Michelle Moser

From: Alicia Williamson
Sent: Tuesday, July 01, 2008 4:11 PM
To: Michelle Moser
Subject: FW: NAPS Unit 3 COL Application - NRC's Environmental Review Supplemental Information Need #11 (2005 Annual Report) - 06/26/08 E-mail 2 of 5
Attachments: NAR Report for 2005 final.pdf

From: Tony.Banks@dom.com [mailto:Tony.Banks@dom.com]
Sent: Thursday, June 26, 2008 6:27 PM
To: Alicia Williamson; Laura Quinn; Sandusky, William F III
Cc: Thomas Kevern; Joseph.Hegner@dom.com; Regina.Borsh@dom.com; Joyce.Livingstone@dom.com; Tony.Banks@dom.com
Subject: Fw: NAPS Unit 3 COL Application - NRC's Environmental Review Supplemental Information Need #11 (2005 Annual Report) - 06/26/08 E-mail 2 of 5

On May 16, 22, and 29, 2008, NRC staff and its contractor, Pacific Northwest National Laboratory (PNNL), held conference calls with representatives from Dominion to discuss a number of supplemental "information needs" to support the North Anna Power Station Unit 3 (NAPS) combined license application environmental review. Several of these information needs were identified during the environmental site audit conducted the week of April 14, 2008. Others were identified by subject matter reviewers following the audit.

This e-mail provides some of the requested information listed in NRC's June 16, 2008 letter, which included a total of 35 items. In certain instances, the file size may dictate that more than one e-mail will be needed to transmit the information. In those instances, the e-mail will clearly be identified as "x of y" to ensure accountability.

Please note that Dominion will respond to some of the information needs via e-mail, and to others by letter. In every case, Dominion's goal is to provide complete and accurate information in a timely manner. The use of both e-mail and letters to achieve this goal has been discussed with the NRC project managers.

To ensure that you have received the information, please acknowledge receipt of this transmission.

I can be contacted at (804) 273-2170 or (tony.banks@dom.com) if there are questions.

Thank you -

Tony Banks, MPH, CHMM
Dominion
ESP/COL Project
Environmental Lead

Information Need Request #11 (2005 Annual Report)

Provide a copy of the 2005, 2006, and 2007 annual reports titled "Environmental Study of Lake Anna and the Lower Lake Anna River" that were prepared by Environmental Biology, Environmental Services.

Dominion Response

The following attachment addresses Information Need #11 (2005 Annual Report):

"Environmental Study of Lake Anna and the Lower North Anna River, Annual Report for 2005" by Environmental Biology, Electric Environmental Services

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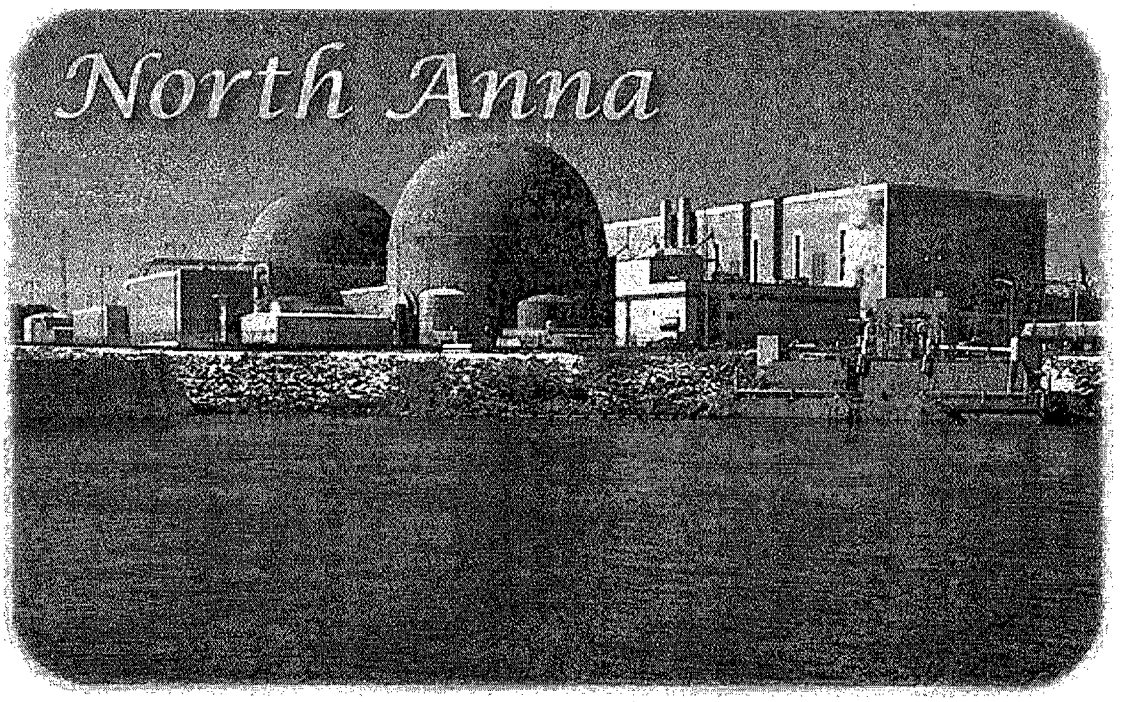
ENVIRONMENTAL STUDY OF LAKE ANNA

AND THE LOWER NORTH ANNA RIVER

ANNUAL REPORT FOR 2005



Prepared by:

ENVIRONMENTAL BIOLOGY

ELECTRIC ENVIRONMENTAL SERVICES

In an effort to conserve our natural resources, this report is being printed on both sides of recycled paper.

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Executive Summary

Following the successful completion of the North Anna Power Station 316(a) Demonstration in 1986, Dominion (the Company) agreed to continue selected environmental monitoring studies on Lake Anna and the North Anna River. Correspondent with the recommendations in the three-year review of post-316(a) studies for 1989-1991, the Company requested and was granted a reduction in certain of the monitoring programs by the Department of Environmental Quality (DEQ). The revised annual study program was to be continued with a review every three years for possible revisions or changes. This report represents findings from monitoring programs conducted during 2005, the second year of the three-year study period 2004 through 2006.

Station generation for 2005 was at an average of 95% of capacity in 2005. Lake Anna water temperatures were within the range of previous years' data. The number and weight of fish collected by gill netting in 2005 were well above the long-term average with a species assemblage similar to previous years. Numbers of fish collected by electrofishing were somewhat below average in 2005 while fish biomass collected by electrofishing was slightly above average. Sunfishes remained the numerically dominant fish species collected by electrofishing.

North Anna River streamflows were moderately high from January to May in 2005 but were generally less than 100 cfs from June through November. A combination of low river flows and high air temperatures resulted in relatively high river temperatures at times during the summer of 2005. Both the total number and number of fish species collected

by electrofishing in the North Anna River in 2005 were within the range of previous years' data. In 2005, 943 fish representing 29 species were collected by electrofishing, including two species which had not been previously collected, one bowfin and one banded killifish.

Underwater observations of the distribution of largemouth and smallmouth bass in the river again indicated that largemouth bass were more abundant in the upper part of the river while smallmouth bass were more abundant in the lower part of the river. Cover use for largemouth bass was primarily wood and vegetation while smallmouth bass were found near vegetation or boulders or in open water.

In summary, the 2005 data indicate that both the lake and river downstream of the lake support a diverse and healthy fishery.

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1.0 Introduction

In 1972, the North Anna River was impounded to create Lake Anna, a 3885 hectare (9600 acres) reservoir (lake) that provides condenser cooling water for the North Anna Power Station (NAPS). Adjacent to Lake Anna is a 1376 hectare (3400 acre) Waste Heat Treatment Facility (WHTF) that receives the cooling water and transfers excess heat from the water to the atmosphere before discharging into the lake.

Aquatic monitoring studies have been conducted on Lake Anna since its inception. In January, 1984, the Company initiated an extensive Section 316(a) demonstration study (P.L. 95-500) to determine if proposed effluent limitations on thermal discharges from the power station were more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in Lake Anna and the lower North Anna River. The final report (Virginia Power 316(a) Report 1986) successfully demonstrated that the operation of the power station had not resulted in appreciable harm to the biological community. The Virginia Water Control Board (VWCB) accepted the study as a successful demonstration in September, 1986.

Subsequent to the 316(a) study, the Company committed with the VWCB to continue environmental monitoring on Lake Anna and the lower North Anna River as part of a post-316 (a) agreement. Also, following each three-year period of data collection, a summary report is provided with recommendations for future studies. This report presents the findings for calendar year 2005, the second year of the three-year period 2004-2006.

2.0 Station Operation

North Anna Power Station (NAPS) operated at an average of 95% of capacity for 2005. The station operated at 100% of capacity for the first and second quarter. Third quarter operations were at 97% and fourth quarter operation was 84%. Unit 1 was shut down for approximately one day on August 5th. Unit 2 was shut down for approximately one day on August 5 and from October 2nd to October 30th (Figure 2.0-1). The quarterly average of 95% for 2005 was the highest yet calculated (Table 2.0-1). Only in five of the previous 27 years has the average exceeded 90%.

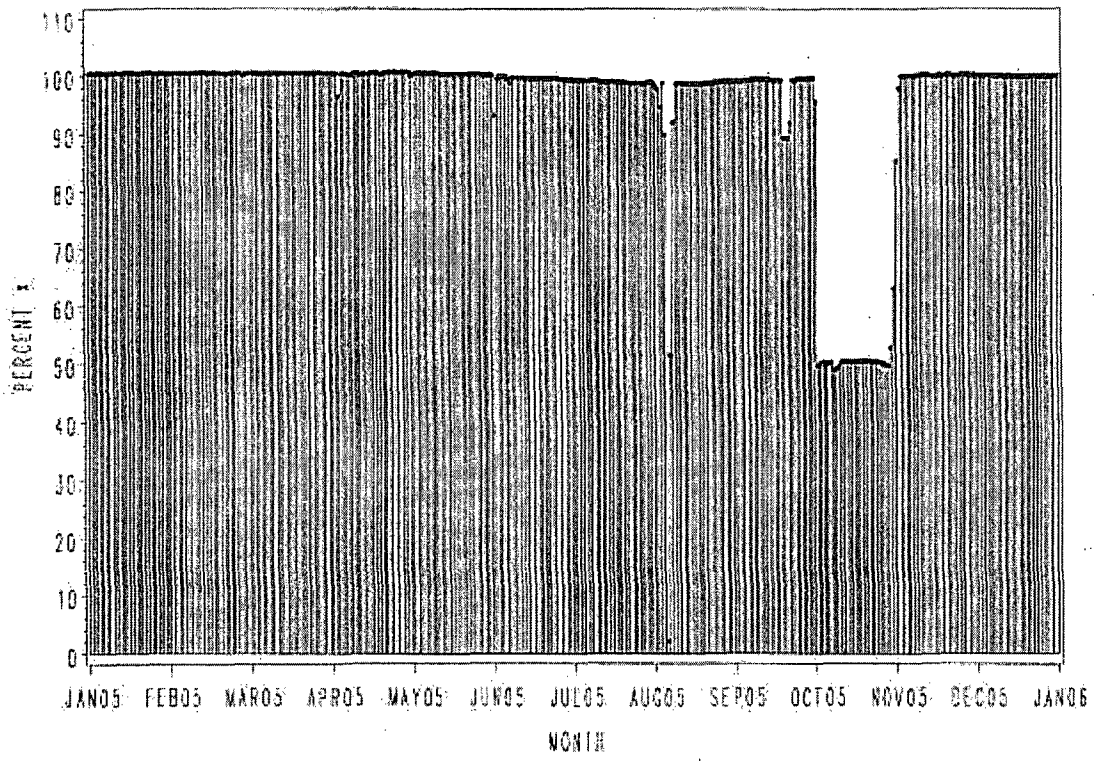


FIGURE 2.0-1. 2005 NORTH ANNA UNITS 1 & 2 DAILY POWER LEVEL

TABLE 2.0-1 Seasonal summary of North Anna Power Station operation (percent of total Station load) 1978-2005.

Year	Winter	Spring	Summer	Fall	Quarterly Average
1978	0	23	42	45	27.5
1979	43	31	44	0	29.5
1980	31	37	53	65	46.5
1981	46	80	67	82	68.8
1982	78	26	19	48	42.8
1983	53	58	96	84	72.8
1984	76	64	16	66	55.5
1985	87	96	82	62	81.8
1986	75	88	62	80	76.3
1987	92	45	23	47	51.8
1988	75	99	94	97	91.3
1989	47	26	87	65	56.3
1990	98	98	69	61	81.5
1991	63	89	84	92	82
1992	35	80	92	71	69.5
1993	49	83	79	82	73.3
1994	96	91	75	91	88.5
1995	87	64	98	97	86.5
1996	76	98	83	66	80.8
1997	98	80	97	97	93
1998	96	81	85	94	89
1999	97	90	87	93	92
2000	84	91	100	100	94
2001	84	94	80	67	81
2002	100	100	87	50.7	84
2003	57	53	100	100	85
2004	97	83	89	96	91
2005	100	100	97	84	95
Quarters at 75-100%	18	19	18	15	

Table 2.0-1/xls

3.0 Lake Anna

3.1 Temperature

Methods

Lake water temperature data in 2005 were collected using continuous monitors (fixed temperature recorders) and instantaneous field surveys. Continuous temperatures were measured with Onset Optical Stowaway temperature recorders which measure and record the water temperature at one hour intervals at seven (7) stations in the lake and three (3) stations in the WHTF. These instruments were located one meter below the lake surface at the stations depicted in Figure 3.1-1, the lone exception being Station NALST10. The instrument at this station was located at a depth of three meters to account for the turbulence associated with mixing.

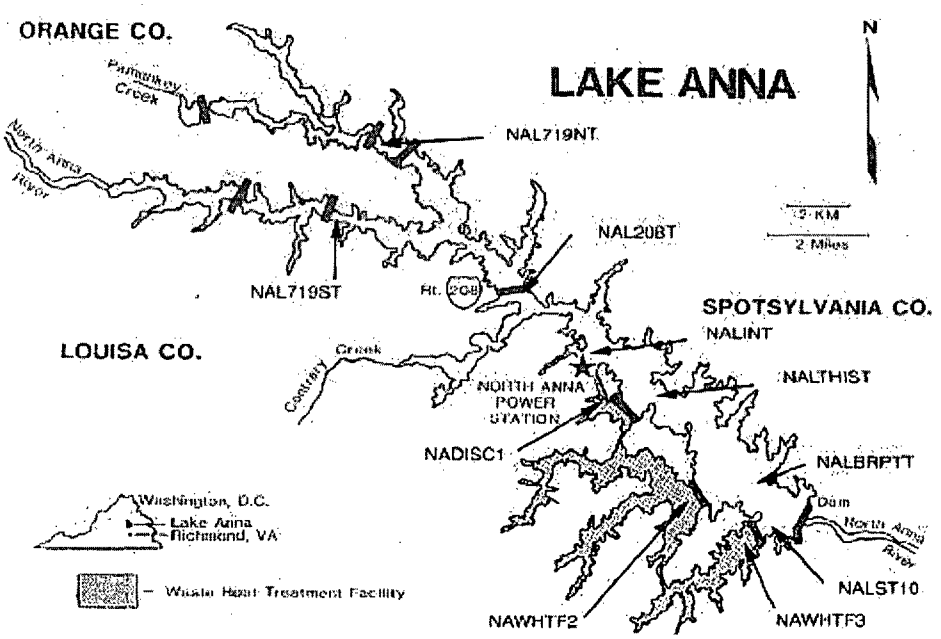


FIGURE 3.1-1 Approximate location of Onset temperature recorders in Lake Anna and WHTF

The instantaneous temperatures were measured using a Yellow Springs Model 3000 T-L-C or a Hydrolab field temperature instrument. Temperatures were measured at one (1) meter intervals, surface to bottom, at the stations shown in Figure 3.1-2.

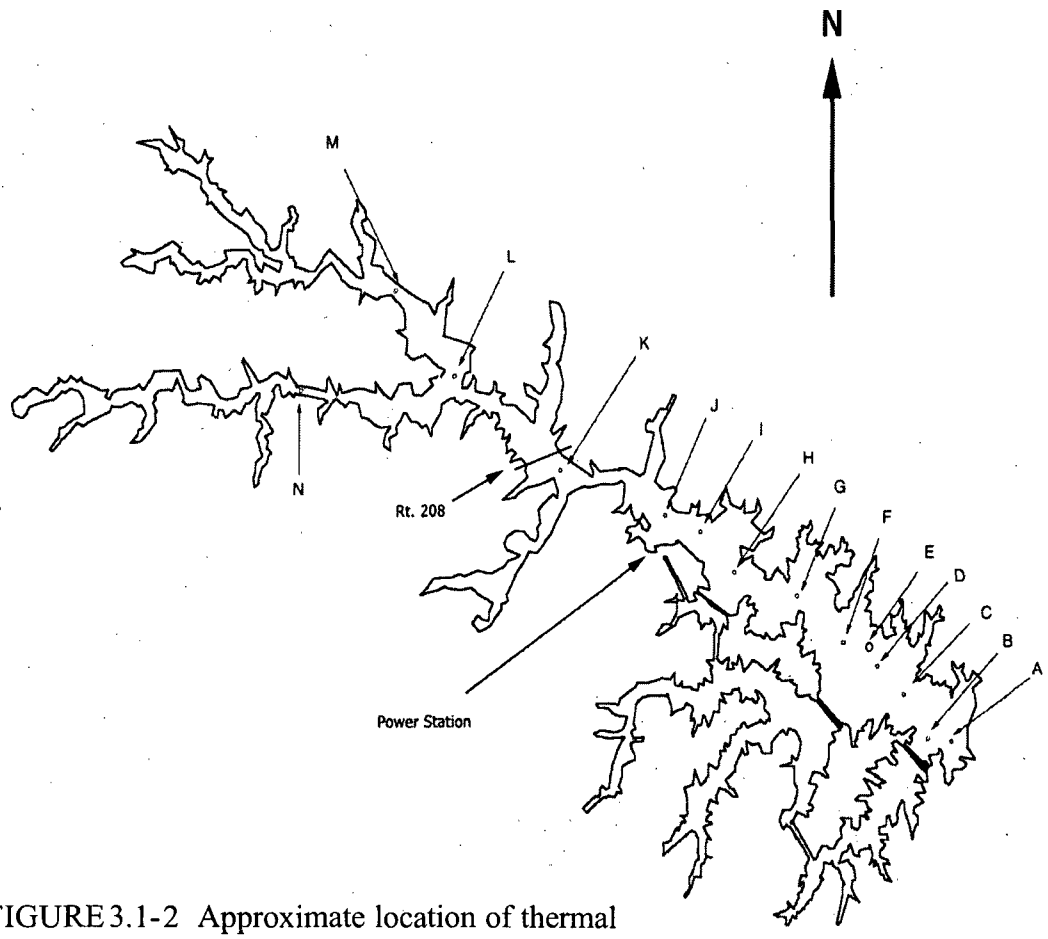


FIGURE 3.1-2 Approximate location of thermal plume sampling stations on Lake Anna

Results

The maximum hourly temperature recorded for the lake in 2005 by continuous monitors was 33.5°C in August at Station NALINT which is located at the station intake (Table 3.1-1). The highest hourly temperature previously recorded and reported in the lake to date was 33.7°C in 1977. Hourly maxima previously reached 33.5°C during five hours in three other years. The lowest hourly temperature recorded was 2.9°C in January at Station NAL719ST located on the North Anna arm of the upper lake. This temperature was within the range of previously reported annual minimum temperatures.

The instantaneous temperature surveys were conducted in February, April, August, and November to provide temperature data to assess seasonal thermal stratification patterns in the lake (Table 3.1-2). The February survey shows little stratification with a thermocline at the 8-9 meter depth limited to the lower lake.

The April survey results show a thermocline at the 8 to 10 meter depth at the lower lake stations and continuing in the shallow upper lake at a depth of 6 to 7 meters. The August survey shows a thermocline at the 14 to 19 meter depth in the lower lake that does not appear in the upper lake. The November survey shows a consistent decrease in temperature with depth and an overall difference of approximately 1 to 1.5°C from surface to bottom throughout the lake.

TABLE 3.1-1. SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 2005. ALL RESULTS ARE CALCULATED FROM HOURLY TEMPERATURES (IN DEGREES CELSIUS). ALL ARE SURFACE INSTRUMENTS EXCEPT FOR NALST10 WHICH IS AT MID-DEPTH. A "*" INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTION OR DAMAGE.

YEAR=2005 MONTH=JANUARY

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	10.1	9.8	11.7	11.8	12.2	12.6	13.3	21.9	18.7	16.2	13.0
HOURLY MEAN	6.1	6.3	7.8	8.6	9.1	10.4	11.0	18.8	15.0	13.0	10.3
HOURLY LOW	2.9	3.2	3.7	5.4	5.7	7.6	8.6	15.6	10.6	9.5	7.4
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2005 MONTH=FEBRUARY

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	7.9	7.5	9.0	9.9	10.3	11.9	12.0	19.8	16.3	14.5	11.8
HOURLY MEAN	5.5	5.6	6.4	7.6	8.3	10.0	10.7	17.9	14.1	12.6	10.0
HOURLY LOW	3.4	3.7	3.5	5.5	6.1	8.1	8.9	15.9	11.2	10.2	7.7
HOURS	672	672	672	672	672	672	672	672	672	672	672

YEAR=2005 MONTH=MARCH

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	11.9	12.0	12.0	12.4	13.2	14.6	14.1	22.5	19.1	17.9	14.4
HOURLY MEAN	7.9	7.8	8.5	9.5	10.0	11.4	12.0	19.9	16.0	14.2	11.4
HOURLY LOW	5.0	5.1	6.1	7.4	7.6	9.1	10.3	18.0	13.4	11.7	9.5
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2005 MONTH=APRIL

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	19.9	19.4	20.0	19.9	20.1	20.0	18.8	27.9	24.8	23.1	20.0
HOURLY MEAN	15.4	15.6	15.5	15.7	15.8	16.3	16.0	25.1	21.8	20.1	16.3
HOURLY LOW	11.3	10.8	10.5	10.9	11.5	12.7	12.6	21.4	17.7	16.6	11.7
HOURS	719	719	719	719	719	719	719	719	719	719	720

TABLE 3.1-1(CONT.). SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 2005. ALL RESULTS ARE CALCULATED FROM HOURLY TEMPERATURES (IN DEGREES CELSIUS). ALL ARE SURFACE INSTRUMENTS EXCEPT FOR NALST10 WHICH IS AT MID-DEPTH.

A "*" INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTION OR DAMAGE.

YEAR=2005 MONTH=MAY

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	23.7	23.3	24.0	25.0	23.8	24.3	23.1	32.0	29.3	27.7	24.6
HOURLY MEAN	19.8	19.7	19.8	20.0	20.0	20.7	20.5	28.9	25.7	24.0	20.9
HOURLY LOW	15.8	16.0	16.2	16.7	16.9	17.8	18.2	26.1	22.0	20.6	17.7
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2005 MONTH=JUNE

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	30.4	30.5	30.1	30.0	29.8	29.6	29.3	36.7	34.7	33.1	30.6
HOURLY MEAN	27.5	27.3	27.0	26.7	26.5	26.6	25.7	33.9	31.7	30.2	26.8
HOURLY LOW	21.7	21.6	22.0	22.1	22.1	22.6	21.7	30.2	27.2	25.8	22.4
HOURS	720	720	720	720	720	720	720	720	720	720	720

YEAR=2005 MONTH=JULY

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	33.3	32.8	32.8	33.4	33.2	33.6	32.3	39.6	37.8	35.9	31.7
HOURLY MEAN	30.2	30.1	30.3	30.4	30.5	30.7	30.6	38.0	35.2	33.6	30.6
HOURLY LOW	27.9	28.0	28.2	28.3	28.4	29.1	28.6	36.2	32.8	31.7	28.2
HOURS	744	744	744	744	744	744	744	744	743	744	744

YEAR=2005 MONTH=AUGUST

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHTF2 8	NAWHTF3 9	NARIV601 11
HOURLY HIGH	32.4	32.2	32.5	33.5	32.5	32.8	32.5	39.8	37.6	35.6	33.8
HOURLY MEAN	30.3	30.2	30.6	30.8	30.9	31.4	31.7	38.1	35.3	33.8	31.1
HOURLY LOW	28.1	27.9	28.6	29.1	29.2	30.1	30.7	31.4	33.3	32.0	29.3
HOURS	744	744	744	744	744	744	744	744	744	744	744

TABLE 3.1-1(CONT.). SUMMARY OF NORTH ANNA FIXED RECORDER TEMPERATURE DATA DURING 2005. ALL RESULTS ARE CALCULATED FROM HOURLY TEMPERATURES (IN DEGREES CELSIUS). ALL ARE SURFACE INTRUMENTS EXCEPT FOR NALST10 WHICH IS AT MID-DEPTH.

A *** INDICATES DATA MISSING DUE TO INSTRUMENT MALFUNCTION OR DAMAGE.

YEAR=2005 MONTH=SEPTEMBER

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHITF2 8	NAWHITF3 9	NARIV601 11
HOURLY HIGH	29.5	29.3	29.8	30.6	30.0	31.0	31.3	37.3	34.9	33.3	31.5
HOURLY MEAN	27.5	27.1	27.9	28.2	28.5	29.3	29.9	36.0	32.9	31.4	28.8
HOURLY LOW	24.5	24.2	25.1	25.6	26.0	26.8	27.9	33.5	29.9	28.4	25.5
HOURS	720	720	720	720	720	720	720	720	720	720	720

YEAR=2005 MONTH=OCTOBER

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHITF2 8	NAWHITF3 9	NARIV601 11
HOURLY HIGH	25.3	25.1	25.9	26.2	26.5	27.5	28.1	33.7	31.6	29.6	27.9
HOURLY MEAN	20.7	20.6	21.7	22.2	22.3	22.9	23.4	29.4	25.4	23.9	22.5
HOURLY LOW	14.7	15.1	16.7	17.3	17.4	18.2	18.5	22.4	20.0	19.2	16.8
HOURS	744	744	744	744	744	744	744	744	744	744	744

YEAR=2005 MONTH=NOVEMBER

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHITF2 8	NAWHITF3 9	NARIV601 11
HOURLY HIGH	16.4	16.7	18.1	18.3	18.3	19.4	19.5	27.0	23.9	22.0	19.7
HOURLY MEAN	13.7	14.0	15.5	15.9	16.1	17.3	17.7	24.8	21.3	19.2	16.8
HOURLY LOW	9.6	10.1	12.0	12.8	12.9	14.5	15.0	22.0	17.8	16.1	14.0
HOURS	720	720	720	720	720	720	720	720	720	720	720

YEAR=2005 MONTH=DECEMBER

STATISTIC/ STATION	NAL719ST 6	NAL719NT 5	NAL208T 4	NALINT 2	NALTHIST 1	NALBRPTT 3	NALST10 10	NADISC1 7	NAWHITF2 8	NAWHITF3 9	NARIV601 11
HOURLY HIGH	10.9	10.8	12.8	13.4	13.8	15.3	15.7	25.5	19.2	17.7	14.9
HOURLY MEAN	5.8	6.3	8.5	9.5	9.7	11.5	12.0	22.5	16.6	13.7	11.5
HOURLY LOW	3.6	4.1	6.3	7.6	7.8	9.3	10.1	20.8	13.9	12.1	8.8
HOURS	744	744	744	744	744	744	744	744	744	744	744

TABLE 3.1-2. NORTH ANNA LAKE SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR STATIONS IN LAKE ANNA.

DATE	DEPTH (M)	STATION A	B	C	D	E	F	G	H	I	J	K	L	M	N
02/09/2005	0	10.4	10.2	9.7	10.1	9.9	10.5	10.0	9.7	9.3	8.7	7.4	5.8	5.9	6.4
	1	10.3	10.2	9.5	9.7	9.8	9.8	9.8	8.6	8.8	8.2	6.7	4.7	4.8	5.6
	2	10.3	10.1	9.3	9.4	9.4	9.7	9.6	7.8	7.9	7.6	5.9	4.2	4.8	4.4
	3	10.2	10.1	9.0	9.2	9.1	9.5	9.3	7.8	7.1	7.5	5.1	4.1	4.4	4.3
	4	10.2	9.7	8.9	9.3	9.1	9.4	9.1	7.6	6.6	7.2	4.4	4.0	4.3	4.3
	5	10.0	9.3	8.7	8.9	8.9	9.1	8.7	7.5	6.3	6.7	4.1	4.0	4.2	4.3
	6	10.0	9.2	8.5	8.7	8.5	8.4	7.6	7.3	6.1	6.3	4.0	4.0	4.2	4.3
	7	9.7	9.1	8.4	8.4	8.2	7.8	7.1	6.8	5.9	5.5	4.0	4.0	4.3	4.3
	8	9.6	8.8	8.3	8.3	7.9	7.4	6.8	6.2	5.8	5.3	4.0		4.3	
	9	7.8	8.6	7.8	8.1	7.6	7.3	6.7	6.2	5.7	5.2	4.0			
	10	7.5	8.5	7.5	7.7	7.5	7.1	6.7	6.0	5.5	4.9	4.0			
	11	7.5	8.4	7.5	7.5	7.4	6.9	6.7	5.9	5.2	4.7	4.0			
	12	7.5	8.3	7.5	7.5	7.4	6.8	6.5	5.7	5.0	4.6	4.0			
	13	7.5	8.2	7.4	7.4	7.4	6.7	6.3	5.7	5.0	4.5	4.0			
	14	7.5	8.2	7.4	7.4	7.4	6.7	5.9	5.7		4.5				
	15	7.5	8.2	7.4	7.4	7.4	6.7	5.6	5.7						
	16	7.5	8.2	7.4	7.4	7.3	6.7	5.5							
	17	7.5		7.4	7.3	7.3	6.7	5.5							
	18	7.5		7.4	7.3	7.3	6.7	5.5							
	19	7.5		7.4	7.3		6.8	5.5							
	20	7.5					6.7								
	21	7.5													

TABLE 3.1-2(CONT.). NORTH ANNA LAKE SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR STATIONS IN LAKE ANNA.

		STATION														
DATE	DEPTH (M)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
9/4/13/2005	0	15.7	15.8	15.8	15.7	15.6	15.5	15.5	15.2	15.3	15.4	15.3	15.0	15.4	15.7
	1	15.7	15.8	15.8	15.7	15.6	15.5	15.5	15.2	15.3	15.4	15.2	15.0	15.4	15.7
	2	15.6	15.7	15.8	15.6	15.5	15.5	15.5	15.2	15.2	15.4	15.2	15.0	15.1	15.6
	3	15.6	15.5	15.8	15.5	15.5	15.5	15.5	15.2	15.2	15.4	15.1	14.9	15.0	15.4
	4	15.6	14.3	15.5	15.5	15.5	15.5	15.5	15.2	15.2	15.3	14.9	14.9	14.8	14.7
	5	15.6	13.7	15.3	15.4	15.4	15.5	15.5	15.1	15.2	15.3	14.6	14.9	14.7	14.2
	6	15.6	13.5	15.3	15.4	15.3	15.5	15.5	15.1	15.2	15.3	14.4	14.9	11.8	14.1
	7	15.6	13.1	15.3	15.4	14.7	14.9	14.6	15.1	13.3	15.1	13.0	14.8	11.4	13.6
	8	15.3	12.9	15.1	15.1	12.9	14.7	13.3	13.2	12.2	13.6	12.6		11.4	
	9	13.8	12.8	13.5	14.2	12.9	14.3	11.6	11.8	11.6	13.2	11.7			
	10	11.6	11.6	12.8	12.3	12.1	13.5	11.4	11.2	11.6	11.3	11.1			
	11	11.6	11.4	12.4	11.5	10.9	11.8	11.3	11.1	11.2	11.3	10.8			
	12	11.2	11.2	12.2	11.0	10.8	11.3	10.9	11.0	10.7	11.3	10.8			
	13	10.8	11.1	11.5	10.9	10.8	11.3	10.8	10.7	10.7	11.1	10.8			
	14	10.7	11.1	10.9	10.8	10.8	10.8	10.8	10.7		11.1				
	15	10.7	11.0	10.8	10.8	10.8	10.8	10.6	10.7						
	16	10.6	11.0	10.8	10.8	10.7	10.7	10.6							
	17	10.6		10.7	10.6	10.6	10.7	10.6							
	18	10.6		10.7	10.6	10.6	10.6	10.6							
	19	10.6		10.6	10.6		10.6	10.6							
	20	10.5					10.6								
	21	10.4													

TABLE 3.1-2(CONT.). NORTH ANNA LAKE SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR STATIONS IN LAKE ANNA.

STATION

DATE	DEPTH (M)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
08/16/2005	0	32.3	31.9	32.2	32.2	32.2	31.9	31.8	31.6	31.5	31.4	31.3	31.3	31.0	30.9
	1	32.3	31.9	32.2	32.2	32.2	31.9	31.7	31.6	31.5	31.4	31.3	31.3	31.1	30.9
	2	32.2	31.9	32.2	32.2	32.1	31.9	31.7	31.6	31.5	31.4	31.3	31.2	31.0	30.9
	3	32.1	31.9	32.1	31.9	31.9	31.8	31.6	31.6	31.4	31.4	31.3	31.1	30.9	30.8
	4	32.1	31.9	31.9	31.9	31.9	31.7	31.5	31.4	31.4	31.3	31.2	31.1	30.9	30.7
	5	32.0	31.8	31.8	31.8	31.8	31.7	31.5	31.2	31.3	31.2	31.2	31.0	30.9	30.6
	6	32.0	31.7	31.7	31.7	31.7	31.7	31.5	31.0	30.9	31.2	30.7	30.6	30.7	30.1
	7	32.0	31.2	31.6	31.5	31.6	31.6	31.5	31.0	30.8	31.1	30.5	29.8	30.5	30.1
	8	32.0	30.4	31.4	31.5	31.4	31.6	31.5	30.6	30.7		30.2		29.9	
	9	32.0	30.2	31.3	31.3	31.4	31.6	30.9	30.2	30.3				28.9	
	10	30.6	29.8	31.1	31.1	31.1	31.4	30.4	30.1	30.3					
	11	30.0	29.6	30.9	30.9	30.9	30.1	30.3	30.0	29.8					
	12	29.7	29.2	30.4	30.0	30.3	29.6	29.7	29.7	29.4					
	13	29.5	28.4	29.3	29.6	29.5	29.6	29.6	29.4	29.4					
	14	28.8	27.7	29.2	29.5	29.4	29.5	29.3	29.3						
	15	28.7	25.8	28.9	29.1	28.8	29.2	29.1	29.3						
	16	27.5	25.0	28.1	28.5	28.7	28.7	28.0							
	17	26.8		23.2	25.9	24.5	28.2	25.7							
	18	22.1		23.2	23.0	24.4	24.4	24.6							
	19	20.7		19.8	22.9		24.4	21.2							
	20	18.7					24.4								
	21	18.3													

TABLE 3.1-2(CONT.). NORTH ANNA LAKE SURVEY SHOWING TEMPERATURES (IN CELSIUS DEGREES) MEASURED AT ONE METER INTERVAL DEPTHS FOR STATIONS IN LAKE ANNA.

		STATION													
DATE	DEPTH (M)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
11/15/2005	0	18.5	18.6	18.2	18.2	18.2	17.8	17.5	17.2	16.9	16.7	16.4	15.4	14.8	14.9
	1	18.4	18.6	18.2	18.1	18.2	17.8	17.5	17.1	16.8	16.7	16.3	15.0	14.8	14.5
	2	18.3	18.5	18.2	18.0	18.0	17.8	17.4	17.0	16.8	16.7	16.2	14.9	14.6	14.2
	3	18.3	18.5	17.8	18.0	17.8	17.8	17.4	16.9	16.7	16.7	16.1	14.9	14.4	14.0
	4	18.1	18.5	17.6	17.6	17.5	17.7	17.2	16.8	16.5	16.7	15.4	14.9	14.1	13.9
	5	18.1	18.5	17.4	17.6	17.5	17.7	17.2	16.6	16.4	16.5	15.2	14.9	14.0	13.9
	6	18.1	18.5	17.3	17.3	17.4	17.6	17.1	16.5	16.3	16.3	15.1	14.8	13.7	13.9
	7	18.1	18.5	17.3	17.3	17.3	17.2	17.0	16.2	16.2	16.0	15.1	14.8	13.7	13.9
	8	17.3	18.2	17.2	17.2	17.2	17.0	17.0	16.0	16.1	15.7	15.0		13.7	
	9	17.0	17.8	17.2	17.2	17.2	17.0	16.7	16.0	16.1	15.6	14.9			
	10	17.0	17.8	17.1	17.2	17.2	16.9	16.5	16.0	16.0	15.3	14.9			
	11	17.0	17.5	17.1	17.1	17.0	16.7	16.3	15.8	15.8	15.3	14.8			
	12	17.0	17.5	17.1	17.1	17.0	16.5	16.2	15.5	15.4	15.3	14.8			
	13	17.0	17.4	17.1	17.0	17.0	16.4	16.1	15.5	15.4	15.3				
	14	17.0	17.4	17.0	17.0	16.9	16.2	16.1	15.5		15.3				
	15	17.0	17.4	17.0	17.0	16.9	16.2	16.0	15.5						
	16	17.0	17.4	17.0	16.9	16.9	16.2	16.0							
	17	17.0		16.9	16.9	16.9	16.2	15.9							
	18	17.0		16.9	16.9	16.9	16.2	15.9							
	19	17.0		16.9	16.9		16.2	15.9							
	20	17.0					16.2								
	21	17.0													

3.2 Fish Population Studies - Gill Netting

Methods

The monitoring of fish assemblage abundance and species composition for Lake Anna and the WHTF continued in 2005 using the same basic sampling technologies applied since 1972. Experimental gill netting was used to capture fishes which normally inhabit the deeper strata of the lake, or exhibit a diel movement to and from the shoreline. Each experimental gill net consists of six, fifty foot long by six foot deep panels beginning with 1/2 inch mesh in the first panel (set next to the shoreline) and increasing by 1/2 inch increments ending with 3 inch mesh in the final panel. Similar to previous years, 2005 gill net surveys were conducted during March, June, August, and November at the stations shown in Figure 3.2-1. Experimental gill nets were set near littoral drop-off areas with procedures remaining unchanged since 1972. Standard physiochemical measurements (surface water temperature (°C), dissolved oxygen (mg/l), pH and conductivity (umhos) were recorded at the time of each sample collection. Fish collected by gill netting were returned to the laboratory where all individuals were measured to the nearest millimeter total length and weighed to the nearest 0.1 gram.

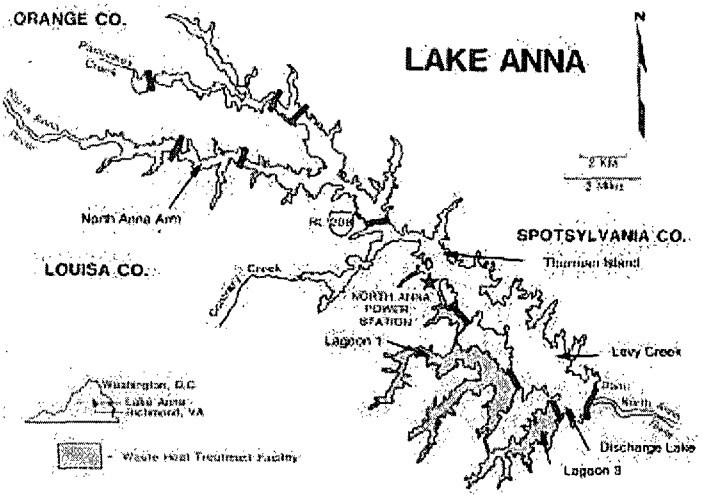


FIGURE 3.2-1 Location of gill netting station on Lake Anna

Results

Standard physicochemical measurements were recorded during gill net surveys. The data show seasonal changes in temperature and dissolved oxygen as would be expected (Table 3.2-1). Conductivity and pH were relatively stable. The data are consistent with historical trends and indicate that water quality in Lake Anna continues to be capable of supporting a healthy fishery.

TABLE 3.2- 1 Surface water temperature (C), conductivity (umhos),pH (standard units) and dissolved oxygen (mg/l) recorded at time of sampling during 2005

MARCH					JUNE				
Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen	Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen
Dike 1 WHTF	17.5	50	6.8	10.8	Dike 1 WHTF	32.8	53	7	7.5
Dike 3 WHTF	11.6	49	6.8	9.9	Dike 3 WHTF	30.4	58	7	7.7
Lagoon 1	16.7	51	6.7	10.5	Lagoon 1	32.8	53	7	7.5
Lagoon 3	12.3	44	6.7	10.6	Lagoon 3	29.3	52	7.9	8.2
Thurman Island	7.1	48	6.8	12.8	Thurman Island	28.8	53	7.2	9.4
Dike 1 Lake	7.8	52	6.7	11.3	Dike 1 Lake	27.1	53	7.5	8.3
Dike 3 Lake	10.9	45	6.7	10.4	Dike 3 Lake	26.5	53	6.8	6.6
Lower Lake Cove	9.5	47	6.7	10.6	Lower Lake Cove	30	53	6.9	7.1
North Anna Arm	5.7	47	6.8	14.3	North Anna Arm	29	56	8.6	9.4
Gillneting Stations					Gillneting Stations				
Lagoon 1	18	50	6.8	10.9	Lagoon 1	33.6	53	6.8	7.5
Lagoon 3	12	49	6.3	11.3	Lagoon 3	31.1	51	7.2	7.6
Lower Lake	11.5	47	6.9	11.8	Lower Lake	27.8	53	6.8	7
Thurman Island	7.8	48	7.1	12.3	Thurman Island	27.3	52	7.5	7.4
North Anna Arm	5.3	57	6.7	14.2	North Anna Arm	28.8	56	8.3	9.4
Levy Creek	10.4	57	7.1	12.7	Levy Creek	27.2	53	6.7	10.6

AUGUST					NOVEMBER				
Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen	Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen
Dike 1 WHTF	39	42	7.3	6	Dike 1 WHTF	25.7	64	7.2	4.9
Dike 3 WHTF	35.3	42	7.5	6.8	Dike 3 WHTF	20.1	63	7.7	4.9
Lagoon 1	*	*	*	*	Lagoon 1	24.5	62	7.2	4.6
Lagoon 3	35.8	42	7.6	7.3	Lagoon 3	19.8	63	7.5	5.5
Thurman Island	31.1	42	7.5	8.5	Thurman Island	16.8	64	7.1	5.3
Dike 1 Lake	31.4	42	7.5	8.1	Dike 1 Lake	16.8	63	7.4	5.2
Dike 3 Lake	32.5	43	7.2	6.1	Dike 3 Lake	18.7	63	7.2	4.6
Lower Lake Cove	32.7	42	7.5	8.7	Lower Lake Cove	18.8	63	7.4	5.1
North Anna Arm	30.5	41	8.4	9.5	North Anna Arm	14.8	66	8.3	6.6
Gillneting Stations					Gillneting Stations				
Lagoon 1	39	41	7.2	6.1	Lagoon 1	25.8	63	7.1	6.3
Lagoon 3	35.8	42	7.4	6.4	Lagoon 3	20.7	63	7.4	4.6
Lower Lake	32.5	43	7.6	5.6	Lower Lake	14.2	58	7.4	9.8
Thurman Island	32.1	39	7.9	6.5	Thurman Island	11.2	56	7.7	10
North Anna Arm	31.3	40	8.1	8.7	North Anna Arm	7.3	65	7.6	10.6
Levy Creek	32.4	42	7.5	6.4	Levy Creek	12.8	57	7.4	11.3
									10.3

* = Missing data

Eighteen (18) species of fish representing seven (7) families were collected in Lake Anna and the WHTF by quarterly gill netting in 2005 (Table 3.2-2).

Table 3.2-2. Fishes collected in Lake Anna by gill netting during 2005

FAMILY	SPECIES	LAKE	WHTF
Clupeidae	Alosa aestivalis	X	
	Dorosoma cepedianum	X	X
	Dorosoma petenense	X	X
Cyprinidae	Cyprinus carpio	X	X
Catostomidae	Carpiodes cyprinus	X	
Ictaluridae	Ameiurus catus	X	X
	Ameiurus nebulosus	X	
	Ictalurus furcatus	X	X
	Ictalurus punctatus	X	X
Moronidae	Morone americana	X	X
	Morone saxatilis	X	X
Centrarchidae	Lepomis cyanellus	X	X
	Lepomis gulosus	X	
	Lepomis macrochirus	X	
	Lepomis microlophus	X	X
	Micropterus salmoides	X	X
	Pomoxis nigromaculatus	X	X
Percidae	Sander vitreus	X	X

A total of 996 fish weighing 386.5 kg was collected in 2005 from four stations in the lake and two stations in the WHTF (Table 3.2-3). The 2005 total number of fish (996) was greater than 2004 (863) and 2003 (576) and gill net biomass in 2005 (385.3 kg) was less than biomass totals in 2004 (394.5) and greater than 2003 (243.5 kg). Of the 996 fish collected, 736 (268.8 kg) were collected in the lake and 260 (117.1 kg) were collected in the WHTF. The March survey yielded the greatest total weight of fish collected which represented 34.9% of the total weight of all fish collected from all stations combined (37% = common carp Cyprinus carpio). The June survey yielded the greatest total number (367) of fish collected from gill

netting which represented 36.8% of the total of all fish collected (40% = gizzard shad Dorosoma cepedianum and 24.9% channel catfish Ictalarus punctatus).

TABLE 3.2-3 NUMBER AND WEIGHT (g) OF FISHES BY STATION COLLECTED BY GILL NETTING AT LAKE ANNA DURING 2005

STATION	MARCH	JUNE	AUGUST	NOVEMBER	TOTAL	CPUE
LAGOON 1						
NUMBER	46	45	2	32	125	31.25
WEIGHT	29354	22585	463	15392	67793	16948
LAGOON 3						
NUMBER	14	38	60	23	135	34
WEIGHT	10431	13748	14629	11079	49887	12472
LEVY CREEK						
NUMBER	28	89	19	12	148	37
WEIGHT	20276	18586	3691	9843	52395	13099
LOWER LAKE						
NUMBER	38	53	32	38	161	40
WEIGHT	37864	24305	6560	34969	103697	25924
NORTH ANNA ARM						
NUMBER	77	59	128	60	324	81
WEIGHT	24615	20659	11680	25132	82086	20522
THURMAN ISLAND						
NUMBER	4	83	8	8	103	26
WEIGHT	6205	19375	695	4339	30614	7653
TOTALS						
NUMBER	207	367	249	173	996	42
WEIGHT	128744	119258	37718	100752	386472	16103

Table 3.2-3 also includes the average number and weight of fish collected per net set for each station for comparison of catch per unit effort by number (CPUE-N) and weight (CPUE-W). CPUE-N for all stations combined in 2005 was 42 fish per set while CPUE-W was 16.1 kg per set. A further examination of the CPUE data for 2005 show that CPUE-N ranged from a low of 26 fish per net at the Thurman Island Station to a high of 81 fish per net at the North Anna Arm Station. CPUE-W ranged from a low of 7.6 kg per net at the Thurman Island Station to a high of 25.9 kg at the Lower Lake Station.

These values are compared to CPUE in previous years in Figure 3.2-2. Over the last 10 years, CPUE-N has ranged from 24 to 43 with a mean of 34.7, while CPUE-W has ranged from 10 kg to 16 kg with a mean of 14.1 kg. In 2005, both CPUE-N (42) and CPUE-W (16.1) were above the long term mean.

FIGURE 3.2-2 Gill Net data (1995-2005) average number and average weight (Kg)

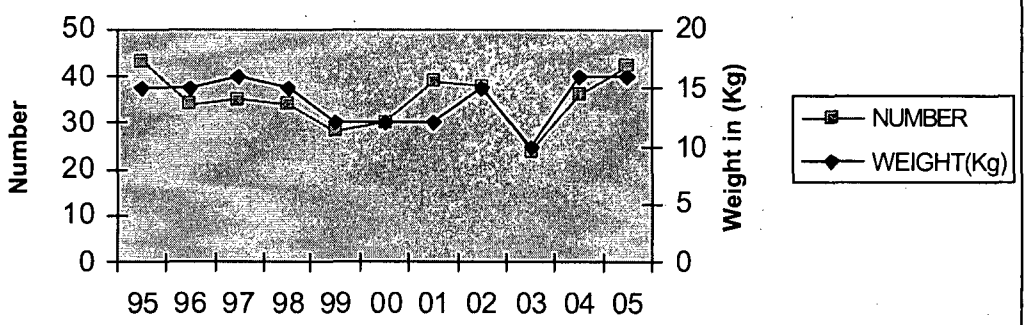


Table 3.2-4 presents the gill net catch by species and season at lake stations in 2005. The numerically dominant species collected in the lake was gizzard shad followed by channel catfish and black crappie Pomoxis nigromaculatus. These results are similar to data collected in 2003 and 2004 and are also consistent with other years. The dominant species in the lake from gill netting in terms of biomass was striped bass Morone saxatilis followed by walleye Sander vitreus. Striped bass and walleye have consistently comprised a large portion of the biomass of lake stations in previous years.

TABLE 3.2-4 GILL NET SUMMARY 2005
GILL NET - LAKE
STATION:ALL STATIONS

SPECIES	MARCH NUMBER	MARCH WEIGHT	JUNE NUMBER	JUNE WEIGHT	AUGUST NUMBER	AUGUST WEIGHT	NOVEMBER NUMBER	NOVEMBER WEIGHT	TOTALS NUMBER	TOTALS WEIGHT	% OF TOTAL NUMBER	% OF TOTAL WEIGHT
D.cepedianum	38	4443	158	31432	30	4771	12	1386	238	42031	32	16
I. punctatus	13	3544	38	13685	25	7065	17	10704	93	34998	13	13
P. nigromaculatus	17	3615	5	425	48	3239	14	3020	84	10298	11	4
M. saxatilis	30	36847	27	12854	1	219	18	15969	76	65889	10	25
S.vitreus	31	36150	2	1891			20	24038	53	62078	7	23
D. petenense					48	363			48	363	7	0
M. americana	9	897	21	1203	11	1307	5	282	46	3687	6	1
A. catus	8	2929	17	2554	3	904	17	9668	45	16055	6	6
M. salmoides	1	535	3	2467	7	759	4	2621	15	6380	2	2
C. carpio			5	15775	4	3270	2	5410	11	24455	1	9
L. macrochirus			5	59	2	108	2	65	9	231	1	0
L.microlophus			1	383	2	312	2	223	5	918	1	0
L. gulosus					3	94	1	52	4	146	1	0
A.aestivalis					2	36	1	19	3	55	0	0
A.nebulosus			1	148			2	440	3	588	0	0
L.cyanellus			1	71					1	71	0	0
I.furcatus					1	180			1	180	0	0
C.cyprinus							1	388	1	388	0	0
Total No.	147		284		187		118		736		100	
Total Wt.	88959		82945		22626		74282		268812		100	

The numerically dominant species collected by gill netting in the WHTF in 2005 was channel catfish followed by gizzard shad, largemouth bass, and common carp (Table 3.2-5). The weight-dominant species in the WHTF gill netting in 2005 was common carp followed by channel catfish and gizzard shad. Due to their relatively high numbers, gizzard shad have generally ranked high in biomass catch in both the lake and WHTF. Channel catfish, common carp and white catfish Ameiurus catus have also commonly ranked high in biomass in both places. Largemouth bass has frequently represented a substantial portion of the biomass in the WHTF as well.

TABLE 3.2-5 GILL NET SUMMARY 2005
GILL NET- WHTF
STATION:ALL STATIONS

SPECIES	MARCH NUMBER	MARCH WEIGHT	JUNE NUMBER	JUNE WEIGHT	AUGUST NUMBER	AUGUST WEIGHT	NOVEMBER NUMBER	NOVEMBER WEIGHT	TOTALS NUMBER	TOTALS WEIGHT	% OF TOTAL NUMBER	% OF TOTAL WEIGHT
I. punctatus	23	9294	20	6321	30	5719	20	6721	93	28054	36	24
D. cepedianum	7	2671	33	10817	19	4985	6	2855	65	21329	25	18
M. salmoides	1	774	14	5700	6	1121	11	6715	32	14309	12	12
C. carpio	10	14670	8	12310	1	2780	7	4160	26	33920	10	29
M. americana	5	1175	1	22			6	1133	12	2329	5	2
L. microlophus			4	598	5	481			9	1079	3	1
A. catus	4	1139	1	245			1	135	6	1519	2	1
S.vitreus	4	3210					2	3530	6	6740	2	6
M.saxatilis	4	6105					1	1214	5	7319	2	6
P. nigromaculatus	1	178	2	319					3	497	1	0
D. petenense							1	9	1	9	0	0
I. furcatus	1	572							1	572	0	0
L. cynaellus					1	8			1	8	0	0
Total No.	60		83		62		55		260		100	
Total Wt.	39785		36332		15092		26471		117680		100	

3.3 Fish Population Studies - Electrofishing

Methods

Boat electrofishing was used in 2005 to evaluate the assemblage and abundance of fish populations which normally occupy the shoreline habitat. The techniques, stations, and frequency have remained virtually unchanged since 1972. Sampling was performed in March, June, August, and November at the stations identified in Figure 3.3-1. Each station is 100 meters in length and normally includes a brush pile except for the dike stations which are comprised of uniform rip-rap. Standard physicochemical measurements of surface water temperature (°C), dissolved oxygen (mg/l), pH and conductivity (μmhos) were recorded at the time of each sample collection.

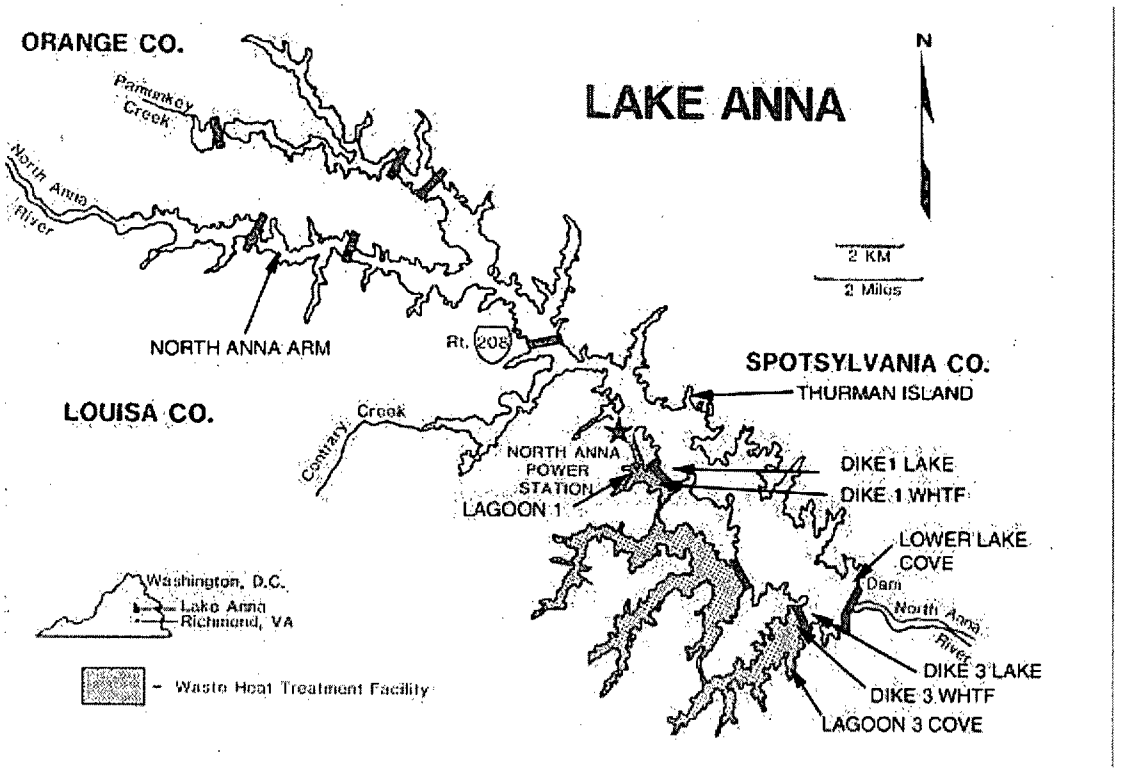


Figure 3.3-1 Location of electrofishing stations on Lake Anna and WHTF

All fish collected were either returned to the laboratory for processing or released in the field, i.e., larger game fish were measured, weighed, and released in the field. In the laboratory, up to twenty-five (25) individuals per species from each station were measured to the nearest millimeter total length and weighed to the nearest 0.1 gram. The remaining fish were enumerated and bulk weighed.

Results

Twenty-six (26) species of fish representing eleven (11) families were collected by electrofishing operations in the lake and WHTF in 2005 (Table 3.3-1).

Table 3.3-1. Fishes collected in Lake Anna and the WHTF by electrofishing in 2005

FAMILY	SPECIES	LAKE	WHTF
Clupeidae	Dorosoma cepedianum	X	X
	Dorosoma pentenense	X	
Esocidae	Esox niger	X	
Cyprinidae	Cyprinella analostana	X	
	Cyprinus carpio	X	
	Notropis procne	X	
Catostomidae	Erimyzon oblongus		X
	Moxostoma erythrurum	X	
Ictaluridae	Ameiurus catus	X	X
	Ameiurus natalis	X	X
	Ameiurus nebulosus	X	
	Ictalurus punctatus	X	X
Aphredoderisae	Aphredoderus sayanus	X	
Cyprinodontidae	Fundulus diaphanus	X	
Poeciliidae	Gambusia holbrooki	X	
Moronidae	Morone americana	X	
	Morone saxatilis	X	
Centrarchidae	Lepomis auritus	X	X
	Lepomis cyanellus	X	X
	Lepomis gulosus	X	X
	Lepomis macrochirus	X	X
	Lepomis microlophus	X	X
	Micropterus salmoides	X	X
	Pomoxis nigromaculatus	X	X
Percidae	Etheostoma olmstedi	X	
	Perca flavescens	X	

A total of 5,320 fish weighing 90.9 kg was collected via electrofishing from the five stations in the lake and the four stations in the WHTF during the 2005 sampling period (Table 3.3-2).

TABLE 3.3-2 NUMBER AND WEIGHT (g) OF FISHES BY STATION COLLECTED BY ELECTROFISHING AT LAKE ANNA DURING 2005

STATION	MARCH	JUNE	AUGUST	NOVEMBER	TOTAL	CPUE
LAGOON 1						
NUMBER	93	19	22	25	159	39.75
WEIGHT	1968.4	734.8	223	963.7	3889.9	972.475
LAGOON 3						
NUMBER	156	39	40	182	417	104.25
WEIGHT	6953.6	2375	536.8	2066.6	11932	2983
DIKE 1-WHTF						
NUMBER	344	105	3	83	535	133.75
WEIGHT	6367.4	1662.7	19.8	2300.2	10350.1	2587.525
DIKE 3-WHTF						
NUMBER	505	60	58	602	1225	306.25
WEIGHT	7628.9	1189.2	484.4	1828.1	11130.6	2782.65
DIKE 1-LAKE						
NUMBER	337	73	59	593	1062	265.5
WEIGHT	4318.2	1586.3	1081.4	3931.8	10917.7	2729.425
DIKE 3-LAKE						
NUMBER	240	82	72	412	806	201.5
WEIGHT	2271.5	1749.9	976	3668.7	8666.1	2166.525
LOWER LAKE						
NUMBER	147	45	44	164	400	100
WEIGHT	1455.6	975.1	1322.5	5192.9	8946.1	2236.525
THURMAN ISLAND						
NUMBER	175	44	25	146	390	97.5
WEIGHT	5662	1237.5	911.5	3980.4	11791.4	2947.85
NORTH ANNA ARM						
NUMBER	14	72	100	140	326	81.5
WEIGHT	332	3321.5	5828.5	3770.9	13252.9	3313.225
TOTAL NUMBER	2011	539	423	2347	5320	147.8
TOTAL WEIGHT	36957.6	14832	11383.9	27703.3	90876.8	2524.4

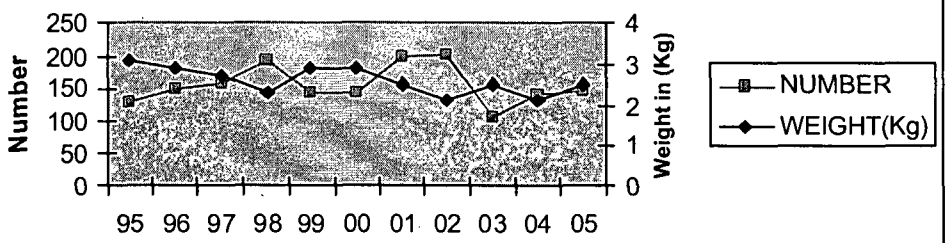
The total number of 5,320 collected from 2005 electrofishing is greater than the 2004 total of 5,117 and 2003 (3,749). Electrofishing biomass in 2005 (90.8 kg) was greater than 2004 (73.6 kg) and 2003 (84.5 kg). Of the 5,320 fish collected in 2005, 2,984 (53.6 kg) were collected from the lake and 2,336 (37.3 kg) were collected from the WHTF (Table 3.3-2). When the data are compared seasonally,

the 2005 electrofishing results are similar to previous years with the greatest numbers of fish being collected in the first quarter (2,011 individuals in March) and fourth quarter (2,347 individuals in November) surveys. Typically, in the fourth quarter, recruitment of the young-of-year (YOY) plus the return of fish to shallow water as the weather cools combine to increase the number of fish available to collection by shoreline electrofishing.

Table 3.2-2 also includes the average number and weight of fish collected per electrofishing sample for each station for comparison of catch per unit effort by number (CPUE-N) and weight (CPUE-W). CPUE-N for all stations combined in 2005 was 147.8 fish per sample while CPUE-W was 2.5 kg per sample. When the catch per unit effort among stations in 2005 is compared, CPUE-N ranged from a low of 39.8 fish per sample at Lagoon 1 Station to a high of 306 fish per sample at the Dike 1 - WHTF (Table 3.3-2). CPUE-W ranged from a low of 0.97 kg per sample at the Lagoon 1 Station to a high of 3.3 kg at the North Anna Arm Station.

These values are compared to CPUE in previous years (Figure 3.3-3). Over the last 10 years, CPUE-N has ranged from 104 to 201 with a mean of 172, while CPUE-W has ranged from 2.1 kg to 3.1 kg with a mean of 2.3 kg. In 2005, CPUE-N (147.8) was somewhat below average while CPUE-W was slightly above average.

FIGURE 3.3-3 Lake Anna Electrofish data (1995-2005) average number and average weight (Kg)



The numerically dominant species collected in both the lake and WHTF by boat electrofishing in

TABLE 3.3-3 ELECTROFISH SUMMARY 2005
ELECTROFISH - LAKE

STATION:ALL STATIONS	MARCH		JUNE		AUGUST		NOVEMBER		TOTALS		% OF TOTAL	
SPECIES	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT
L.macrochirus	753	7531	218	2355	197	2378	1153	6712	2321	18976	78	35
L.cyanellus	47	740	20	467	23	389	103	1008	193	2604	6	5
L.microlophus	53	1234	13	319	6	189	56	1364	128	3107	6	6
M.salmoides	28	3417	8	1275	22	1041	24	3657	80	9390	3	18
L.auritus	9	220	16	314	5	39	39	1135	69	1708	2	3
L.gulosus	8	133	5	190	7	128	36	1047	56	1497	2	3
D.petenense							31	4234	31	4234	1	8
P. nigromaculatus	5	185	13	788	6	465	4	468	28	1905	1	4
D.cepedianum			6	1259	18	1738			24	2997	1	6
P. flavescens	1	28	8	141	3	93	2	35	14	297	1	1
I. Punctatus			2	811	4	235	1	430	7	1276	0	2
A. catus			3	622	2	297	1	15	6	935	0	2
M.americana			2	68	3	118			5	186	0	0
A.nebulosus	1	141	2	462			1	200	4	803	0	1
Fdiaphanus	4	15							4	15	0	0
A.natalis	1	60					1	18	2	77	0	0
E.niger	1	277					1	220	2	497	0	1
M.erythrurum	2	56							2	56	0	0
C.analostana					2	3			2	3	0	0
C.carpio					1	3000			1	3000	0	6
E. olmstedi	1	2							1	2	0	0
M.saxatilis					1	6			1	6	0	0
A.sayanus							1	1	1	1	0	0
G.holbrooki							1	1	1	1	0	0
N.procne	1	2							1	2	0	0
Total No.	913		316		300		1455		2984		100	
Total Wt.(g)	14039		8870		10120		20545		53574		100	

ELECTROFISH TOTALS - WHT

STATION:ALL STATIONS	MARCH		JUNE		AUGUST		NOVEMBER		TOTALS		% OF TOTAL	
SPECIES	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT(g)	NUMBER	WEIGHT
L.macrochirus	901	12069	153	1501	74	619	735	3558	1863	17747	80	48
L.cyanellus	70	885	38	833	27	259	104	665	239	2442	10	7
L.microlophus	65	1474	11	241	2	88	10	529	88	2331	4	6
M.salmoides	39	6060	8	1493	17	67	12	1582	76	9203	3	25
L.gulosus	7	154	4	120	1	47	23	285	35	606	1	2
L.auritus	5	108	3	47			4	146	12	300	1	1
P.nigromaculatus	8	1324	1	177					9	1501	0	4
I.punctatus	2	700	4	1156	1	2			7	1858	0	5
A. catus					1	183	2	306	3	489	0	1
A. natalis							2	88	2	88	0	0
E.oblongus	1	346							1	346	0	1
D.cepedianum			1	394					1	394	0	1
Total No.	1098		223		123		892		2338		100	
Total Wt.(g)	22918		5962		1264		7159		37303		100	

2005 was the bluegill (Table 3.3-3). Bluegill also ranked first in terms of weight in both the lake and WHTF. Largemouth bass ranked second in weight in the lake and in the WHTF. These results are similar to those of 2004 and 2003 as well as those in the historical records as Centrarchids (sunfishes) continued to dominate the electrofishing catch.

Standard physiochemical measurements were recorded at each station during electrofishing surveys and are presented in Table 3.3-4. Again, seasonal changes in water temperatures and dissolved oxygen are noticeable while conductivity and pH remained relatively stable.

TABLE 3.3- 4 Surface water temperature (C), conductivity (umhos),pH (standard units) and dissolved oxygen (mg/l) recorded at time of sampling during 2005

MARCH

Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen
Dike 1 WHTF	17.5	50	6.8	10.8
Dike 3 WHTF	11.6	49	6.8	9.9
Lagoon 1	16.7	51	6.7	10.5
Lagoon 3	12.3	44	6.7	10.6
Thurman Island	7.1	48	6.8	12.8
Dike 1 Lake	7.8	52	6.7	11.3
Dike 3 Lake	10.9	45	6.7	10.4
Lower Lake Cove	9.5	47	6.7	10.6
North Anna Arm	5.7	47	6.8	14.3

JUNE

Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen
Dike 1 WHTF	32.8	53	7	7.5
Dike 3 WHTF	30.4	58	7	7.7
Lagoon 1	32.8	53	7	7.5
Lagoon 3	29.3	52	7.9	8.2
Thurman Island	28.8	53	7.2	9.4
Dike 1 Lake	27.1	53	7.5	8.3
Dike 3 Lake	26.5	53	6.8	6.6
Lower Lake Cove	30	53	6.9	7.1
North Anna Arm	29	56	8.6	9.4

AUGUST

Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen
Dike 1 WHTF	39	42	7.3	6
Dike 3 WHTF	35.3	42	7.5	6.8
Lagoon 1	*	*	*	*
Lagoon 3	35.8	42	7.6	7.3
Thurman Island	31.1	42	7.5	8.5
Dike 1 Lake	31.4	42	7.5	8.1
Dike 3 Lake	32.5	43	7.2	6.1
Lower Lake Cove	32.7	42	7.5	8.7
North Anna Arm	30.5	41	8.4	9.5

NOVEMBER

Electrofish Stations	Temperature	Conductivity	pH	Dissolved Oxygen
Dike 1 WHTF	25.7	64	7.2	4.9
Dike 3 WHTF	20.1	63	7.7	4.9
Lagoon 1	24.5	62	7.2	4.8
Lagoon 3	19.8	63	7.5	5.5
Thurman Island	16.8	64	7.1	5.3
Dike 1 Lake	16.8	63	7.4	5.2
Dike 3 Lake	18.7	63	7.2	4.6
Lower Lake Cove	18.8	63	7.4	5.1
North Anna Arm	14.8	66	8.3	6.6

* = Missing data

Lake Anna was again among the leaders in the State of Virginia for largemouth bass citations with 18 being reported. A citation for largemouth bass is awarded for fish greater than 55.9 cm in length of 3.6 kg in weight.

Overall, the data for gill netting and electrofishing in 2005 reveal no major changes in the fish assemblage of the lake when compared to data from previous years. Lake Anna continues to support a healthy, well-balanced fisheries community.

3.5 Conclusions

- North Anna Power Station operated at an average of 95% of capacity in 2005.

- The 2005 water temperature data from the continuous recorders were within historical ranges.

- Thermal stratification patterns measured in 2005 showed seasonal changes similar to previous years.

- The species composition of the gill net catch in 2005 was consistent with historical data while CPUE-N and CPUE-W were above the mean..

- Centrarchids (sunfishes) were the numerically dominant fish taxa collected by electrofishing in 2005. Electrofishing CPUE-N was somewhat below the mean while CPUE-W was slightly above the mean.

3.6 Recommendations

- Based on these results, it is recommended that biological monitoring of Lake Anna and the WHTF be continued at its present level.

4.0 North Anna River

4.1 River Flow and Rainfall

Methods

River discharge (cfs) data were obtained from the United States Geological Survey (USGS) to document the timing and magnitude of hydrologic events. These events, along with other factors e.q., habitat, sediment loading, etc., are among the most important abiotic factors affecting the abundance and distribution of stream organisms.

Periods of low flow are historically typical of the North Anna River during the summer and early autumn and provide more optimal conditions for the growth and survival of young fish. The spawning success and growth and survival of these fish can then influence fish abundance during the subsequent year. Also, low flow conditions generally provide optimal conditions for electrofishing efficiency because of water clarity and the ability to see and collect fish.

During periods of high flow that typically occur January - March or following extended periods of rainfall, several factors may affect fish abundance. A Spearman's correlation analysis (Hollander and Wolf 1973) conducted in 1993 by Dominion (Dominion 1993) determined that river flow correlates directly with electrofishing catches. Low late winter or spring flows tend to contribute to a relatively high electrofishing catch later in the year, whereas high flows early in the year tend to result in low electrofishing catches. Fish collection result may also be affected by high flow and correspondent water clarity. In addition, low annual fish collection totals may be a result of missed or partially conducted surveys due to consistently high flow. Data were obtained from USGS gaging station 01671020 (Hart Corner) near Doswell, Virginia. The station is located approximately 47 km downstream of the Lake Anna dam (Figure 4.1-1).

Results and Discussion

The historical pattern of seasonal flows in the North Anna River has generally been

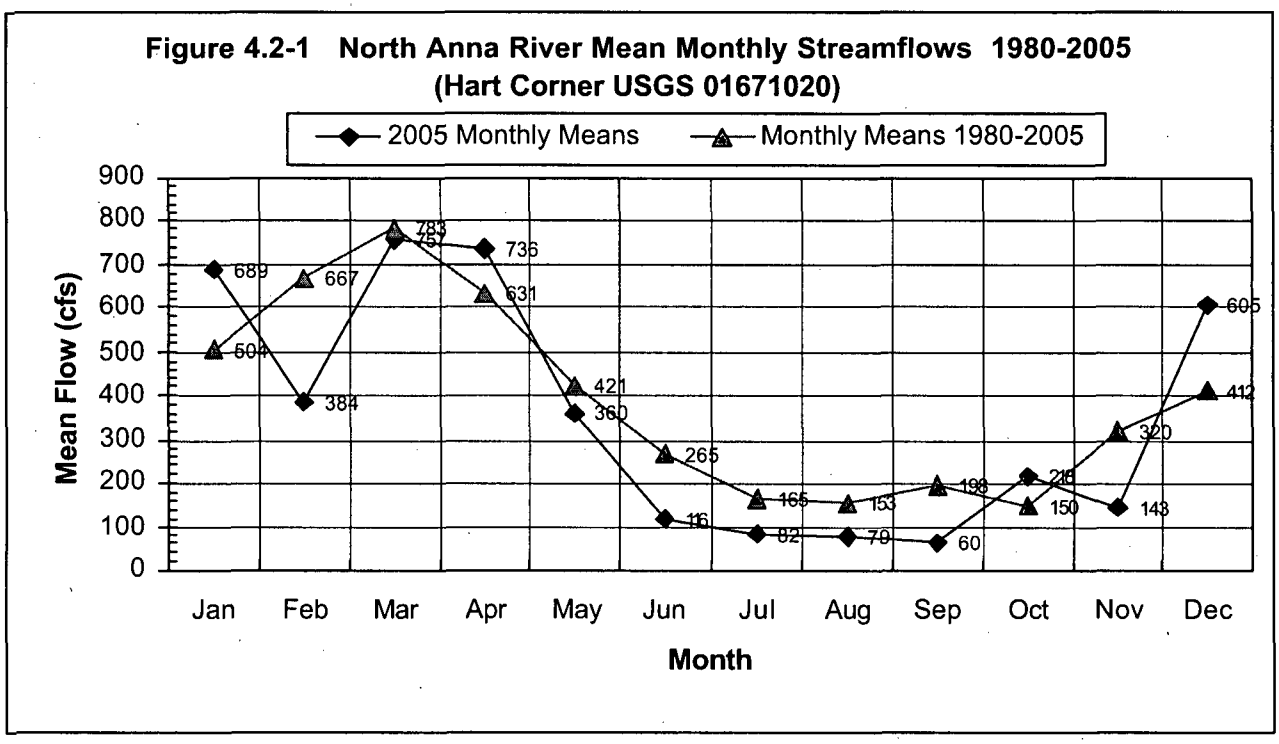
characterized by high flows in the winter and spring, reduced flows during summer and even lower flows during late summer and early autumn. This is a pattern commonly exhibited by many rivers draining the eastern United States, and is generally reflective of annual rainfall patterns. The 2005 seasonal flow pattern was once again similar to historical flow patterns (Figure 4.2-1).

In 2005, North Anna River flows were moderately high (100-800 cfs) from January to May and again in December. During this period, there were also several consecutive days where flows exceeded 1000 cfs with a maximum daily mean of 4,570 cfs in January. Mean daily flows exceeded 2,000 cfs in December and 3,000 cfs in March and April (Table 4.2-1). Higher flows associated with precipitation events are not uncommon in winter and spring as illustrated by the long-term (1980-2005) average stream flow in Figure 4.2-1. Daily mean flow values from mid-June to early October and a portion of November were for the most part below 100 cfs and therefore below the long-term average.

Table 4.2-1 Daily Mean Flow Values for the North Anna River at Hart Corner near Doswell, VA
Discharge, cubic feet per second, CALENDAR YEAR JANUARY TO DECEMBER 2005
DAILY MEAN VALUES

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	272	342	574	744	344	e240	75	77	67	59	89	522
2	377	395	589	1630	363	e228	69	80	61	58	85	591
3	269	399	530	3850	320	e258	68	76	61	58	84	627
4	144	560	498	2910	300	e268	66	68	59	59	81	321
5	144	666	608	908	e274	e255	66	64	59	60	80	---
6	263	660	706	743	e254	e175	70	63	60	61	82	296
7	285	627	665	707	e247	e113	72	71	59	72	83	303
8	290	336	475	1630	e250	106	193	73	60	232	79	427
9	303	306	1280	907	e240	120	110	80	59	225	84	---
10	e270	312	1050	e730	e232	112	82	79	58	200	96	1060
11	e235	306	726	e670	e227	e99	78	75	59	182	89	635
12	223	295	451	e635	e190	e91	71	76	60	374	83	513
13	298	291	336	e611	e135	e89	69	77	60	295	81	487
14	1680	293	473	e511	e120	e86	146	80	60	278	78	339
15	4570	309	678	392	e105	e80	104	79	60	260	77	327
16	3370	305	653	343	176	e79	109	e87	60	248	79	1290
17	e1360	297	364	229	263	e77	78	e135	64	241	102	2190
18	e775	286	320	236	256	e73	72	94	65	221	101	685
19	e685	281	310	304	156	e74	71	109	59	95	100	545
20	680	279	305	301	392	e78	72	102	59	72	95	707
21	678	284	302	299	1750	e90	67	99	58	169	95	684
22	653	335	295	323	825	e86	75	101	58	120	195	666
23	652	339	347	325	217	e85	67	78	57	168	228	382
24	e470	332	733	376	165	e83	65	70	57	136	244	308
25	324	432	1150	331	668	e82	63	67	60	809	334	339
26	365	487	714	309	738	e80	70	65	59	974	206	442
27	395	490	678	295	678	e69	68	64	60	444	186	383
28	339	504	1030	e275	468	71	63	66	60	274	185	355
29	293	---	3190	e260	298	73	63	69	60	126	391	672
30	337	---	2510	290	e263	74	82	66	60	108	498	732
31	372	---	932	---	e260	---	118	64	---	95	---	710
TOTAL	21371	10748	23472	22074	11174	3494	2542	2454	1798	6773	4290	17538
MEAN	689	384	757	736	360	116	82	79	60	218	143	605
MAX	4570	666	3190	3850	1750	268	193	135	67	974	498	2190
MIN	144	279	295	229	105	69	63	63	57	58	77	296

e = estimated



Historical rainfall data for the state of Virginia in 2005 were obtained from the Southeast Regional Climate Center (www.dnr.state.sc.us/climate/sercc/climateinfo) website. Interpretation of the historical data indicated the total rainfall for Virginia in 2005 was 39.84 inches with the greatest accumulated monthly rainfall occurring in July (5.81 inches) and October (5.19 inches). Comparatively in 2004, the total rainfall was 49.15 inches, with 24.44 inches accumulating from June to September. The average annual rainfall for Virginia for the period 1981-2005 is 44.30 inches. The annual total for 2005 was therefore slightly less than 4.5 inches below the historical 24 year average.

4.2 Temperature

Methods

Water temperatures (°C) were recorded hourly at Station NAR-1 in the lower North Anna River during 2005 (Figure 4.1-1) using an Onset temperature recorder. This instrument has an accuracy range of ±0.5°C. Station NAR-1 is located approximately 1 km below the Lake Anna dam.

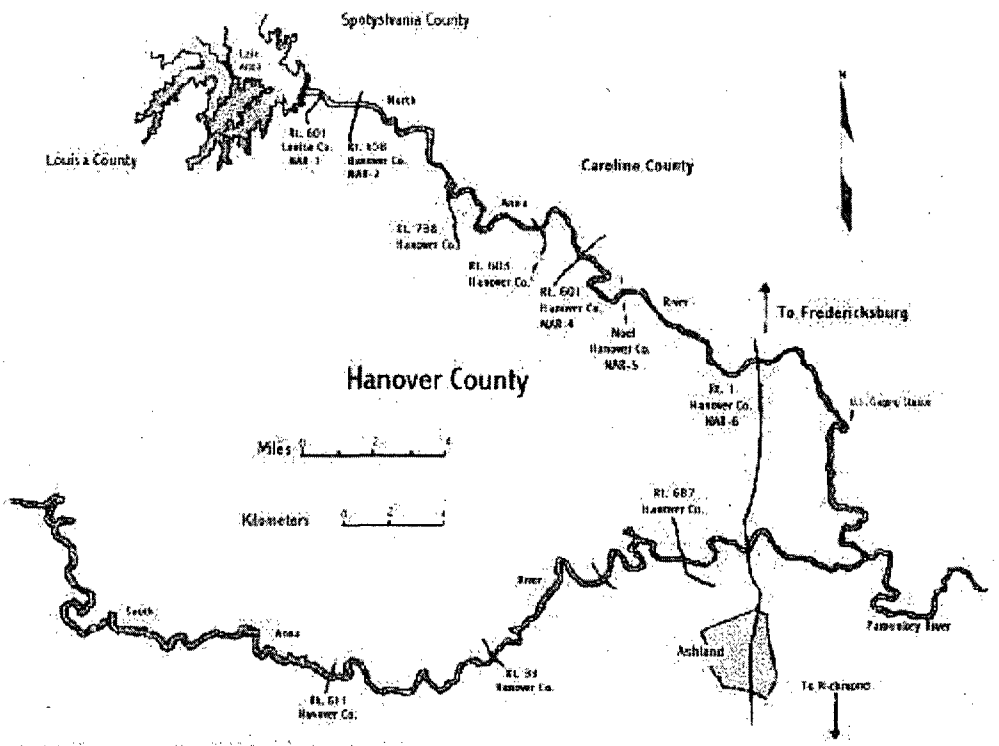


Figure 4.1-1 Location of North Anna River temperature recording, electrofishing, and snorkel survey stations.

Results and Discussions

Water temperatures in the lower North Anna River for 2005 were highest from June through September with a maximum monthly mean water temperature of 31.1° C in August (Table 4.1-1). The maximum hourly water temperature measured in 2005 was 33.8° C also in August. The previous maximum monthly mean was 30.6°C while the previous hourly maximum was 33.6° C.

As previously discussed, river flows were relatively low during the summer of 2005 with daily means rarely exceeding 100 cfs. Water temperatures at NAR-1 exceeded 33.0°C on 12 days in 2005 when air temperatures (reported for Richmond by the National Weather Service Forecast office in Wakefield - www.erh.noaa.gov/akq) reached 35-37.8°C. Therefore it appears that a combination of low flow and high air temperatures resulted in relatively high river temperatures at times during the summer of 2005.

Winter water temperatures were moderate in 2005 with a minimum monthly mean of 10.0°C recorded in February and a minimum hourly temperature of 7.4°C recorded in January.

Table 4.1-1. Mean, maximum, and minimum hourly water temperatures (C) recorded in the North Anna River, at station NAR-1 by month during 2005. Sample size (n) equals the number of hourly observations recorded each month.

NAR-1

Month	Mean	Max	Min	n
January	10.3	13.0	7.4	744
February	10.0	11.8	7.7	672
March	11.4	14.4	9.5	744
April	16.3	20.0	11.7	720
May	20.9	24.6	17.7	744
June	26.8	30.7	22.4	720
July	30.6	33.7	28.2	744
August	31.1	33.8	29.3	744
September	28.8	31.5	25.5	720
October	22.5	27.9	16.8	744
November	16.8	19.7	14.0	720
December	11.5	14.9	8.8	744

4.3 Fish Population Studies-Electrofishing

Methods

Abundance and species composition data for the North Anna River fish assemblage in 2005 were collected during electrofishing surveys. Consistent sampling techniques have been used in all North Anna River electrofishing surveys since 1981.

An approximately 70-m reach of riffle/run type habitat is sampled at each station with an electric seine (Virginia Power 1986). Prior to sampling, each reach is blocked at the downstream ends with a 6.5-mm mesh net. Sampling is conducted by working the electric seine from bank to bank in a zigzag pattern from the upstream to the downstream end of the section. Nearby pool type habitats are then sampled for 10 minutes of effort with a backpack electrofisher. Fish sampled by electric seine and backpack electrofisher are collected using 6.5-mm mesh dip nets.

Most fish collected are preserved in 10% formalin and transported to the laboratory for appropriate processing. Some larger fish are weighed and measured in the field and released. In the laboratory, a maximum of 15 individual specimens of each species is weighed to the nearest 0.1 g and measured to the nearest one (1) mm total length (TL). If more than 15 specimens of a species are collected, those in excess of 15 are counted and weighed in bulk. Electric seine and backpack electrofisher collections are then pooled by station and survey month for analyses.

Sample frequency for electrofishing is typically once per month each year in May, July and September. In 2005, electrofishing surveys on the North Anna River were conducted in May, July and September.

As illustrated below, the total number of river electrofishing collections for a typical sample year (May, July and September) is twenty-four (12 electric seine and 12 backpack); however, in 2005, twenty-two collections were completed (10 electric seine and 12 backpack). During the May survey, electric seine runs at Stations NAR-4 and NAR-6 were not conducted due to high flow conditions.

	May	July	September	Total
Typical Year				
# of seine stations	4	4	4	12
# of backpack stations	4	4	4	12
2005				
# of seine stations	2	4	4	10
# of backpack stations	4	4	4	12

Results and Discussion

In 2005, 943 fish representing 29 species and ten families were collected via electrofishing from the North Anna River (Table 4.3-1).

Table 4.3-1. Number and biomass (g) of fishes collected during May, August and September, 2005 electrofishing surveys of the North Anna River.

Family / Species	NAR-1		NAR-2		NAR-4		NAR-6		Total	
	Number	Total Weight	Number	Total Weight	Number	Total Weight	Number	Total Weight	Number	Total Weight
Petromyzontidae										
Lampetra appendix							1	4.8	1	4.8
Petromyzon marinus							1	4.8	1	4.8
Anguillidae										
Anguilla rostrata	168	2212.4	15	236.8	37	641.1	22	1254.2	242	4344.5
Cyprinidae										
Cyprinella analostana	14	97.1	21	95.7	44	191.4	6	23.3	85	407.5
Lythrurus ardens	28	106.1	21	51.9	36	63.8	6	11.4	91	233.2
Nocomis leptocephalus					4	109.3			4	109.3
Nocomis micropogon	1	18.3			18	332.1	3	8.1	22	358.5
Notomigonus crysoleucas	2	3.5	1	3.0					3	6.5
Notropis amoenus	4	23.9	16	49.5	21	76.8	6	11.1	47	161.3
Notropis hudisonius	1	8.5							1	8.5
Notropis procne			3	7.0	2	4.1	6	8.6	11	19.7
Notropis rubellus					17	12.4			17	12.4
Semotilus corporalis			1	1.0	32	114.3	3	4.4	36	119.7
Catostomidae										
Erimyzon oblongus					1	6.8			1	6.8
Hypentelium nigricans	6	304.4	22	741.8	7	265.4	1	2.1	36	1313.7
Ictaluridae										
Ameiurus natalis	1	1.7			1	1.1			2	2.8
Noturus insignis	20	121.1	9	71	28	191.8	13	107.6	70	491.5
Centrarchidae										
Lepomis auritus	55	1621.0	26	548.9	29	491.2	29	444.4	139	3105.5
Lepomis macrochirus	9	219.8	1	104.8			2	70.3	12	394.9
Micropterus dolomieu					5	46.3			5	46.3
Micropterus salmoides	10	99.0	1	4.4			1	3.0	12	106.4
Pomoxis nigromaculatus							2	82.2	2	82.2
Percidae										
Etheostoma olmstedi	18	30.0	7	8.8	4	7.1	4	2.8	33	48.7
Etheostoma vitreum							2	2.3	2	2.3
Percina notogramma					2	8.9			2	8.9
Percina peltata	25	71.3	15	35.7	11	36.5	12	28.5	63	172.0
Amiidae										
Amia calva							1	457.4	1	457.4
Cyprinodontidae										
Fundulus diaphanus	1	2.1							1	2.1
Poeciliidae										
Gambusia holibrooki							1	0.1	1	0.1
Total	363	4940.2	159	1960.3	299	2600.4	122	2531.4	943	12032.3
Number of species	16		14		18		20		29	

The figure below presents a comparison of fish totals and number of species collected and the number of annual fish collections from the North Anna River from 1986-2005. In addition, mean annual river flow is included for comparative purposes. The largest number of fish collected was in 1991 (3495) and the smallest catch was in 1995 (407) when only 8 collection surveys were conducted. The greatest number of species was collected in 1987 (32) and smallest number was in 1989 (18). The total number of collections for a typical sample year is twenty-four. During the twenty year period 1986-2005, there were eleven years where twenty-four surveys were conducted. The two lowest collection years were in 1989 (8) and 1995 (8).

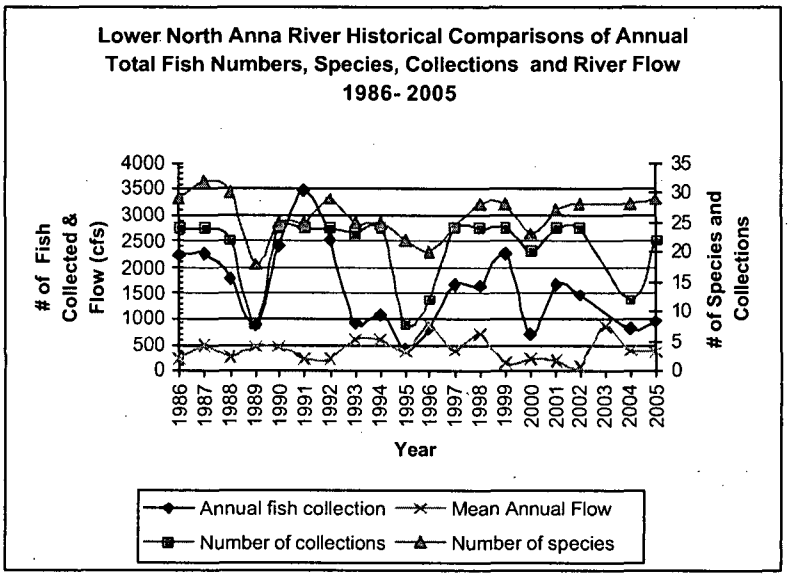
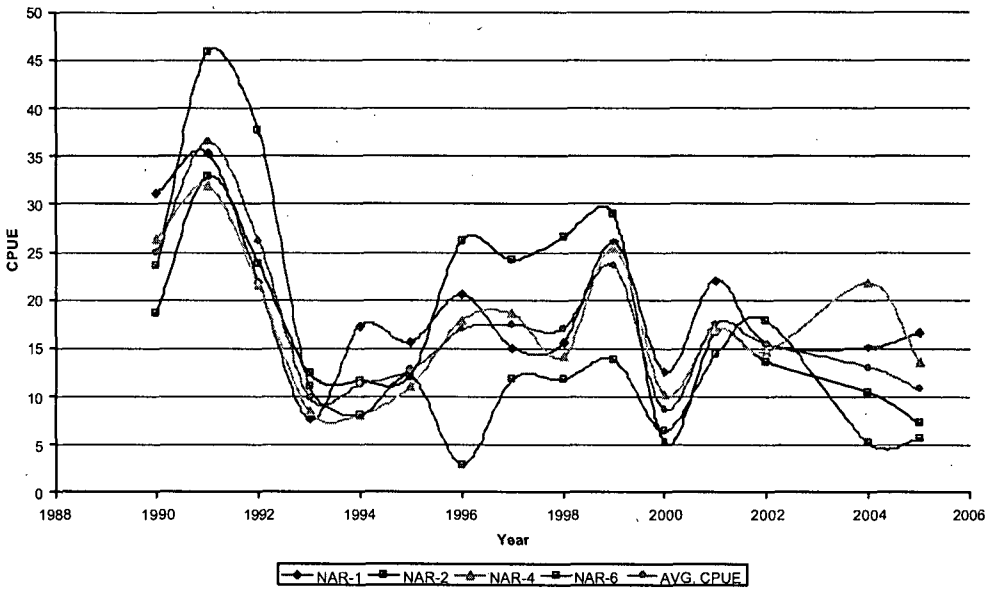


Figure 4.3-1 presents the average number of fish collected annually (1990-2005) at each station and the average annual CPUE for all stations. These numbers were developed by dividing the total number of fish collected for each station as well as for all stations combined by the number of sample collections. This then allows for comparisons of years when a full complement of samples was taken to years when partial sampling was conducted. The highest CPUE (45.75) was recorded in 1991 at NAR-6 and the lowest in 1996 was also at NAR-6 with a CPUE of 2.9 fish per collection. The 2005 average (CPUE) was 10.72 fish per sample which was below the 15 year average of 17.40.

Figure 4.3-1 CPUE (Fish/collection per year) of fish caught from electrofishing the North Anna River for the years 1990-2005



Over the past 20 years of collections, 52 species of fish have been collected from the North Anna River (Table 4.3-2) with annual totals ranging from 18 to 32 species (Table 4.3-3). In 2005, a total of 29 species was collected. This total included two species not collected previously: one banded killifish Fundulus diaphanus at Station NAR-1 and one bowfin Alma calva at NAR-6. Species richness was highest at NAR-6 in 2005 with 20 species collected, while 18, 16 and 14 species were collected at NAR-4, NAR-1 and NAR-2 respectively (Table 4.3-3).

Table 4.3-2 Fishes collected from the North Anna River during annual electrofishing surveys, 1981-2005.

Family	Species	NAR-1	NAR-1	NAR-4	NAR-6
Petromyzontidae	*Lampetra appendix*		X	X	X
	Petromyzon marinus	X	X	X	X
Anguillidae	*Anguilla rostrata*	X	X	X	X
Clupeidae	*Alosa aestivalis*	X			
	Dorosoma cepedianum	X			
Esocidae	*Esox americanus*				X
	Esox niger	X	X	X	X
Cyprinidae	*Cyprinella analostana*	X	X	X	X
	Hybognathus regius			X	X
	Luxilus cornutus			X	
	Lythrurus ardens	X	X	X	X
	Nocomis leptocephalus	X	X	X	X
	Nocomis micropogon	X	X	X	X
	Notemigonus crysoleucas	X	X	X	X
	Notropis amoenus	X	X	X	X
	Notropis hudsonius				X
	Notropis procne	X	X	X	X
	Notropis rubellus	X	X	X	X
	Phoxinus oreas			X	
	Rhinichthys atratulus				X
	Semotilus corporalis	X	X	X	X
Catostomidae	*Catostomus commersoni*		X		X
	Erimyzon oblongus	X	X	X	
	Hypentelium nigricans	X	X	X	X
	Moxostoma macrolepidotum		X	X	X
Ictaluridae	*Ameriurus natalis*	X	X	X	X
	Ameriurus nebulosus	X	X		X
	Ictalurus punctatus				X
	Noturus gyrinus				X
	Noturus insignis	X	X	X	X
Aphredoderidae	*Aphredoderus sayanus*			X	X
Percichthyidae	*Morone americana*	X			
Centrarchidae	*Acantharchus pomotis*	X			
	Centrarchus macropterus				X
	Enneacanthus gloriosus				X
	Lepomis auritus	X	X	X	X
	Lepomis gibbosus	X	X	X	X
	Lepomis gulosus				X
	Lepomis macrochirus	X	X	X	X
	Lepomis microlophus	X	X		X
	Micropterus dolomieu	X		X	X
	Micropterus salmoides	X	X	X	X
	Pomoxis nigromaculatus	X	X	X	X
Percidae	*Etheostoma olmstedi*	X	X	X	X
	Etheostoma vitreum	X	X	X	X
	Perca flavescens	X			X
	Percina notogramma		X	X	X
	Percina peltata	X	X	X	X
Soleidae	*Trinectes maculatus*				X
Poecillidae	*Gambusia holbrooki*			X	X
Amiidae	*Amia calva*				X
Cyprinodontidae	*Fundulus diaphanus*	X			

A common characteristic of stream systems is the tendency for a few species to numerically dominate the stream fish assemblage (Matthews, 1982(. Six (6) to 10 species have accounted for greater than 80 percent of the North Anna River electrofishing catch from all stations in any year since sampling began in a consistent manner in 1981 (Table 4.3-3).

Table 4.3-3. Ranked abundance of species comprising greater than 80 percent of the pooled annual North Anna River electrofishing catch from all stations, 1981-2005. A species rank of 1 indicates it was the most abundant fish collected.

Species	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Notropis procne	2	1	1	1	1	1	1	1	1	4	2	3	1	2	7	3	2	2	4	--	7	6	--	4	--
Cyprinella analostana	1	2	2	3	2	2	5	2	3	2	1	1	3	6	6	1	1	4	2	--	4	4	--	1	4
Lepomis auritus	3	3	3	2	3	4	2	3	2	1	4	2	2	1	1	2	3	1	1	1	1	1	--	3	2
Notropis rubellus	--	5	8	8	10	3	3	4	4	3	3	5	4	3	5	--	8	6	--	--	--	--	--	--	--
Noturus insignis	8	--	--	--	6	5	4	6	7	6	5	8	5	4	3	--	4	7	6	4	5	5	--	5	5
Percina peltata	--	--	7	4	5	6	--	5	--	5	6	--	8	5	8	6	10	--	--	8	--	--	--	8	6
Anguilla rostrata	4	4	4	8	9	--	6	--	6	7	--	7	6	7	4	4	6	5	7	3	3	3	--	2	1
Lythrurus ardens	--	--	--	--	7	7	7	--	--	--	7	4	7	--	2	--	5	3	3	2	2	2	--	--	3
Nocomis micropogon	6	--	5	--	--	8	--	--	--	--	8	8	--	--	9	--	--	--	--	--	--	--	--	--	--
Nocomis leptocephalus	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semotilus corporalis	--	--	9	--	4	9	--	--	--	--	--	--	--	--	--	--	9	--	5	5	6	--	--	--	--
Notropis amoenus	7	6	--	7	--	--	--	--	5	--	--	--	--	--	--	5	7	8	--	--	--	--	--	--	7
Hypentelium nigricans	--	--	--	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8
Notemigonus crysoleucas	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pomoxis nigromaculatus	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--
Etheostoma olmstedi	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nocomis micropogon	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total number of species collected	26	27	29	31	31	29	32	30	18	25	25	29	26	25	22	20	24	26	28	23	27	28	--	28	29
Number of species accounting for >80%	8	6	9	7	10	9	7	8	7	7	8	8	8	7	9	7	10	8	7	8	7	6	--	8	8
Percent of electrofishing catch	83	82	81	83	83	83	80	82	80	80	84	83	83	85	82	82	84	80	82	83	84	86	--	83	82

*-- Indicates species was not among those comprising greater than 80% of the electrofishing catch

This trend continued in 2005 with eight (8) species accounting for 82.0 percent of the total catch in 2005 (Table 4.3-3). When ranking the species in order of abundance (most abundant to least), american eel, Anguilla rostrata was the most abundant species. Other species in 2005 in descending order of abundance were redbreast sunfish Lepomis auritis; rosefin shiner Lythrurus ardens; satinfin shiner Cyprinella analostana; margined madtom Noturus insignis; shield darter Percina peltata; comely shiner Notropis amoenus and northern hogsucker Hypentelium nigricans (Table 4.3-3).

Table 4.3-4 presents a comparison of total fish numbers and weights by sampling stations in 2004 and 2005. In 2004, Station NAR-4 yielded the greatest numerical catch followed in decreasing order by NAR-1, NAR-2 and NAR-6. Only 12 of a possible 24 collections were made in 2004 because of extremely high water in 2004. In 2005, 22 out of 24 collections were made and NAR-1 yielded the most fish and the largest biomass.

Table 4.3-4 Station total fish numbers and weights for 2004 and 2005 collections in the North Anna River

	2004		2005	
Station	**#**	**weight**	**#**	**weight**
NAR-1	227	4753.0	363	4940.2
NAR-2	152	1633.0	159	1960.3
NAR-4	340	1965.0	299	2600.4
NAR-6	80	1922.0	122	2531.4

4.4 Fish Population Studies- Direct Observation

Methods

To further amplify and understand fish population studies in the North Anna River, abundance and distribution data for smallmouth bass and largemouth bass are gathered via direct observation using snorkel surveys. Consistent observation techniques have been used in snorkel surveys since 1987 with some variation in sampling frequency at some stations among years due to instances of high river flow conditions, electrical storms, etc.

Snorkel surveys are conducted during July, August, and September. Four (4) stations (NAR-1, NAR-2, NAR-4 and NAR-5) are monitored twice per month in July, August and September. Abundance estimation procedures are identical to those employed since 1987 (Virginia Power 1988). Counts of smallmouth bass (SMB) and largemouth bass (LMB) are made while swimming 100 m transects along the north and south banks of each station. Transects follow an approximately one-meter depth contour.

All bass sighted are categorized by species as to young-of-year (YOY) ($\leq$120 mm), stock-size (120<SMB<280 mm or 120<LMB<305 mm), or quality-size (SMB$\geq$280 mm or LMB$\geq$305 mm). In addition to size group, all bass sighted are categorized as to type of cover being used; bedrock ledge (Ledge), boulders (Boulder), instream woody debris (Wood), aquatic vegetation (Vegetation), or no apparent cover use (Open). Fish have to be within 0.5m of a cover object at the moment of sighting to be included in a cover use category other than the Open category. Aquatic vegetation was included as a cover type beginning in 1993 due to annual increases in the amount of vegetation observed from 1990 through 1992, and its associated increased use by fish.

During each survey, three successive counts at each station are made at each bankside transect. Each observer makes an independent estimate of the distance that YOY smallmouth bass (TL$\leq$120 mm) could be distinguished from YOY largemouth bass (TL$\leq$120 mm) at each station.

Lateral visibility at each station is estimated by averaging the independent estimates of both observers. Counts of smallmouth bass and largemouth bass are converted to density estimates (number/hectare of bankside channel) to account for differences in average visibility among survey days and sampling stations. Density estimates for all smallmouth bass and largemouth bass larger than YOY size are then pooled by species, station, and sample year to facilitate identification of species-specific and station-specific changes over time. Calculations of median density estimates by sample year and associated 95% confidence intervals are based on Walsh averages (Hollander and Wolfe 1973). YOY densities are not calculated as it was doubtful that YOY are as susceptible to the observation technique as are larger fish, due primarily to their small size and cryptic nature.

Cover utilization data from the first of three sets of observations obtained during each snorkel survey are used to examine differences in cover use by smallmouth bass and largemouth bass. Data from only the first count are used because it is assumed fish observed during the first count would be relatively undisturbed by divers, whereas fish observed on the second and third counts may change their positions in response to divers passing by during the first count.

Results and Discussion

Snorkel surveys for 2005 were conducted in July, August and September. Two surveys were completed in both July and August; however, only one survey was conducted in September due to high river flow. The 2005 surveys were conducted between 0829 and 1406 hours. River temperatures at time of surveys ranged from 23.3°C at NAR-4 on 9/2/05 to 30.1°C at NAR-1 on 7/1/05. The average visibility for all four stations in 2005 was 1.56 meters. Comparatively, average visibility was highest at NAR-5 (2.00 meters), followed in decreasing order by NAR-1 (1.45 meters) and NAR-2 (1.45 meters) and NAR-4 (1.35 meters).

During most previous years, observations indicated that largemouth bass were

numerically dominant at the upper stations (NAR-1 and NAR-2) while smallmouth bass were more abundant at the lower stations (NAR-4 and NAR-5). Both species do however occupy the entire study area.

In 2005, more largemouth bass were seen than smallmouth bass (387 vs. 294) (Table 4.4.1). As in most previous years, smallmouth bass observations were typically low at stations NAR-1 and NAR-2 and high at NAR-4 and NAR-5. Particularly notable in 2005 was the large number of YOY largemouth bass observed along the north shore of NAR-1 and relatively high numbers of YOY smallmouth bass at NAR-4 and NAR-5.

Table 4.4-1. Number of smallmouth bass and largemouth bass observed during North Anna River snorkel surveys conducted in 2005. Sample size (n) equals the number of times each count was performed in 2005.

				Smallmouth bass [1]			Largemouth bass [2]		
Station	Bank	Count	n	SMBYOY	SMB<11	SMB>11	LMBYOY	LMB<12	LMB>12
NAR-1	North	1	5	2	0	0	47	8	3
		2	5	0	0	0	56	6	2
		3	5	1	0	0	46	7	4
	South	1	5	0	5	2	4	1	9
		2	5	1	1	1	16	3	8
		3	5	1	3	1	4	6	4
NAR-2	North	1	5	0	1	1	7	5	1
		2	5	0	3	0	5	7	3
		3	5	0	2	0	6	6	3
	South	1	5	6	4	0	4	8	3
		2	5	0	3	2	9	9	4
		3	5	2	4	1	4	10	2
NAR-4	North	1	5	6	3	0	1	5	2
		2	5	12	4	1	2	8	3
		3	5	6	9	0	4	2	1
	South	1	5	12	9	3	0	1	0
		2	5	18	6	1	0	0	0
		3	5	24	5	3	1	1	0
NAR-5	North	1	5	2	9	8	1	5	4
		2	5	4	11	9	2	3	1
		3	5	10	11	12	0	2	0
	South	1	5	7	3	1	1	3	0
		2	5	14	5	0	0	2	0
		3	5	16	3	0	1	1	0

[1] SMYOY were less than or equal to 120 mm, SMB<11 were 121-279 mm, SMB>11 were larger than or equal to 280 mm TL.

[2] LMBYOY were less than or equal to 120 mm, LMB<11 were 121-304 mm, LMB>11 were larger than or equal to 305 mm TL.

Median density estimates for largemouth bass and smallmouth bass observed in 2005 for stations NAR-1, NAR-2, NAR-4 and NAR-5 are compared to historical density estimates in Figures

4.4-1 through 4.4-4. These estimates do not include young-of-year (YOY) size fish as it is doubtful that the smaller individuals are as susceptible to the observation techniques as are larger fisher. Instances with median densities of zero do not necessarily indicate that no fish of a given species and size category were observed. A median density of zero indicates that fewer than 50% of the ranked (ordered lowest to highest) density estimates were greater than zero. Assuming all scheduled snorkel surveys are conducted each year, there are 36 density estimates developed for each species and size category of fish for each sampling station (6 surveys per year x 2 banks per station x 3 counts per bank). If species and size category of fish are observed in fewer than 18 of those 36 counts that the density estimates are based on, the median will be zero, despite the presence of the fish. Although the use of medians versus averages tends to make it more difficult to report relatively uncommon fishes, it has the advantage of being more representative of non-normally distributed data like that generally obtained by the snorkel surveys.

Figure 4.4-1. NAR-1 smallmouth and largemouth bass median densities, and mean visibility, 1987-2005.

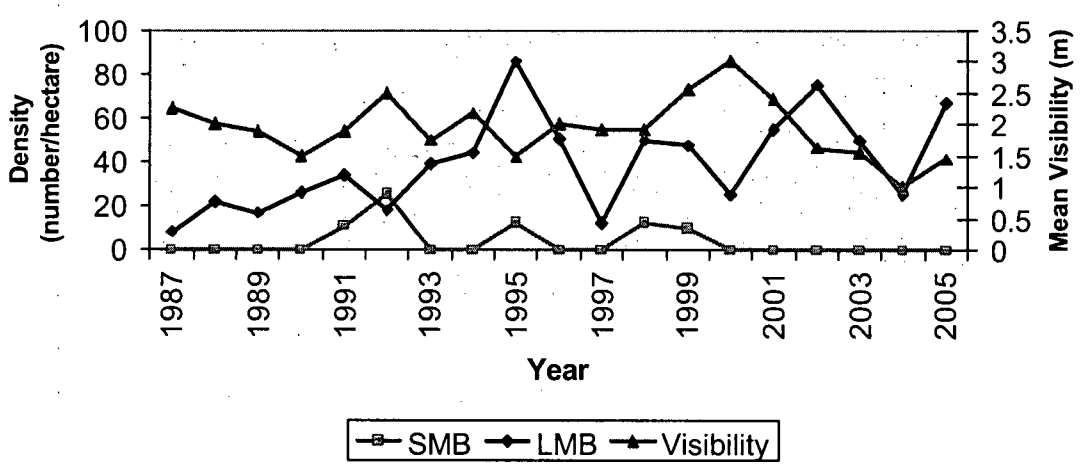


Figure 4. 4-2. NAR-2 smallmouth and largemouth bass median densities, and mean visibilities, 1987-2005.

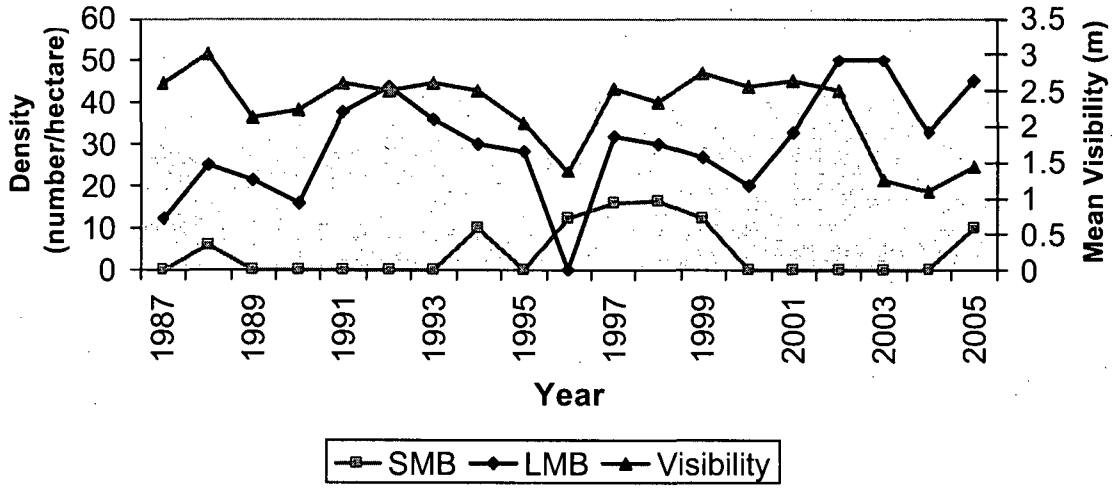


Figure 4. 4-3. NAR-4 smallmouth and largemouth bass median densities, and mean visibilities, 1987-2005.

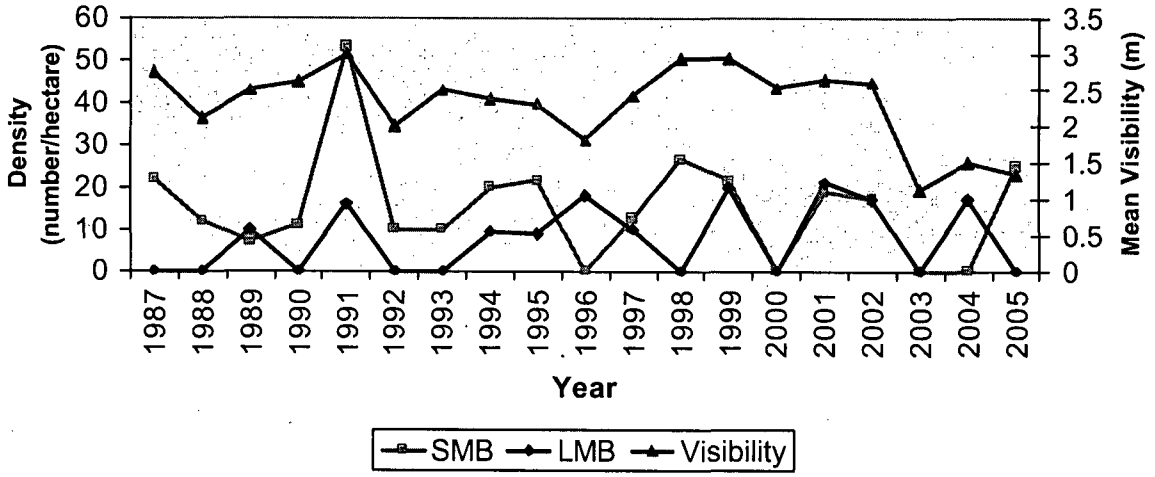
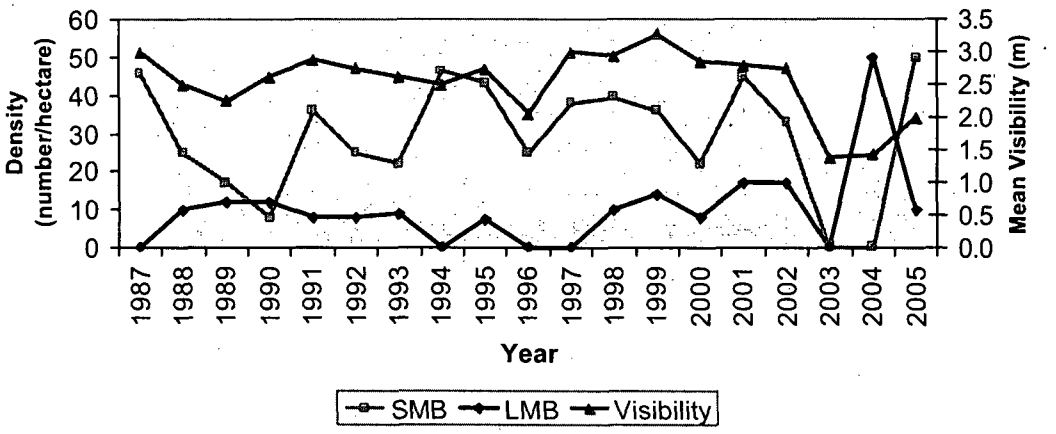


Figure 4. 4-4 . NAR-5 smallmouth and largemouth bass median densities, and mean visibilities, 1987-2004.



During most years, the median density estimates show largemouth bass to be more abundant at the two uppermost stations (NAR-1 and NAR-2) which are nearer the Lake Anna dam, while smallmouth bass are more abundant at the downstream sites, especially NAR-5.

Largemouth bass annual median densities have generally ranged from 20-80 fish/hectare at NAR-1 while smallmouth bass annual median densities there rarely exceed 10 fish/hectare. In 2005, median densities for largemouth and smallmouth bass as NAR-1 were 67 fish/hectare and 0 fish/hectare, respectively.

At Station NAR-2, annual median densities of largemouth bass have generally ranged from 20-50 fish per hectare. The median density for 2005 at NAR-2 for largemouth bass was 45 fish/ hectare. Smallmouth bass annual median densities have rarely exceeded 10 fish/hectare at NAR-2 and have frequently been zero. The median density for smallmouth bass at NAR-2 was 10 fish/ hectare in 2005.

Annual median density estimates at NAR-4 show smallmouth bass to be slightly more abundant at this site during many of the sample years with annual median densities generally ranging from 10-30 fish/hectare, while largemouth bass annual median densities ranged from

approximately 0-25 fish/hectare (Figure 4.4-3). The median density of smallmouth bass at NAR-4 in 2005 was 25 fish/hectare while the median density for largemouth bass was 0 fish/hectare.

Smallmouth bass annual median densities have usually ranged from about 20-50 fish/hectare at NAR-5 since 1987. The median smallmouth bass density was 50 fish/hectare at NAR-5 in 2005. Largemouth bass annual median densities at this station have rarely exceeded 20 fish/hectare with a median density of 10 largemouth bass/hectare recorded in 2005.

Observations of cover use by smallmouth bass and largemouth bass are difficult to interpret without accounting for the availability of various cover types. For this reason, cover use data obtained in 2005 are primarily presented for documentation purposes (Table 4.4-2).

Table 4.4-2. Cover use by smallmouth bass and largemouth bass in the North Anna River observed during the first of three counts made during snorkel surveys conducted in 2005.

	Cover Type				
NAR-1	Ledge	Boulder	Wood	Vegetation	Open*
SMBYOY**	0	0	0	2	0
SMB<11	0	0	3	0	2
SMB>11	0	0	2	0	0
LMBYOY	0	0	1	49	1
LMB<12	0	0	0	8	1
LMB>12	0	0	4	7	1
NAR-2	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	0	0	1	2	3
SMB<11	0	0	1	4	0
SMB>11	0	0	0	1	0
LMBYOY	0	0	0	11	0
LMB<12	0	0	7	4	2
LMB>12	0	0	1	1	2

	Cover Type				
NAR-4	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	1	9	0	4	4
SMB<11	0	6	1	0	4
SMB>11	0	2	0	0	0
LMBYOY	0	0	1	1	0
LMB<12	1	0	1	4	0
LMB>12	0	1	0	1	0
NAR-5	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	0	3	0	2	4
SMB<11	1	4	1	3	3
SMB>11	1	2	3	2	1
LMBYOY	0	0	0	2	0
LMB<12	1	2	2	2	1
LMB>12	1	0	1	2	0

*Fish observed in open water that were farther than 0.5 m from any cover type.
**See Table 4.3-1 for size category definitions.

When cover use data are pooled for all stations in 2005 (Table 4.4-3) smallmouth bass were usually observed in open water or associated with boulder or vegetation cover when it was available. Largemouth bass were observed most frequently near wood or vegetation.

Table 4.4-3. Cover use by smallmouth bass and largemouth bass in the North Anna River observed during the first of three counts made during snorkel surveys conducted in 2005. Data for observations at all stations are pooled.

All Stations	Cover Type				
	Ledge	Boulder	Wood	Vegetation	Open
SMBYOY	1	12	1	10	11
SMB<11	1	10	6	7	9
SMB>11	1	4	5	3	1
LMBYOY	0	0	2	63	1
LMB<12	2	2	10	18	4
LMB>12	1	1	6	11	3

4.5 Conclusions

- In 2005, North Anna River flows were moderately high from January to May. Several consecutive days where flows exceeded 1000 cfs occurred during this period and again in mid-December with a maximum daily mean flow of 4,570 cfs which occurred in January. River flow from June - November was generally less than 100 cfs.

- The total rainfall in Virginia in 2005 was 39.84 inches, with the greatest accumulated monthly rainfall occurring in July and October.

- A combination of low summer river flows and higher than normal summer air temperatures resulted in relatively high river temperatures at times during the summer of 2005.

- In 2005, 943 fish were collected from the North Anna River electrofishing surveys representing 29 species and ten families. Both the total numbers and number of species collected in 2005 were within the range of previous totals.

- Collection results in 2005 indicated that NAR-1 yielded the greatest numerical catch followed in decreasing order by NAR-4, NAR-2 and NAR-6. Biomass in 2005 was highest at NAR-1 followed in decreasing order by NAR-4, NAR-6, and NAR-2.

- In 2005, two species were collected that had not been collected previously. A banded killifish, Fundulus diaphanus was collected at NAR-1 and a bowfin Amia calva was collected at NAR-6.

- Historically, six to 10 fish species have accounted for 80 percent of the North Anna River electrofishing catch which is not uncommon in stream systems. In 2005, eight species comprised 82% of the total catch: American eel, redbreast sunfish, rosefin shiner, satinfin shiner, margined madtom, shield darter, comely shiner and northern hogsucker.

- Underwater observations of smallmouth bass and largemouth bass made in 2005 were typical of earlier surveys. Historically largemouth bass have been numerical dominant at the upper stations (NAR-1 and NAR-2) while smallmouth bass were numerically dominant at the lower stations (NAR-4 and NAR-5). However, both species do occupy the entire study area. In 2005, this was again the case. Especially notable in 2005 were large numbers of YOY observed of both species.

- In 2005, median densities of largemouth bass were higher at upper river stations (range: 45-67 fish/hectare) than at the lower river stations (range: 0-10 fish/hectare). Median densities of smallmouth bass ranged from 0-10 fish/hectare at upper river stations (NAR-1, NAR-2) and from 25-50 fish/hectare at the lower river stations (NAR-4, NAR-5). These density estimates are consistent with those calculated previously.

- Observation of cover use in 2005 indicated that largemouth were more associated with wood and vegetation while smallmouth bass were found near vegetation or boulder cover or in open water.

Recommendations

- The North Anna River below the Lake Anna dam has been monitored extensively since 1981 and the fish assemblage has remained relatively stable with some fluctuations in fish numbers year to year due to natural occurrences such as floods. After such events, fish assemblages demonstrated recovery. Electrofishing surveys have provided fish abundance and species composition data and underwater observations have provided useful fisheries data on LMB and SMB assemblages and habitat preferences. Therefore, the current surveillance program of the North Anna River below Lake Anna dam should be continued with no changes in effort are recommended at this time.

5.0 Literature Cited

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