	7.1	400	20.5
6/18/2003	8.2	6.6	350	19.2
6/19/2003	8.3	7.3	380	19.7
6/24/2003		7.4	400	20.8
6/25/2003	8.5	12.3	370	22.7
6/30/2003	8.4	8.7	330	22.6
7/1/2003	9.0	10.9	400	23.0
7/3/2003	8.4	8.0	350	23.6
7/9/2003	7.0	7.1	330	24.6
7/10/2003	7.9	7.0	340	22.0
7/14/2003	8.6	6.4	250	23.3
7/15/2003	8.4	5.9	340	23.8
7/23/2003	7.1	6.6	560	22.1
7/28/2003	8.5	5.5	430	21.8
8/1/2003	8.6	6.8	600	23.9
8/4/2003	7.3	7.4	570	23.7
8/5/2003	8.3	8.1	495	24.7
8/13/2003	8.5	5.6	280	23.5
8/14/2003	8.5	7.0	360	24.8
8/15/2003				
8/18/2003	8.6	5.4	500	24.7
8/22/2003	8.1	8.3	530	25.1
8/26/2003	8.9	8.7	310	24.3
8/27/2003	7.6	8.0	480	24.3
8/29/2003	8.4	8.4	280	23.4
9/3/2003	8.5	7.0	490	21.8
9/5/2003	8.6	7.1	450	20.3

Set Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
9/8/2003	9.2	9.9	490	21.7
9/9/2003	7.5	9.8	350	21.4
9/15/2003	8.9	8.4	485	22.0
9/16/2003	7.1	7.4	370	20.2
9/22/2003	8.7	8.6	360	19.0
9/24/2003	8.6	9.1	525	18.2
9/30/2003	8.7	9.8	310	15.4

TABLE D-6

MEASUREMENTS OF pH, DO, CONDUCTIVITY, AND TEMPERATURE AT THE SURFACE IN SPICER CREEK DURING 2003

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
3/3/2003	7.9	11.3	2020	0.3
3/14/2003	8.2	18.0	1880	0.7
3/17/2003	7.8	12.9	550	1.6
3/21/2003	7.6	12.8	610	2.7
3/24/2003	8.2	12.4	630	7.8
3/25/2003	8.6	11.7	830	8.1
3/26/2003	8.1	10.7	773	6.9
3/27/2003	8.9	11.4	650	11.6
3/28/2003	8.5	9.3	720	8.8
3/29/2003	8.4	11.7	970	5.7
3/30/2003	7.8	12.7	825	3.5
3/31/2003	8.2	13.1	720	3.4
4/1/2003	8.1	13.1	725	6.1
4/2/2003	7.6	11.7	875	4.3
4/3/2003	8.2	13.6	1240	0.9
4/4/2003	8.2	13.5	1300	0.9
4/5/2003	8.1	13.8		0.7
4/7/2003	7.9	14.5	1060	1.0
4/8/2003	8.0	14.3	1140	2.2
4/9/2003	7.8	14.7	1360	2.5
4/10/2003	8.1	12.8	655	7.9
4/11/2003	8.1	11.4	760	7.5
4/12/2003	7.3	10.1	620	6.4
4/13/2003	8.4	13.6	630	11.6
4/14/2003	8.2	10.4	675	13.3
4/15/2003	7.6	7.5	715	12.9
4/16/2003	8.2	9.8	705	8.1
4/18/2003	8.1	10.8	710	10.9
4/21/2003	8.1	6.8	845	12.6
4/22/2003	8.0	6.9	975	6.3
4/23/2003	8.1	6.5	895	9.9
4/25/2003	8.2	8.9		14.6
4/28/2003	8.1	8.3	950	14.7
4/29/2003	7.9	6.7	1020	13.9
4/30/2003	8.2	8.0	995	16.5
5/2/2003	8.3	6.3	1170	13.5

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
5/5/2003	8.0	8.7	1098	12.7
5/6/2003	7.9	7.8	1020	13.9
5/7/2003	7.3	7.8	905	13.4
5/9/2003	8.1	7.4	830	14.5
5/12/2003	8.2	7.7	625	12.0
5/13/2003		9.0	765	10.4
5/14/2003	7.8	8.2	695	14.2
5/19/2003	7.8	6.4	723	16.1
5/20/2003	8.2	7.8	595	13.8
5/21/2003		8.2	485	14.9
5/23/2003	8.2	7.2	570	18.0
5/27/2003	8.2	7.5	528	17.1
5/28/2003	8.2	6.7	560	17.7
5/29/2003	8.3	5.9	570	20.2
5/31/2003	7.1	5.3	560	16.6
6/2/2003	8.0	6.4	570	15.5
6/3/2003	7.9	6.4	545	15.2
6/4/2003	8.0	6.3	580	16.3
6/6/2003	8.0	7.1	565	19.1
6/9/2003	7.8	4.6	758	18.7
6/10/2003	7.9	4.1	873	18.9
6/11/2003	7.8	4.6	930	18.8
6/13/2003	8.1	6.3	735	16.9
6/16/2003	8.0	3.9	735	20.4
6/17/2003	7.7	5.9	840	20.8
6/23/2003		5.4	820	22.0
6/24/2003	8.4	11.0	685	23.5
6/30/2003	8.5	8.5	255	24.0
7/1/2003	8.8	7.4	400	21.2
7/3/2003	8.3	5.7	270	22.2
7/7/2003	8.0	4.3	505	24.4
7/8/2003		5.9	270	24.8
7/15/2003	8.2	4.6	935	22.0
7/18/2003	8.2	8.1	910	23.5
7/24/2003	8.7	8.6	620	21.9
7/25/2003	8.4	5.7	980	20.6
7/30/2003	9.0	12.0	1210	27.6
7/31/2003	9.0	11.2	1160	26.3
8/6/2003	8.8	4.2	740	26.0
8/7/2003	8.3	3.2	1050	22.7

Date	pH	DO (ppm)	Conductivity (*u*mhos/cm)	Temperature (°C)
8/12/2003	8.0	8.4	1060	23.8
8/15/2003	8.6	6.0	925	25.7
8/19/2003	9.2	8.2	220	24.6
8/20/2003	8.9	8.7	280	25.6
8/26/2003	8.5	7.8	230	24.4
8/28/2003	8.2	7.6	370	22.7
9/2/2003	8.3	10.0	690	19.7
9/4/2003	8.6	6.0	310	20.7
9/10/2003	8.4	5.6	520	19.1
9/11/2003	8.8	10.6	630	22.7
9/17/2003	8.1	6.5	630	19.8
9/18/2003	8.3	5.9	550	18.5
9/23/2003	8.3	7.9	290	19.2
9/25/2003	8.0	9.3		17.9
9/29/2003	8.0	7.6	1030	15.0

APPENDIX E – WATER AND WEIR ELEVATION

FIGURE E-1

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING MARCH 2003

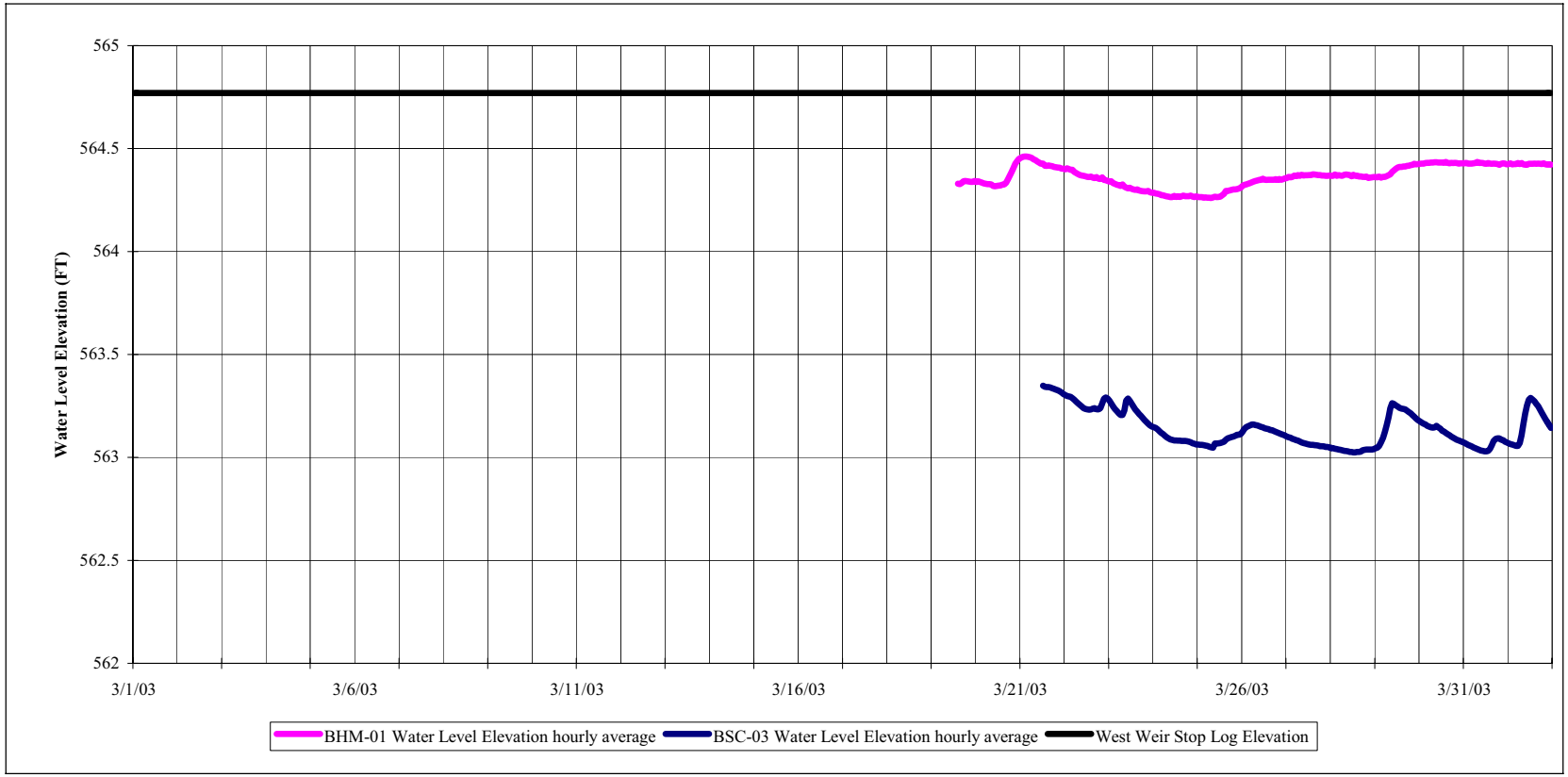


FIGURE E-2

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING APRIL 2003

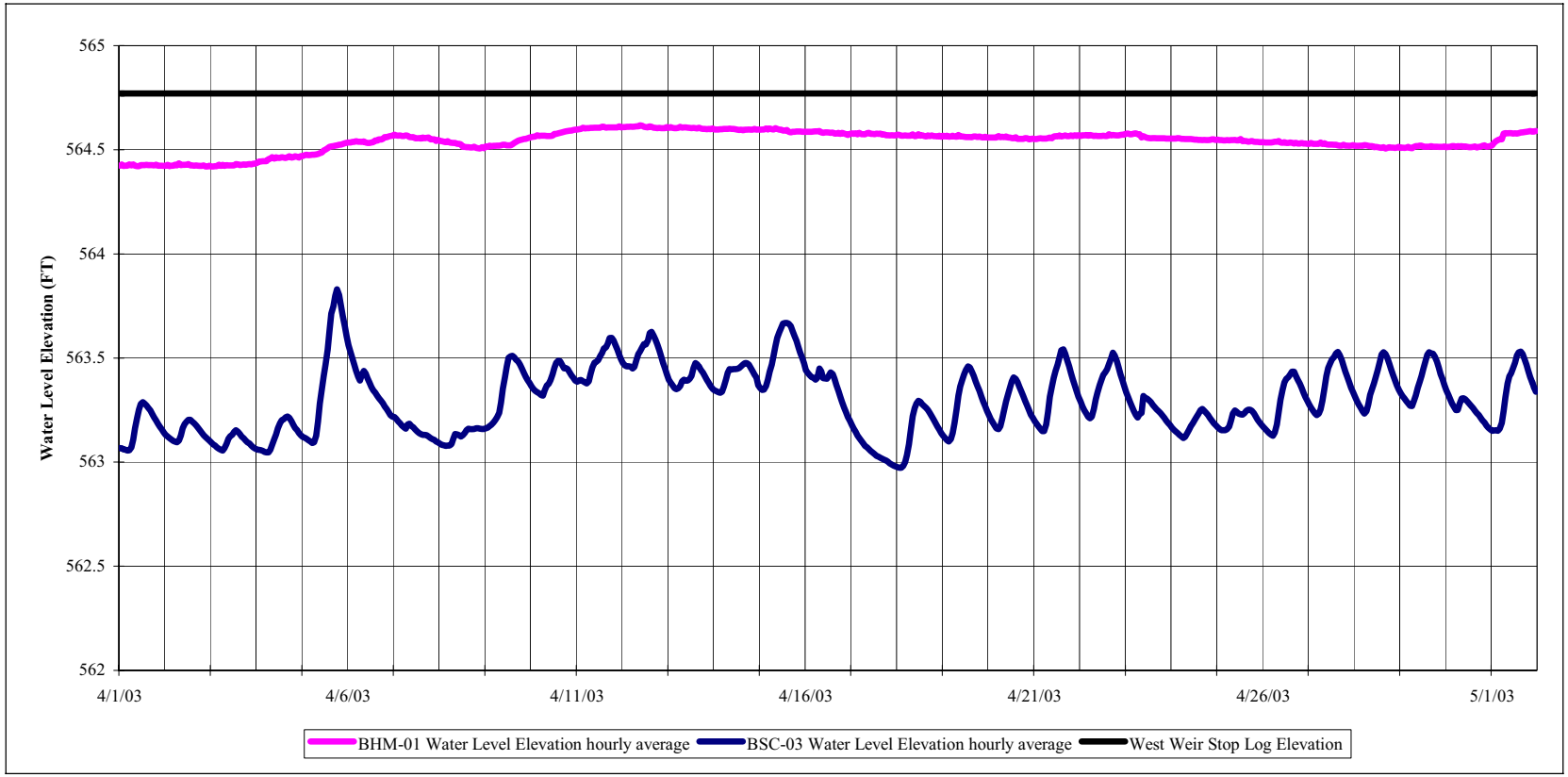


FIGURE E-3

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING MAY 2003

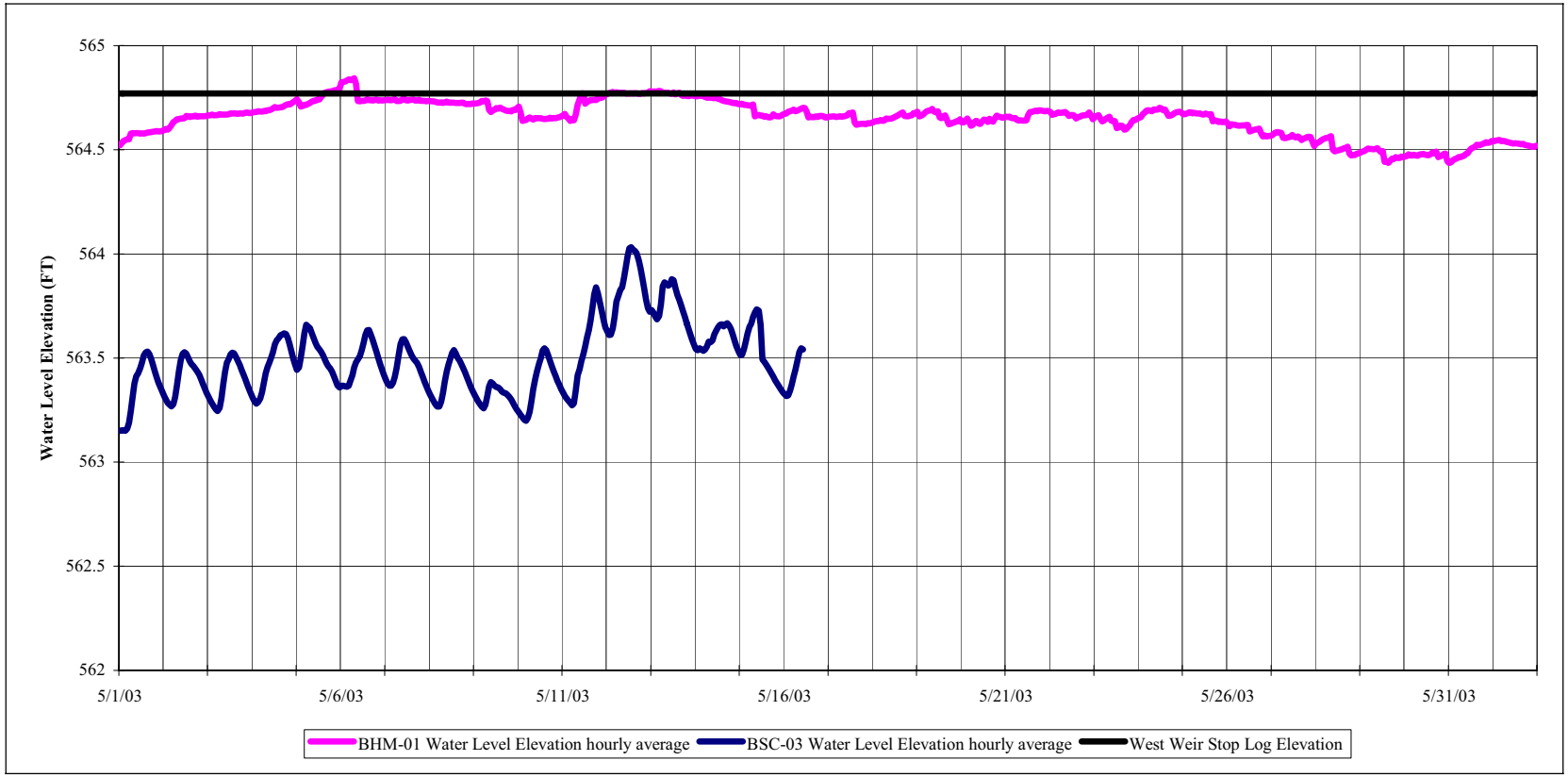


FIGURE E-4

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING JUNE 2003

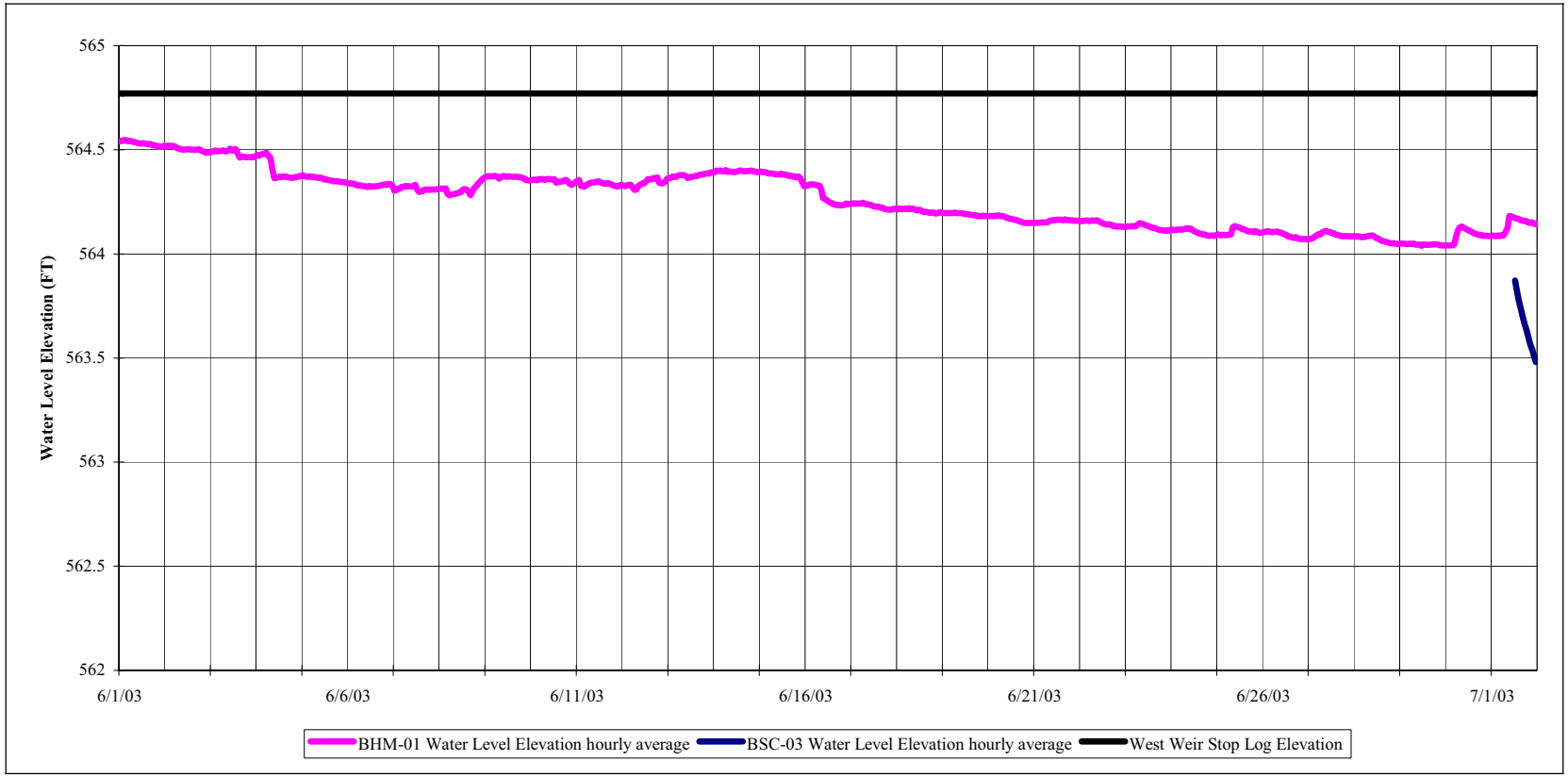


FIGURE E-5

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING JULY 2003

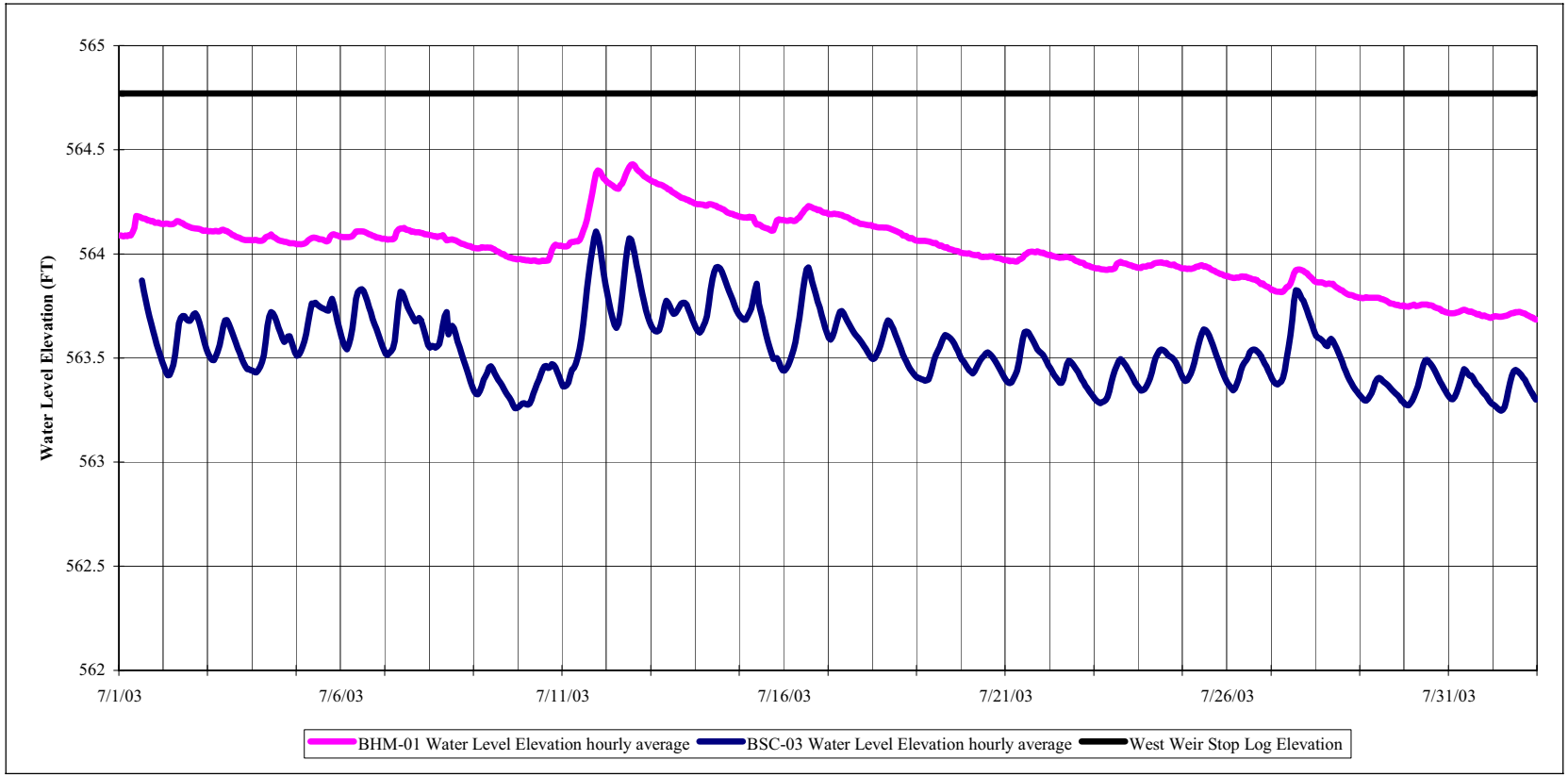


FIGURE E-6

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING AUGUST 2003

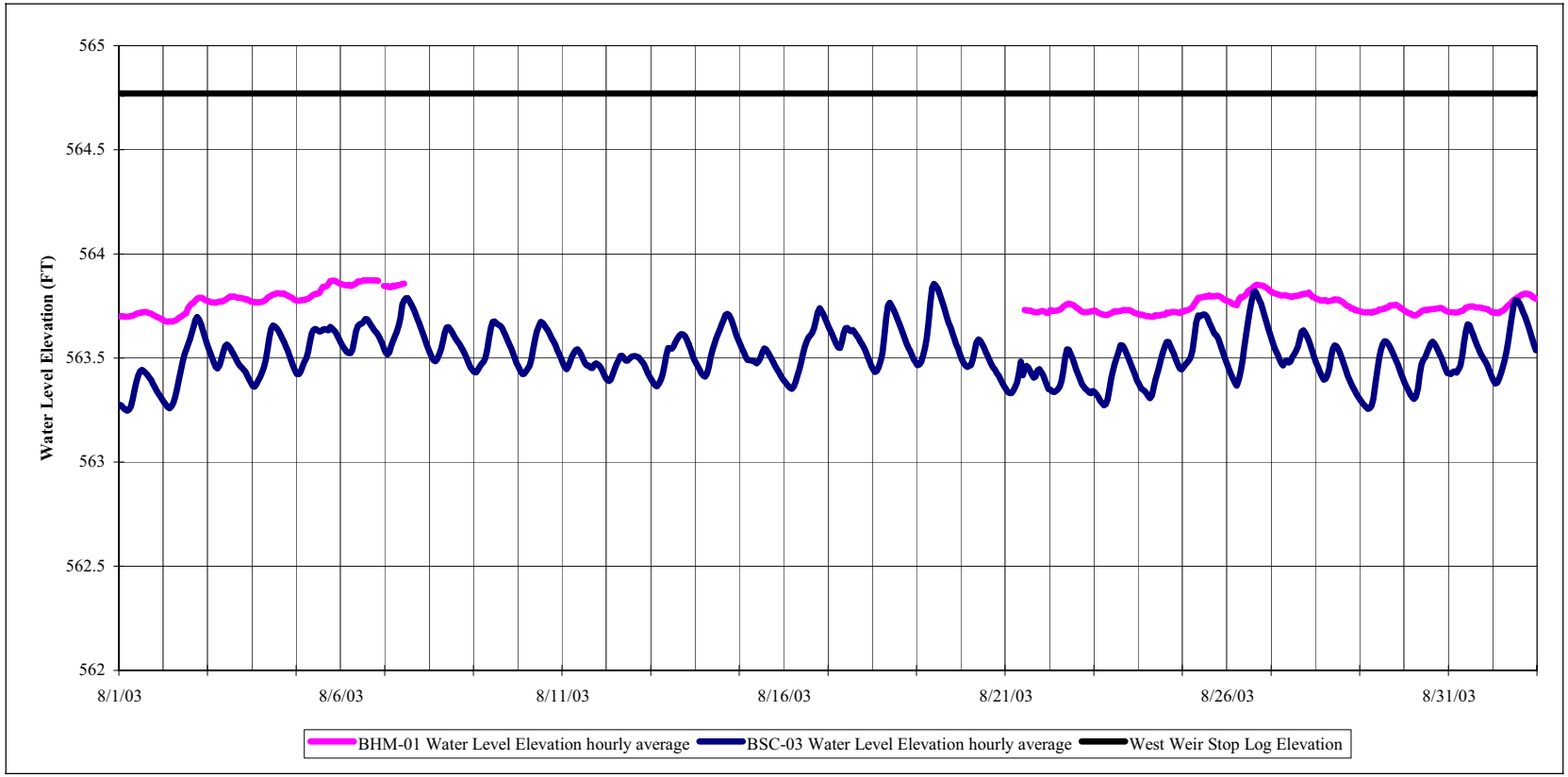


FIGURE E-7

WATER ELEVATIONS IN BURNT SHIP CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE WEST WEIR DURING SEPTEMBER 2003

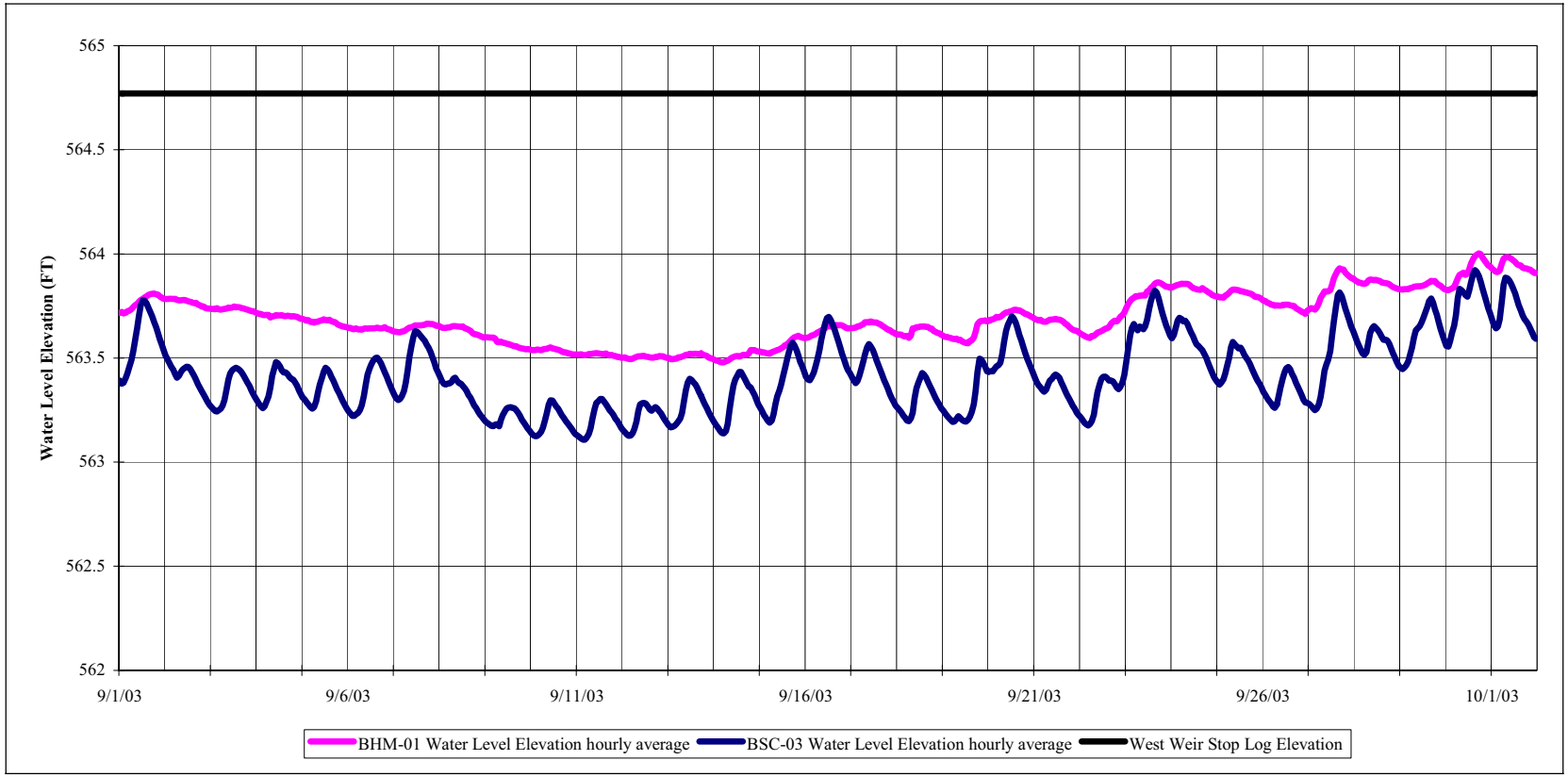


FIGURE E-8

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING MARCH 2003

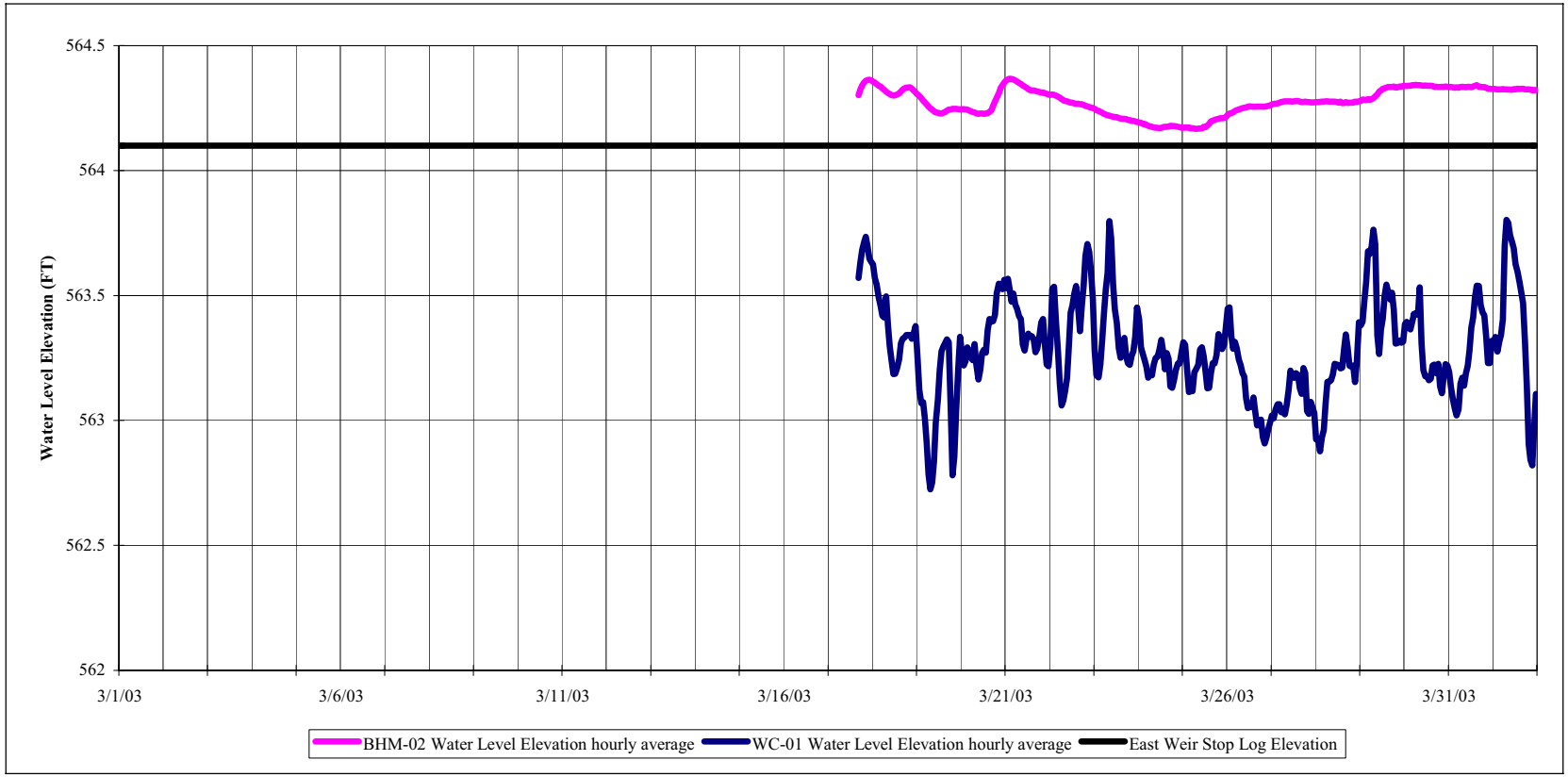


FIGURE E-9

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING APRIL 2003

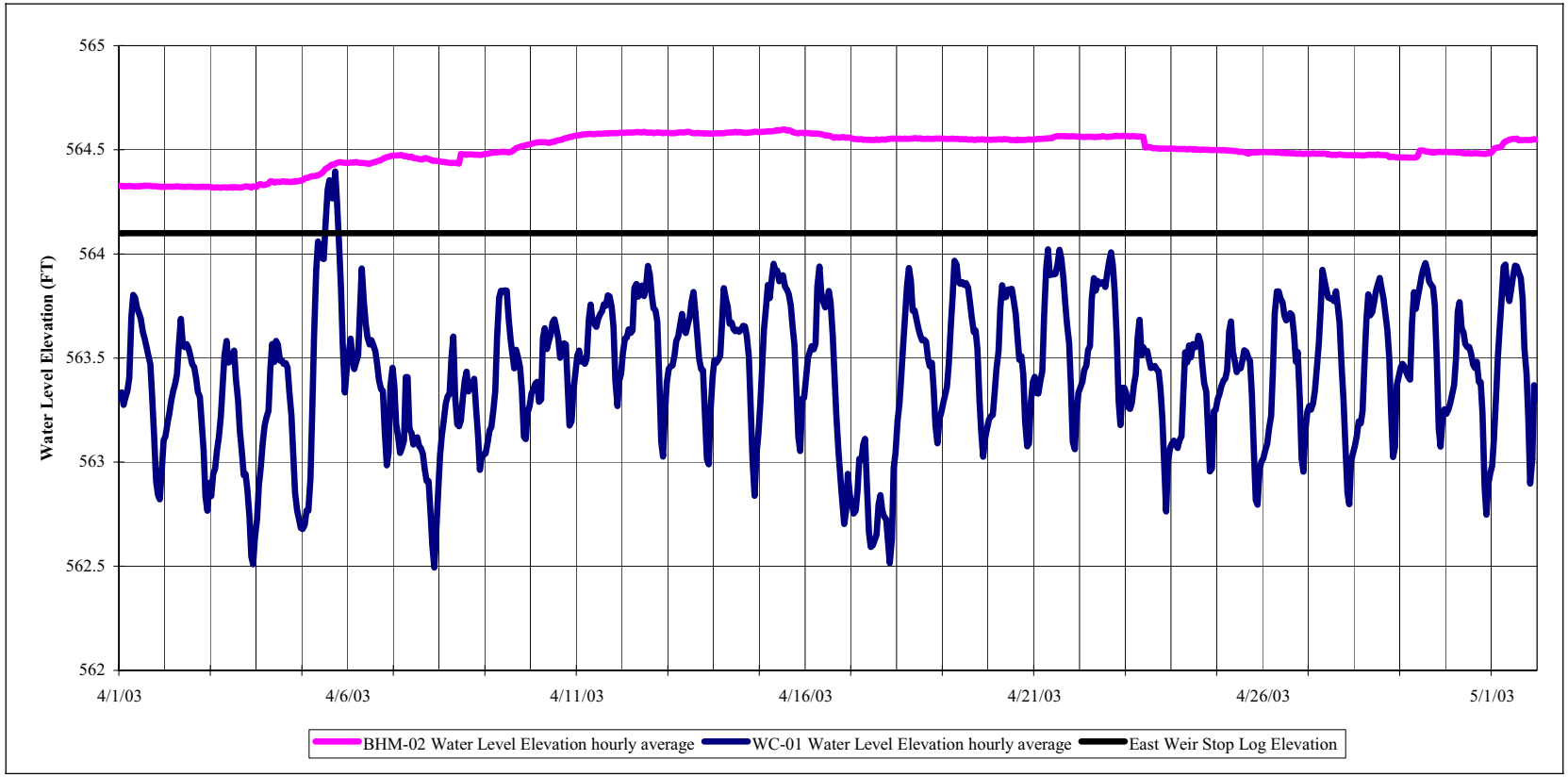


FIGURE E-10

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING MAY 2003

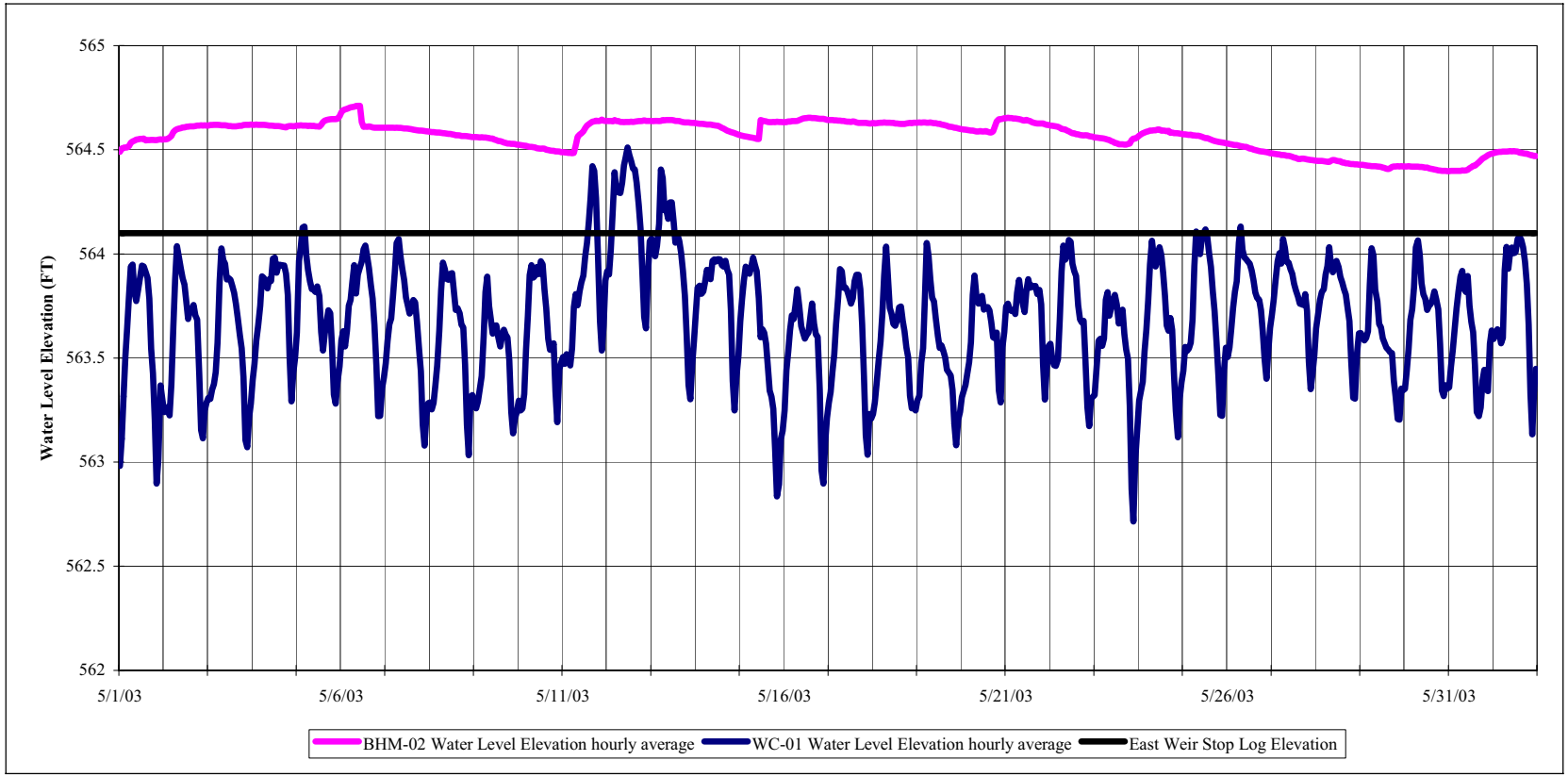


FIGURE E-11

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING JUNE 2003

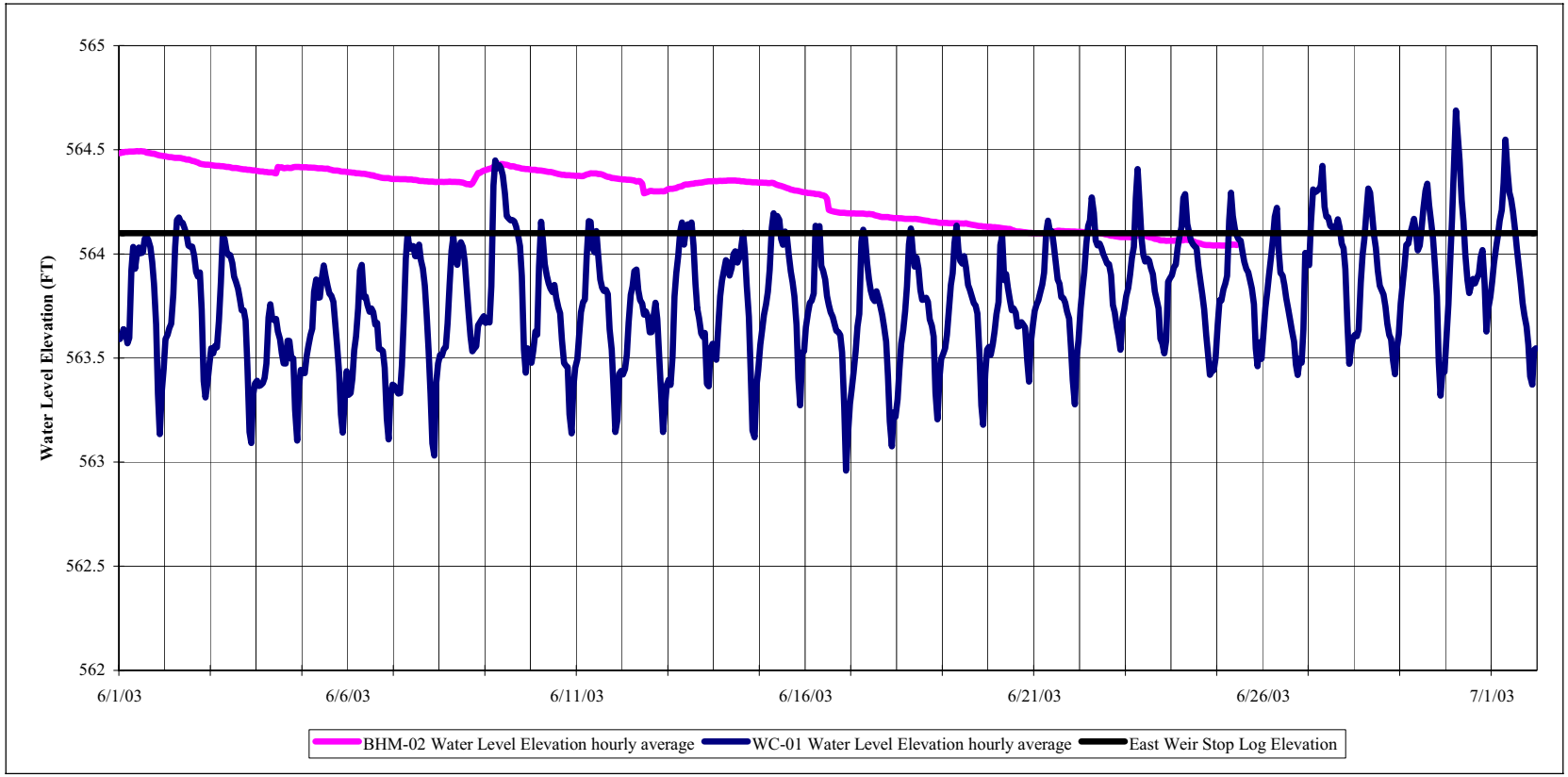


FIGURE E-12

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING JULY 2003

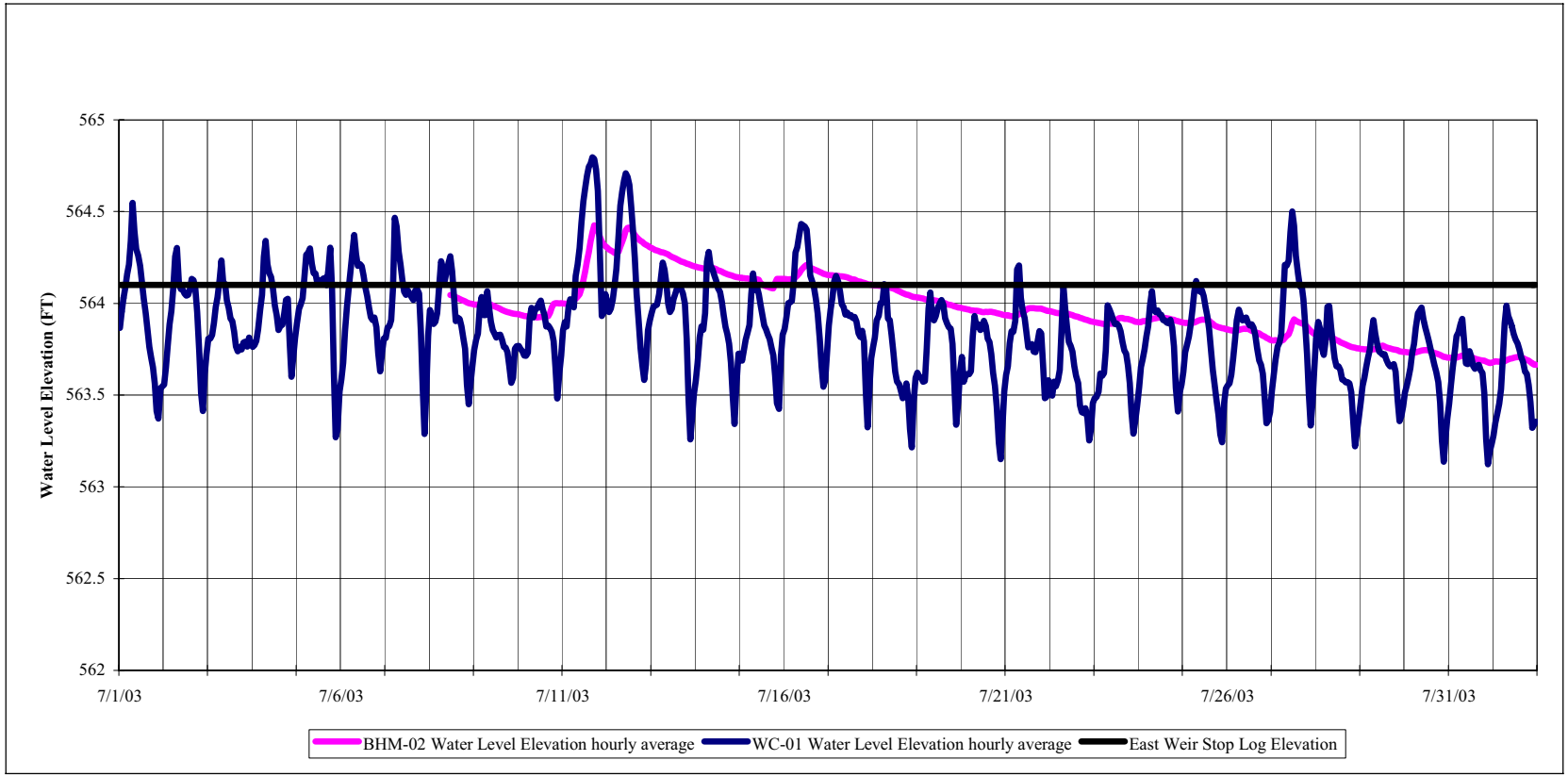


FIGURE E-13

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING AUGUST 2003

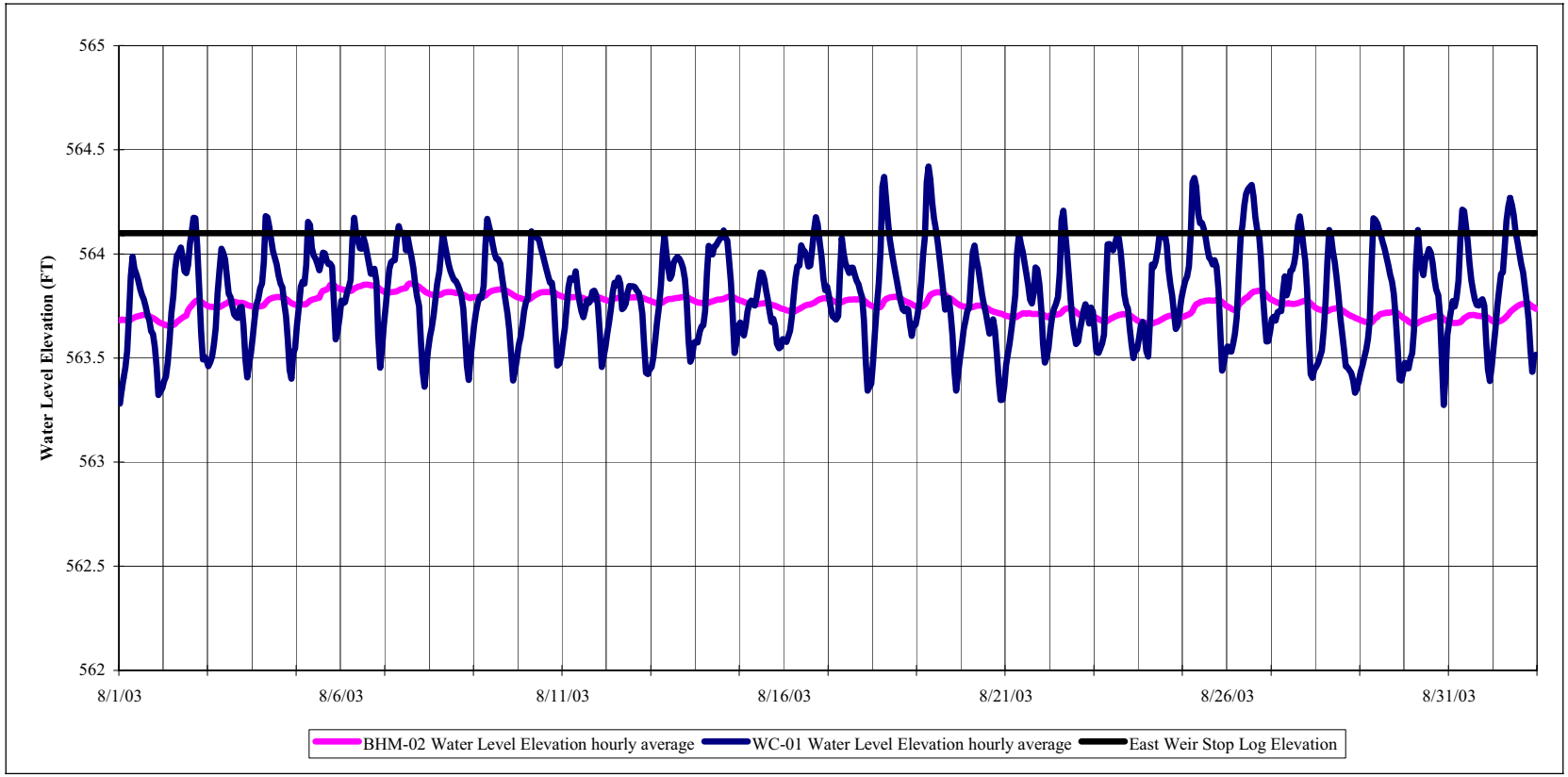
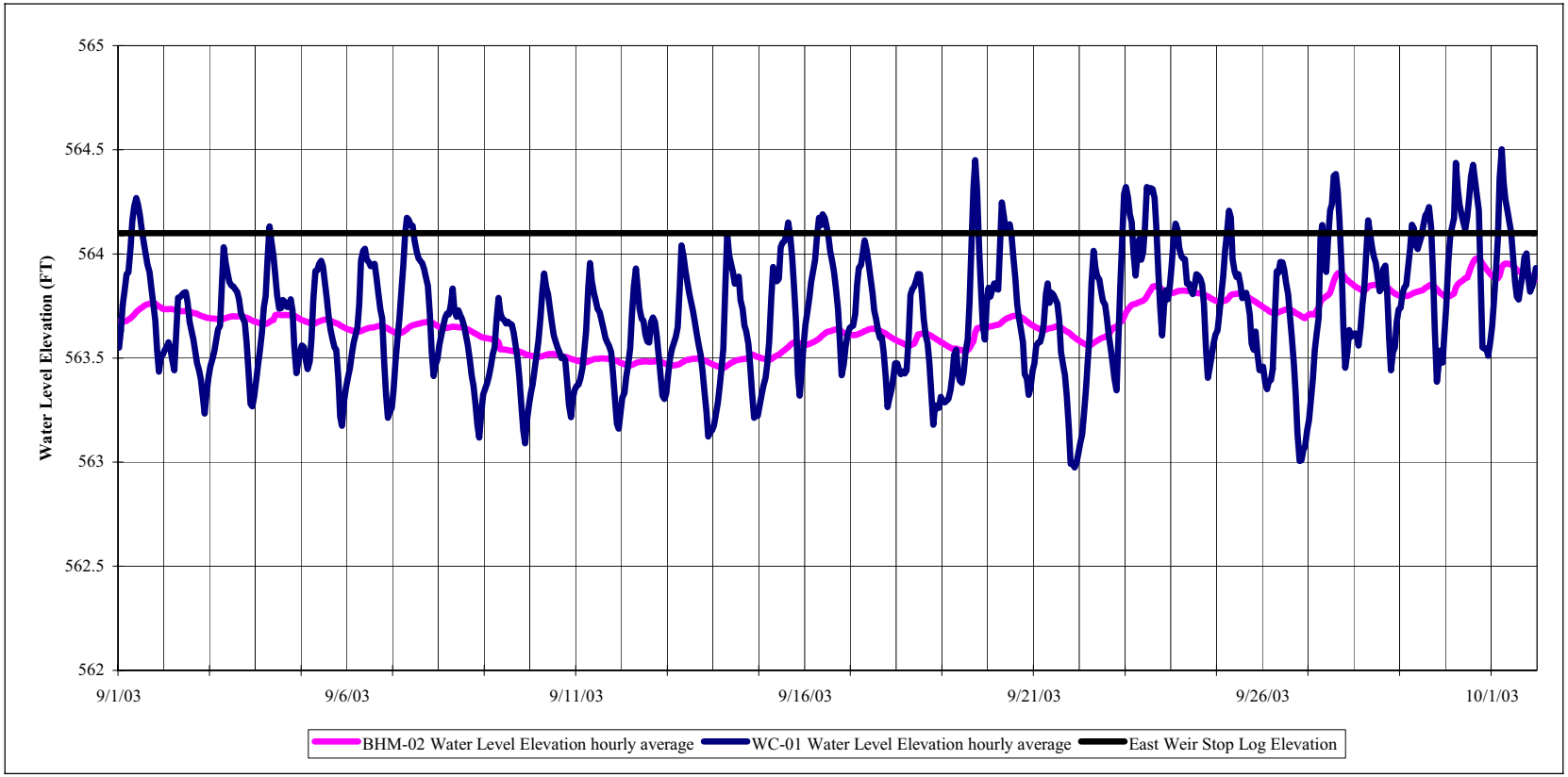


FIGURE E-14

WATER ELEVATIONS IN WOODS CREEK AND BUCKHORN MARSH IMPOUNDMENT AND THE ELEVATION AT THE TOP OF THE STOPLOGS IN THE EAST WEIR DURING SEPTEMBER 2003



APPENDIX F - SPECIES CAUGHT IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, SPICER CREEK AND BIG SIX MILE CREEK, DURING 2003, LISTED IN PHYLOGENETIC ORDER

TABLE F-1

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BUCKHORN MARSH IMPOUNDMENT DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Siluriformes	Ictaluridae	*Notorus gyrinus*	Tadpole madtom
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Gasterosteiformes	Gasterosteidae	*Culaea inconstans*	Brook stickleback
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	Centrarchidae	Sunfish family
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie

TABLE F-2

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY ELECTROFISHING IN BUCKHORN MARSH IMPOUNDMENT DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	Centrarchidae	Sunfish family
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass

TABLE F-3

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BURNT SHIP CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Cypriniformes	Cyprinidae	*Semotilus atromaculatus*	Creek chub
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Siluriformes	Ictaluridae	*Notorus gyrinus*	Tadpole madtom
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Esocidae	*Esox masquinongy*	Muskellunge
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Gasterosteiformes	Gasterosteidae	Gasterosteidae	Sticklebacks
Gasterosteiformes	Gasterosteidae	*Culaea inconstans*	Brook stickleback
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill

TABLE F-3 (CONT.)

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BURNT SHIP CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie
Perciformes	Percidae	*Perca flavescens*	Yellow perch

TABLE F-4

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY ELECTROFISHING IN BURNT SHIP CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Gasterosteiformes	Gasterosteidae	*Culaea inconstans*	Brook stickleback
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie

TABLE F-5

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN WOODS CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	Gizzard shad
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Cypriniformes	Cyprinidae	*Semotilus atromaculatus*	Creek chub
Cypriniformes	Catostomidae	*Carpiodes cyprinus*	Quillback
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Cypriniformes	Catostomidae	*Moxostoma spp.*	Redhorse
Cypriniformes	Catostomidae	*Moxostoma carinatum*	River redhorse
Cypriniformes	Catostomidae	*Moxostoma valenciennesi*	Greater redhorse
Siluriformes	Ictaluridae	*Ameiurus natalis*	Yellow bullhead
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Siluriformes	Ictaluridae	*Ictalurus punctatus*	Channel catfish
Siluriformes	Ictaluridae	*Notorus gyrinus*	Tadpole madtom
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Esocidae	*Esox masquinongy*	Muskellunge
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Salmoniformes	Salmonidae	*Oncorhynchus mykiss*	Rainbow trout

TABLE F-5 (CONT.)

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN WOODS CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Atheriniformes	Atherinidae	*Labidesthes sicculus*	Brook silverside
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	Centrarchidae	Sunfish family
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis annularis*	White crappie
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie
Perciformes	Percidae	*Perca flavescens*	Yellow perch
Perciformes	Sciaenidae	*Aplodinotus grunniens*	Freshwater drum

TABLE F-6

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY ELECTROFISHING IN WOODS CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	Centrarchidae	Sunfish family
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis annularis*	White crappie
Perciformes	Percidae	*Perca flavescens*	Yellow perch
Perciformes	Sciaenidae	*Aplodinotus grunniens*	Freshwater drum

TABLE F-7

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN GUN CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	Gizzard shad
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Cypriniformes	Cyprinidae	*Semotilus atromaculatus*	Creek chub
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Cypriniformes	Catostomidae	*Hypentelium nigricans*	Northern hog sucker
Cypriniformes	Catostomidae	*Moxostoma sp.*	Redhorse
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Siluriformes	Ictaluridae	*Notorus gyrinus*	Tadpole madtom
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Esocidae	*Esox masquinongy*	Muskellunge
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Gasterosteiformes	Gasterosteidae	*Culaea inconstans*	Brook stickleback
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish

TABLE F-7 (CONT.)

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN GUN CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis annularis*	White crappie
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie
Perciformes	Percidae	*Perca flavescens*	Yellow perch
Perciformes	Sciaenidae	*Aplodinotus grunniens*	Freshwater drum

TABLE F-8

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BIG SIX MILE CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Lepisosteiformes	Lepisoteidae	*Lepisosteus osseus*	Longnose gar
Amiiformes	Amiidae	*Amia calva*	Bowfin
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	Gizzard shad
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Cypriniformes	Cyprinidae	*Semotilus atromaculatus*	Creek chub
Cypriniformes	Catostomidae	*Carpiodes cyprinus*	Quillback
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Cypriniformes	Catostomidae	*Moxostoma sp.*	Redhorse
Cypriniformes	Catostomidae	*Moxostoma carinatum*	River redhorse
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Esocidae	*Esox masquinongy*	Muskellunge
Salmoniformes	Salmonidae	*Oncorhynchus mykiss*	Rainbow trout
Atheriniformes	Atherinidae	*Labidesthes sicculus*	Brook silverside
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Perciformes	Percichthyidae	*Morone americana*	White perch
Perciformes	Percichthyidae	*Morone chrysops*	White bass

TABLE F-8 (CONT.)

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN BIG SIX MILE CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	Centrarchidae	Sunfish family
Perciformes	Centrarchidae	*Micropterus dolomieui*	Smallmouth bass
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis annularis*	White crappie
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie
Perciformes	Percidae	*Etheostoma nigrum*	Johnny darter
Perciformes	Percidae	*Perca flavescens*	Yellow perch
Perciformes	Sciaenidae	*Aplodinotus grunniens*	Freshwater drum
Perciformes	Gobiidae	*Neogobius melanostomus*	Round goby

TABLE F-9

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Amiiformes	Amiidae	*Amia calva*	Bowfin
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	Gizzard shad
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp
Cypriniformes	Cyprinidae	Cyprinidae	Minnows
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner
Cypriniformes	Cyprinidae	*Nocomis biguttatus*	Hornyhead chub
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd
Cypriniformes	Cyprinidae	*Semotilus atromaculatus*	Creek chub
Cypriniformes	Catostomidae	*Carpiodes cyprinus*	Quillback
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker
Cypriniformes	Catostomidae	*Hypentelium nigricans*	Northern hog sucker
Siluriformes	Ictaluridae	*Ameiurus natalis*	Yellow bullhead
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead
Siluriformes	Ictaluridae	*Notorus gyrinus*	Tadpole madtom
Siluriformes	Ictaluridae	*Noturus miurus*	Brindled madtom
Salmoniformes	Esocidae	*Esox lucius*	Northern pike
Salmoniformes	Esocidae	*Esox masquinongy*	Muskellunge
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow

TABLE F-9 (CONT.)

THE SCIENTIFIC AND COMMON NAMES OF FISHES CAUGHT BY SEINING, FYKE NETTING, AND ELECTROFISHING IN SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY, AND SPECIES

Order	Family	Scientific Name	Common Name
Atheriniformes	Atherinidae	*Labidesthes sicculus*	Brook silverside
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Perciformes	Percichthyidae	*Morone americana*	White perch
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass
Perciformes	Centrarchidae	*Pomoxis annularis*	White crappie
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie
Perciformes	Percidae	*Perca flavescens*	Yellow perch
Perciformes	Sciaenidae	*Aplodinotus grunniens*	Freshwater drum

TABLE F-10

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY AND SPECIES

Order	Family	Scientific Name	Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Lepisosteiformes	Lepisoteidae	*Lepisosteus osseus*	Longnose gar					X	
Amiiformes	Amiidae	*Amia calva*	Bowfin	X	X	X	X	X	X
Clupeiformes	Clupeidae	*Dorosoma cepedianum*	Gizzard shad			X	X	X	X
Cypriniformes	Cyprinidae	*Cyprinidae*	Minnow family	X	X	X	X	X	X
Cypriniformes	Cyprinidae	*Carassius auratus*	Goldfish	X	X	X	X	X	X
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Carp	X	X	X	X	X	X
Cypriniformes	Cyprinidae	*Luxilus cornutus*	Common shiner	X	X	X	X	X	X
Cypriniformes	Cyprinidae	*Notemigonus crysoleucas*	Golden shiner	X	X	X	X	X	X
Cypriniformes	Cyprinidae	*Notropis atherinoides*	Emerald shiner	X	X	X	X	X[1]	X
Cypriniformes	Cyprinidae	*Nocomis biguttatus*	Hornyhead chub						X

TABLE F-10 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY AND SPECIES

Order	Family	Scientific Name	Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Cypriniformes	Cyprinidae	*Notropis hudsonius*	Spottail shiner	X	X	X	X	X	X
Cypriniformes	Cyprinidae	*Pimephales notatus*	Bluntnose minnow	X	X		X	X	X
Cypriniformes	Cyprinidae	*Semotilus atromaculatus*	Creek chub		X	X	X	X	X
Cypriniformes	Cyprinidae	*Scardinius erythrophtalmus*	European rudd	X	X	X	X	X	X
Cypriniformes	Catostomidae	*Carpiodes cyprinus*	Quillback			X		X	X
Cypriniformes	Catostomidae	*Catostomus commersoni*	White sucker		X	X	X	X	X
Cypriniformes	Catostomidae	*Hypentelium nigricans*	Northern hog sucker				X		X
Cypriniformes	Catostomidae	*Moxostoma sp.*	Redhorse			X	X	X	
Cypriniformes	Catostomidae	*Moxostoma carinatum*	River redhorse			X		X	
Cypriniformes	Catostomidae	*Moxostoma valenciennesi*	Greater redhorse			X			

TABLE F-10 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY AND SPECIES

Order	Family	Scientific Name	Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Siluriformes	Ictaluridae	*Ameiurus natalis*	Yellow bullhead			X			X
Siluriformes	Ictaluridae	*Ameiurus nebulosus*	Brown bullhead	X	X	X	X	X	X
Siluriformes	Ictaluridae	*Ictalurus punctatus*	Channel catfish			X			
Siluriformes	Ictaluridae	*Notorus gyrinus*	Tadpole madtom	X	X	X	X		X
Siluriformes	Ictaluridae	*Noturus miurus*	Brindled madtom						X
Salmoniformes	Esocidae	*Esox lucius*	Northern pike	X	X	X	X	X	X
Salmoniformes	Esocidae	*Esox masquinongy*	Muskellunge		X	X	X	X	X
Salmoniformes	Umbridae	*Umbra limi*	Central mudminnow	X	X	X	X		X
Salmoniformes	Salmonidae	*Oncorhynchus mykiss*	Rainbow trout			X		X	
Atheriniformes	Atherinidae	*Labidesthes sicculus*	Brook silverside			X		X	X

TABLE F-10 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY AND SPECIES

Order	Family	Scientific Name	Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Atheriniformes	Cyprinodontidae	*Fundulus diaphanus*	Banded killifish	X	X	X	X	X	X
Gasterosteiformes			Sticklebacks		X				
Gasterosteiformes	Gasterosteidae	*Culaea inconstans*	Brook stickleback	X	X		X		
Perciformes	Percichthyidae	*Morone americana*	White perch					X	X
Perciformes	Percichthyidae	*Morone chrysops*	White bass					X	
Perciformes	Centrarchidae	*Centrarchidae*	Sunfish family	X		X	X[1]	X	
Perciformes	Centrarchidae	*Ambloplites rupestris*	Rock bass	X	X	X	X	X	X
Perciformes	Centrarchidae	*Lepomis spp.*	Sunfish	X	X	X	X	X	X
Perciformes	Centrarchidae	*Lepomis cyanellus*	Green sunfish	X	X		X	X	X
Perciformes	Centrarchidae	*Lepomis gibbosus*	Pumpkinseed	X	X	X	X	X	X

TABLE F-10 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY AND SPECIES

Order	Family	Scientific Name	Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Perciformes	Centrarchidae	*Lepomis macrochirus*	Bluegill	X	X	X	X	X	X
Perciformes	Centrarchidae	*Micropterus dolomieui*	Smallmouth bass			X[1]		X	
Perciformes	Centrarchidae	*Micropterus salmoides*	Largemouth bass	X	X	X	X	X	X
Perciformes	Centrarchidae	*Pomoxis annularis*	White crappie			X	X	X	X
Perciformes	Centrarchidae	*Pomoxis nigromaculatus*	Black crappie	X	X	X	X	X	X
Perciformes	Percidae	*Etheostoma nigrum*	Johnny darter					X	
Perciformes	Percidae	*Percina caprodes*	Logperch				X[1]		
Perciformes	Percidae	*Perca flavescens*	Yellow perch		X	X	X	X	X
Perciformes	Sciaenidae	*Aplodinotus grunniens*	Freshwater drum			X	X	X	X

TABLE F-10 (CONT.)

FISHES CAUGHT AND OBSERVED IN BUCKHORN MARSH IMPOUNDMENT, BURNT SHIP CREEK, WOODS CREEK, GUN CREEK, BIG SIX MILE CREEK AND SPICER CREEK DURING 2003 LISTED PHYLOGENETICALLY BY ORDER, FAMILY AND SPECIES

Order	Family	Scientific Name	Common Name	Buckhorn Marsh Impoundment	Burnt Ship Creek	Woods Creek	Gun Creek	Big Six Mile Creek	Spicer Creek
Perciformes	Gobiidae	*Neogobius melanostomus*	Round goby					X	
Total Number of Species[2] Caught and Observed				21	25	33	30	35	34

[1] Observed but not caught.

[2] Does not include a count of family or genera.