Region 4

MONTANA DEPARTMENT OF FISH, WILDLIFE & PARKS
FISHERIES DIVISION
JOB PROGRESS REPORT

State: Montana
Federal Aid Project No. F-113-R1
Project Title: Statewide Fisheries Investigations
F-113-R2
Job Title: Northcentral Montana Warm and Coolwater Fisheries

2000 Annual Report

ABSTRACT

Water levels reached dead storage at Bynum Reservoir and Lake Frances by mid to late summer of 2000. Aeration systems were installed in Bynum Reservoir to help minimize winterkill. Limited surveys were conducted at Bynum and Frances. Vertical gill nets and hydroacousitic surveys were undertaken at Tiber Reservoir to monitor cisco populations. East Fork Reservoir, the Judith River, the Musselshell River, Murphy Coulee and five small reservoirs were sampled in 2000. Species distribution in seine hauls on the lower Musselshell River was similar to that found in the 1980's.

OBJECTIVES

The purpose of this project is to implement the Fisheries Program on warm and coolwater ecosystems in the Missouri River drainage in northcentral Montana. Major watersheds include the Missouri, Teton, Judith and Musselshell drainages.

The mission of the Fisheries Division of MDFWP is to preserve and enhance aquatic species and their ecosystems to meet the public's demand for recreational opportunities while assuring stewardship of aquatic life. The Fisheries Program is divided into four major elements, with objectives and outcomes as follows:

The Fisheries Management element of the fisheries program has 21 objectives and the following desired outcomes:

1. A healthy aquatic resource, including native-species fisheries and sport fisheries.
2. Public satisfaction with available angling opportunities.
3. Public support for ongoing efforts to restore, maintain, and protect the state's aquatic resources.

The Habitat element of the fisheries program has 15 objectives and the following desired outcomes:

1. Diverse, high-quality aquatic ecosystems that support healthy fish populations and provide fishing opportunities.

2. Public participation in efforts (the department's as well as other state and federal agencies) to conserve and improve fish habitat through formation of watershed protection groups and partnership for the protection and restoration of habitat.

The Fishing Access element of the fisheries program has 16 objectives and the following desired outcomes:

1. Provide a diversity of fishing opportunities throughout the state that might otherwise be unavailable.
2. Provide the public with a variety of incidental, non-angling recreational activities by maintaining access to Montana's waters through the fishing access site program.

The Aquatic Education element of the fisheries program has 11 objectives and the following desired outcomes:

1. Opportunities for the public, youth and adults, to learn about the state's aquatic ecosystems and their importance.
2. Fishing and water safety skills for program participants.
3. Enhanced public understanding of Montana's natural and cultural resources.
4. An educated public able to make informed decisions about using and preserving Montana's aquatic resources.

PROCEDURES

Fish populations were sampled with sinking and floating 125 x 6 foot multifilament experimental gill nets with 25 foot sections of 0.75, 1.00, 1.25, 1.50 and 2.00 inch square mesh; 100 foot deep x 10 foot wide vertical gill nets (six nets of differing square mesh: 0.50, 0.75, 1.00, 1.25, 1.50 and 2.00 inch); 3 x 4 foot frame trap nets (0.25 inch square mesh); 4 x 6 foot frame trap nets (1.00 inch square mesh); 50 X 4 foot 1/8 inch mesh beach seine; and 100 x 10 foot seines (0.25 inch square mesh). Stomach samples were collected from some fish for food habits. Scale and fin ray/spine samples wee taken for age and growth studies. Vertical plankton tows were made using a 30 cm conical net with a 15 cm radius (0.153 mm mesh). Walleye dorsal spines were mounted and sectioned according to methods described by Mackay et al. (1990). Relative weights (Wr) of walleye, northern pike and yellow perch were determined using MDFWP computer programs which utilized data in Murphy et al. 1990, Willis 1989, and Willis et al. 1991. Floy T-tags and metal jaw tags were used on walleye. The electrofishing system used to capture largemouth bass in Payola Reservoir was adapted from a system described by Novotny and Priegal (1974). The electroshocking apparatus was boom-type and mounted on a 14-foot aluminum McKenzie style drift boat powered by a 10-hp outboard motor. Power was supplied by a 5000 watt AC generator. The alternating current was delivered to a Coffelt Model VVP-10 rectifying unit, which changes the alternating current to continuous direct current. The positive electrode consisted of circular hoops with twelve 16-inch stainless steel droppers fastened to each hoop. These electrodes were supported by fiberglass booms and were positioned about 6 feet in front of the boat. The hull of the boat served as a negative. Abbreviations for fish species appearing in tables and figures throughout this report are as follows (unless otherwise noted): WE=walleye; NP=northern pike; YP=yellow perch; SNS=shovelnose sturgeon; CIS=cisco; SS=spottail shiner; ES=emerald shiner; LND=longnose dace; LC=lake chub; FHC=flathead chub; FM=fathead minnow; MSc=mottled sculpin; WSu=white sucker; and LnSu=longnose sucker.

FINDINGS

CHOTEAU AREA WATERS

Bynum Reservoir

Approximately 1000 discarded Christmas trees were placed along the shoreline at Bynum Reservoir on March 18, 2000. They were placed along selected elevations to serve as yellow perch spawning habitat in anticipation of rising spring water levels.

Five trap nets on April 20 and three trap nets on April 21, 2000, caught a total of 1,006 walleye, 26 yellow perch and 1,751 white sucker. Records of miscellaneous species are on file in the Choteau field office. Water temperatures varied from 51-54°F. To monitor harvest of walleye, a total of 202 fish greater than 14 inches were tagged and released. These fish ranged from 14.0-28.0 inches (average 18.9) and 0.78-9.30 pounds (average 2.47). Anglers returned 59 tags from fish tagged from 1994 through 2000 (Table 1). The highest cumulative return is 20 percent for fish tagged in 1997 while 4 percent of the fish tagged in 2000 were harvested.

Bynum Reservoir covers approximately 3500 acres at full pool and has a maximum depth of 39 feet. During trapping surveys in April, maximum depth was 18 feet. Throughout the summer of 2000, water levels receded, reaching dead storage on August 16. At this level, surface was reduced to approximately 490 acres with a maximum depth of 8 feet.

Due to low water levels, annual forage sampling and fall gill netting surveys were not conducted. However, seining, small mesh trap nets (1/4") and large mesh trap nets (1") were employed on August 22, 2000. Three seine hauls produced 325 yellow perch, 2340 spottail shiner, and 9 young-of-the-year (YOY) walleye. Two small mesh trap nets captured 1400 spottail shiner, 150 yellow perch and 4 adult walleye. Two large mesh trap nets caught 230 adult white sucker, 2 adult yellow perch and 66 walleye. The walleye ranged in length from 10.8 to 24.1 inches.

Because of the shallow depths remaining at dead storage, there was a concern for overwinter survival of the fish in the lake. Going into the winter, the lake would essentially be divided into two areas, connected by a shallow channel of less than two feet. The largest, but shallowest of these two areas, covered approximately 400 acres and had a maximum depth of 4.5 feet. The other area was about 90 acres and 8.5 feet deep. To lessen the chances of winterkill, four aeration devices were installed, two each in the different areas of the lake. The aeration devices are Koenders Windmills manufactured in Englefeld, SK, Canada. Oxygen levels were monitored throughout the winter and results will appear in a future report.

The lake was closed to fishing effective October 2, 2000, to reduce the chances of anglers falling through thin ice resulting from the windmill operation. The closure was also put into effect to protect the remaining adult walleye and yellow perch populations that would be

Table 1. Angler exploitation of walleye and northern pike in Region Four reservoirs as indicated by voluntary tag returns (1995-2000).

Lake	Species	Year tagged	Number tagged	1995	1996	1997	1998	1999	2000	Cumulative
Bynum Res.	WE	1995	347	26 (7.5)	10 (2.9)	9 (2.6)	7 (2.0)	2 (0.6)	5 (1.4)	59 (17.0)
		1996	250		5 (2.0)	12 (4.8)	11 (4.4)	4 (1.6)	7 (2.8)	39 (15.6)
		1997	250			17 (6.8)	14 (5.6)	8 (3.2)	11 (4.4)	50 (20.0)
		1998	206				15 (7.3)	4 (1.9)	12 (5.8)	31 (15.0)
		1999	129					1 (0.8)	14 (10.9)	15 (11.6)
		2000	202						8 (4.0)	8 (4.0)
Lake Francis	WE	1995	289	17 (5.9)	6 (2.1)	11 (3.8)	6 (2.1)	7 (2.4)	6 (2.1)	53 (18.3)
		1996	73		1 (1.4)	2 (2.7)	2 (2.7)	1 (1.4)	5 (6.8)	11 (15.1)
		1997	226			7 (3.1)	10 (4.4)	11 (4.9)	15 (6.6)	43 (19.0)
		1998	78				5 (6.4)	5 (6.4)	5 (6.4)	15 (19.2)
	NP	1995	325	26 (8.0)	13 (4.0)	2 (0.6)	0 (0.0)	2 (0.6)	0 (0.0)	43 (13.2)
		1996	46		6 (13.0)	2 (4.3)	0 (0.0)	1 (2.2)	2 (0.4)	11 (23.9)
		1997	155			7 (4.5)	8 (5.2)	0 (0.0)	0 (0.0)	15 (9.7)
		1998	55				5 (9.1)	0 (0.0)	0 (0.0)	5 (9.1)
Tiber Res.	WE	1995	500	63 (12.6)	18 (3.6)	13 (2.6)	2 (0.4)	5 (1.0)	1 (0.2)	102 (20.4)
		1996	499		40 (8.0)	26 (5.2)	5 (1.0)	3 (0.6)	1 (0.2)	75 (15.0)
		1997	499			39 (7.8)	22 (4.4)	16 (3.2)	10 (2.0)	87 (17.4)
		1998	475				46 (9.7)	31 (6.5)	15 (3.2)	92 (19.4)
		1999	525					36 (6.9)	20 (3.8)	56 (10.7)
	NP	1995	182	14 (7.7)	7 (3.8)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	22 (12.1)
		1996	250		26 (10.4)	8 (3.2)	3 (1.2)	3 (1.2)	0 (0.0)	40 (16.0)
		1997	79			13 (16.5)	1 (1.3)	3 (3.8)	0 (0.0)	17 (21.5)
		1998	127				15 (11.8)	2 (1.6)	1 (0.8)	18 (14.2)
		1999	167					9 (5.4)	3 (1.8)	12 (7.2)

able to spawn and maintain the fishery providing water levels increased during the coming year. It is anticipated that the lake will re-open in the spring of 2001.

Lake Frances

Routine spring trapping and fall gill netting surveys were not conducted in Lake Frances during 2000. Water levels receded throughout the summer. Irrigation releases from the lake were curtailed on July 15 due to low levels and the need to conserve the remaining water for the town of Conrad. Maximum depth going into the winter was 25 feet compared to a normal maximum of 42 feet.

Anglers returned 32 walleye tags and 2 northern pike tags during 2000 (Table 1). Walleye cumulative tag returns range from 14.5 percent for 1994 to 19.2 percent for 1998. Cumulative returns on northern pike range from 9.1 percent (1998) to 23.9 percent (1996). Throughout the summer, anglers enjoyed catch rates of 0.24 walleye per hour and 0.64 northern pike per hour as reported in Hill, (2001).

Limited forage surveys were conducted in August 23, 2000, in which 13 seine hauls were made (Appendix I). Fairly shallow water was encountered in all pulls. Both yellow perch and spottail shiner numbers were approximately one-third of what is considered to be average (Figure 1).

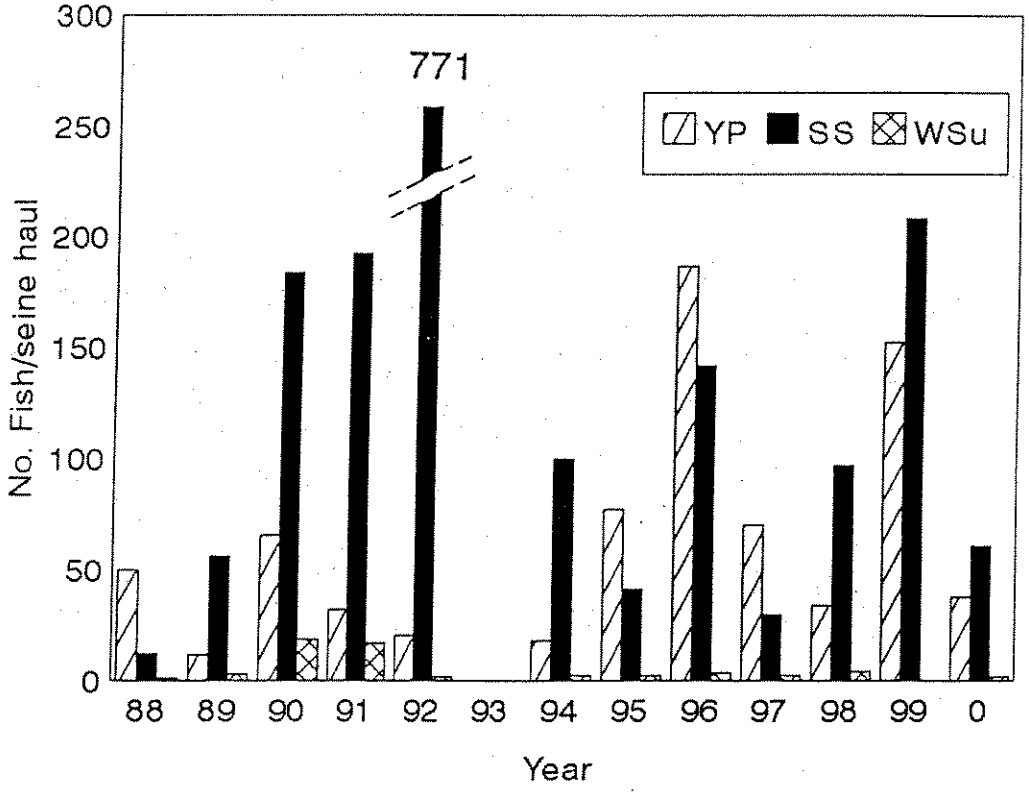

Figure 1. Forage fish trends in Lake Frances, 1988-00.

Tiber Reservoir

Spring Trapping Surveys. Limited surveys were conducted in the spring of 2000 at Tiber Reservoir. Five trap nets were fished overnight on May 1 and caught 43 walleye, 13 northern pike, 2 rainbow trout, 1 burbot, 2 yellow perch, 2 cisco and 1 longnose sucker. The reservoir was at elevation 2983.3 feet M. S. L. The Marias River above the reservoir was electrofished on May 2, 2000, and 230 walleye were captured along with 1 northern pike, 4 burbot and 3 rainbow trout. Other species observed but not netted include longnose sucker, white sucker, carp and flathead chub. Flows in the Marias River approximated 1070 c.f.s. during the survey.

Walleye captured in the Marias River averaged 14.2 inches (range 8.3-26.2) and 0.89 pounds (range 0.23-8.60). Fifty-six percent of the sample was between 13 and 16 inches in length. All walleye were observed for tag loss of metal jaw tags and cinch tags placed on fish in earlier years. A total of seven walleye were observed that were tagged either in 1998 or 1999. One of those tagged in 1999 lost the cinch tag.

Exploitation. Anglers returned 47 walleye and 4 northern pike tags during 2000 from fish tagged between the years 1994 and 1999 (Table 1). Cumulative returns for walleye range from 10.7 percent in 1999 to 20.4 percent in 1995. Northern pike cumulative returns range from 7.2 percent (1999) to 21.5 percent (1997).

Forage Fish. A total of 50 seine hauls were made in late August, 2000, to sample forage fish in four areas of the reservoir (Appendix I). Yellow perch numbers declined from 13.7 fish per pull in 1999 to 4.4 fish per pull (Figure 2). Likewise, spottail shiner declined from 48 in 1999 to 39 fish per pull in 2000. Emerald shiner increased from 3.4 in 1999 to 7.7 fish per pull in 2000. Other species were taken in smaller numbers. Water temperatures ranged from 66-68°F during seining. The lake elevation was fairly stable at 2984 feet M. S. L.

Fall Gill Netting. Twenty-nine gill nets fished in early September,2000, caught eight species (Table 2). For the second year in a row, cisco predominated the overall catch at 152 fish and were most abundant in the Devon area. Trends in the catch of walleye, northern pike, yellow perch and white sucker is shown in Figure 3. Walleye and northern pike catch rate is comparable to 1999 while a slight increase is noted for yellow perch and a slight decrease for white sucker. Appendix II lists netting summaries for four individual areas of the reservoir. The reservoir elevation was 2983.8 feet M. S. L. during the survey.

Monthly Cisco Sampling. Vertical gill nets were employed monthly throughout the summer in the Bootlegger Trail area (BT) to monitor trends in the cisco population. The first netting in May resulted in only five cisco but each successive netting produced more fish, with 160 cisco caught in the September nets. Cisco were evenly distributed throughout the water column (0-100') in June, were most common in the 26-75 feet range in July, most common in 51-75 feet range in August and in the upper 75 feet in September. As documented for 1999 (Hill, et al. 2000), cisco appeared to seek out temperatures in the 50's to low 60's°F. during 2000 also. The majority of fish taken during surveys appear to be from the 1997 introduction (96 %) with the remainder being from the 1998 introduction (based solely on

Table 2. Overnight gill netting results in Tiber Reservoir, September 6-8, 2000. *

Species	No. of fish	Length range	(avg.)	Weight range	(avg.)	Wr [1] range	(avg.)	C.F. [2] range	(avg.)
WE	43	7.4-13.6	(11.5)	0.09-0.70	(0.44)	61.4 - 93.5	(78.7)	21.3 - 32.7	(27.9)
	4	14.3-14.8	(14.6)	0.80-0.96	(0.88)	70.8 - 81.7	(76.7)	26.2 - 30.2	(28.3)
	4	15.5-19.7	(17.6)	0.96-1.84	(1.39)	51.7 - 75.0	(65.9)	20.1 - 28.2	(25.1)
	1		(20.7)		(2.35)		(67.3)		(26.5)
NP	2	18.8-19.1	(19.0)	1.29-1.44	(1.36)	87.1 - 92.6	(89.8)	19.7 - 20.7	(20.0)
	31	20.0-32.3	(24.9)	1.72-8.90	(4.14)	82.4 -139.4	(107.5)	18.7 - 31.9	(24.4)
YP	50	5.4 - 8.9	(7.6)	0.05-0.31	(0.19)	65.1 - 96.7	(81.2)	30.1 - 47.2	(40.3)
	21	9.0-10.9	(9.6)	0.32-0.55	(0.41)	78.6 - 97.9	(87.8)	41.8 - 51.0	(46.1)
	2	11.6-11.7	(11.6)	0.62-0.68	(0.65)	70.5 - 79.5	(75.0)	38.7 - 43.6	(41.1)
WSu	2	9.5-12.8	(11.2)	0.36-0.97	(0.67)				
	30	14.3-19.2	(16.2)	1.27-2.74	(1.89)				
LnSu	2	11.8-12.5	(12.2)	0.62-0.70	(0.65)				
	5	15.8-18.4	(16.8)	1.43-2.53	(1.92)				
CIS	152	5.6-13.4	(12.4)	0.06-1.04	(0.74)				
SNS	1		(34.0)		(5.40)				
Carp	12	23.2-30.5	(27.3)	6.00-14.50	(10.80)				

* 15,600 surface acres; 29 sinking gill nets; 18.1 hours/net.
[1] Wr = relative weight
[2] C.F. = condition factor

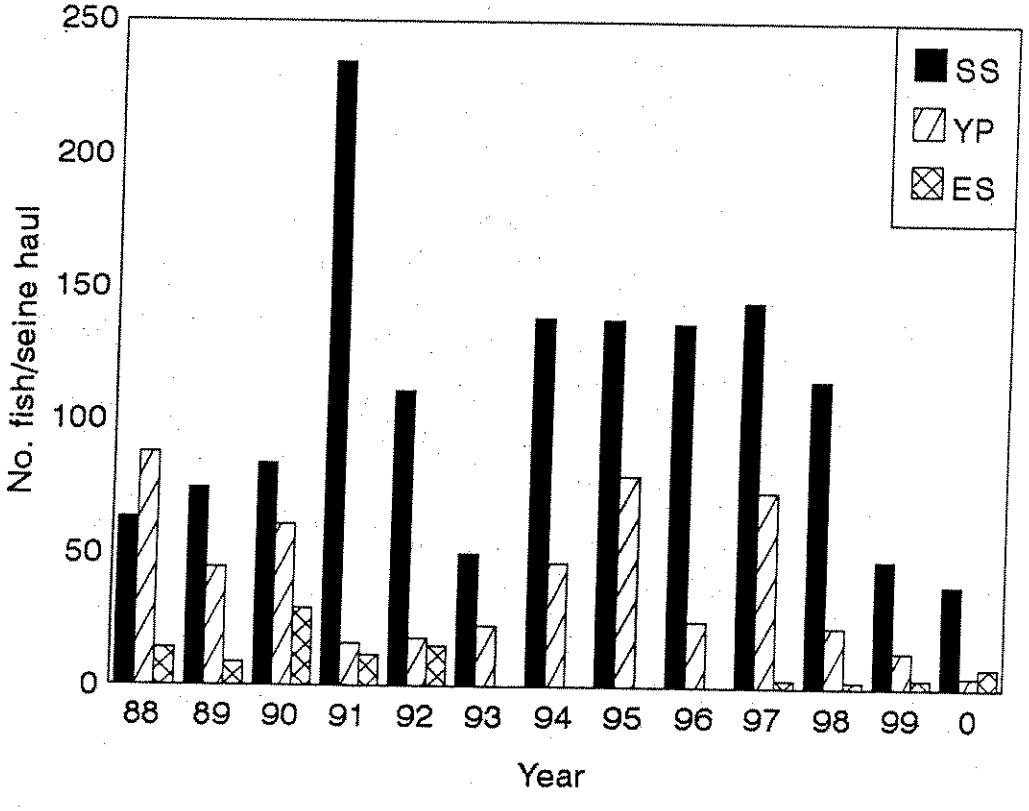

Figure 2. Forage fish trends in Tiber Reservoir, 1988-00.

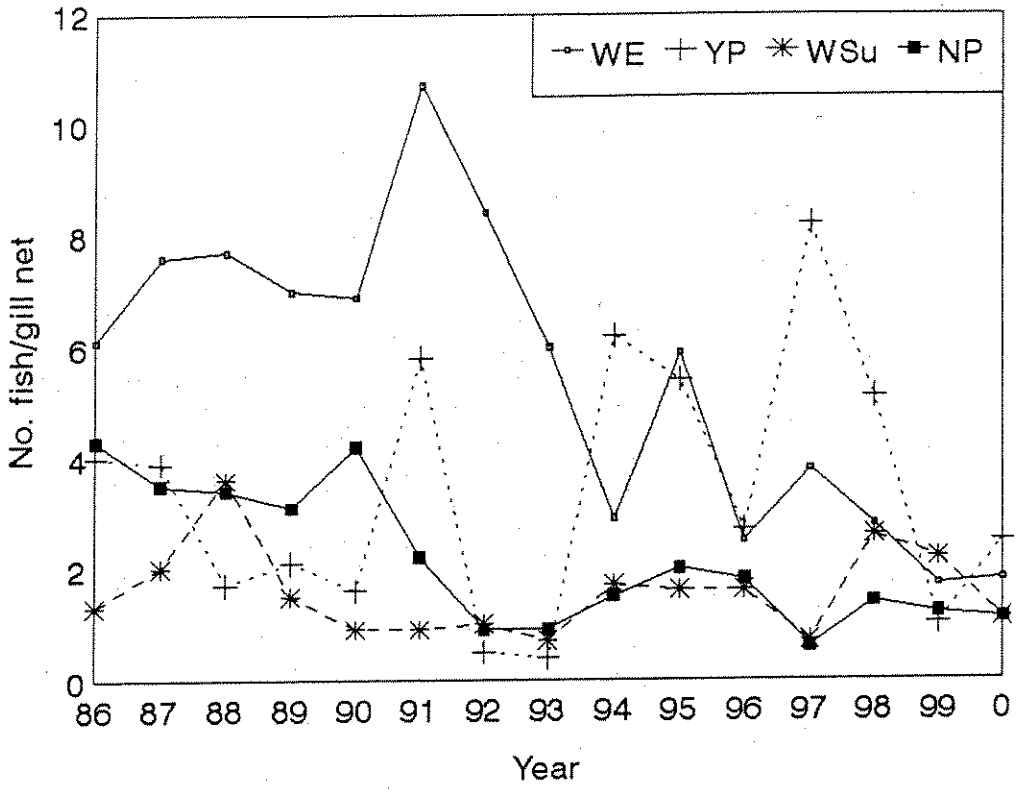

Figure 3. Trends in the fish populations in Tiber Res. (fall gill nets, 1986-00).

length of fish). The 2000 document referenced above reported 97% of the sample was from the 1997 introduction. Most of the fish ranged in size from 11.5 –12.9 inches.

In addition to the BT station, vertical gill nets were also fished in the Willow Creek Arm (WCA) and Dam areas during the annual September netting survey. Temperatures ranged from 60°F (BT) to 63°F (Dam) to 67°F (WCA). Depths at the three sites were as follows: BT-97 feet; WCA-90 feet; and Dam-115 feet. A total of 397 adult cisco were captured with 163 taken in the WCA and 159 in the BT area (Table 4). Other species taken include 2 spottail shiner in the WCA area and 1 northern pike in the BT area.

Cisco Reproduction. In 1999, cisco spawned between November 23 and December 6, and an estimated 1.3 billion eggs were deposited (Zollweg, 2000). It was anticipated that corresponding large numbers of fry would hatch in the spring of 2000. Young–of-the-year (YOY) cisco were captured in vertical gill nets in the BT area in September and only seven fish were taken. They ranged in length from 5.3-6.2 inches. Vertical gill nets were placed in the BT area again in October, specifically for YOY cisco and five additional fish were taken with a length range of 6.1-6.5 inches. The catch of YOY cisco during 2000 surveys compares to 65 YOY cisco taken in September, 1997, following the first introduction (Hill, et al. 1998).

Water Chemistry. Temperature, dissolved oxygen and specific conductivity profiles were recorded monthly at the plankton station near the Dam. Surface temperatures ranged from 51°F in May to 75°F in July. Bottom temperatures (135 feet) varied from 43-53°F throughout the period. A weak thermocline began developing at approximately 30 feet

below the surface in July and was very evident between 55 and 60 feet in August. The entire water column was super-saturated with dissolved oxygen in May and ranged from 6.8 to 8.8 p.p.m. throughout June, July and August. The lowest levels were detected near the bottom in September at 6.1 p.p.m. Specific conductivity varied from 520 to 550 mS/cm throughout the summer.

Northern pike food habits 1997-2000. A total of 17 northern pike stomachs were examined in 1997, 34 stomachs in 1998, 20 stomachs in 1999 and 17 stomachs were analyzed in 2000. Pike collected in 1997 ranged in size from 10.4 to 26.3 inches with an average size of 21.5 inches. In 1998, the length ranged from 14.5 to 27.0 inches and averaged 21.6 inches. The 1999 sample averaged 22.1 inches and varied from 17.2 to 28.9 inches in length. In 2000, pike ranged from 18.8 to 30.2 inches with a length average of 23.4 inches.

Percent biomass for prey items identified in northern pike stomachs during 1997 through 2000 is presented in Figure 4. Common carp accounted for 38 percent of the total biomass in 1997. In 1998, spottail shiners and cisco comprised similar biomass at 26 and 23 percent, respectively. Cisco increased to a high of 63 percent of the biomass in 1999 followed by 58 percent of the biomass in 2000. Crayfish were consumed in all years at similar levels ranging between 11 and 23 percent of the biomass. The highest use of yellow perch occurred in 1998 at 9 percent of the total biomass. Miscellaneous species consumed by northern pike included white sucker and walleye.

Summary of biomass(grams), biomass-percent composition, prey numbers, percent composition by number, frequency of occurrence, and percent occurrence of prey items for each year is presented in Appendices III-VI. Crayfish were the most numerous prey items taken in all four years with a high of 50 crayfish recorded in 1998. Forty-eight spottail shiners were identified in 1998 but were found in only three of the thirty-four stomachs examined. Crayfish recorded the highest percent occurrence during 1998, 1999 and 2000 being found in 35 to 62 percent of the stomachs. Spottail shiners occurred most often of all prey items in 1997 with a 29 percent occurrence. Percent empty calculations for the two stomach collection methods during 1998-2000 varied between 40 to 71.4 percent empty (Table 3). Food habit summaries by month were not examined due to the low sample sizes.

Table 3. Summary of northern pike stomachs examined and percent empty during creel census surveys and fall gill net sets on Tiber Reservoir, 1997-2000.

YEAR	# STOMACHS EXAMINED DURING CREEL CENSUS	PERCENT EMPTY	# STOMACHS EXAMINED DURING FALL GILL NET SETS	PERCENT EMPTY
1997	NA	NA	NA	NA
1998	NA	NA	40	40.0
1999	19	47.4	31	61.3
2000	14	71.4	33	60.6

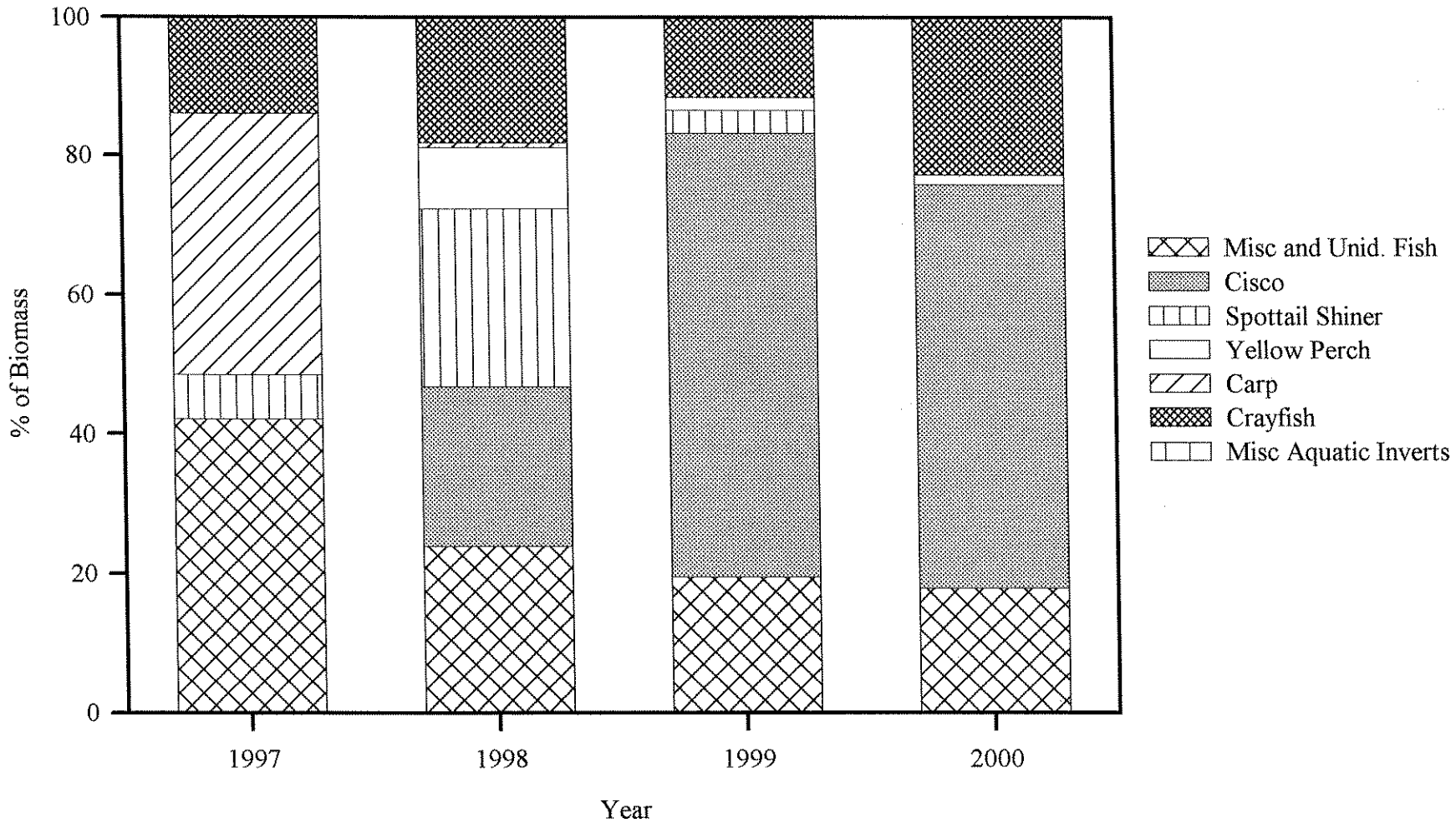

Figure 4. Percent biomass of major prey items in northern pike diets for Tiber Reservoir, from 1997 through 2000.

Walleye Food Habits. Eighty walleye stomachs were analyzed from Tiber Reservoir during May through September, 2000. Sixty percent of the 150 stomachs examined during creel census were empty while 50 percent of the 40 stomachs were empty during fall gill net sets. Walleye ranged in length from 9.8 to 20.7 inches with a 13.8-inch average.

Fish species comprised 74 percent of the biomass in walleye diets (Figure 5). Spottail shiners made up 41.8 percent of the total biomass followed by 17.8 percent for yellow perch, 14.8 percent for unidentified fish, 14.1 percent for crayfish and 11.6 percent for aquatic insects/organisms.

Breakdown of biomass by month for the major prey categories is presented in Figure 6. Spottail shiners dominated the May/June samples with 86 percent of the biomass. In July, aquatic invertebrates accounted for 51 percent of the biomass with ephemeroptera and odonata nymphs each representing 25 percent of the biomass. Crayfish and spottail shiners were also important in July with 27 and 21 percent biomass, respectively. Crayfish were the primary prey item in August samples at 64 percent of the biomass and 63 percent occurrence. Yellow perch comprised 41 percent of the September biomass followed by spottail shiners with 33 percent. As seen in previous years (Hill et al, 1999) fish species dominated the September sample with 99 percent of the biomass.

Summary of biomass, biomass-percent composition, number, number-percent composition, frequency of occurrence and percent occurrence of all prey items in walleye stomachs is presented in Appendix VII. The Order Odonata (damselfly and dragonfly nymphs) were the most numerous prey item (333) followed by the Order Ephemeroptera (mayfly nymphs) at 76 individuals. Mayflies recorded the highest frequency at 36.3 percent occurrence. Forty-three spottail shiners were identified in 22 stomachs for a 27.5 percent occurrence. Crayfish(45) were consumed by 20 walleye for a 25 percent occurrence. No cisco were identified in the 80 stomachs examined in 2000.

2000 Walleye Biomass Summary

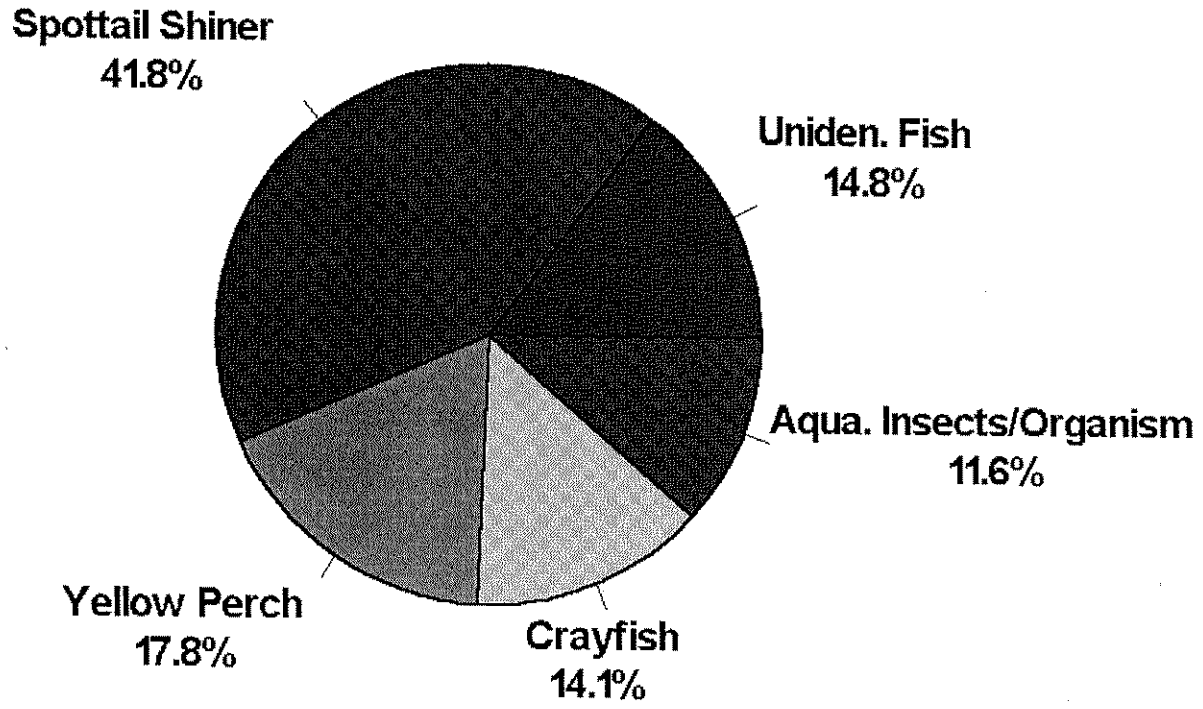

Figure 5. Percent biomass by prey category for walleye diets in Tiber Reservoir,2000

Tiber Reservoir Walleye Food Habits

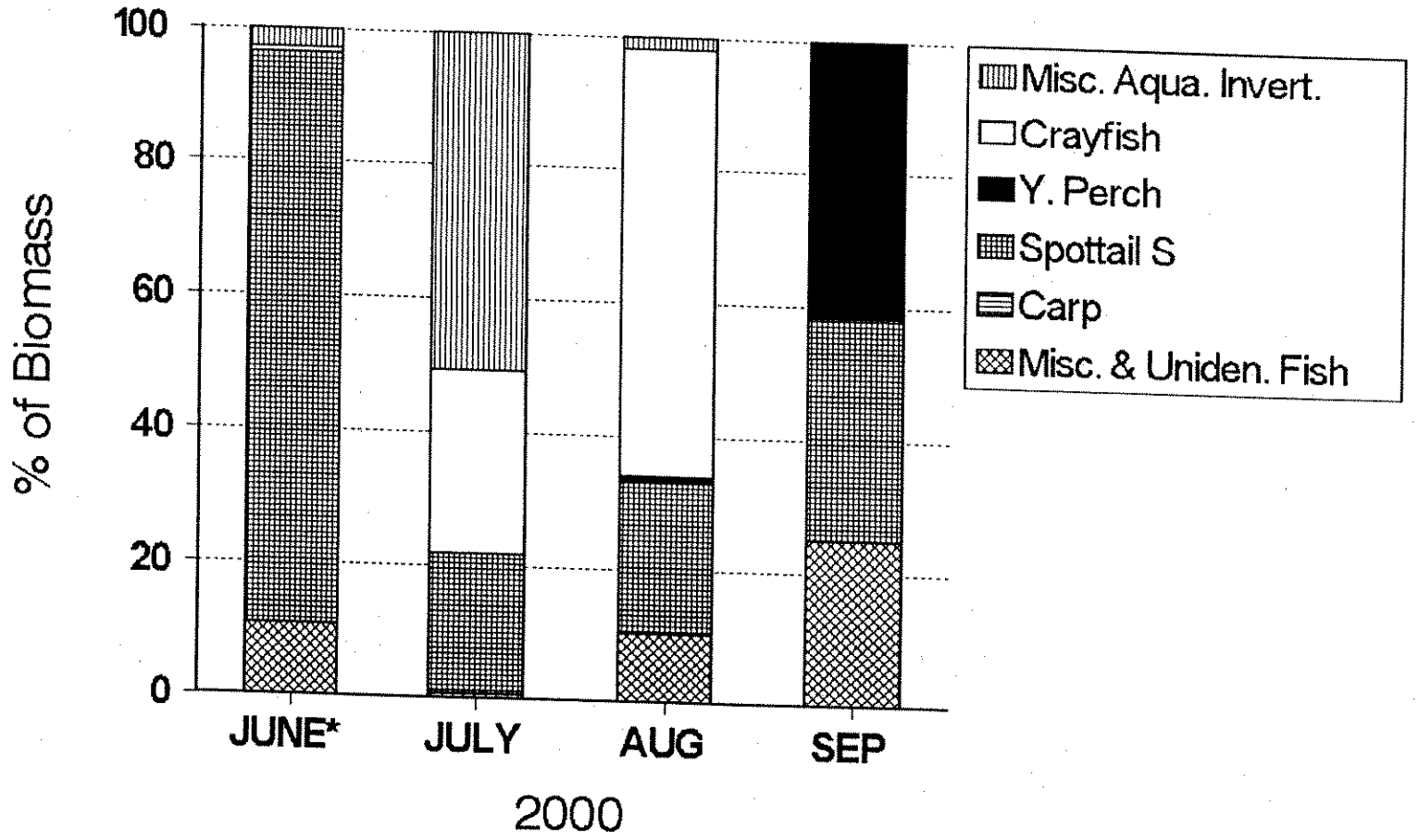

Figure 6. Percent biomass of major prey categories by month for walleye diets in Tiber Reservoir during 2000. (May and June samples combined).

Habitat Improvement. The Hi-Line Sportsmen Club installed 30 Christmas tree units to serve as yellow perch spawning structure. They were placed in the Dike area in early May and additional units will be installed in future years.

Hydroacoustics. In 1997 and 1998, approximately 5,000,000 cisco fry were introduced into Tiber Reservoir for the purpose of providing forage for walleye. Hydroacoustic sampling was initiated in 1996 to monitor pre-introduction population status of Tiber Reservoir. These surveys have continued in an attempt to determine the fate of the cisco introduction. Vertical gillnetting and limited trawling have been completed concurrent with hydroacoustic surveys to apportion both large and small acoustic targets. Limited pelagic trawling was again used during 2000 surveys in an attempt to determine success of cisco reproduction. Initial survey gear (1996 and 1997) consisted of a BioSonics Model 105 dual beam echosounder (420 kHz; 6^0 and 15^0 transducer). Surveys completed since 1998 have been conducted using a Hydroacoustics Technology Inc. (HTI) split beam digital echo sounder (200 kHz; 15^0 circular transducer). Data was collected in digital format to an onboard computer using HTI Digital Echo Processor (DEP) software. HTI EchView software was used to track acoustic targets.

Hydroacoustic surveys for 2000 were conducted on September 20th between 1917 and 2413 hours. Tiber Reservoir forebay elevation during the 2000 survey was 2982.91 feet msl. Forebay elevation was used to determine reservoir volume from approximately one meter below the surface to one meter above the reservoir bottom by five-meter intervals. Fish were weighted according to where they fell in the acoustic beam followed by volumetric expansion of fish densities across all transects to the entire reservoir. Fish densities were collected along 18 equally spaced transects suggested by Gunderson (1993) and the same transects used since 1996 (Hill and Teuscher, 1997). Transect locations are shown in Figure 7 and GPS coordinates and lengths are reported in Table 4. Some transects were excluded due to problems with volumetric expansion due to trees or loss of bottom tracking.

A total of 4.25 million targets were enumerated during the 2000 hydroacoustics estimate. Based on the proportion of cisco captured in vertical gill nets (99.3%) the 2000 cisco estimate is calculated at 4.2 million. Adjusted for cisco greater than four inches (young of the year cisco collected in verticals were 4-7 inches) the estimate was calculated at 1.6 million. The total pelagic estimate in 2000 (at depths greater than 21 meters) was 718,000 (727,000 * 99.3%) cisco (Appendix IX). Targets were sorted according to size and age distribution of cisco in gill nets (Table 5). Approximately 62% of targets were less than four inches, which compares to 86% (1997), 73% (1998) and 72% (1999). Young of the year cisco were determined to be between 4 and 7 inches and 11% of the acoustic targets fell within this seize range resulting in an estimate of 176,000. Age two and three cisco were determined to be between 10 and 14 inches accounting for 19% or 304,000 cisco. The remaining 8% of targets fell between 7 and 10 inches. Based on cisco age and length data collected during gill netting and seining efforts, it was determined that very few, if any, YOY cisco were less than 4 inches in length.

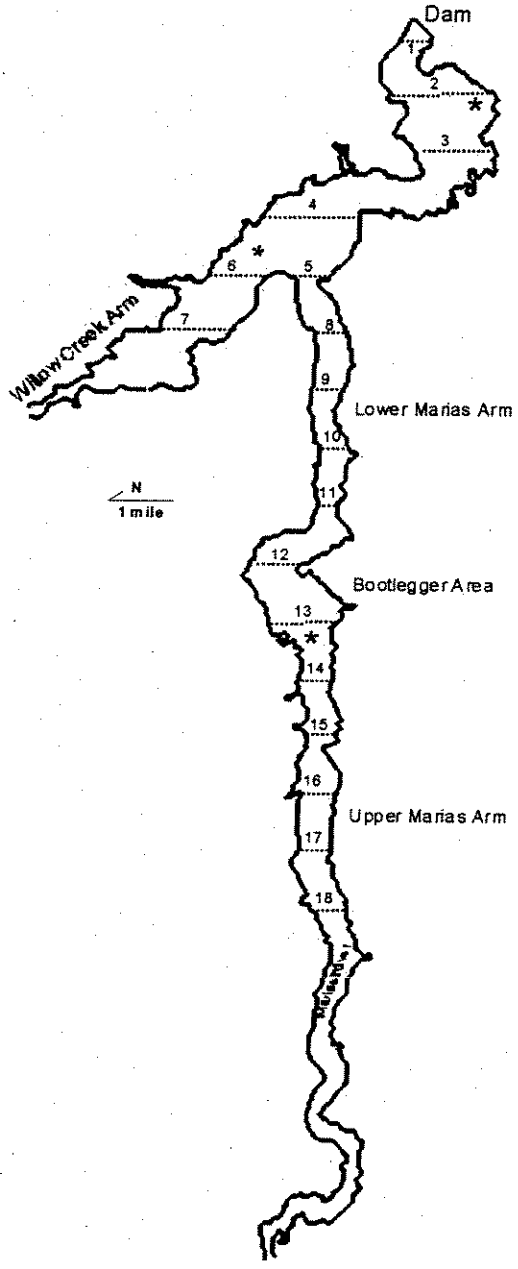

Figure 7. Hydroacoustic transects and vertical gillnet locations on Tiber Reservoir. Vertical gillnet locations are indicated with *.

Table 4. Transect locations, estimated transect length, and hydroacoustic estimates of fish densities (fish/1000m^3) in Tiber Reservoir (1996 through 2000).

Transect Number	Transect Location	Length (m)	1996	1997	1998	1999	2000
1	48°19.19N 111°06.70W	805	0.36	0.43	3.12	3.74	2.30
2	48°21.50N 111°10.16W	2,961	0.40	0.50	2.84	2.84	1.34
3	48°18.48N 111°08.03W	2,511	0.21	0.32	1.89	1.19	1.13
4	48°18.94N 111°08.77W	1,352	0.92	0.42	2.90	2.58	1.33
5	48°20.05N 111°10.18W	1,465	0.26	1.03	Excluded	1.33	4.56
6	48°20.77N 111°12.49W	1,561	3.32	0.97	5.12	5.14	3.59
7	48°22.61N 111°12.76W	2,510	8.47	2.23	1.46	1.79	2.38
8	48°20.99N 111°12.65W	1,110	0.32	1.93	5.08	2.80	7.10
9	48°20.27N 111°13.94W	901	0.31	2.19	4.81	1.68	6.86
10	48°20.68N 111°15.33W	805	0.47	1.83	Excluded	2.21	8.49
11	48°20.61N 111°16.17W	547	Excluded	Excluded	3.93	4.17	6.84
12	48°20.98N 111°17.55W	1,561	0.97	0.52	4.19	2.93	5.37
13	48°20.51N 111°18.84W	2,011	0.20	1.32	2.52	2.28	4.86
14	48°20.49N 111°20.40W	853	0.87	2.30	Excluded	Excluded	7.50
15	48°20.50N 111°21.68W	901	1.27	0.97	4.67	2.04	4.29
16	48°20.48N 111°22.94W	1,014	2.32	0.51	3.76	3.45	5.20
17	48°20.73N 111°24.05W	853	1.30	1.39	1.93	1.66	3.98
18	48°20.43 N 111°25.36W	853	5.43	2.22	Excluded	1.92	3.39
Mean (fish/1000m^3)			1.61	1.24	3.44	2.57	4.47

Total acoustic targets enumerated in 2000 (4.25 million) compares with previous years of 2.0 million in 1996 (pre-cisco introduction), 1.2 million (1997), 3.2 million (1998) and 2.7 million targets in 1999 (Appendix X). Targets identified as cisco (based on proportion in verticals) and greater than four inches have also increased from 122,000 in 1997 to 864,000 (1998), 756,000 (1999) and 1.6 million in 2000. Possibly the most significant trend is the consistency of the pelagic (water deeper than 21 meters) estimates since 1997. The 2000 pelagic estimate of 718,000 compares closely with 869,000 in 1998 and 782,000 cisco in 1999. The three-year consistency of these pelagic estimates may indicate a ballpark carrying capacity estimate. Furthermore, estimates of cisco greater than four inches since 1997 have closely paralleled pelagic estimates. The 2000 estimate of cisco greater than four inches was twice the pelagic estimate (1.6 million minus 726,000). This difference of 873,000 could indicate cisco that are pioneering non-pelagic habitats in Tiber.

Vertical gillnets fished in 2000 collected 404 cisco ranging in size from 5.3 to 13.1 inches in total length (Figure 8). Approximately 96% of the fish were collected in the 1", $1^{1/2}$" and $1^{3/4}$" mesh net (Table 5). Vertical distribution showed that 81% of the fish were caught in the top 75 feet. Fish were distributed by area with 40% collected in Willow Creek, 18% in Bootlegger and 41% at the Dam area. Of note is that seven young of the year cisco (5.3"-6.2") were collected the Bootlegger area in the ¾" mesh net at 51 to 100 feet. Two spottail shiners (both 4.1") were collected in the ½" mesh net in the Willow Creek area between 26 and 75 feet.

Vertical acoustic target distribution during 2000 surveys indicates that 83% of fish were encountered in the top 69 feet (21 meters) (Appendix VIII). Cisco densities were highest in the Lower Marias Arm and the Bootlegger areas (Table 4, Figure 7). Acoustic targets approximating young of the year cisco were recorded throughout the reservoir. However, transects near the dam (Transects 2,3,4 and 5) recorded high numbers in the top 20 meters. Transects in the Bootlegger area (Transects 12 and 13) recorded the highest numbers in deeper water below 20 meters. Transect 16 recorded the highest percentage of young of the year at 16% of total targets encountered.

A large number of targets less than four inches were again tracked during 2000 surveys. Approximately 62% of all targets were less than four inches in length (average 2.4") (Figure 9). Transects 12, 13 and 14 recorded the highest proportion of small fish in water less than 20 meters. Transect one at the dam also recorded 59% of targets less than four inches in water greater than 20 meters (Appendix VIII). Identification of these small targets still has proven elusive as mid-water trawling efforts in 2000 collected only two mature cisco (12"). Successful collection of young of the year cisco in gillnets (5.3-6.2"; Figure 8) would suggest that these small acoustic targets are not cisco.

Table 5. Vertical gill net results from three areas of Tiber Reservoir, 2000 (Cisco only). Length range and averages of cisco are represented in parenthesis.

		Number of Fish by Net Size						
Area (date)	**Depth Range (feet)**	**½"**	**¾"**	**1"**	**1 ¼"**	**1 ½"**	**2"**	**Length Range (average)**
WCA (9/6/00)	0-25	0	1	5	8	8	0	11.3-13.1 (11.98)
	26-50	0	0	7	29	33	1	
	51-75	0	0	2	18	22	0	
	76-100	0	1	5	11	12	0	
DAM (9/6/00)	0-25	0	0	3	8	9	0	11.2-13.0 (12.1)
	26-50	0	0	0	7	2	0	
	51-75	0	0	2	6	9	1	
	76-100	0	0	2	14	11	0	
BOOTLEGGER (9/26/00)	0-25	1	1	6	15	17	0	5.3-12.8 (11.73)
	26-50	0	1	6	18	24	2	
	51-75	0	5	7	21	23	0	
	76-100	0	4	3	5	8	0	

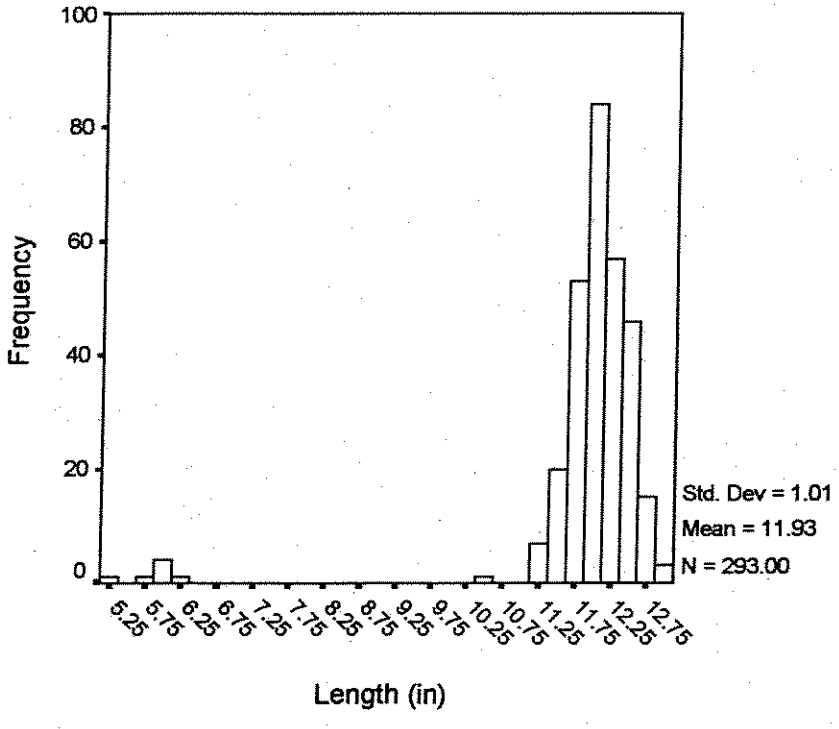

Figure 8. Length frequency of cisco collected in vertical gillnets (Dam, Willow Creek and Bootlegger areas) in Tiber Reservoir, September 2000.

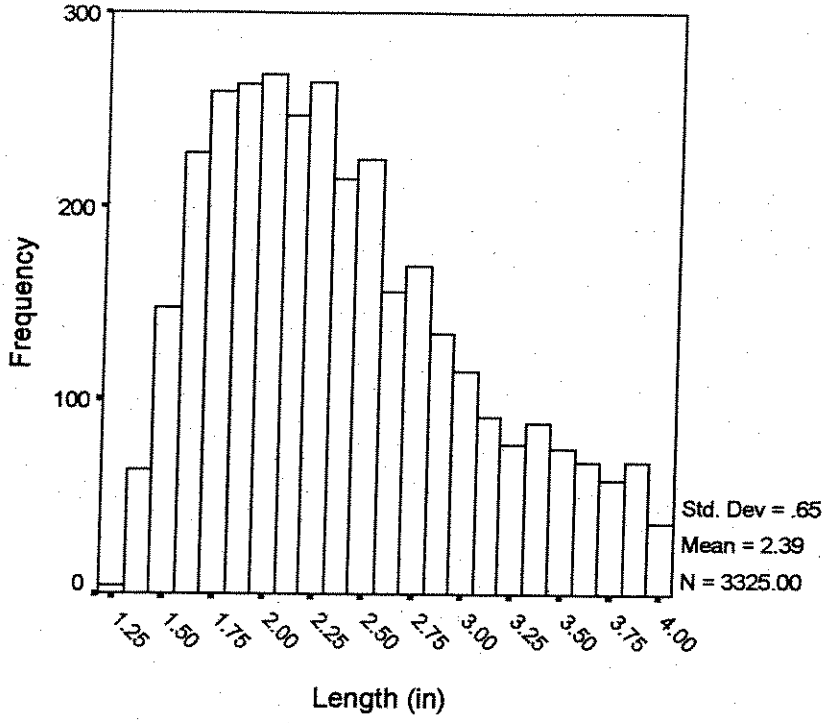

Figure 9. Length frequency of acoustic targets less than four inches across all transects in Tiber Reservoir, September 2000.

Creel Census

Creel censuses were conducted at Lake Frances and Tiber Reservoir on weekends beginning on Memorial Day and concluding on Labor Day. This data is presented in a separate document (Hill, 2001).

LEWISTOWN AREA WATERS

East Fork Reservoir

Yellow perch catch rate increased from 11 per seine haul in 1999 to 51 per haul in 2000 (Hill et al. 2000, Table 6). However, yellow perch catch was low compared to the 500 per seine haul captured in 1998 (Hill et al. 1999). Northern pike (< 4 inches long) were captured at a rate of 0.3 per net, which is similar to catch rates in recent years. White suckers were also captured.

Gill netting captured 9 northern pike, 59 white suckers, 1 longnose sucker and 15 yellow perch. These catch rates are less than observed in 1999 and are generally lower than typical catch of the past several years (Figure 10, Table 7). Average white sucker size continues to increase. When northern pike were first found in East Fork Reservoir in 1988, white suckers averaged 8.5 inches and 0.28 pounds (Figure 11). In the last year, average white sucker size increased from 15.7 inches (1.63 pounds) to 16.0 inches (1.85 pounds). Crayfish numbers in East Fork Reservoir have increased dramatically since one was captured in 1997 (Figure 10). In 2000, crayfish catch averaged 50 per net.

Petrolia Reservoir

Due to extremely low water and time constraints Petrolia Reservoir was not sampled in 2000.

Table 6. Seining results (100 foot seine) in Lewistown area reservoirs from 2000.

Reservoir	Date	# of Hauls	Species	Total N	N < 4 in long	Total Length (inches) Min	Max	Avg
East Fork	8/22/2000	9	Northern pike	11	3	2.5	19.5	8.7
			White sucker	5	1	1.9	17.5	13.6
			Yellow perch	457	393	1.8	5.8	2.9

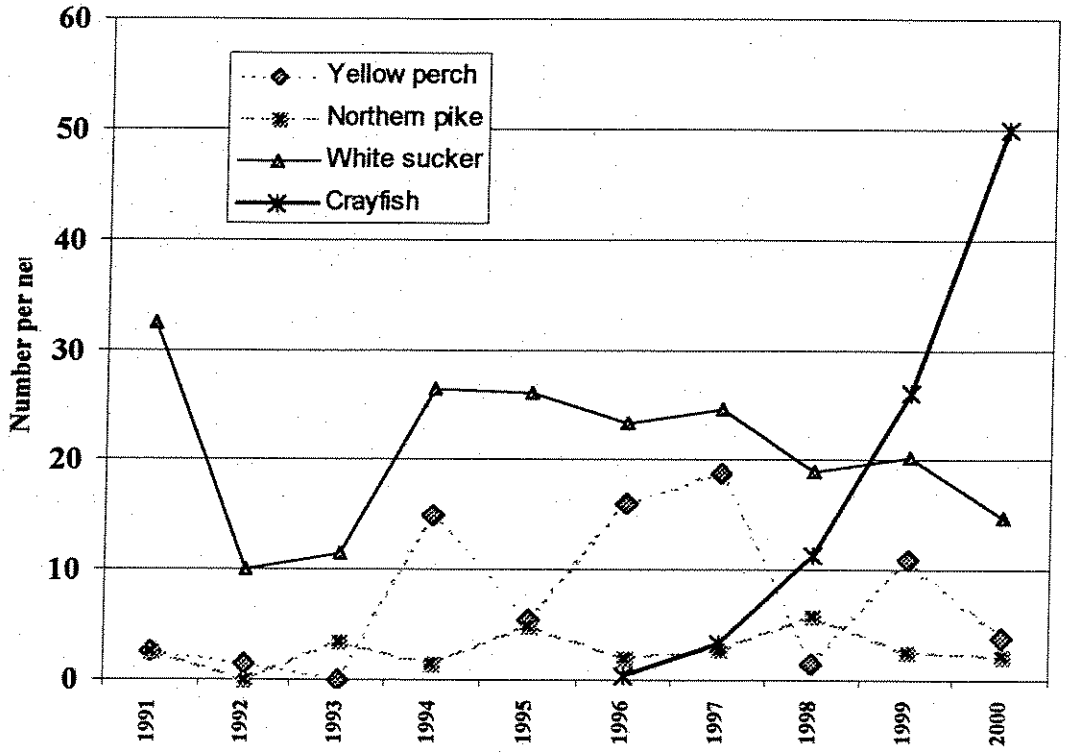

Figure 10. Average number of fish caught per net during fall gill netting in East Fork Reservoir.

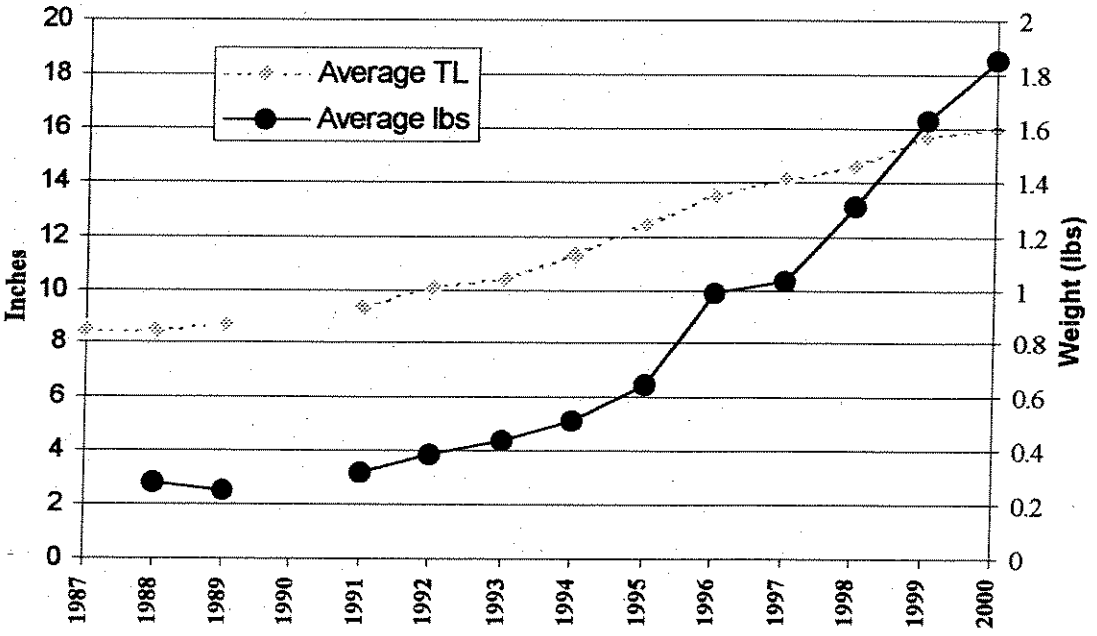

Figure 11. White sucker size in East Fork Reservoir during fall gill netting.

Other Lewistown Reservoirs

Drought impacted streams and reservoirs in the Lewistown vicinity in 2000. Most reservoirs had adequate depth for stocking fish, but continued drought into fall 2000 means winter-kill is likely during 2000 – 2001. On April 27, 2000 two seine hauls were done at Holland Reservoir and one at Catfish Reservoir. No fish were captured. Warm water fisheries in Lower Carter Pond and Big Casino Reservoir are discussed in a companion report, Northeastern Montana, Coldwater Lake Ecosystems (Tews et. al. 2001).

Jakes Reservoir: Gill netting captured 89 yellow perch and 10 large white suckers (Table 7). Two yellow perch were over 10 inches, with an average length of 6.0 inches. Last netted in 1997, when only 6 yellow perch were captured, gill nets in Jakes Reservoir have not captured yellow perch larger than 9 inches since 1989 (Hill et al. 1995, Hill et al. 1998). The capture of two large perch indicates that the seventeen 2 – 4 pound northern pike stocked in Jakes Reservoir in 1996 may have had a limited impact on the stunted perch population. However, with a 6 inch average size, the population is still stunted.

Dry Wolf Reservoir (Upper Wolf Coulee): Gill netting captured 8 largemouth bass that were accidentally stocked in 1999 (Table 7). Fifty-one salamanders were also captured. Channel catfish that were stocked in 1998 and 1999 were not captured. After 2000, channel catfish will not be stocked in Dry Wolf Reservoir, unless further sampling indicates past stocking was successful.

Payola Reservoir: Payola reservoir was sampled by electrofishing when it was extremely low. Conductivity was 1400 µohms/cm, which is marginal for electrofishing. During a 2.1 hour night time survey, 3 largemouth bass ranging from 9.4 – 14.4 inches were captured as were 22 yellow perch, which averaged 9 inches and were up to 1.2 pounds (Table 7). These are very different results than found during 1998 electrofishing when the largest yellow perch captured was 6.6 inches long (Hill et al. 1999).

Lewistown Area Streams

Murphy Coulee: To assist the BLM in development of a watershed plan for Armells Creek, 3 seine hauls were completed on April 12, 2000 at T20N R21E S10 near the mouth of Murphy Coulee. Murphy Coulee flows into Armells Creek. The stream appears to be perennial and conductivity was about 5800 µohms/cm. Flow was not measured but was estimated at about 1 cfs. Hundreds a minnows were sampled. Species included white sucker, creek chub, lake chub, fathead minnow, western silvery minnow, longnose dace and one sand shiner. Longnose dace, western silvery minnow, fathead minnow and creek chub were the most common species. This is an extension of range of the sand shiner and creek chub (Holton and Johnson 1996). Identification of the sand shiner, creek chub, fathead minnow and western silvery minnow has been verified (Dr, William Gould, 2001).

Musselshell River: Two sites were sampled on the lower Musselshell River in 2000. Six seine hauls completed near the Mosby Bridge and 5 hauls on the Charles Russell

Table 7. Overnight gill netting and electrofishing results from warmwater lakes in the Lewistown area in 1999.

Reservoir (Date)	# of [1] Nets	Avg hrs/ net	Species	N	Total Length (Inches)			Weight (lbs.)			Wr^2		
					Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
East Fork	2F	20.6	Crayfish	200									
Reservoir (9/12/00)	2S		Northern Pike	9	15.4	21.6	18.9	0.71	2.18	1.45	73.9	95.16	86.7
			Longnose sucker	1	11.6	11.6	11.6	0.51	0.51	0.51	-	-	-
			White sucker	59	13.5	17.4	16.0	1.17	2.48	1.85	82.3	113.8	101.8
			Yellow perch	15	5.6	10.9	7.6	0.07	0.64	0.27	67.1	104.8	89.0
Jakes (4/26/00)	1S	20.1	White sucker	10	15.7	18.4	17.6	1.70	2.73	2.34	85.9	103.1	96.6
			Yellow perch	89	5.1	13.1	6.0	0.04	1.14	0.09	43.8	92.55	58.6
Dry Wolf Reservoir (4/26/00)	1S	24.2	Largemouth bass	8	5.0	5.9	5.4	0.06	0.11	0.08			
			salamander	51									
Payola Reservoir (6/27/00)	Electrofish (2 hrs)		Largemouth bass	3	9.4	14.4	12.7	0.44	1.52	1.15	93.7	106.2	101.9
			Yellow perch	22	7.4	13.5	9.0	0.17	1.20	0.37	103.1	126.5	113.6

1: S = sinking net, F= floating net; 2: Relative weights (Wr) were determined using formulas and data from Anderson and Neuman 1996, and Bister and Willis 1999.

Wildlife Refuge captured about 15 different species (Table 8). Game fish included channel catfish, smallmouth bass, sauger and crappie. Emerald shiners and longnose dace were the most common species at both sites. Flathead chub and smallmouth bass were only captured near Mosby, while crappie and sauger were only captured at the downstream site. Drought impacted the Musselshell River in both 1999 and 2000. During sampling in August 2000, water was confined to isolated pools. Species composition was very similar to that observed by Marcuson and Cardinal (1981) who sampled the Musselshell from Mosby upstream. Marcuson and Cardinal captured green sunfish and mountain suckers, which were not captured in 2000. Relative abundance of species differed greatly between 1981 and 2000, which is likely due to extensive sampling much further upstream in 1981.

Judith River: Ten seine hauls completed on the Judith River on the Beckman Wildlife Management area captured 11 different species (Table 8). Channel catfish were the only game fish captured. Brook stickleback were sampled which is an extension of their range (Holton and Johnson 1996). In the last few years, this species has become common in the Carter Ponds near Lewistown, which eventually flow into the Judith River.

Table 8. Fish captured with a 50 foot long seine on streams in 2000.

Stream	Date	# of Hauls	Species	N	N/ Net	Total Length (inches) Min	Max	Avg	(N)
Judith River T18N, R16E, Sec. 4,5 & 34	8/3/00	10	*Catostomus sp.*	47	4.7				
			White sucker	27	2.7				
			Mountain sucker	1	0.1			3.4	1
			Shorthead redhorse	22	2.2	2.4	5.0	4.0	3
			Channel catfish	7	0.7			1.2	1
			Flathead chub	2	0.2				
			Lake chub	41	4.1				
			Longnose dace	413	41.3	1.2	2.2	1.5	10
			Hybognathus sp.	3	0.3				
			Carp, adult	3	0.3				
			Carp	6	0.6				
			Mottled sculpin	4	0.4			1.5	1
			Brook stickleback	1	0.1				
Musselshell River (Mosby) T14N R30E Sec. 28	8/24/00	6	Longnose sucker	6	1.0	2.4	3.2	2.7	3
			White sucker	5	0.8	3.7	7.4	5.6	2
			Shorthead redhorse	78	13.0	2.3	5.9	3.3	11
			River carpsucker	11	1.8	1.5	5.2	3.8	7
			Channel catfish	14	2.3	1.9	4.5	2.7	4
			Flathead chub	45	7.5	2.7	4.8	3.3	17
			Longnose dace	215	35.8	2.3	2.3	2.3	1
			Fathead minnow	59	9.8				
			Emerald shiner	398	66.3	1.7	3.8	2.2	14
			Unknown minnow	22	3.7				
			Carp	226	37.7	1.3	4.0	2.6	17
			Carp, adult	1	0.2				
			Hybognathus sp.	7		4.7	5.8	5.1	7
			Smallmouth bass	4	0.7	3.9	4.1	4.0	4
Musselshell River (CMR) T18N R29E Sec. 1	8/25/00	5	White sucker	1	0.2			15	1
			Shorthead redhorse	11	0.4			5.4	1
			River carpsucker	20	4.0				
			Channel catfish	42	8.4	1.0	6.0	3.9	6
			Flathead chub	8	1.6	4.0	5.0	4.5	3
			Longnose dace	107	21.4				
			Fathead minnow	35	14.4				
			Emerald shiner	504	100.8				
			Unknown minnow	4	0.8				
			Carp	139	27.8				
			Hybognathus sp.	99	19.8			5.5	1
			Crappie	20	4.0	1.0	1.5	1.3	4
			Sauger, adult	1	0.2				

DISCUSSION AND RECOMMENDATIONS

Bynum Reservoir water levels gradually decreased throughout the summer, ending up with less than 500 surface acres and a maximum depth of only 8 feet. Four air-inducing windmills were installed at two locations in attempts to reduce winterkill at this popular walleye lake. Future surveys need to determine whether or not fish survived the winter and also to determine whether or not additional walleye need to be stocked once water levels returns to more normal situations.

Future surveys are also needed at Lake Frances to determine whether or not low water levels has had any impact on the walleye, yellow perch and northern pike fishery. Recent alternate-year stocking of walleye fingerlings needs to be evaluated to determine their contribution to the fishery. Future plants of walleye should be marked with tetracylcline to separate planted from wild fish.

Efforts should continue on Tiber Reservoir using vertical gill nets and hydroacousitic surveys to monitor cisco numbers and whether or not natural reproduction is occurring. The Bureau of Reclamation should be encouraged to minimize drawdown of lake levels during the cisco spawning and incubation period.

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DATE: June, 2000

Principal Fish Species Involved: Walleye, northern pike, yellow perch, cisco, largemouth bass, smallmouth bass, channel catfish, white sucker, longnose sucker, carp, brook stickleback, sand shiner and spottail shiner.

Code Numbers of Waters Referred to in Report:

14-7080	Bynum Reservoir
14-7440	Lake Frances
14-9240	Tiber Reservoir
16-1800	Judith River, Section 1
16-4950	East Fork Spring Creek Reservoir
16-6070	Jakes Reservoir
16-2640	Murphy Coulee
18-4320	Musselshell River, Section 1
18-7395	Catfish Reservoir
18-7839	Holland Reservoir
18-8700	Payola Reservoir
18-8720	Petrolia Reservoir
18-9480	Upper Wolf Coulee (Dry Wolf) Reservoir

Appendix I. Forage fish/reproduction survey results for several Region Four reservoirs during August 2000 (beach seining).

Water	Date	Water temp (F°)	No.of pulls	Number of fish/pull												
				YP	SS	WSu	Cray	WE	NP	Carp	MSc	LC	ES	FHC	LND	FM	LnSu
Lake Frances	8/23/00	65°	13	37.8	60.9	1.5	0.2	0.4	0.4								
Tiber Res.																	
Dam	8/30/00	68°	14	1.4	29.6	4.1	0.4			0.9	0.3		0.8				
WCA	8/29/00	67°	16	8.9	32.9	2.9	0.1		0.3	2.1			6.2			0.1	0.1
BT	8/28/00	68°	8	3.6	35.5	3.8	0.8	0.4		0.3		0.5	0.8	0.3	0.1		
Devon	8/28/00	66°	12	2.3	60.5	2.8	0.1	1.9				1.8	22.6	0.8	0.3		
Tiber combined			50	4.4	39.0	2.8	0.3	0.5	0.1	1.0	0.1	0.5	7.7	0.2	0.1	Tr.	Tr.

Appendix II. Gill net summaries by area of Tiber Reservoir, 2000.

Area (date)	No.of nets	Hours fished	Species	No.of fish	Length range (avg)		Weight range (avg)	
WCA area (9/6/00)	11	19.75	WE	20	10.4-13.6	(11.7)	0.33 - 0.70	(0.47)
				2	14.3-14.5	(14.4)	0.80 - 0.90	(0.85)
				2	15.5-19.7	(17.6)	0.96 - 1.54	(1.25)
				1		(20.7)		(2.35)
			NP	1		(18.8)		(1.29)
				14	21.1-28.5	(24.6)	1.90 - 6.70	(3.76)
			YP	36	5.4 - 8.9	(7.5)	0.05 - 0.31	(0.19)
				16	9.1-10.9	(9.5)	0.33 - 0.55	(0.40)
			WSu	1		(12.8)		(0.98)
				21	14.5-17.8	(16.1)	1.27 - 2.42	(1.88)
			LnSu	2	16.1-17.2	(16.6)	1.77 - 1.93	(1.85)
			Cisco	40	11.7-13.4	(12.5)	0.57 - 1.04	(0.79)
			Carp	5	23.2-30.4	(27.1)	6.00 - 14.5	(10.70)
Dam area (9/7/00)	6	15.25	WE	5	9.8-13.0	(11.9)	0.24 - 0.60	(0.47)
			NP	1		(19.1)		(1.44)
				6	20.0-30.0	(22.9)	1.72 - 7.90	(3.26)
			YP	3	5.5- 8.3	(7.3)	0.07 - 0.25	(0.19)
			WSu	6	14.3-19.2	(16.7)	1.33 - 2.74	(2.04)
			Cisco	3	11.8-12.2	(12.0)	0.63 - 0.71	(0.66)
			Carp	1		(26.2)		(9.10)
BT area (9/7-8/00)	6	17.50	WE	11	7.4-12.8	(10.9)	0.09 - 0.56	(0.38)
				1		(14.7)		(0.96)
			NP	2	22.3-22.7	(22.5)	2.55 - 2.88	(2.71)
			YP	11	7.2- 8.7	(7.8)	0.13 - 0.29	(0.20)
				3	9.0-10.1	(9.6)	0.32 - 0.45	(0.40)
			WSu	2	14.5-16.3	(15.4)	1.35 - 1.90	(1.62)
			LnSu	1		(11.8)		(0.62)
				1		(15.8)		(1.43)
			Cisco	10	5.6-12.7	(11.5)	0.06 - 0.74	(0.62)
			SNS	1		(34.0)		(5.40)
			Carp	2	26.5-30.5	(28.5)	8.60-14.40	(11.50)
Devon area (9/8/00)	6	18.55	WE	7	9.8-13.1	(11.6)	0.28 - 0.63	(0.45)
				1		(14.8)		(0.85)
				2	16.2-19.1	(17.6)	1.20 - 1.84	(1.52)
			NP	9	21.5-32.3	(27.3)	2.09 - 8.90	(5.63)
			YP	2	10.1-10.5	(10.3)	0.50 - 0.55	(0.53)
				2	11.6-11.7	(11.6)	0.62 - 0.68	(0.65)
			WSu	1		(9.5)		(0.36)
				1		(15.3)		(1.53)
			LnSu	1		(12.5)		(0.70)
				2	16.7-18.4	(17.5)	1.96 - 2.53	(2.25)
			Cisco	99	11.3-13.4	(12.4)	0.40 - 1.01	(0.74)
			Carp	4	24.8-29.5	(27.4)	9.20-13.70	(10.90)

Appendix III. Summary of biomass, biomass-% composition, number, number-% composition, frequency of occurrence and percent occurrence of prey items in northern pike stomachs taken from Tiber Reservoir during June-September, 1997.

Prey Item	Biomass-grams	Biomass-Percent Composition	Number	Number-Percent Composition	Frequency of Occurrence	Percent Occurrence
Unidentified Fish	6.47	5.6	2	5.0	2	11.8
Spottail Shiner	7.27	6.3	6	15.0	5	29.4
Yellow Perch	0.00	0.0	0	0.0	0	0.0
Common Carp	46.63	37.6	8	20.0	4	23.5
Cisco	0.00	0.0	0	0.0	0	0.0
Misc. Fish	42.49	36.6	3	7.5	2	11.8
Crayfish	16.09	13.9	15	37.5	4	23.5
Ephemeroptera	0.12	0.1	1	2.5	1	5.9
Diptera	<0.01	<0.1	1	2.5	1	5.9
Odonata	<0.01	<0.1	1	2.5	1	5.9
Amphipoda	<0.01	<0.1	2	5.0	1	5.9
Other Aquatic Organisms	0.03	<0.1	1	2.5	1	5.9
TOTAL	**116.1**	**100**	**40**	**100**	**# stomachs = 17**	
Vegetation & Debris	137.54				7	41.2

Appendix IV. Summary of biomass, biomass-% composition, number, number-% composition, frequency of occurrence and percent occurrence of prey items in northern pike taken from Tiber Reservoir during June-September, 1998.

Prey Item	Biomass-grams	Biomass-Percent Composition	Number	Number-Percent Composition	Frequency of Occurrence	Percent Occurrence
Unidentified Fish	10.96	1.7	5	4.2	5	14.7
Spottail Shiner	162.85	25.5	48	40.3	3	8.8
Yellow Perch	56.37	8.8	4	3.4	4	11.8
Carp	4.76	0.7	5	4.2	3	8.8
Cisco	146.58	22.9	2	1.7	2	5.9
Misc. Fish	142.33	22.3	5	4.2	4	11.8
Crayfish	114.97	18.0	50	42.0	21	61.8
Ephemeroptera	0.00	0.0	0	0.0	0	0.0
Diptera	0.00	0.0	0	0.0	0	0.0
Odonata	0.00	0.0	0	0.0	0	0.0
Amphipoda	0.00	0.0	0	0.0	0	0.0
Other Aquatic Organisms	0.00	0.0	0	0.0	0	0.0
TOTAL	**638.82**	**100**	**119**	**100**	**# stomachs = 34**	
Vegetation & Debris	5.23				11	32.4

Appendix V. Summary of biomass, biomass-% composition, number, number-% composition, frequency of occurrence and percent occurrence of prey items in northern pike stomachs taken from Tiber Reservoir during June-September, 1999.

Prey Item	Biomass-grams	Biomass-Percent Composition	Number	Number-Percent Composition	Frequency of Occurrence	Percent Occurrence
Unidentified Fish	47.78	7.8	7	13.7	6	30.0
Spottail Shiner	20.02	3.3	5	9.8	3	15.0
Yellow Perch	11.69	1.9	2	3.9	2	10.0
Carp	0.00	0.0	0	0.0	0	0.0
Cisco	388.12	63.7	4	7.8	4	20.0
Misc. Fish	71.78	11.8	2	3.9	2	10.0
Crayfish	69.18	11.4	23	45.1	7	35.0
Ephemeroptera	0.00	0.0	0	0.0	0	0.0
Diptera	0.00	0.0	0	0.0	0	0.0
Odonata	0.00	0.0	0	0.0	0	0.0
Amphipoda	0.00	0.0	0	0.0	0	0.0
Other Aquatic Organisms	0.46	0.1	8	15.7	1	5.0
TOTAL	**609.03**	**100**	**51**	**100**	**# stomachs = 20**	
Vegetation & Debris	0.25				3	15.0

Appendix VI. Summary of biomass, biomass-% composition), number, number-% composition, frequency of occurrence and percent occurrence of prey items in northern pike stomachs taken from Tiber Reservoir during June-September, 2000.

Prey Item	Biomass- grams	Biomass-Percent Composition	Number	Number-Percent Composition	Frequency of Occurrence	Percent Occurrence
Unidentified Fish	50.77	18.0	4	9.1	4	23.5
Spottail Shiner	0.00	0.0	0	0.0	0	0.0
Yellow Perch	3.85	1.4	1	2.3	1	5.9
Common Carp	0.00	0.0	0	0.0	0	0.0
Cisco	163.67	58.0	4	9.1	4	23.5
Misc. Fish	0.00	0.0	0	0.0	0	0.0
Crayfish	63.71	22.6	32	72.7	10	58.9
Ephemeroptera	0.00	0.0	0	0.0	0	0.0
Diptera	0.00	0.0	0	0.0	0	0.0
Odonata	0.00	0.0	0	0.0	0	0.0
Amphipoda	0.00	0.0	0	0.0	0	0.0
Other Aquatic Organisms	0.02	<.01	3	6.8	1	5.9
TOTAL	**282.0**	**100**	**44**	**100**	**# stomachs = 17**	
Vegetation & Debris	1.00				2	11.8

Appendix VII. Summary of biomass, biomass-% composition, number, number-% composition, frequency of occurrence and percent occurrence of prey items in walleye stomachs taken from Tiber Reservoir during June-September, 2000.

Prey Item	Biomass-grams	Biomass-Percent Composition	Number	Number-Percent Composition	Frequency of Occurrence	Percent Occurrence
Unidentified Fish	32.29	14.8	38	6.4	22	27.5
Spottail Shiner	91.43	41.8	43	7.3	22	27.5
Yellow Perch	38.89	17.8	4	0.7	3	3.7
Common Carp	0.00	0.0	0	0.0	0	0.0
Cisco	0.00	0.0	0	0.0	0	0.0
Misc. Fish	0.00	0.0	0	0.0	0	0.0
Crayfish	30.82	14.1	45	7.6	20	25.0
Ephemeroptera	13.29	6.1	76	12.9	29	36.3
Diptera	0.12	0.1	34	5.8	10	12.5
Odonata	11.49	5.3	333	56.4	21	26.3
Amphipoda	0.12	0.1	16	2.7	7	8.7
Other Aquatic Organisms	0.05	0.02	1	0.2	1	1.3
TOTAL	**218.5**	**100**	**590**	**100**	**# stomachs = 80**	
Vegetation & Debris	2.85				6	7.5

Appendix VIII. Distribution of acoustic targets by size (< 4", 4-7", 7-10" and > 10") and depth (<20m and >20m) for all transects during fall hydroacoustic surveys on Tiber Reservoir – 2000.

		Less than 20 meters								Greater than 20 meters							
T-sect	**Total #**	**#<4"**	**%**	**#4-7"**	**%**	**#7-10"**	**%**	**#>10"**	**%**	**#<4"**	**%**	**#4-7"**	**%**	**#7-10"**	**%**	**#>10"**	**%**
T1	461	144	31%	2	0%	1	0%	2	0%	271	59%	11	2%	6	1%	24	5%
T2	480	99	21%	15	3%	22	5%	40	8%	117	24%	68	14%	65	14%	54	11%
T3	214	61	29%	4	2%	10	5%	75	35%	40	19%	23	11%	17	8%	80	37%
T4	250	78	31%	6	2%	6	2%	12	5%	98	39%	18	7%	18	7%	14	6%
T5	672	277	41%	53	8%	50	7%	93	14%	52	8%	66	10%	39	6%	42	6%
T6	296	167	56%	17	6%	24	8%	53	18%	26	9%	7	2%	0	0%	2	1%
T7	114	81	71%	8	7%	9	8%	10	9%	6	5%	0	0%	0	0%	0	0%
T8	588	346	59%	23	4%	41	7%	66	11%	28	5%	16	3%	29	5%	39	7%
T9	475	279	59%	22	5%	19	4%	47	10%	57	12%	14	3%	11	2%	26	5%
T10	553	269	49%	28	5%	35	6%	86	16%	74	13%	29	5%	6	1%	26	5%
T11	247	65	26%	18	7%	31	13%	59	24%	32	13%	16	6%	6	2%	20	8%
T12	277	157	57%	40	14%	27	10%	40	14%	11	4%	2	1%	0	0%	0	0%
T13	347	230	66%	45	13%	14	4%	58	17%	0	0%	0	0%	0	0%	0	0%
T14	222	160	72%	10	5%	4	2%	48	22%	0	0%	0	0%	0	0%	0	0%
T15	47	19	40%	8	17%	4	9%	16	34%	0	0%	0	0%	0	0%	0	0%
T16	75	50	67%	15	20%	5	7%	5	7%	0	0%	0	0%	0	0%	0	0%
T17	37	24	65%	4	11%	3	8%	6	16%	0	0%	0	0%	0	0%	0	0%
T18	7	7	100%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%

Appendix IX. Tiber Reservoir hydroacoustic fish population estimates for 2000. Fish abundance below the thermocline have also been included

Year	depth (m)	mean density (fish / m^3)	s.d. (fish / m^3)	lake volume (m^3)	number of fish	% of total
	1-6	4.70E-03	3.37E-03	259,103,346	1,216,761	28.6
	6-11	5.58E-03	5.35E-03	198,852,978	1,109,977	26.1
	11-16	3.83E-03	2.05E-03	152,413,660	583,710	13.7
	16-21	5.29E-03	6.29E-03	116,875,921	618,159	14.5
	21-26	3.75E-03	3.54E-03	85,710,406	321,445	7.6
	26-31	2.46E-03	1.81E-03	34,131,721	83,988	2.0
	31-36	1.75E-03	4.13E-04	61,583,619	107,857	2.5
	36-41	2.76E-03	8.82E-04	13,651,948	37,620	0.9
	41-46	4.79E-02	N/A	3,663,049	175,616	4.1
2000			**total fish**		**4,255,133**	**100**
			total fish below the thermocline		**726,526**	

Appendix X. Tiber Reservoir hydroacoustic fish population estimates for 1998 and 1999. Fish abundance below the thermocline and number of fish per acre have also been included

Year	depth (m)	mean density (fish / m^3)	s.d. (fish / m^3)	lake volume (m^3)	number of fish	% of total
	1-6	2.45E-03	3.23E-03	366,003,934	895,858	28.1
	6-11	1.55E-03	7.78E-04	249,823,622	386,827	12.1
	11-16	2.25E-03	1.62E-03	166,093,975	373,405	11.7
	16-21	4.89E-03	5.40E-03	134,992,595	659,829	20.7
	21-26	7.14E-03	4.74E-03	91,193,879	651,180	20.4
	26-31	3.54E-03	1.88E-03	52,379,129	185,675	5.8
	31-36	1.23E-03	6.21E-04	21,933,891	26,979	0.8
	36-41	1.05E-03	5.76E-04	4,618,894	4,855	0.2
			total fish		**3,184,608**	**100**
			total fish below the thermocline		**868,689**	
1998			**fish/acre**		**187**	
	1-6	1.52E-03	5.06E-04	366,003,934	555,929	20.7
	6-11	1.85E-03	9.34E-04	249,823,622	461,426	17.2
	11-16	2.96E-03	1.65E-03	166,093,975	490,847	18.3
	16-21	2.93E-03	2.27E-03	134,992,595	395,051	14.7
	21-26	3.80E-03	4.27E-03	91,193,879	346,109	12.9
	26-31	4.46E-03	4.56E-03	52,379,130	233,730	8.7
	31-36	7.22E-03	1.16E-02	21,933,892	158,458	5.9
	36-41	9.12E-03	5.53E-03	4,618,895	42,132	1.6
	41-46	2.32E-02	2.06E-02	46,867	1,089	0.0
	46-50	1.96E-03	N/A	6,167	12	0.0
			total fish		**2,684,783**	**100**
			total fish below the thermocline		**781,518**	
1999			**fish/acre**		**158**	

Appendix XI. Tiber Reservoir hydroacoustic fish population estimates for 1996 and 1997. Fish abundance below the thermocline and number of fish per acre have also been included

Year	depth (m)	mean density (fish / m^3)	s.d. (fish / m^3)	lake volume (m^3)	number of fish	% of total
	1-6	1.96e-03	2.32e-03	281,164,432	552,434	37.3
	6-11	1.96e-03	2.70e-03	228,196,216	447,005	30.2
	11-16	1.57e-03	2.21e-03	164,356,460	258,106	17.4
	16-21	9.70e-04	1.26e-03	135,292,058	130,592	8.8
	21-26	5.80e-04	4.30e-04	94,347,938	54,980	3.7
	26-31	3.30e-04	3.30e-04	68,599,294	22,365	1.5
	31-36	1.80e-04	1.60e-04	46,825,364	8,519	0.6
	36-41	2.30e-04	2.70e-04	21,079,188	4,788	0.3
	41-46	1.40e-04	2.00e-04	6,817,850	970	0.1
	41-50	1.30e-04	1.90e-04	667,594	87	0.0
		total fish			**1,479,846**	**100**
		total fish below the thermocline			**91,710**	
1996		**fish/acre**			**105**	
	1-6	6.30e-04	6.30e-04	308,815,904	195,789	16.1
	6-11	9.60e-04	1.02e-03	251,431,202	241,757	19.9
	11-16	1.53e-03	1.58e-03	180,916,740	276,937	22.8
	16-21	1.23e-03	1.32e-03	148,833,974	182,391	15.0
	21-26	2.00e-03	2.16e-03	105,883,370	211,749	17.4
	26-31	1.01e-03	1.11e-03	77,226,188	77,878	6.4
	31-36	3.60e-04	2.90e-04	56,787,446	20,371	1.7
	36-41	2.60e-04	1.60e-04	29,032,318	7,604	0.6
	41-46	6.70e-05	1.70e-05	10,709,886	716	0.1
	46-50	0	0	2,122,480	0	0.0
		total fish			**1,215,192**	**100**
		total fish below the thermocline			**318,318**	
1997		**fish/acre**			**71**	