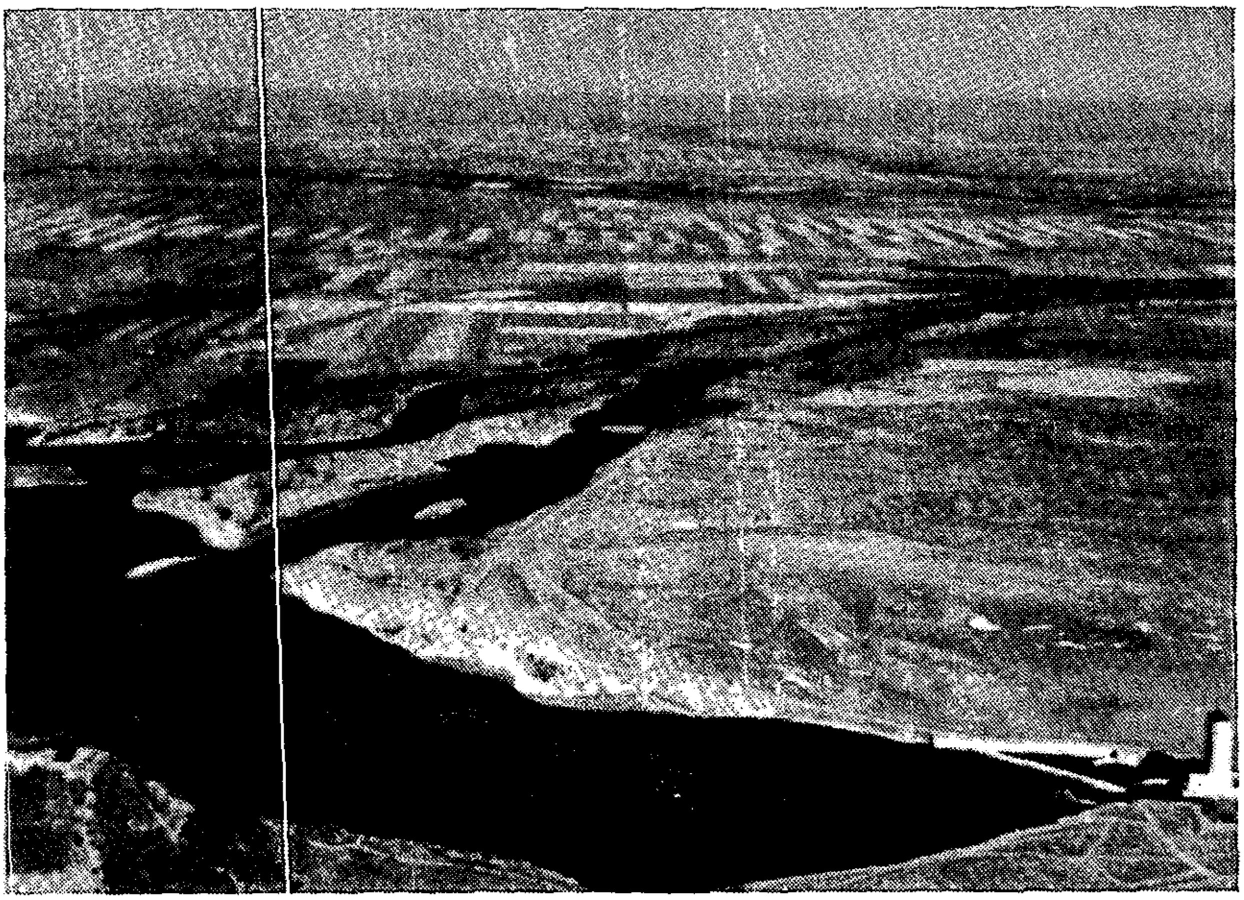
EVALUATION OF THE FISHERY IN THE FORT PECK TAILWATER/DREDGE CUT AREA AND ASSESSMENT OF POTENTIAL IMPACTS FROM INCREASED HYDROPOWER PRODUCTION AT FORT PECK DAM ON THIS FISHERY



Prepared by:

Kenneth J. Frazer
Montana Department of Fish, Wildlife and Parks
May 1985

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INTRODUCTION

In response to a congressional resolution adopted 25 November 1969, the U.S. Army Corps of Engineers (COE) undertook a study to evaluate the potential of increasing hydropower production along the Missouri River between Three Forks, Montana and Sioux City, Iowa commonly called the "Missouri River Umbrella Study." The first report for this study, published in 1977, identified Fort Peck Dam in Northeast Montana as one of the sites where additional hydropower could be generated (U.S. Army Corps of Engineers 1977) and recommended congressional authorization for the COE to conduct Phase I advanced engineering and design studies at Fort Peck. The recommendations for Fort Peck called for the addition of two new 92.5 megawatt hydropower units to increase the output capacity of Fort Peck from 165 to 350 megawatts. This would have increased the maximum turbine discharge capacity of Fort Peck from 15,200 to 32,600 cfs. To dampen increased fluctuations caused by the increased discharge, the project called for the construction of a reregulation dam 8 miles downstream. This dam would create a 20,000 acre-foot storage reservoir requiring the acquisition of approximately 1,290 acres of private land in the area (Army Corps of Engineers). There were a number of potential adverse impacts associated with this plan. As a result, the COE began to reevaluate the Fort Peck project and look for alternative plans for increasing hydropower production at Fort Peck while minimizing impacts.

Previous work on the Fort Peck tailwater and dredge cut fisheries has been very limited. Paddlefish tagging was initiated in the dredge cuts in 1968 and continued through 1980. Paddlefish tag returns are monitored and harvest records calculated on an annual basis (Needham 1979-1984). A paddlefish population estimate was conducted in the upper dredge cut in 1978 (Needham 1979).

A series of 10 125-foot experimental gill nets have been fished overnight in the tailpool and dredge cuts each summer beginning in 1979 to investigate yearly changes in the fish populations of the area (Needham and Gilge 1984). In 1981 four 100x6-foot ½-inch square mesh monofilament gill nets were added to the net series to obtain information on rainbow smelt abundance. Rainbow smelt first migrated to the Fort Peck tailwater area in 1980 from Garrison Reservoir, North Dakota; no major smelt runs have occurred since that time.

A series of seine hauls were made in the area in 1979 with a 100-x9-foot by ¼-inch minnow seine to evaluate the forage fish population (Needham 1980). Four gill nets were set under the ice in the upper dredge cut in 1979. A fisheries survey and inventory study on the Missouri River between Fort Peck Dam and the North Dakota Border was initiated in 1979. The major emphasis of this study has been from the Milk River downstream. Very little effort has been expanded in the Fort Peck tailwater and dredge cut areas.

In order to accurately evaluate the impacts of proposed hydropower projects on the downstream fishery at Fort Peck, more information on this fishery was needed. As part of their evaluation of alternative project proposals for Fort Peck, the COE funded a study to inventory the fishery in the area and identify impacts associated with various proposed projects. This is the final report for this study.

DESCRIPTION OF STUDY AREA

The study area extends from Fort Peck Dam downstream approximately 10 miles to the mouth of the Milk River.

Fort Peck Dam is a large earth filled dam located at river mile 1771.6 on the Missouri River in northeast Montana. The dam was closed in 1937 and backs water 134 miles upstream to near Zortman, Montana. Four large penstock tubes withdraw water 185.5 feet below the top of the dam.

Two of these penstocks are used for power generation and have a maximum discharge capacity of just over 17,000 cfs. The capacity of the two powerhouses is 185 megawatts. The total discharge capacity through all four penstocks is 45,000 cfs. A separate spillway system located on a bay west of the main dam has a discharge capacity of 230,000 cfs.

Fort Peck Dam is the upstream-most dam in a series of dams on the middle Missouri River operated by the COE. It is operated for flood control, navigation and power production. The dam has altered the natural temperature and discharge patterns in the river downstream.

Fort Peck Dam is presently operated as a combined base load and peaking plant. The amount of power peaking depends on the water availability.

Habitat

The study area below the dam contains several habitat features (Figure 1). The tailrace area immediately below the dam consists of a shallow shelf of large boulders dropping off into a pool approximately 40 feet deep. A number of large boulders have been placed in the channel to absorb discharge from the dam. The spaces between the boulders in the center of the channel have filled in with gravel and silt. Boulders along the edges of the current are not silted in and provide fish habitat. The banks just downstream of the dam have been riprapped. The banks in the remainder of the study section are predominately steep vertical sand and silt banks that are very unstable. The bottom in the tailpool area is composed of sand and silt. Most of the tailpool is less than 10 feet deep with a number of shallow mud flats. There are a couple of 30 to 40 feet deep holes three to four miles below the dam. Approximately 0.9 miles below the dam the tailpool is split by a series of large islands; the main flow going down the west channel. Near the upstream end of Duck Island, the current velocity in the west channel increases as the river passes through a narrow, rocky chute. Downstream from this point there are a number of gravel bars and small gravel points intermixed with a sand and silt bottom.

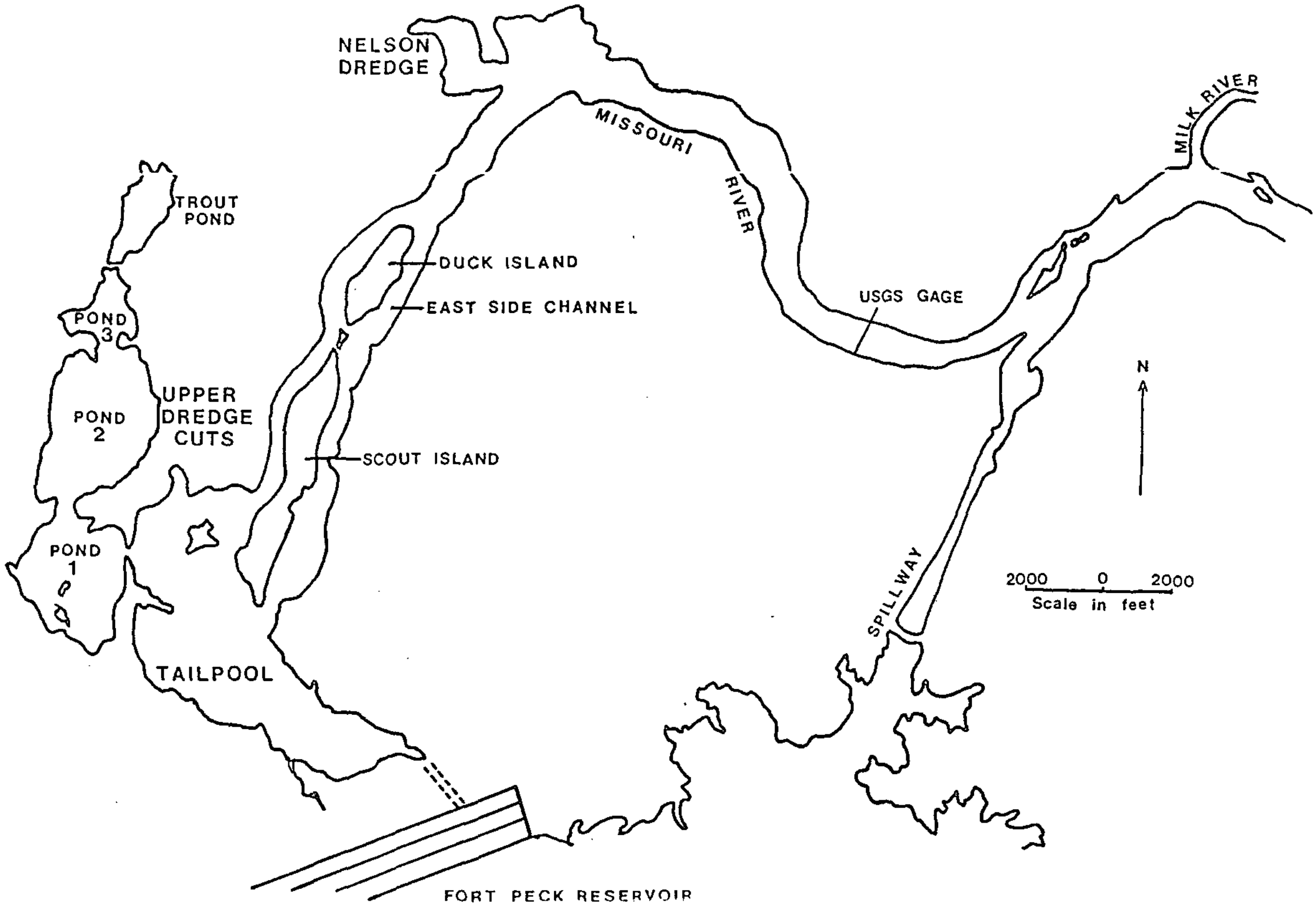

Figure 1. Study area

The east side channel behind Duck and Scout Islands provides critical habitat for rainbow trout spawning, incubation and rearing. This side channel is about 2.5 miles long; it passes about 1 to 10% of the water discharged from the dam. The bottom in the upper end of the side channel begins as sand and silt, then turns to more gravel and cobble. Two large riffle areas in the lower quarter mile of the side channel provide the major spawning and rearing habitat for rainbow. The dimensions of these riffles are given in table 1.

Table 1. Physical characteristics of the two riffle areas located in the lower east side channel, 1983.

	Upper Riffle	Lower Riffle
Thalweg distance	660 ft.	155 ft.
Approximate area	177,800 $ft.^2$	81,600 $ft.^2$
Average width	385 ft.	515 ft.[a/]
Width range	285-570	447-577
Gradient	3.2 ft./1000 ft.	3.9 ft./1000 ft.

[a/] Only about 70% active riffle.

A unique habitat feature is the dredge cut ponds. These are areas that were excavated to provide fill during construction of the dam. They are connected directly to the main river. The water levels in these ponds are influenced by the discharge from the dam.

There are two dredge cut areas. The upper dredge cut is located approximately 1.6 miles downstream from the dam and consists of a series of three interconnected ponds (Figure 1) with a single connection to the river. These ponds have a total surface area of approximately 650 acres and a maximum depth of approximately 31 feet. Average depth for the whole area is 15 to 20 feet. The banks and bottom in these ponds are composed of sand and silt. The banks are steep and very unstable with little shoreline cover. There are two gravel points which provide spawning habitat for walleye and sauger.

The Nelson dredge cut is located approximately 6 miles downstream and consists of one 66 acre pond with an approximate maximum depth of 28 feet. The opening to Nelson dredge is larger than the opening to the upper dredge cuts, facilitating exchange of water with the river. The bottom and banks are similar to the upper dredge cut area.

Fisheries

The variety of habitat found in the study area has resulted in the development of a diverse fishery in this area. A total of 39 species of fish in 14 families has been collected while sampling or are otherwise known to occur in the study area (Table 2). Several other species have been reported from the Missouri River or its tributaries between Fort Peck and Garrison reservoirs, but have not been collected in the study area (Brown 1971, Stewart 1982).

Walleye and sauger are the most popular game fish in the study area. They are found in all parts of the study area but appear to favor certain habitat areas. It appears that the majority of walleye and sauger in the area are migratory fish from downstream. Some walleye and perhaps sauger spawning occurs in the study area.

Northern pike is another popular game fish. They are found predominantly in the dredge cuts, although a few are found in the tailpool and main channel as well. Pike do spawn in the dredge cuts if spring water levels are high enough to keep vegetation wetted, but no evidence of successful reproduction has been found.

A population of trophy-sized rainbow trout inhabit the study area and spawn successfully in the east side channel and in the main river. This population of rainbow was first documented in 1979 (Stewart 1980); however, locals report catching rainbow in the area for several years before that. Limited rainbow stocking has occurred in both the study area and in Garrison Reservoir in the past; however, the actual origin of this rainbow population is not known. These rainbow provide an important fishery that is unique to this part of eastern Montana. Sampling efforts indicated that rainbow trout remain in the study area throughout the year.

A population of lake trout is found in the tailpool area below the dam. These fish provide a good fishery, especially in the spring and fall. They also move into the dredge cuts during the winter and are caught by ice fishermen. It is not known if any lake trout spawning occurs below Fort Peck Dam or if the population depends entirely on recruitment from the reservoir.

A population of paddlefish is present in the study area. A mark-and-recapture estimate made in 1978 estimated a population of approximately 3,400 paddlefish in the upper dredge cut during late June and early July. Another 500 paddlefish were thought to be present in Nelson dredge that summer (Needham 1979). Tag return data indicates that these fish are part of a paddlefish population that inhabits Garrison Reservoir and migrates up both the Missouri and the Yellowstone rivers. Paddlefish in the study area apparently key to the dredge cut areas, especially the upper dredge cuts but they also use the tailpool on a seasonal basis. It appears that the dredge cuts are vital to maintaining a paddlefish population in the area. Sampling results indicated that part of the paddlefish population remained in the study area for extended periods of time.

Other game fish captured in the study area include channel catfish, burbot, shovelnose sturgeon and an occasional brown trout. In 1983, 45,000 chinook salmon were planted below Fort Peck Dam. In 1984, another 217,000 were planted. It is hoped that these fish will migrate downstream to Garrison Reservoir to mature, then return to the study area to spawn.

Table 2. Fish species found in the Fort Peck Tailwater/Dredge Cut Study Area.

ACIPENSERIDAE (Sturgeon family)
Scaphirhynchus platorynchus - Shovelnose sturgeon (A)
Scaphirhynchus albus - Pallid sturgeon (R)

POLYODONTIDAE (Paddlefish family)
Polyodon spathula - Paddlefish (A)

LEPISOSTEIDAE (Gar family)
Lepisosteus platostomus - Shortnose gar (R)

HIDONTIDAE (Mooneye family)
Hiodon alosoides - Goldeye (A)

SALMONIDAE (Trout family)
Coregonus artedii[c/] - Cisco (R)
Coregonus clupeaformis[e/] - Lake whitefish (R)
Salmo gairdneri - Rainbow trout (C)
Salmo trutta - Brown trout (R)
Salvelinus namaycush - Lake trout (C)
Oncorhynchus tshawytscha[a/] - Chinook salmon (R)

OSMERIDAE (Smelt family)
Osmerus mordax - Rainbow smelt (R)

ESOCIDAE (Pike family)
Esox lucius - Northern pike (A)

CYPRINIDAE (Minnow family)
Phoxinus eos - Northern redbelly dace (R)
Cyprinus carpio - Carp (A)
Hybopsis gracilis - Flathead chub (R)
Couesius plumbeus - Lake chub (C)
Notropis artherinoides - Emerald shiner (C)
Netropis hudsonius[d/] - Spottail shiner (R)
Hybognathus argyritis - Western silvery minnow (C)
Pimephales promelas - Fathead minnow (R)

CATOSTOMIDAE (Sucker family)
Carpoides carpio - River carpsucker (A)
Cycleptus elongatus - Blue sucker (C)
Ictiobus bubalus - Smallmouth buffalo (A)
Ictiobus cyprinellus - Bigmouth buffalo (A)
Moxostoma macrolepidotum - Shorthead redhorse (A)
Catostomus catostomus - Longnose sucker (A)
Catostomus commersoni - White sucker (A)

ICTALURIDAE (Catfish family)
Ictaluras melas - Black bullhead (R)
Ictaluras punctatus - Channel catfish (C)
Noturas flavus - Stonecat (R)

GADIDAE (Codfish family)
Lota lota - Burbot (C)

PERCICHTHYIDAE (Sea bass family)
Morone chrysops[b/] - White bass (R)

CENTRARCHIDAE (Sunfish family)
Micropterus dolomieui - Smallmouth bass (R)
Pomoxis annularis - White crappie (R)

PERCHIDAE (Perch family)
Perca flavescens - Yellow perch (C)
Stizostedion canadense - Sauger (C)
Stizostedion vitreum - Walleye (C)

SCIAENIDAE (Drum family)
Aplodinotus grunniens - Freshwater drum (R)

a/ First planted in study area in 1983.
b/ Single individual captured in the dredge cuts.
c/ First planted in Ft. Peck Reservoir in 1983.
d/ First planted in Ft. Peck Reservoir in 1982.
e/ Single individual captured in 1984.
A = Abundant C = Common R = Rare

Methods

Physical Measurements

During 1983, staff gauges were placed at seven locations in the study area to monitor the extent and magnitude of water level fluctuations due to power peaking (Figure 2). No standard monitoring schedule was established for these gauges. In 1984 three Stevens type F continuous reading water level recorders were utilized to develop a better understanding of the relationship between dam discharges and water levels in the downstream areas. Two of these were installed in the upper dredge cut, the third in the east side channel (Figure 2). These recorders were suspended above the water on a wooden platform by a piece of perforated 4-inch PVC pipe. The PVC pipe was mounted on a 12- x 18-inch piece of ¼-inch steel plate. Three-foot lengths of 5/8-inch rebar were welded to the bottom of this plate and driven into the bottom. The PVC pipe was leveled as nearly as possible and guyed to three steel fence posts. A second piece of 2-inch PVC was banded to the main pipe to house the counterweight. A weighted bottle or fishing bobber was used as a float. This was counterbalanced with lead weights. These recorders were checked weekly. Staff gauges were placed at the same location as the recorders.

The USGS was contracted to take two flow measurements at the opening to the upper dredge cuts during incoming and outgoing flows. These flows were supposed to be measured just after major increases or decreases in discharge from the power house. Because the change in discharges didn't occur at the designated times the results of these flow measurements are of limited value.

A level and rod were used to map gravel areas and bottom contours in the east side channel. Fourteen cross sections were surveyed across the major riffle areas. Elevations were determined and bottom types and water depths were recorded at 2 foot intervals across each cross section.

Data were collected for the Wetted Perimeter (WETP) Computer Program (Nelson 1984) to develop a relationship between flow and available bottom habitat in the east side channel. Two cross sections were established in the major spawning and rearing riffles of the side channel. Water surface elevations were measured at high, medium and low discharges using a level, level rod and standard surveying techniques. The channel profile was measured at low flow. Flows were measured at various discharge rates using a Price AA flow meter. These data were entered into the computer at Montana State University in Bozeman to ascertain the minimum instream flow for the east side channel.

Standard surveying methods and a Lowrance Model X-15 fish locator, with a chart recorder, were used to map bottom contours of the upper dredge ponds. Baselines were established along the west side of all three ponds. The lengths and angles of all baselines were related together, and baselines were marked off in 500-foot intervals. Cross sections were established at each 500-foot mark running at a known angle off of the baselines; both edges of the dredge ponds were marked for each cross section. A transit was used to keep a boat on the cross section line as it ran across the pond at a known speed. The bottom contours were recorded on the fish locator. A mark was made on the recorder every 30 seconds to relate distance to time. The cross sections on pond 3 were sounded through the ice. Cross sections were marked off across the ice. At known intervals (usually 100 feet) across each transect, small pockets were cut

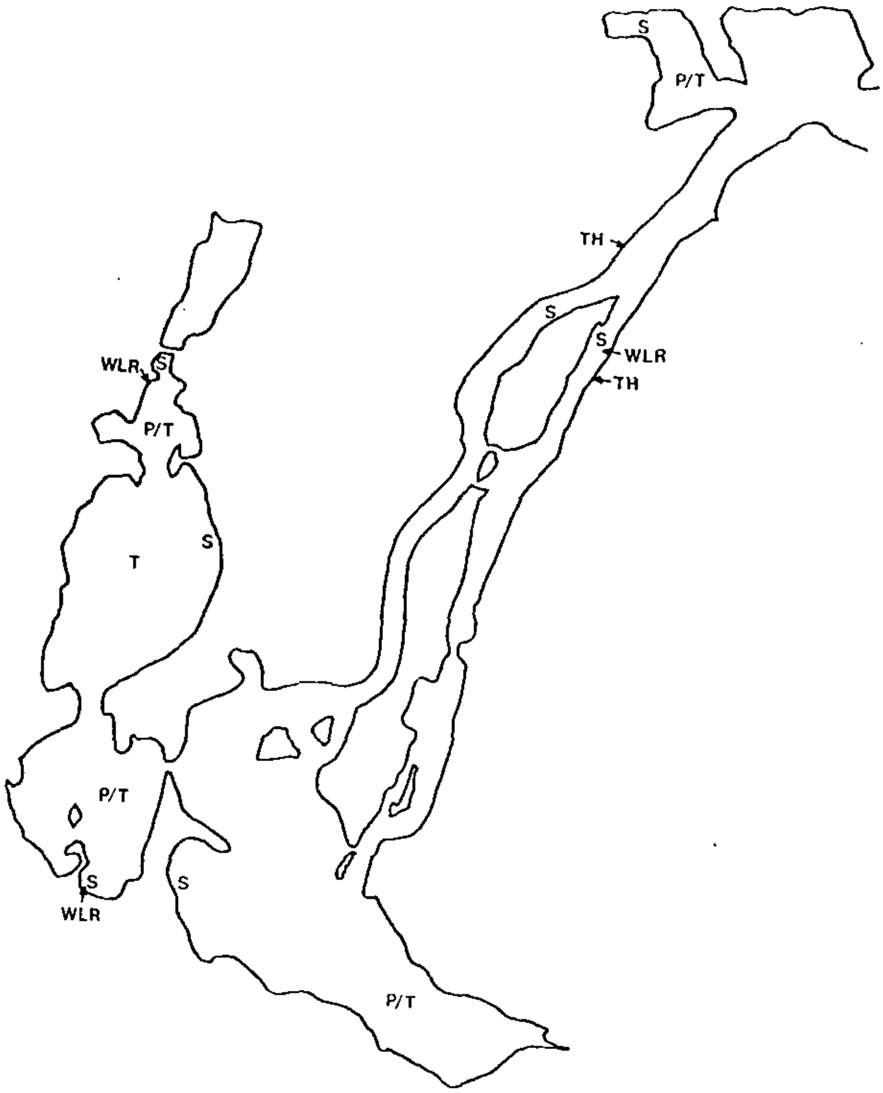

Figure 2. Locations of: Staff gages, 1983(s), water level recorders (WLR), temperature profile sites (T), thermographs (TH), and plankton sampling sites (P).

in the ice with an auger; these pockets were filled with water and a Lowrance Model 2330 tri-range fish locator was used to shoot the bottom depth through the ice. A tracing made from an aerial photo was enlarged to a known scale, cross sections were located and depths at each 100-foot interval were recorded. Bottom contour lines were drawn in using the recorded depths and the chart recordings of the bottom profile. A computing planimeter was used to calculate volumes for each contour; these values were summed to give a total volume for each dredge cut pond.

Water temperature profiles were measured at five sampling sites approximately biweekly (Figure 2). Profiles were measured from the bottom up and recorded to the nearest foot for each 0.5° C. change in temperature using YSI Model 54 oxygen and temperature meter.

This same method was used to measure several temperature profile series from the opening to the upper dredge cuts across pond 1 during different discharge patterns. This was done to develop a better understanding of how the cold water from the tailpool distributes once it flows into the dredge ponds.

Continuous recording, 30-day thermographs were used to monitor water temperatures in the main river and east side channel (Figure 2). In 1983 a single thermograph was placed in the east side channel on 12 April then moved to the main river from mid-July to early November. In 1984, one thermograph was monitored in the main river from 18 April through 18 September, a second one was monitored in the east side channel from 26 June through early August.

Thermographs were also used to record movement of cold water under the bridge at the opening to the dredge cuts. Three thermographs were placed in a boat tied to or anchored inside the bridge. The probes from these thermographs were suspended at different depths and were left out during a complete cycle of daily discharge patterns.

Discharge records at the Fort Peck powerhouse were utilized to develop a better understanding of the operation patterns of the dam. These records were also used when developing relationships between discharge and water levels.

Zooplankton

Zooplankton samples were collected using a 12-inch diameter Wisconsin-type net with a one meter long filtering cone constructed of 160 micron Nitex netting. A weighted sampling bucket was attached to this net to ensure a swift vertical descent. All samples were taken from an anchored boat to prevent drift and ensure vertical tows. Four sites were sampled on approximately a biweekly basis. These sites included pond 1 and pond 3 of the upper dredge cut, Nelson dredge and the tail pool (Figure 2). Specific sites were chosen based on depth. Where the water was deep enough, duplicate vertical tows were made from 25 feet to the surface. The site in pond 3 was less than 25 feet deep so tows were started at 20 feet.

Duplicate zooplankton samples were combined in the field and preserved with 5% formalin. Samples were diluted in the laboratory, stirred to get a random suspension, and subsamples were withdrawn using a 2-ml Hensen-Stempel pipette. Three 2-ml subsamples were counted for each sample using a modified Ward plankton counter (Ward 1955). Counts were made using a dissecting microscope at 30x total magnification. The percent of the total sample actually counted ranged from 2.4 to 9.4% depending on plankton density.

Organisms were separated while counting based on obvious morphological characteristics. Several subsamples were sent to Steve Leathe (Montana Department of Fish, Wildlife and Parks) to be keyed to lower taxa, but no attempt was made to separate these taxa while counting. Separate counts were made for Leptodora. Three 10-ml subsamples were taken from the diluted sample and scanned under low power. These organisms were relatively large and seldom appeared in the small subsamples during counts. A filtering efficiency was not calculated for the plankton net.

Electrofishing

Boat electrofishing was conducted using a boom-mounted positive electrode with a 240-volt gas-powered generator connected to a Coffelt VVP-10 voltage regulating box. Pulsed DC current was used. A 13.5-foot boat with a 25-horsepower outboard was used during spring electrofishing in 1983. An 18-foot boat, powered by an 85-horsepower outboard jet, was used for summer and fall shocking in 1983 and for all shocking in 1984. Both boats were equipped with lights and most shocking was done at night.

Spring shocking efforts in 1983 were concentrated in the east side channel and the main river from the head of Duck Island to Nelson dredge. Summer and fall shocking concentrated on the main river from the head of Duck Island to the spillway and in the tailrace pool immediately below the dam.

In 1984, spring shocking efforts were concentrated in the upper dredge cuts and in the river downstream of Nelson dredge. Summer and fall efforts concentrated on the tailpool and upper dredge cuts.

Only game fish or small fish were netted. No attempt was made to record other fish seen. All fish were measured to the nearest 0.1 inch and weighted to the nearest 0.01 pounds. Rainbow trout, walleye, sauger and lake trout that were large enough were tagged with numbered Floy anchor tags.

Young-of-the-year (YOY) rainbow trout were sampled by electrofishing in 1983 and 1984 using boat-mounted electrofishing equipment and a handheld electrode. In 1983, the east side channel and riffle areas in the main channel near Duck Island and by the USGS gauge house 8 miles below the dam were sampled. Due to the heavy growth of filamentous algae in the side channel in 1984, YOY shocking was much slower and only the main side channel riffles were sampled. The hand held electrode was also used to electrofish the shoreline areas of the upper dredge cuts in 1984.

Gill Netting

Gill nets were set in the upper and lower dredge cuts and the tailpool area during the spring, summer and fall. Netting sites were those that had been previously established by Needham (1979) (Appendix A). A series of 10 125-foot experimental gill nets with mesh sizes ranging from 3/4 to 2 inches, and four 100-x 6-foot monofiliment gill nets with ½-inch square mesh were fished during each season when possible. Due to the large number of fishermen in the spring of 1983, the upstream experimental and ½-inch gill nets in the tailpool were not set. Pond 3 of the upper dredge cuts was frozen by the time the fall gill net series was set in 1984 so no net was set at that site. All gill nets were set in the afternoon and fished overnight.

All game fish and a representative sample of other fish were measured to the nearest 0.1 inches and weighed to the nearest 0.01 pounds. A total count was made of all fish.

Age and Growth

Scales were collected from rainbow trout. Cellulose acetate impressions were made of these scales and examined at 48x magnification on microfiche projector. Measurements were made to each annulus and to the anterior edge from the center of the scale. The lengths, weights, ages and scale measurements were entered in files on the Montana State University Sigma 7 computer in Bozeman. The FIRE I age and growth program (Hesse 1977) was used to calculate condition factors and lengths at previous annuli.

Paddlefish Sampling

Paddlefish were sampled in the upper and lower dredge cuts utilizing a 550-foot x 18-foot seine with 2½-inch square mesh. This seine was set from a boat to enclose part of a bay and then worked to shore from both ends. During 1983, seining was conducted at random in a number of different locations in the upper dredge cuts. In 1984, five standard sampling sites were selected (Appendix A). All of these sites were seined on a normal sampling day.

During 1984, 4- and 5-inch square mesh gill nets were used to sample paddlefish, In September, two 150-foot nets were set in pond 2 and a 100-foot net in pond 1 of the upper dredge cuts. One 150-foot net was set on the bottom and the other two were floating sets. Large-mesh gill nets were set overnight on two occasions in late November. The first set included one 150-foot floating net in the tailpool just downstream from upper dredge cuts and a 100-foot floating and a 150-foot sinking net in pond 1 of the upper dredge cut. The second series included comparable sets of one 100-foot and two 150-foot floating nets. Three nets were set in pond 1 and three in the tailpool downstream from the upper dredge cuts.

Total length and eye-to-fork lengths were measured to the nearest 0.5 inch on all paddlefish collected in 1983. Only eye-to-fork lengths were measured in 1984. Other paddlefish research has determined eye-to-fork length to be a more valid index of paddlefish growth than total length. Rosen (1976) found that the growth in length of the rostrum was not proportional to growth in total body length. In order to compare lengths from this study with earlier work, total length measurements from past studies were converted to eye-to-fork lengths using a formula developed by Elser (1983). This formula was:

$$EFL = 0.8033\ TL - 6.8513$$

where EFL = eye-to-fork length in inches and
TL = total length in inches

All paddlefish were weighed to the nearest 0.5 pound. All paddlefish collected were punch-marked on the right or left operculum to distinguish if they were caught in the upper or Nelson dredge cuts. Most paddlefish captured in 1984 were tagged with numbered jaw tags.

Thirteen of the largest paddlefish collected while seining in May of 1984 were checked for sexual development by making a small incision into the peritonisl cavity and examining gonadal development. The incision was sewn up using dissolving suture material. One of these fish was recaptured in the fall and appeared to have healed very well.

Forage Fish

Two different minnow seines were used in 1983 to sample forage fish and YOY game fish. Thirteen sites were sampled in the upper and Nelson dredge cut areas using a 100-foot x 9-foot seine with ¼-inch square mesh (Appendix A). Sample sites were selected based on available habitat and on sites that had been sampled in 1979 (Needham and Gilge 1980). The seine was set from a boat to enclose the desired area, then worked to shore from both ends. A 50-foot x 6-foot x ¼-inch minnow seine was also used. This net was worked through small areas of cover by wading. Sites sampled included several that had been previously sampled with the 100-foot seine plus two areas in the main tailpool that had produced fish while seining in 1979, but were not sampled with the 100-foot seine (Appendix A).

The 50-foot seine was used exclusively in 1984. Sample sites were selected based on available flooded shoreline vegetation at the time of sampling. Twenty-one seine hauls were made in the upper dredge cuts and seven in Nelson dredge in the spring. Twelve seine hauls were made in the upper dredge cuts in August (Appendix A).

Forage fish and YOY game fish were also sampled in the dredge cuts using a 16-foot semi-balloon otter trawl with a ¼-inch cod end. This trawl was rigged with a 50-foot long double harness which was connected to a cable winch mounted on an 18-foot boat powered by an 85 horsepower outboard jet. The boat was run at approximately 4,500 rpm while towing. The trawl was pulled approximately 100 feet behind the boat. In 1983, most trawling was done as close to shoreline drop offs as possible around most of the shorelines of both the upper and Nelson dredge cuts. Tows were started and ended at natural breaks such as points and ranged in length from 5 to 12 minutes. Trawling efforts in 1984 were confined to the upper dredge cuts. More effort was made to sample the open water areas looking for cisco. Tows ranged in length from 7 to 27 minutes. Additional data were collected on forage fish and YOY game fish while gill netting and electrofishing as previously described.

Spawning Surveys and Egg Sampling

Rainbow redds were counted in the east side channel and main river in 1983 and 1984. No standard counting schedule was established in 1983. In 1984, counts were made at approximately two week intervals after the first redds were located. Elevations were measured for many of the redds built in 1983 and these redds were located on a map by triangulation using standard surveying techniques. In 1984, several redds were marked with rebar so they could be located later for sampling. Thirteen of these redds were excavated to determine egg survival. A 36- X 36-inch drift net made from fiberglass screen was placed downstream of the redd. Gravel in the redd was turned over with a shovel to free eggs and allow them to drift into the net. Eggs were sorted in the field and all live eggs were returned to the gravel after counting.

A 7- X 17-inch fine mesh long-handled net was used to sample for walleye and sauger eggs. The net was held downstream of gravel areas to be sampled, and the gravel was agitated by kicking towards the net. Eggs loosened were collected in the net, sorted in the field and stored in 5% formaldehyde.

Larval fish were sampled with a 20-inch diameter by 63 inch long drift net. The net was suspended in the current 15 feet downstream of a metal anchoring post and fished in 2.5 to 3 feet of water. This net could only be fished for 30 minutes before it became clogged and began to backwash. Samples were sorted in the field and stored in 5% formaldehyde.

Rainbow Redd Experiment

Artificial redds were constructed at three elevations near the upper riffle area in the east side channel. Elevations were selected based on actual elevations of natural rainbow redds in the immediate area. The shallowest experimental redds were about the same elevation as the shallowest natural redds. Forty percent of the natural redds in the area were shallower than the middle experimental elevation, and 60 percent were deeper than the deepest experimental redds. Ripe rainbow trout were collected by electrofishing on 5 May in the side channel area, and eggs were stripped and fertilized. Twenty-four fiberglass screen bags were partially filled with ½-inch gravel. One hundred fertilized eggs were placed in each bag, and the bag was sealed. Two bags were placed in each of two experimental redds and four bags in a third redd at each elevation. This was necessary to ensure that other incubating eggs were not disturbed when a two bag sample was retrieved for examination. All the bags were covered with clean gravel, and a protective wire grill was placed over each redd.

Depth and velocity measurements were taken at each experimental redd during the observed range of flows. Two bags were dug at each elevation on each sampling date and numbers of live and dead eggs were counted.

RESULTS AND DISCUSSION

PHYSICAL PARAMETERS

General Operational Plan for Fort Peck Project

Fort Peck Reservoir is the upstream most reservoir of six main stem Missouri River reservoirs operated by the COE as part of the Missouri River main stem reservoir system. This system is operated under the guidelines of a general operating plan (US Army COE 1984) within the constraints of the available water supply for that year. Flood control is the primary consideration in the total operation of this system. Within the limits imposed by necessary flood control, the system is managed to provide water for navigation, hydropower production, irrigation, downstream water supply and water quality control.

Fort Peck Reservoir has several functions in the total operation scheme of the system because of its large storage capacity and location at the upstream end of the system. Fall and winter water releases throughout the entire reservoir system are managed to achieve a 1 March system storage level at or below the base of the annual flood control zone. This would be an elevation of 2234.0 feet for Fort Peck Reservoir. During the navigation season which normally runs from 1 April through 1 December releases from the four lower main stem reservoirs are used to provide a majority of the necessary navigation flows. Discharges from Fort Peck and Garrison Reservoirs are reduced to store water. In the fall and winter when ice limits discharge levels from the lower reservoirs, discharges are increased from Fort Peck Dam and Garrison Dam to meet high seasonal power demands. Figure 3 shows the monthly discharge patterns from Fort Peck Dam over the past 20 years. In general, discharges were high during the winter and dropped to low levels in the spring. The summer discharge levels were controlled by the available water in the drainage. Generally, the better the water supply in the upper drainage, the higher the summer discharge level. Under normal conditions the maximum releases from Fort Peck Dam are controlled by the discharge capacity of the power plant; this is approximately 17000 cfs.

Minimum daily releases at Fort Peck are established as those necessary to supply water quality control and water intake requirements downstream. Instantanious hourly releases from the dam can drop to zero. Under normal conditions, Fort Peck is operated as a peaking power plant. The normal peaking pattern observed during this study was to run at peak discharge during the day, drop to low discharge at 2300 or 2400 hours, stay low until about 0500 or 0600 hours, then rise rapidly back to peak levels.

Influence of Fort Peck Dam on the River Downstream

The construction of Fort Peck Dam changed the natural flow and temperature patterns of the Missouri River below the dam. Natural flows would peak during spring runoff, decrease during the summer and be lowest during late fall and winter. The normal release pattern from Fort Peck Dam is just the opposite with the lowest discharge levels occurring in the spring and early summer and the highest discharges during the late fall and winter (Figure 3).

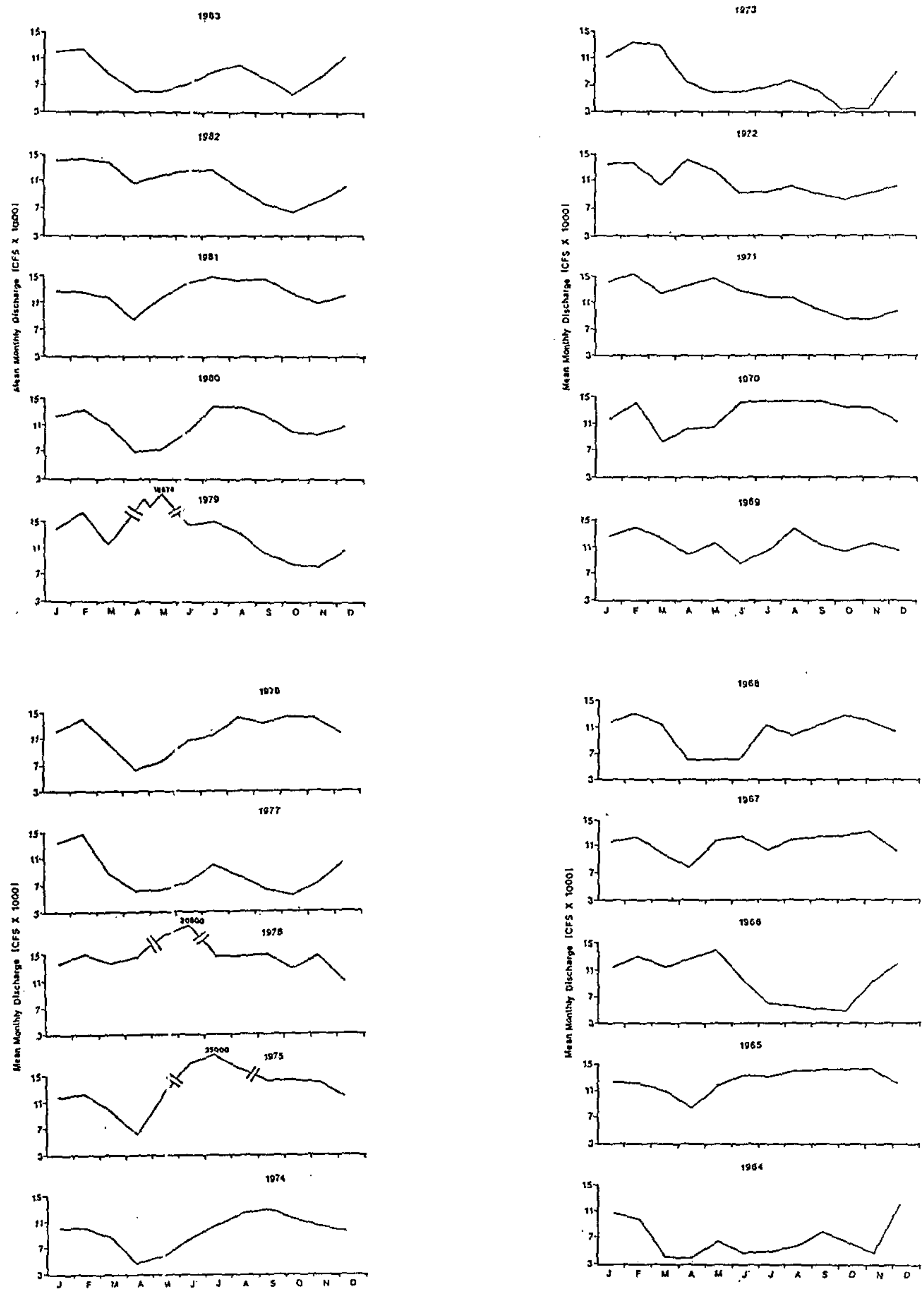

Figure 3. Pattern of average monthly discharges from Fort Peck Dam, 1964 to 1983.

Water Level Fluctuations

The unnatural flow conditions below the dam are accompanied by daily fluctuations in water levels due to the peaking operation of Fort Peck Dam. Table 3 presents the average and greatest daily fluctuations in discharge and the average monthly discharges from Fort Peck Dam observed during this study. The average monthly discharge patterns were similar for 1983 and 1984; discharge levels were maintained at a higher level during the summer and fall of 1984. The most extreme month of peaking occurred in July of 1983 when the average daily fluctuation in discharge was 10,485 cfs. The most extreme daily fluctuations in discharge occurred in May 1984 when discharge levels ranged from 2,832 to 16,320 cfs and in November 1984 when discharges ranged from 2,688 to 16,920 cfs within a 24-hour period. Table 4 presents the maximum seasonal and 24-hour changes in water levels recorded on three water level recorders installed in pond 1 and 3 of the upper dredge cut and in the east side channel in 1984. The large tailpool area and the dredge cut ponds act as reregulation pools to buffer the effects of rapid changes in discharge from the dam. Water moves back and forth between areas which tends to lessen the impacts of sudden changes in discharge on any one area and extends water level fluctuations over a longer period of time. Table 5 presents a series of hourly staff gage readings at five different locations starting three hours after discharges stabilized at a higher level. The change in discharge was small, but water levels continued to rise at all sites for at least 11 hours.

Flows were measured off the bridge at the mouth of the upper dredge cuts after increases and decreases in discharge to determine the volume of water being exchanged. Dam discharges on 25 September increased from approximately 6200 cfs at 0500 hours to 11,400 cfs at 0700 hours. A flow measurement taken off the bridge between 0900 and 1000 hours showed a flow of 711 cfs into the dredge cuts. A flow measurement starting approximately 30 minutes after the discharge decreased from 11,500 cfs to 7100 cfs measured a flow of 1,713 cfs out of the dredge cuts. The changes in discharge levels reported here were small compared to the average daily fluctuations in discharge reported in Table 3. These flows gave some indication of the potential reregulation effect the dredge cuts have on the total system.

Water Temperature Patterns

Water passing through Fort Peck Dam is withdrawn from the bottom of the reservoir, this has a significant effect on downstream water temperatures. Summer water temperatures remain much colder than they would in a normal river system. The warmest water temperature recorded in 1984 in the main river approximately 6 miles below the dam was 14.4°C. The normal maximum daily water temperatures throughout the summer ran around 12°C. Berg (1981) recorded maximum water temperatures of at least 25°C each summer between 1976 and 1979 in the Missouri River upstream from Fort Peck Reservoir near Robinson Bridge. In July of 1979 water temperatures reached 26.7°C.

Appendix B shows the water temperature profiles recorded at standard sampling stations on various dates in 1983 and 1984. No stratification occurred at the tailpool site in 1983. In June of 1984, there was a slight stratification in

Table 3. Summary of monthly discharge statistics for Fort Peck Dam for 1983 and 1984.

Month	Avg. Monthly Discharge (cfs)	Avg. Daily Fluctuation in Discharge (cfs)	Greatest Daily Fluctuation in Discharge (cfs)	Discharge Range For the Month (cfs)
		1983		
Jan	12,223	7,452	10,464	4,800 - 16,488
Feb	12,696	7,046	11,276	4,944 - 14,400
Mar	8,761	6,917	9,912	2,592 - 15,864
Apr	6,870	6,212	8,904	2,760 - 11,664
May	6,555	6,293	9,528	0 - 12,648
June	7,160	6,705	11,952	2,856 - 15,864
July	9,255	10,485	12,624	2,496 - 15,792
Aug	10,632	6,108	11,616	3,024 - 16,008
Sept	8,200	4,817	8,328	2,784 - 15,480
Oct	5,945	4,940	7,128	2,520 - 10,344
Nov	8,300	8,722	10,800	2,640 - 13,584
Dec	11,300	7,903	11,136	3,360 - 16,416
		1984		
Jan	12,539	3,289	8,736	6,432 - 16,032
Feb	12,972	1,736	4,728	10,416 - 15,504
Mar	7,990	4,938	9,768	3,000 - 13,698
Apr	7,687	5,910	9,192	2,736 - 12,456
May	9,497	8,392	13,398	2,736 - 16,320
June	9,667	6,929	9,648	2,736 - 14,112
July	9,574	5,443	9,264	4,920 - 14,880
Aug	10,755	6,447	10,368	4,800 - 15,720
Sept	7,673	6,363	11,520	3,456 - 15,024
Oct	10,071	5,771	10,296	2,808 - 13,536
Nov	12,153	8,516	14,232	2,184 - 16,920
Dec	12,148	7,271	11,640	3,336 - 16,416

Table 4. Maximum seasonal and 24-hour changes in water levels recorded on three water level recorders installed in the study area in 1984.

Recorder Location	Maximum Seasonal Water Level Fluctuation (feet)	Maximum 24-hr. Water Level Fluctuation (feet)
Pond 1	3.42	3.35
Pond 3[a/]	1.70	1.38
East Side Channel	2.53	2.23

[a/] Pond 3 was frozen in the fall when the most extreme fluctuations were recorded at the other two sites.

Table 5. Hourly change in staff gage elevations at five locations on November 2, 1983 compared to discharge from Fort Peck Dam.

Time	Discharge (cfs)	Pond 1		Pond 2		Pond 3		Tailpool		Nelson Dredge	
		Elevation	Hourly Change	Elevation	Hourly Change	Elevation	Hourly Change	Elevation	Hourly Change	Elevation	Hourly Change
0400	2832										
0500	2856										
0600	2856										
0700	7632										
0800	7248										
0900	7248	0.30		0.44		0.50		0.69		1.75	
			0.11		0.13		0.10		0.07		0.06
1000	7344	0.41		0.57		0.60		0.76		1.81	
			0.11		0.08		0.10		0.09		0.08
1100	7272	0.52		0.65		0.70		0.85		1.89	
			0.10		0.11		0.11		0.10		0.06
1200	7320	0.62		0.76		0.81		0.95		1.95	
			0.09		0.09		0.05		0.08		0.07
1300	7248	0.71		0.85		0.86		1.03		2.02	
			0.08		0.05		0.05		0.05		0.03
1400	7344	0.79		0.90		0.91		1.08		2.05	
			0.03		0.07		0.10		0.04		0.06
1500	7272	0.82		0.97		1.01		1.12		2.11	
			0.03		0.03		0.04		0.06		0.04
1600	7368	0.85		1.00		1.05		1.18		2.15	
			0.10		0.15		0.04		0.03		0.04
1700	7320	0.95		1.15		1.09		1.21		2.19	

the surface water of the tailpool. In the fall of both years, water temperature in the tailpool increased as temperatures were decreasing at the other sites; this resulted in the tailpool being the warmest area in the late fall. This temperature pattern was related to the turnover of Fort Peck Reservoir. Water in the reservoir above the dam was beginning to destratify by mid-September both years (Wiedenheft 1984, 1985) indicating that the reservoir was beginning to mix. This brought warm surface water to the bottom where it passed through the dam into the tailpool. The tailpool remained the warmest site through the last sampling date both years. The opposite effect of spring turnover was seen in 1984. Water temperatures in the tailpool dropped 1.5°C between mid and late April. This was about the time the ice went off the reservoir and the water started to mix bringing cold surface water to the bottom. Stratification of water first appeared in early June of 1984. The warmest surface temperature recorded occurred in pond 3 in late June. The windy weather and slightly higher discharges in 1984 prevented the development of as pronounced a stratification as was seen in 1983. The profiles recorded on 8 September 1984 were taken the day after a bad wind storm, most of the stratification had been lost. During 1984, water temperatures warmed up fastest in pond 3; this site remained the warmest during most of the summer. Pond 2 warmed up faster than pond 1. This indicated that water circulation due to changing discharges had progressively less effect the further the sample site was from the river.

Nelson dredge developed some stratification during the summer, but water temperatures remained much colder than the upper dredge cuts. It appeared that the circulation of water due to changing discharges was more pronounced in Nelson dredge than in even pond 1 of the upper dredge cuts.

Water temperature patterns were monitored in the upper dredge cuts during different discharge patterns to determine a relationship between water exchange and water temperature. Two series of temperature profiles were measured starting approximately 100 feet outside the bridge at the mouth of the upper dredge cuts, running under the bridge and straight across pond 1. Figure 4 shows the location of the temperature stations. Figure 5 shows the bottom profile along this temperature line. A shallow shelf starts just outside the bridge and extends approximately 150 feet into pond 1; the bottom then drops off to a minimum depth of about 18 feet.

The lower graph in Figure 6 shows the first temperature series that was measured starting at 0830 on 10 August 1984. Discharge from the dam had increased from around 9000 cfs at 0600 to approximately 13,000 cfs at 0700 producing a good flow from the tailpool into the dredge cuts. This figure shows a 10-foot deep layer of cold water flowing in under the bridge. When this cold dense water reached the drop off, it flowed down along the bottom under the warm surface water. The erratic temperature profile just inside the drop off and the fluctuating temperatures at some of the deeper depths in the other transects showed that the cold water was mixing throughout the pond. An obvious plume of clear water from the tailpool extended into the dredge cuts to about the edge of the drop off. A very definite change in water temperature could be felt while crossing this plume.

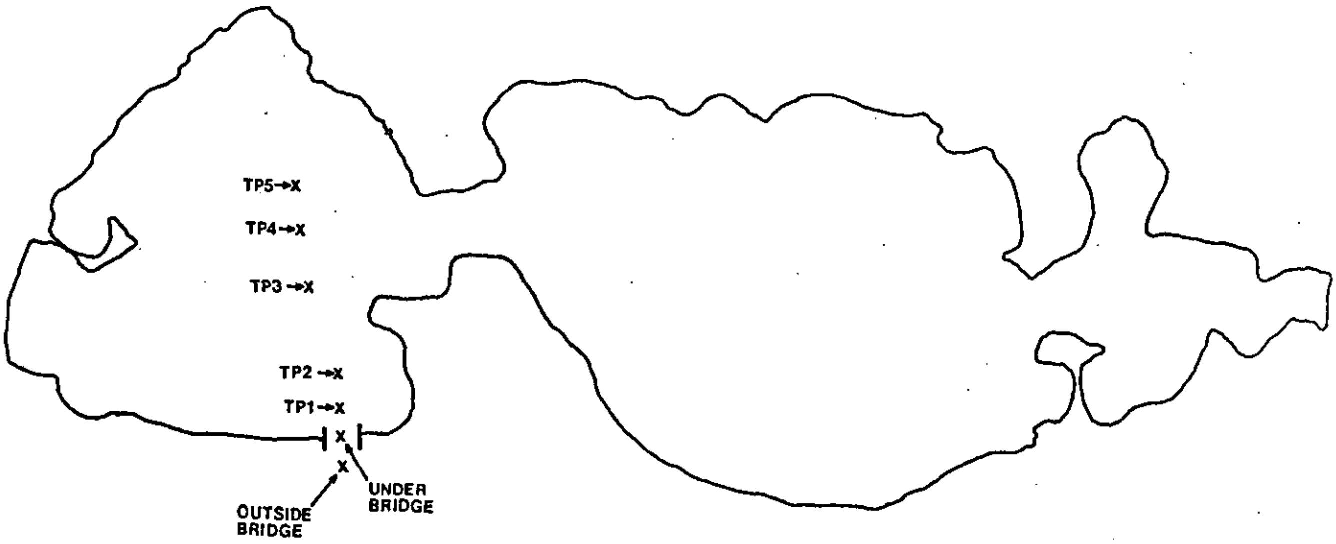

Figure 4. Location of temperature stations in pond 1 of the upper dredge cuts.

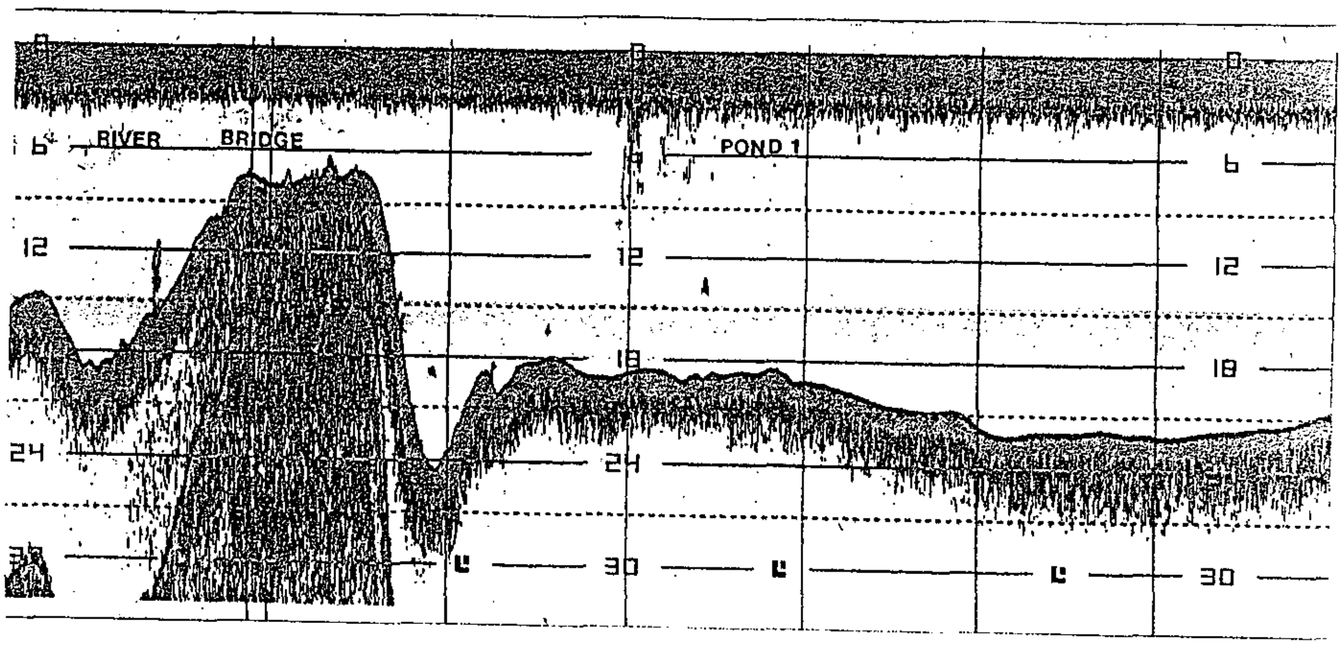

Figure 5. Recording of the bottom profile of pond 1 of the upper dredge cuts starting in the tailpool and moving west under the bridge and across the pond.

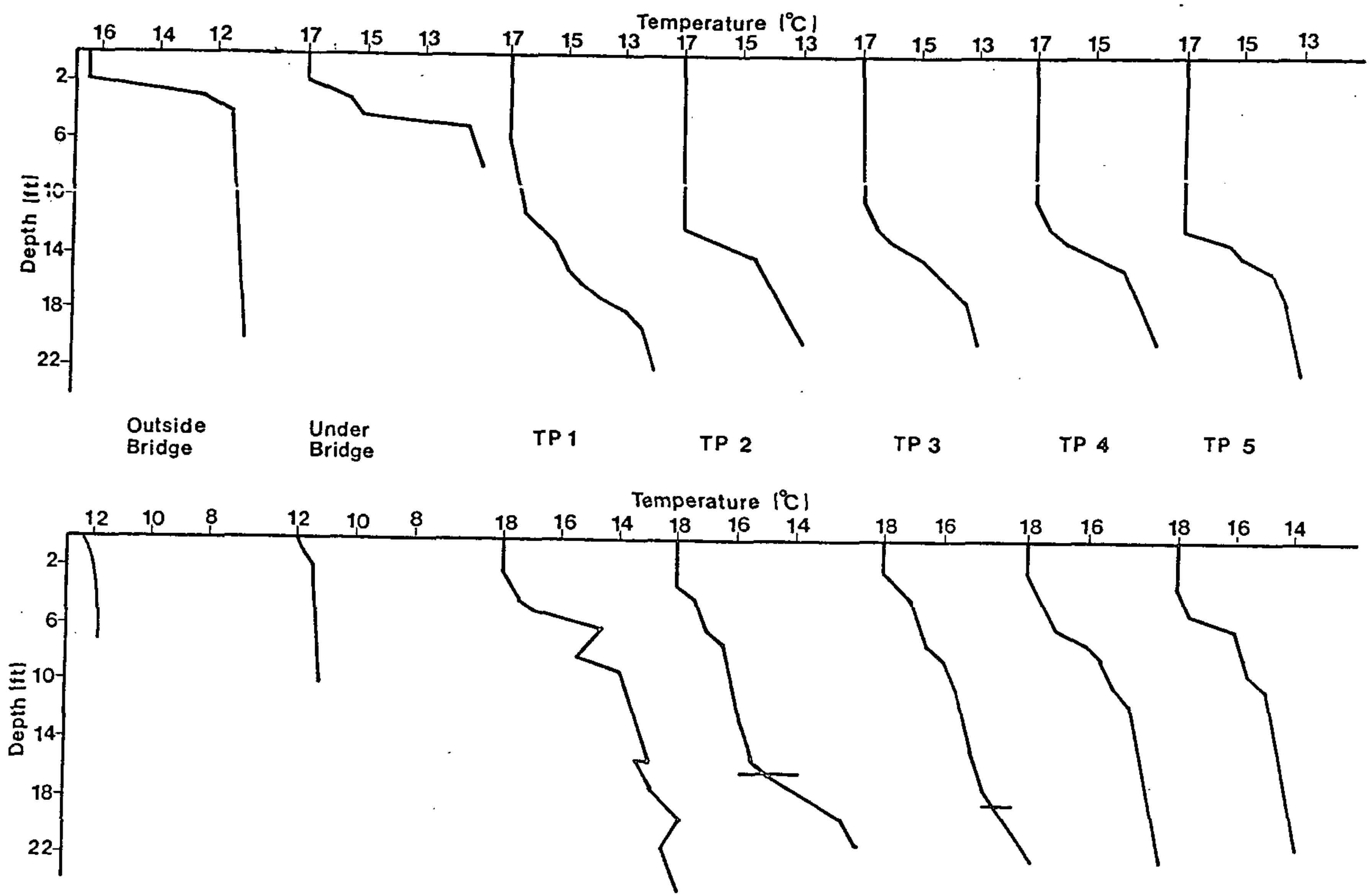

Figure 6. Water temperature profiles recorded at a series of stations starting outside the opening to the upper dredge cuts and extending west across pond 1. Lower graph - flow into dredge cuts, upper graph - no flow.

The upper graph in Figure 6 shows the temperature profiles recorded at these same stations starting at 1000 hours on 22 August, 1984. Dam discharges had remained around 10,000 to 11,000 cfs since 0800 the day before, and there was no current in either direction under the bridge. A surface plume of warm water extended under the bridge and out into the tailpool. A plume of muddy water was visible extending about 100 feet outside the bridge and again there was a definite temperature change crossing the edge of this plume. The surface layer of warm water extended down much deeper in the center of pond 1, and it appeared that the cold water was trapped near the bottom. The steep drop off just inside the bridge probably held the cold dense bottom layer in and allowed the warm surface water to move out over the shallow shelf under the bridge.

Figure 7 presents the temperature graphs recorded for three different thermograph probes suspended at different depths under the bridge at the opening to the dredge cuts between 21 and 23 August 1984. These graphs are compared to the hourly discharge records for the same time period. This figure verified the water movement patterns discussed above. Discharge from the dam had increased from around 6000 cfs to about 11,000 cfs approximately four hours before the thermographs were installed resulting in a flow of water into the dredge cuts. This produced an inflow of cold water at all depths under the bridge as seen in the lower graph of Figure 6. By about 1600 hours, flow into the dredge cuts slowed down and a layer of warm surface water started to extend out under the bridge. At around 2100 hours, the discharge level dropped slightly which started a flow back out of the dredge cuts. This flow started with a surge of warm water at all depths, but the bottom layers were rapidly replaced with cold water. This resulted in the stratification pattern seen in the upper graph of Figure 6.

Instream Flow Assessment for Spawning and Rearing Habitats

The wetted perimeter/inflection point analysis was applied to the east side channel. The maintenance of suitable flows in riffles from the onset of rainbow trout spawning, during late March, through the rearing period, lasting until the end of September, is essential. A considerable portion of the better spawning sites are located along the margins of the riffles, therefore, flows must be maintained at a proper magnitude to provide suitable flows during both spawning and incubation periods. Border sites in riffles consisting of large cobbles or brush with attached growths of filamentous algae comprise the chief rearing habitat. Flows should be kept at an adequate level to insure that this habitat remains watered. The most useful indicator for maintenance of suitable flows through riffle habitat is the wetted perimeter of the channel (Nelson 1984). Steady releases from the dam for several 48 hour periods were maintained while water elevations were measured at two cross section riffle sites. The actual water releases used for calibration were 4,400, 7,200 and 9,800 cfs. A composite of these two cross sections are shown in Figure 8. The inflection point, where the wetted perimeter losses of channel increase at an accelerated rate occurs at a side channel flow of 250 cfs.

Figure 9 represents the relationship between flows in the east side channel (near the cross section) and discharge from Fort Peck Dam. Because this relationship is based on a limited number of flow measurements, it is only an approximation and may not be entirely correct, but it was considered to be adequate for assessing dam releases. The linear relationship shown represented

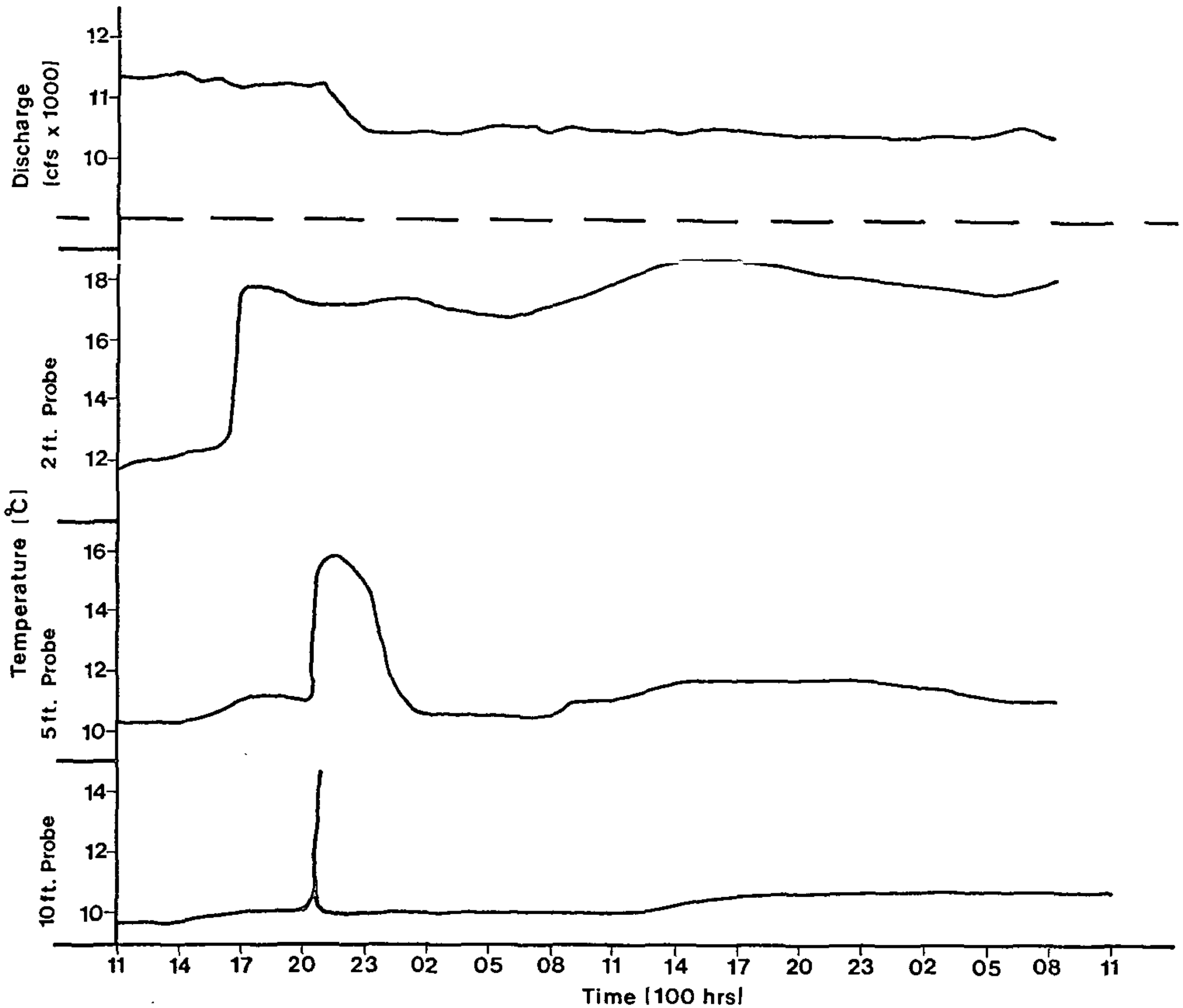

Figure 7. Graphs of water temperatures recorded on three thermographs stationed under the bridge at the mouth of the upper dredge cuts, probes were located at 2, 5 and 10 foot depths. Temperatures are compared to hourly discharge from Fort Peck dam during this same time.

a close fit to the available data (r = .96), but the curved relationship is a better representation of how stream flows respond to changing discharge. This is especially true at the lower end of the curve below the inflection point where a small drop in discharge results in a large loss of the remaining flows. Extrapolating off Figure 9 indicates that dam discharge should be maintained at 6,700 cfs to insure a minimum instream flow of 250 cfs in the side channel. This relationship does not consider the buffering effects of bank storage and reregulation from the tailpool and dredge cuts. It may be possible to maintain an instream flow of 250 cfs in the side channel for a limited time with an instantaneous discharge of less than 6,700 cfs.

This lower instantaneous discharge level would be dependent upon the average daily discharge level that was being maintained at the time. The higher the average daily discharge the more water would be available in bank storage and in the tailpool and dredge cuts to buffer the low releases.

It is very important that a minimum flow of 250 cfs be maintained in the side channel throughout the spawning and rearing seasons to provide suitable conditions for rainbow trout.

Morphometery of the Upper Dredge Cuts

Table 6 presents several morphometric features determined for the upper dredge cuts. The volume, depth and surface area measurements were calculated based on the high water line determined from an aerial photo. The maximum pool elevation recorded in the dredge cuts in 1984 was approximately 2,031.2 feet; it was assumed that the high water line on the aerial photo corresponded to this elevation. Length, width and average depths are approximations and were not calculated exactly.

Table 6. Morphometric characteristics of the three ponds of the upper dredge cuts.

	Maximum Width (feet)	Maximum Length (feet)	Average Depth (feet)	Surface Area (Acres)	Calculated Volume (Acre-feet)
Pond 1	3,750	4,500	14	241.2	3,334
Pond 2	3,705	4,857	20	364.7	7,254
Pond 3	2,667	3,000	16	78.0	1,253

Several problems surfaced while analyzing the field data that was collected during mapping of the dredge cuts. Because of the width of the dredge cuts, it was not possible to measure distance across with a transit and stadia rod. Location of the sounding boat on a cross section line and the length of the cross section were based on boat speed. It was difficult to maintain a consistent boat speed on every run due to changing wind and water conditions.

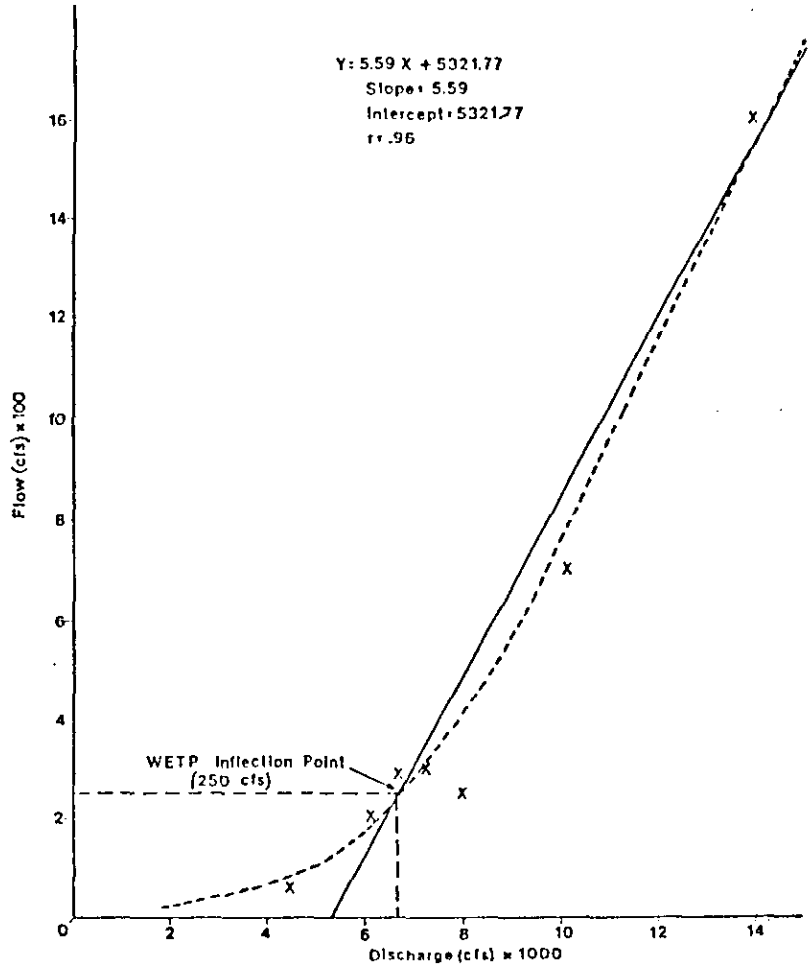

Figure 8. Wetted perimeter - flow relationship for a composite of two riffle cross sections located in the east side channel below Fort Peck Dam, 1983.

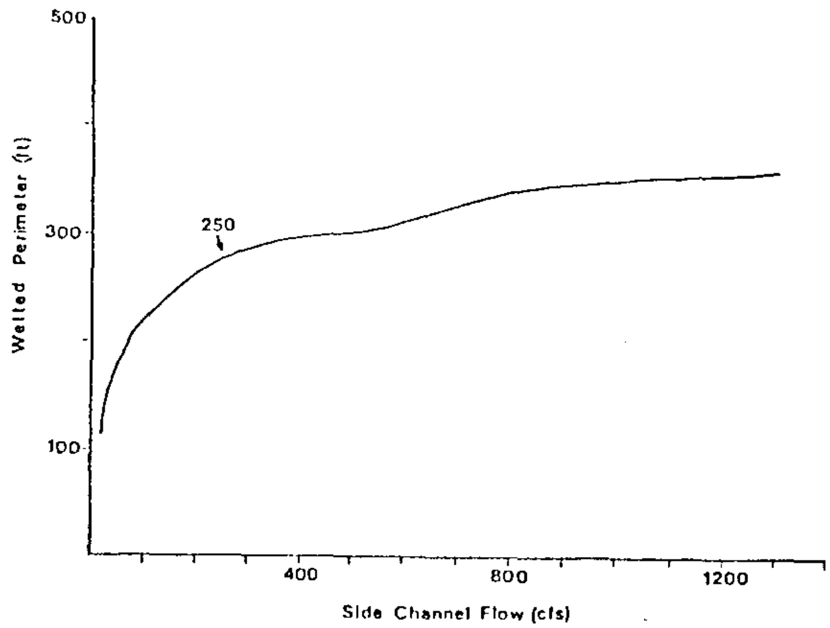

Figure 9. Relationship between Fort Peck Dam discharge and flow in the east side channel.

As a result, the lengths of some cross sections measured from the aerial photo and lengths measured from the sounding charts did not totally agree. The average difference between these two measurements for the 16 cross sections sounded with a boat was about 9%.

Because the dredge cuts were dredged, their bottom contours did not follow the same patterns that would be expected in a natural pond. This made it difficult to interpolate contour lines between the 500-foot cross section lines. Appendix C presents contour maps that were developed for the three dredge ponds based on available data and on knowledge gained during other sampling and should give a good representation of what the bottom of the dredge cuts look like.

Pond 2 presented the greatest problem as it contained a number of shallow points and ridges only some of which occurred at the cross section lines. It was difficult to relate these together between 500-foot cross sections. Volume calculations were based on these contour maps; consequently, they may be somewhat in error.

Zooplankton

Species Composition

Seven species of cladocerans and four species of copepods were identified in zooplankton samples collected from the Fort Peck area (Table 7). During counting, zooplankton were separated based on obvious morphological characteristics so some closely related organisms were counted as a group. Major zooplankton species were combined under four groups for analysis. Daphnia retrocurva were counted separate from other Daphnia in the study area. Daphnia retrocurva comprised 39.5% of the zooplankton collected from all sites combined in 1983 and 32.5% in 1984. Other Daphnia and Diaphanosoma were combined under Daphnia sp. This group comprised 4.5% of the 1983 zooplankton sample and 13.5% of the 1984 sample. Diaptomus made up only 2.5% of the zooplankton sample collected in 1983 and 3% in 1984. Cyclops was the most common zooplankton group in the study area. This group included Cyclops sp. and Mesocyclops sp. Cyclops comprised 53% of the zooplankton collected at all sites in 1983 and 50% in 1984. Two other cladocerans, Leptodora and Bosmina were also found; they made up less than 0.2% of the zooplankton sampled both years. Leptodora, the largest zooplankton species found in the study area was only collected in plankton samples from the upper dredge cuts from late July to mid-September during both 1983 and 1984. Bosmina was only found in two samples in 1984; one from pond 1 in early October and a second from Nelson dredge in mid-October.

Table 7. Crustacean zooplankton organisms identified from the Fort Peck study area during 1983 and 1984.

Clodocera

Daphnia retrocurva

Daphnia pulex

Daphnia schodleri

Daphnia galeata mendotae

Diaphanosoma sp.

Bosmina sp.

Leptodora kindtii

Copepoda

Diaptomus - 2 species

Cyclops sp.

Mesocyclops sp.

Since no filtering efficiency was determined for the plankton net used in this study, it was not possible to calculate actual plankton densities. Leathe (1982) found seasonal filtering efficiencies for a 0.5 meter diameter Wisconsin-type plankton net varied from 38% to 68% with an average filtering efficiency of 56%. The filtering efficiency of the smaller net used in this study was probably even lower. Plankton densities presented in this discussion are based on an assumed filtering efficiency of 100%; this allowed comparisons between sampling sites and sampling periods even though actual densities were not known. The same plankton net was used in Fort Peck Reservoir (Wiedenheft 1984) making it possible to compare plankton densities between the study area and the reservoir.

Seasonal Patterns

Figure 10 compares seasonal trends of combined zooplankton densities at the four major sample sites. Seasonal densities peaked earlier in the upper dredge cuts than at Nelson dredge or the tailpool; densities in pond 3 peaked earlier than pond 1. This corresponded with warming water temperatures at the different sample sites. Pond 3 warmed up faster, than pond 1. Nelson dredge warmed up more than the tailpool but never reached the temperatures found in the upper dredge cuts (Appendix B). Major population peaks occurred during the middle of the summer in the upper dredge cuts, but the major peaks occurred during the spring and fall in the tailpool. The peak plankton densities in the tailpool appeared to be related to spring and fall turnover of Fort Peck Reservoir. Circulation of water within a reservoir during turnover results in a more uniform distribution of plankton throughout the water column (Ruttner 1974). Higher concentrations of zooplankton in the deeper water near the intake structures of Fort Peck Dam during turnover resulted in higher zooplankton concentrations in the tailpool at these times.

Figures in Appendix D compare the combined densities of major groups of zooplankton at the four sample sites during different sampling periods. The most obvious trend that appeared in these data, and held for both years was that the total concentration of zooplankton remained highest in pond 3 on all sampling dates. This was probably a result of differences in flushing time and water temperatures at the four sites.

Pond 3 was the most isolated sample site and experienced the least influence from changing discharge levels. This resulted in warmer water temperatures and a longer turnover time of water at this site which gave zooplankton populations more time to build up. Cowell (1967) indicated that the standing crop of zooplankton in a reservoir or a stream-lake system was influenced by the water exchange rate (flushing time) (Cowell 1967). Brook and Woodward (1956) found that water exchange rates must be greater than 18 days for significant development of zooplankton, and Johnson (1964) observed that the effect was not linear; that it was considerably greater when the mean flushing time was less than 15 days.

Figures in Appendix D also show the trend of higher zooplankton concentrations at the tailpool site in the spring and fall.

Figures 11-13 compare the seasonal densities of the four major groups of zooplankton by sampling area. The main trend that appeared in the 1983 data was

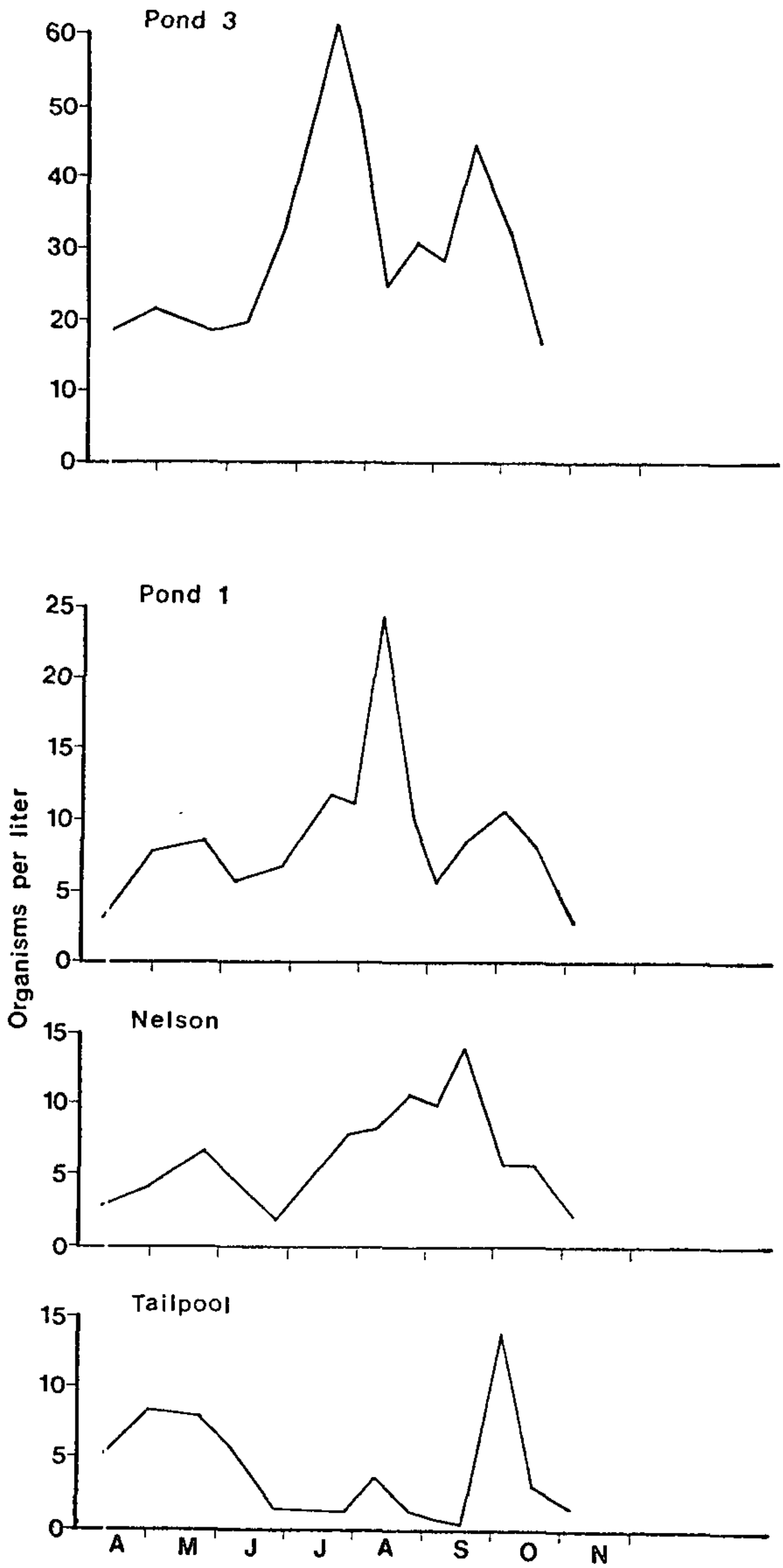

Figure 10. Seasonal trends in total densities (No./l) of major zooplankton organisms collected at four major stations in 1984.

the increased zooplankton concentration in the tailpool in the fall. Concentrations of three of the four major zooplankton groups were increasing in the tailpool in the fall; Daphnia retrocurva was decreasing. D. retrocurva was the most common Daphnia found in the study area but was rare in Fort Peck Reservoir, Cyclops was common in both areas, other Daphnia and Diaptomus were more common in the reservoir than in the study area. Based on this, the fall pattern for the tailpool site in Figure 11 provided good evidence that most of the fall zooplankton in the tailpool was coming from the reservoir. It was not possible to identify seasonal trends in 1983 since a full season of sampling was not conducted.

Several seasonal trends were evident in 1984 (Figures 12 and 13). D. retrocurva was the only major zooplankton group that was not represented at all sites throughout the sampling period. This species first appeared in pond 3 in late May and in the other three areas in June. D. retrocurva and Cyclops were the most abundant species at all sites. D. retrocurva showed bimodel peak in pond 3 and a single major peak in the other three areas. The major seasonal peak of all zooplankton occurred in early August in the upper dredge cut sites and in mid-September in Nelson dredge. The tailpool site showed major peaks in the spring and the fall with a small peak in August that corresponded to the seasonal peaks in the dredge cuts. The spring peak in the tailpool was the result of high levels of Daphnia other than D. retrocurva. These high Daphnia concentrations occurred in May when Fort Peck Reservoir was undergoing spring turnover; most of these organisms probably came through the dam. The tailpool showed two peaks in the fall. D. retrocurva and Cyclops concentrations started to increase in September and peaked in early October. Both of these species were common below Fort Peck Dam; D. retrocurva was uncommon in the reservoir. The concentrations of these organisms started to increase before fall turnover of the reservoir and peaked just as turnover was beginning. Based on these data it appeared that this peak was due to a natural population of these species occurring in the tailpool and not to flushing of plankton from above. This peak corresponded to the highest water temperatures recorded in the tailpool during the study (Appendix B). The second fall peak in the tailpool occurred in mid-October during fall turnover. This peak involved Daphnia sp. and Diaptomus, both groups more common in the reservoir than in the downstream area. Concentrations of these organisms were low at the other downstream sample sites at this time. Therefore, it appeared that this part of the fall tailpool peak was due to flushing of zooplankton through the dam. Even at peak levels, zooplankton concentrations in the tailpool were low compared to the other downstream sites.

Comparison of Densities with Fort Peck Reservoir

Table 8 compares the combined concentrations of major zooplankton groups collected throughout the 1984 sampling period from ponds 1 and 3 of the upper dredge cuts and from Fort Peck Reservoir just above the dam. The seasonal zooplankton peak occurred in June in the reservoir compared to August in the dredge cuts. The surface water in the reservoir warmed much faster than water in the downstream area which was probably a major factor influencing the timing of seasonal peaks. Combined zooplankton densities were higher in pond 3 of the dredge cuts than in Fort Peck Reservoir during every month except June when peak densities occurred in the reservoir. Densities were higher in the reservoir than in pond 1 for all months except August, the peak month in the dredge cuts. One of the major factors affecting plankton densities in a reservoir system is

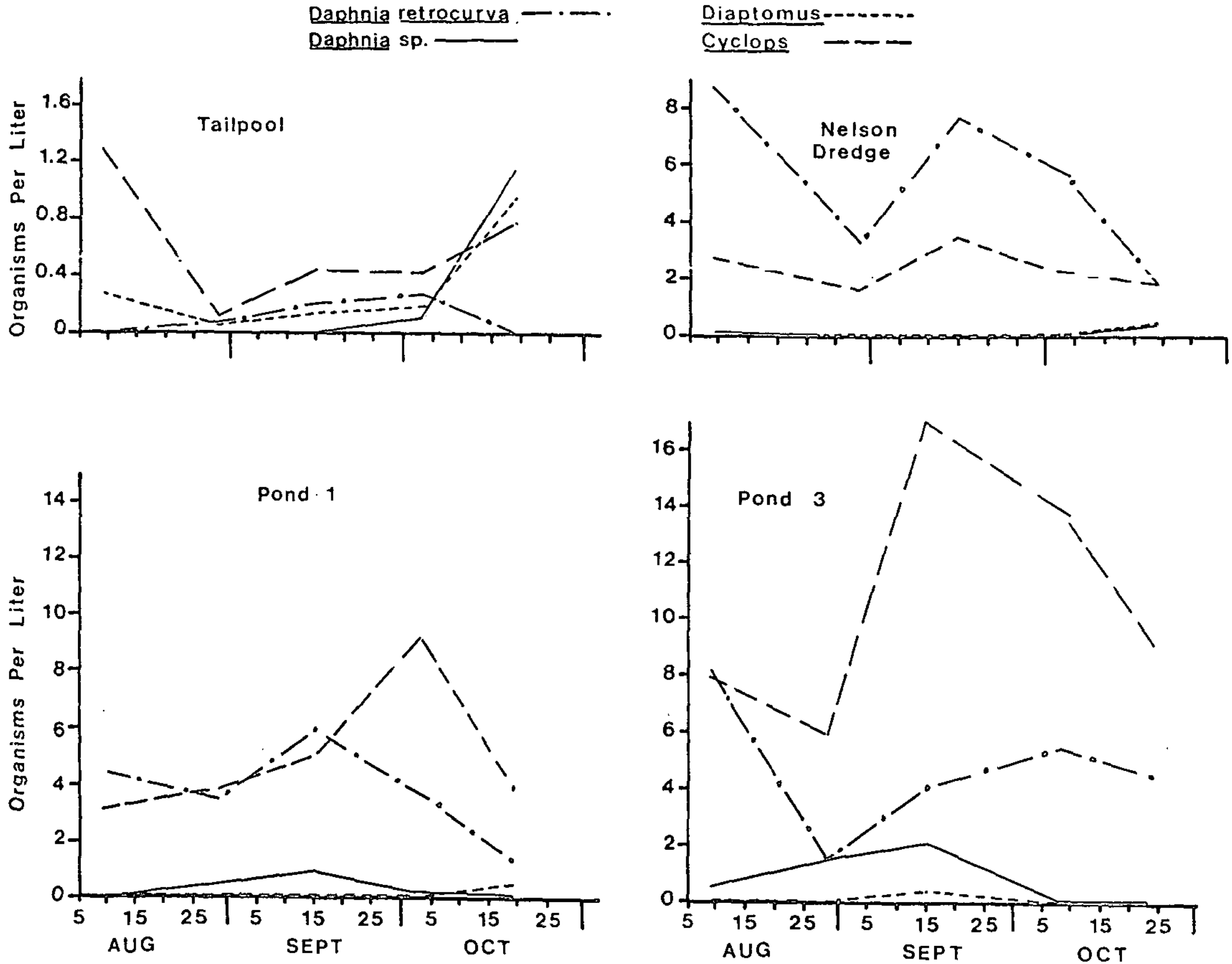

Figure 11. Comparison of 1983 seasonal density trends for four major zooplankton groups separated by sampling locations.

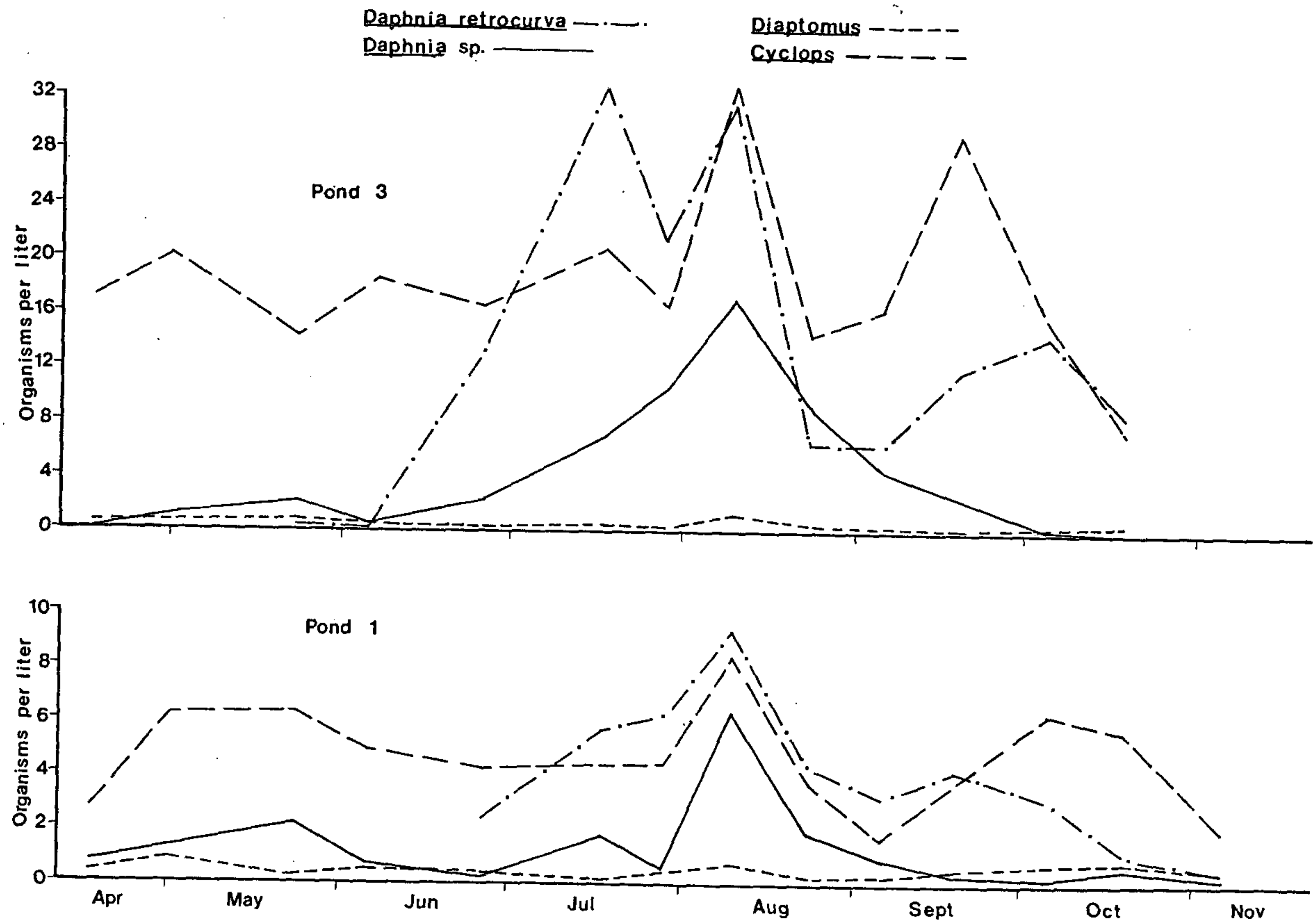

Figure 12. Comparison of 1984 seasonal density trends for four major zooplankton groups separated by sampling locations.

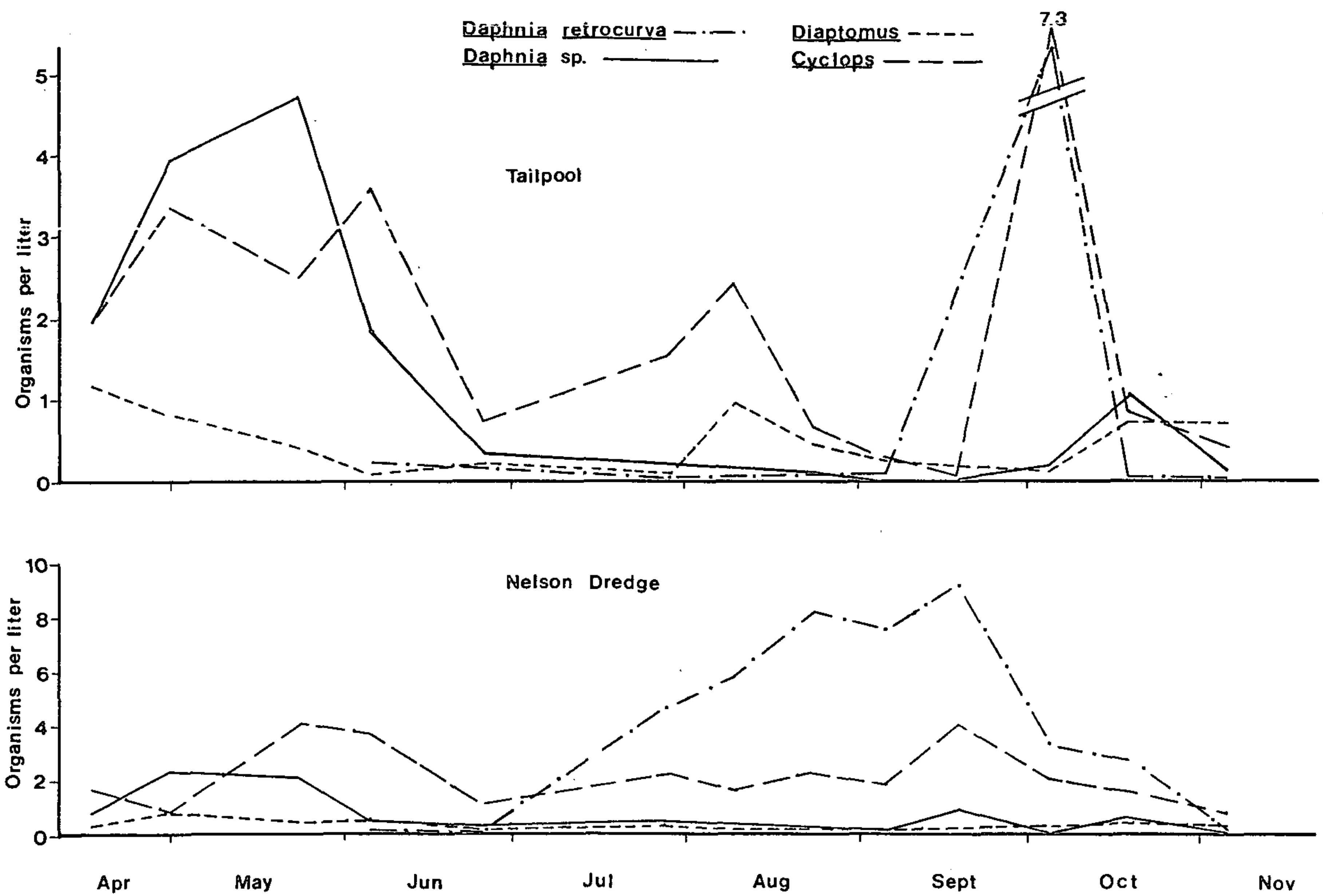

Figure 13. Comparison of 1984 seasonal density trends for four major zooplankton groups separated by sampling locations.

the water exchange rate (turnover time) (Cowell 1967). Turnover time in pond 1 was much shorter than in pond 3 which was a major factor affecting plankton densities between these two areas.

Table 8. Comparison of the combined concentrations of the major zooplankton groups collected in 1984 from pond 1 and pond 3 of the upper dredge cuts and from Fort Peck Reservoir near York Island.[a]

Sampling Period	Combined densities (organisms/liter)		
	Pond 1	Pond 3	Fort Peck Reservoir
May	7.89	21.32	10.3
June	5.90	19.86	73.8
July	11.71	61.24	27.0
August	24.60	84.02	17.3
September	5.75	28.10	21.4

[a] Fort Peck data from Wiedenheft, MDFWP

Plankton production should have been better in Fort Peck Reservoir than in the dredge cuts because of the warmer water temperatures in the reservoir. This did not appear to be the case when comparing zooplankton densities in pond 3 and the reservoir. Based on the data in Table 8, it appeared that the turnover rate of water in Fort Peck Reservoir was somewhere between the turnover rates for pond 1 and pond 3 of the dredge cuts. Soltero et al. (1973) reported that deep water withdrawal in reservoirs tends to draw nutrient-rich water from the bottom of the reservoir resulting in increased nutrients in the water being discharged downstream. This may have helped to enhance zooplankton production in the dredge cuts.

Vertical distribution

Table 9 presents the concentrations of major zooplankton organisms collected in two samples pumped from different depth above and below the thermocline in pond 1 of the upper dredge cut. Water temperatures was 17°C at 10 foot and 13°C at 22 foot. Figure 3 in Appendix B shows the water temperature profile in pond 1 for 25 August, one day after this sampling was conducted. There appeared to be some definite stratification of zooplankton. No *Daphnia* were found in the sample from 22 foot, but *D. retrocurva* were very common in the 10 foot sample. *Cyclops* were present throughout the water column, but appeared to be more concentrated at the deeper depths. *Diaptomus* appeared to be fairly evenly distributed throughout the water column. Table 9 also presents the concentrations of zooplankton collected in a 25 foot vertical tow in pond 1 several days later. It was not possible to compare densities since the sampling efficiencies of either collecting method was not known. *D. retrocurva* and *Cyclops* were still the most common organisms found in the vertical tow, but some other *Daphnia* species were also collected which were not seen in the pumped

Table 9. Comparison of densities of major zooplankton groups in water pumped from 10 and 22 foot depths (above and below the thermocline) in pond I and in a normal 25 foot vertical plankton tow collected in the same area.

Zooplankton Group	10 ft. Sample Organisms per liter	22 ft. Sample Organisms per liter	25 ft. Vertical Tow Organisms per liter
Daphnia retrocurva	2.81	0	3.52
Daphnia sp.	0	0	0.49
Cyclops	3.03	5.25	3.83
Diaptomus	0.11	0.17	0.14

samples. These Daphnia may have been concentrated at a depth that was not sampled with the pump. The concentrations of D. retrocurva were higher in the vertical tow sample while the concentrations of Cyclops were much higher in the combined pump samples. This discrepancy was probably related to the selective sampling efficiencies of the different methods. The pump may have been able to draw Cyclops in from a larger area around the intake or Daphnia close to the intake may have been able to avoid the suction and move out of range of the pump. More work would be needed to develop a good understanding of plankton distribution in the dredge cuts in relation to water temperatures, but these results did indicate that plankton developed some vertical distribution within the water column in the dredge cuts. Other factors such as light penetration probably also played a role in the vertical distribution of plankton.

RAINBOW TROUT

Rainbow trout were first planted in the Missouri River below Fort Peck Dam in 1950 (Table 10). Between 1950 and 1963, 49,643 catachable-sized rainbow were stocked in the river below the dam. This stocking was discontinued after the dredge cut trout pond was isolated in 1963. After this, rainbow were stocked in the trout pond rather than the river (Needham, personal communications). Approximately 38,000 surplus rainbow fingerlings available during 1980 and 1981 were planted in the upper dredge cuts outside the trout pond dam. Adipose fins were clipped on 22,000 of these fry released in 1981 in an attempt to identify future returns. No follow-up studies were conducted on the catchable plants made in the 1950's and 1960's. There were reports of these rainbow being caught by anglers. Limited rainbow sampling has occurred in the study area since 1980. No fin-clipped fish were ever recovered.

Table 10 Rainbow stocking records for the Missouri River downstream from Fort Peck Dam.

Stocking Date	Number Stocked	Size (length in inches
1954	3,870	10
1956	5,455	10
1961	4,900	10
1962	3,200	10
1963	6,720	8
1980	15,840	3
1981	22,000	3

A concentration of rainbow trout spawners was first documented in a small area downstream from Fort Peck Dam in 1979 (Stewart 1980). These fish were observed for only a short time in the spring and were concentrated in the east side channel and along the east riverbank downstream from the side channel. It was not known how long rainbow had been spawning in this area. Local anglers reported catching large rainbow in this area for a number of years.

Rainbow spawners were not sampled in 1979. Some rainbow were collected in the study area every spring between 1980 and 1984. Table 11 presents data on the adult rainbow collected during this time. In the spring of 1980, 22 rainbow were captured by electrofishing in the east side channel area below the dam. All of these fish were mature spawners. Their average total length and weight were 22.3 inches and 4.36 pounds. Fifty rainbow were collected in 1981; these fish averaged slightly smaller than the rainbow sampled in 1980. In 1982, little effort was spent sampling rainbow; only nine were captured (Stewart 1982). In 1983, a major effort was made to sample rainbow in the study area. Seven electrofishing trips were made through the east side channel and in the main river between Duck Island and Nelson dredge between 7 April and 25 May. This involved approximately 11.25 hours of actual shocking effort. Rainbow trout was the major species captured. A total of 112 rainbow were handled including three fish that had been tagged in 1981. Thirteen tagged fish were recaptured a second time during later electrofishing runs.

Table 11 Rainbow trout collected by electrofishing in the Missouri River between Fort Peck Dam and the Milk River from 1980 to 1984 (not including young-of-the-year or yearling rainbow).

Date	Number[a]	Mean Length (inches)	Mean Weight (pounds)	Length Range	Weight Range
1980	22	22.3	4.36	16.5-24.8	2.00-6.10
1981	50	21.7	3.65	12.3-26.5	0.74-6.60
1982	10	21.6	3.27	20.5-22.6	2.51-3.83
1983	130	20.7	4.01	9.2-25.6	0.32-6.20
1984	8	18.3	2.50	12.2-23.2	0.70-4.52

[a] Sampling effort was not comparable between years.

Eight yearling rainbow were collected in 1983. These fish averaged 5.7 inches total length and ranged from 4.1 to 6.8 inches long. The remaining 104 rainbow all appeared to be mature spawners. Of these, six fish were between 13.0 and 18.0 inches. The remaining were all greater than 18.0 inches total length averaging 21.6 inches long and 4.2 pounds. The largest fish collected was 25.6 inches long and 6.2 pounds. Thirty-one rainbow were collected in the study area during 10 nights of electrofishing between 19 July and 3 November. These fish again fell into distinct size groups. Four YOY rainbow were collected. These fish ranged from 2.7 to 5.1 inches total length. Seven rainbow ranging from 8.3 to 10.4 inches long were collected. One 16.2-inch fish was collected in mid-July. The remaining 19 fish ranged from 19.7 to 24.5 inches total length and had an average weight of 4.25 pounds. No special effort was made to sample adult rainbow during 1984; however, eight rainbow were collected while electrofishing for walleye and sauger downstream from Nelson dredge.

Distribution and Movement

The major concentration of rainbow trout in the spring was in the east side channel and along the east riverbank downstream from the side channel. Adult rainbow were collected in the spring as far downstream as the gravel bar by the USGS gauge house approximately 8 miles below the dam. Rainbow were collected between the rapids at the head of Duck Island and the mouth of the spillway from the spring through the last sampling date on 20 October. Sampling in the tailrace immediately below the dam produced only one YOY rainbow; however, anglers report catching large rainbow in this area.

It had been theorized that rainbow trout below Fort Peck Dam were part of a migratory population of rainbow that spent the major portion of their lives in Garrison Reservoir, only migrating to the Fort Peck area to spawn. No evidence is currently available to directly link Fort Peck rainbow with Garrison Reservoir. Large rainbow were found in the study area up to the last sampling date on 20 October indicating that these rainbows are probably resident below Fort Peck Dam.

Tag return data also supported the contention that rainbow trout are resident fish (Table 12). Rainbow tagged in the study area were recaptured in the same area in following years, rainbow tagged in the spring were recaptured in the study area during the summer and fall, and fish tagged late in the fall were recaptured the following spring. These data indicate that rainbow remained in the area throughout the year.

Table 12 Tagging data for rainbow trout tagged and recaptured in the study area downstream from Fort Peck Dam.

Date	Number Tagged	Number Recaptured 1981	1982	1983	1984	Percent Return
1980	22	5[1]	1			27.3
1981	50	1[2]	2	3[3]		12.0
1982	9			1		11.1
1983 (Spring)	97			2[4]	4	7.2
1983 (Summer & Fall)	25				3[5]	12.0

[1] Three recaptured by electrofishing.
[2] Tagged in April, recaptured in dredge cuts in July.
[3] Two recaptured by electrofishing.
[4] One recaptured in July, one recaptured by electrofishing in October.
[5] All tagged October 20.

Tag return data also give some indication of the size of the adult rainbow population present in the study area. Table 12 presents the number of rainbow that were tagged compared to the number recaptured since 1980. The percent of fish recaptured was quite high, especially considering that angling for rainbow in the area was limited almost exclusively to a couple of months in the spring and utilized by a relatively small number of anglers. The 1983 recapture percents are based on only one year of returns. Fish tagged in 1983 will be subject to recapture for at least two more years based on returns of 1981 tags. These results indicated that the total number of adult rainbow in this population is not large.

Age and Growth

Scale samples were collected from most rainbow sampled in 1983 for age and growth analysis; seventy-five scales could be read. Ages of these fish ranged from 0-8 years (Table 13). The mean length and weight and condition factors for each year-class indicated that conditions below Fort Peck Dam were very favorable for rainbow growth. The back-calculated length of rainbow at each annulus are presented in Table 14. The Montastyrsky logrithmic equation best fits the data (r = .89), indicating a curvilinear growth pattern. This r value is good considering the small sample size and the low number of younger aged fish. The growth rate of Fort Peck rainbow appeared to be exceptional. The calculated rate for Fort Peck rainbow was greater than the calculated growth reported for other rainbow populations in Montana in 1964 (Peters 1964). Growth rates for Fort Peck rainbow were better than those reported for rainbow in the Big Hole or the Yellowstone Rivers in 1982 or 1983 (Oswald 1984; Swedberg 1984).

Growth rates were at least as good as the growth observed for rainbow in the Bighorn River in 1984 (Wade Fredenberg, MDFWP, unpublished data).

Table 13. Age frequency of rainbow trout sampled from the Fort Peck tailwater area during 1983 with mean length, weight and condition factor (K_{TL}) of each age class.

Age	Number Fish	% of Sample	Mean Length (inches)	Mean Weight (pounds)	Mean K_{TL}
1	3	4.0	5.6	--	--
2	6	8.0	9.9	0.44	1.30
3	7	9.3	15.8	1.75	1.12
4	22	29.3	21.4	3.85	1.08
5	23	30.7	21.9	4.29	1.12
6	11	14.7	22.5	4.64	1.09
7	0	0	--	--	--
8	3	4.0	24.6	5.36	0.99

Table 14 Calculated lengths at each annulus and length increments for rainbow trout collected below Fort Peck Dam in 1983 (monastyrsky logarithmic method.

Age Group	No. Fish	Length at Annulus 1	2	3	4	5	6	7	8
1	3								
2	6	5.5	7.2						
3	7	6.8	10.5	16.1					
4	22	6.8	10.0	16.9	20.6				
5	23	6.4	9.5	15.3	19.1	21.6			
6	11	6.6	8.8	14.9	18.8	21.3	22.5		
7	0	---	---	---	---	---	---	---	---
8	3	6.3	9.7	15.0	18.4	20.3	22.1	23.8	24.6
Grand Average: Calculated Length		6.5	9.5	15.9	19.6	21.4	22.4	23.8	24.6
Length Increment		6.5	3.0	6.4	3.7	1.8	1.0	1.4	0.8

Table 15 compares the calculated growth rate of Fort Peck rainbow with the calculated growth of rainbow in other Montana waters. The rainbow sampled in the Marias River in 1982 were part of a tailwater fishery located below Tiber Dam and were considered to have a very good growth rate (Gardner and Berg 1983). This growth rate was still slower than the growth rate calculated for Fort Peck rainbow. Carlander (1970) reported only one other study where the calculated growth rates for rainbow trout (other than steelhead) was better than the growth rate calculated for Fort Peck rainbow. These fish were from six lakes in New Zealand. Other sampling results verified these calculated growth rates. On 21 August 1983, 32 YOY rainbow were collected in the east side channel area. The average length of these fish was 2.0 inches. They ranged from 1.4 to 2.6 inches total length. On 10 October 1983, 43 days later, 10 YOY rainbow collected averaged 3.0 inches total length and ranged from 2.2 to 3.5 inches. In 1984, 140 YOY rainbow sampled on 20 and 21 August again averaged 2.0 inches total length and ranged from 1.4 to 2.5 inches. Twenty YOY rainbow collected on 19 September 1984, less than a month after the first sampling, averaged 2.4 inches total length. These data indicated YOY rainbow were growing at a rate of 0.75 to 1.0 inch per month in the late summer and fall. This growth probably continued into November before water temperatures became too cold. Seven small rainbow were collected in the spring of 1981 between 7 and 27 April. They averaged 6.4 inches total length and ranged from 4.8 to 7.7 inches long. In 1983, eight small rainbow were collected between 14 April and 7 May. They ranged between 4.1 and 6.8 inches and averaged 5.7 inches total length. Three of these rainbow measuring 4.7, 5.2 and 6.8 inches long were determined to be age 1 fish. These results agree with the back-calculated average growth rate of 6.5 inches for age 1 fish. Six rainbow ranging from 9.2 to 10.4 inches total length were collected during the summer of 1983. These fish were all aged as 2+. Seven of eight rainbow between 13.1 and 18.7 inches caught in 1983 were determined to be age 3. All of these fish in which sex could be determined were males. The only female found in this size group was aged at 4. The remaining rainbow collected in 1983 ranged from 18.9 to 25.6 inches total length. All of these fish from which scales could be read were age 4, 5, or 6, with 3 of the largest fish being aged as 8 years old. Twenty-two rainbow collected in the east side channel in 1980 were aged at 5, 6 and 7 (Stewart 1981). Brown (1971) reported that few rainbow normally live beyond four or five years of age. After reviewing many studies on rainbow trout, Carlander (1970) found that the maximum age reported in any study for rainbow trout was eight. This indicated that the Fort Peck rainbow exhibited a very good longevity.

The age and growth and longevity data collected for these rainbow is very significant and may have important implications for future rainbow trout management elsewhere in Montana. The Montana Dept. of Fish, Wildlife and Parks is currently evaluating several rainbow strains in an attempt to improve the rainbow stocking program in the state. The Fort Pect rainbow appear to have many of the desireable characteristics that are being selected for.

In 1982, 10 Fort Peck rainbow were collected and sent to the University of Montana in Missoula for genetic analysis in an attempt to determine the origin of these fish. Results of these tests indicated that the genetic makeup of these rainbow was 90% Arlee, which has been the major stock of rainbow planted in Montana, and 10% unidentified stock (Robb Leary, unpublished date). Arlee rainbow are fall spawners while Fort Peck rainbow are spring spawners. Arlee rainbow have very poor longevity compared to the excellent longevity observed in the Fort Peck rainbow. These data indicate that the Fort Peck rainbow are a unique strain of rainbow that have apparently adapted to the conditions found below Fort Peck Dam. The fact that they are a self reproducing population adapted to Montana conditions and that they are spring spawners exhibiting both excellent growth and good longevity makes them an extremely valuable fishery resource in Montana. In 1984 the limit on these rainbow was lowered from 10 to 2 fish to help protect the limited spawning population. More restrictive regulations may be required in the future if this fishery becomes more popular.

Table 15 Calculated growth of rainbow trout sampled from the Fort Peck tailwaters in 1983 compared to calculated growth in other major Montana waters.

Water[a/]	No. of Fish	Average calculated length (inches) at each annulus							
		1	2	3	4	5	6	7	8
Fort Peck tailwater 1983	75	6.3	9.7	15.0	18.4	20.3	22.1	23.8	24.6
Marias River 1982	165	4.4	11.0	14.3	16.6	18.1	19.0		
Missouri River (Holter Dam) 1948	472	3.5	8.6	11.7	14.2	15.9	17.1		
Beaverhead River 1961	32	2.7	8.9	13.2	14.9				
West Gallatin River 1948-49	182	3.2	6.5	8.9	12.1	15.6			
Madison River 1950	436	4.3	9.4	12.6	14.9	18.5			
Rock Creek 1959	541	3.0	6.8	10.9	14.0	16.7			
Big Spring Creek 1960	100	4.6	11.4	14.9	17.5	20.6			
Ennis Lake 1950	329	3.1	8.8	13.7	16.1	17.8			
Georgetown Lake 1960	399	3.1	6.8	9.4	15.2	22.7			
Canyon Ferry Res. 1958	43	3.4	7.2	13.8	17.1	19.0			
Fort Peck Res. 1950	222	3.0	7.3	12.6	16.3	17.6	21.0		

[a/] Marias River data from Gardner and Berg 1983, other data from Peters 1964.

Spawning

Rainbow redd construction was monitored during 1983 and 1984. The first redd count was made on 6 April 1983 when 13 redds were located in the east side channel and tall pilings area just downstream from the mouth of the side channel. On 12 April, 33 redds were counted in this same area. Between 16 May and 1 June 1983, a combined total of 187 rainbow redds were located throughout the study area (Figure 14). During 1984 redd counts were made approximately every two weeks starting on 28 March. Thirty-one redds were located on this first count. New redds were discovered on each counting date through 5 June. It appeared that a large percent of early redds located in main current were indistinguishable at later counts. It also appeared that a number of fish spawned in the same general areas throughout the spawning period. Considerable superimposition of redds may have occurred in some areas. This made it impossible to get an accurate total redd count for the area. On 16 April, 105 redds were counted and another 6 previously located redds were known lost. Between 16 April and 5 June, 135 new redds were located. This included increases over previous counts in an area and redds located in new areas. This gave a total count on 5 June of 246 redds (Figure 15). There were several areas of preferred habitat where it was not possible to make good counts. These were usually in areas of fairly fast water. Early redds in these areas were lost due to scouring and/or algae. Later fish spawned over these same areas, making it very difficult to distinguish new redds from old ones or to determine how many fish had spawned in these areas. Only known new redds were counted in these areas later in the spawning season. The higher average discharge in 1984 made it very difficult to count redds in the main river, so some redds were undoubtedly not counted in these areas. Therefore, the actual number of redds built in 1984 was probably higher than the total count given. This same pattern probably occurred in 1983 making the single combined count between 16 April and 1 June a low estimate of the total number of redds constructed.

Rainbow spawned in the same general areas during 1983 and 1984. Concentrations of redds were located in the same areas of major riffles both years. This was partially due to fluctuating water levels during the spawning season which limited usable spawning habitat and forced fish into deeper areas. The normal peaking pattern at Fort Peck was followed throughout the spring spawning season. Most rainbow spawning occurred at night under cover of darkness, which meant the majority of spawning took place during dropping or low water. This forced fish to select deeper areas in the main channel and severely limited the use of shallower areas for spawning. The different discharge patterns observed during the 1983 and 1984 spawning seasons exemplified these problems. Figure 16 compares the maximum, minimum and average daily discharges from Fort Peck Dam during the 1983 and 1984 spawning seasons. Rainbow spawned from late March through May both years. The average daily discharge level was higher in 1984 than in 1983 for most of the spawning season. During 1983, the average discharge stayed around 6500 to 7000 cfs throughout the period. In 1984, average daily discharges increased from around 6000 cfs at the end of March to over 9000 cfs by mid-April and remained near or above this level for the rest of the spawning season. Another important, and apparently critical difference was the higher minimum daily discharge levels that were maintained during most of the 1984 spawning season. During 1983, the minimum daily discharge was less than 3300 cfs for 82% of the days between 1 April and 31 May. The minimum daily discharge was above 4200 cfs for 59% and above 5000 cfs for 26% of this same time period in 1984. Based on our wetted perimeter/inflection point analysis, the minimum flow for maintaining good spawning conditions was 250 cfs which corresponds to a discharge of 6700 cfs from the dam (Figure 9). However, even the difference between 1983 and 1984 minimum discharge levels had a significant impact on the rainbow spawning. The increased average daily discharge flooded more shallow areas during a greater period of the time. The higher minimum discharges maintained water over more of this area even at low flow making more spawning substrate available.

In 1983 two riffles in the east side channel were surveyed and mapped; contour intervals were later plotted to describe the channel characteristics. Results of monitoring water elevations at these riffles at medium (545 cfs), low (169 cfs) and extremely low (55 cfs) flows are shown in Figures 17 and 18. These figures depict the corresponding dewatering of bottom substrate at these three flows. Both riffles were essentially dewatered at the extremely low flow of 55 cfs.

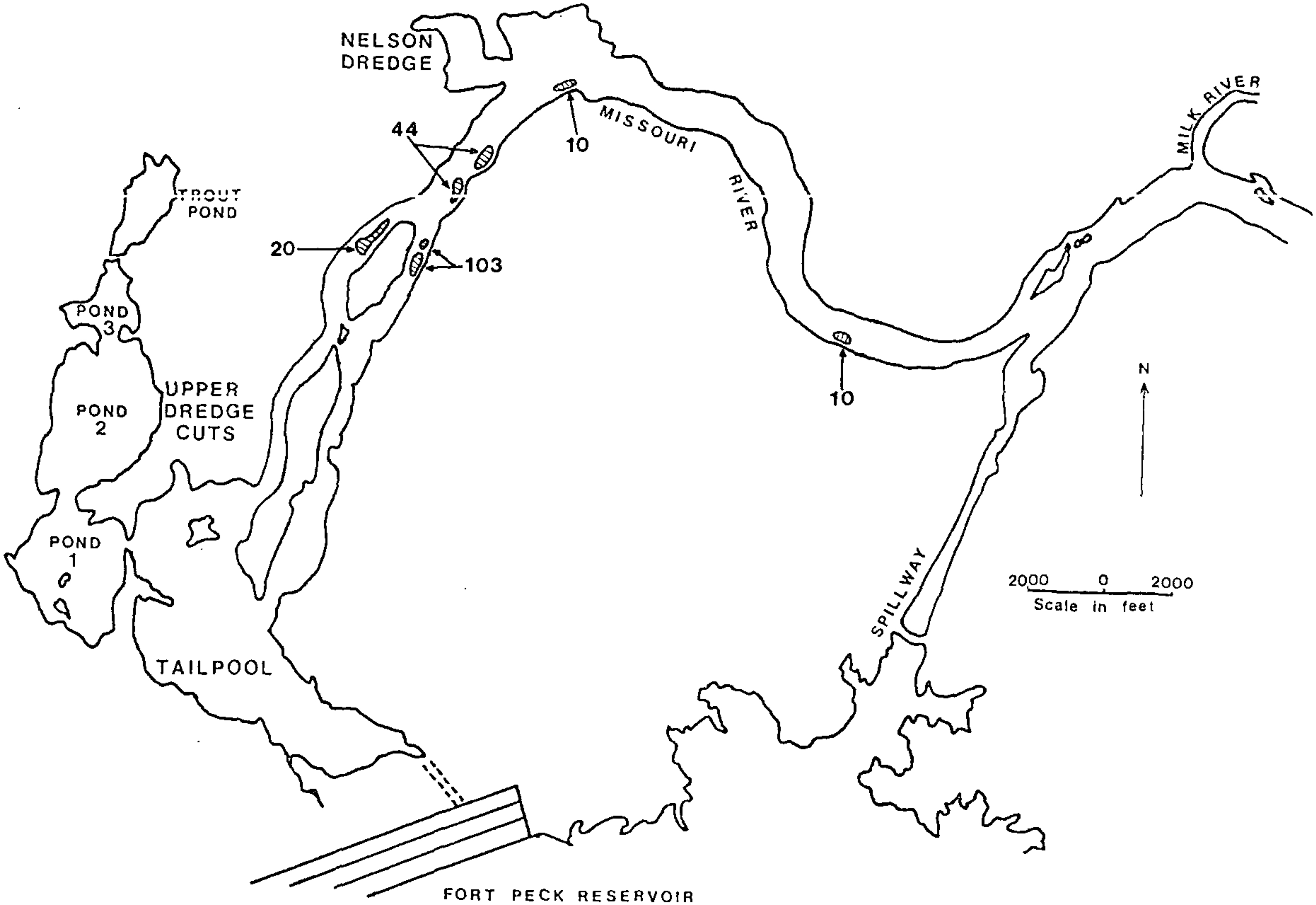

Figure 14. Location of rainbow redds counted in the study area in 1983.

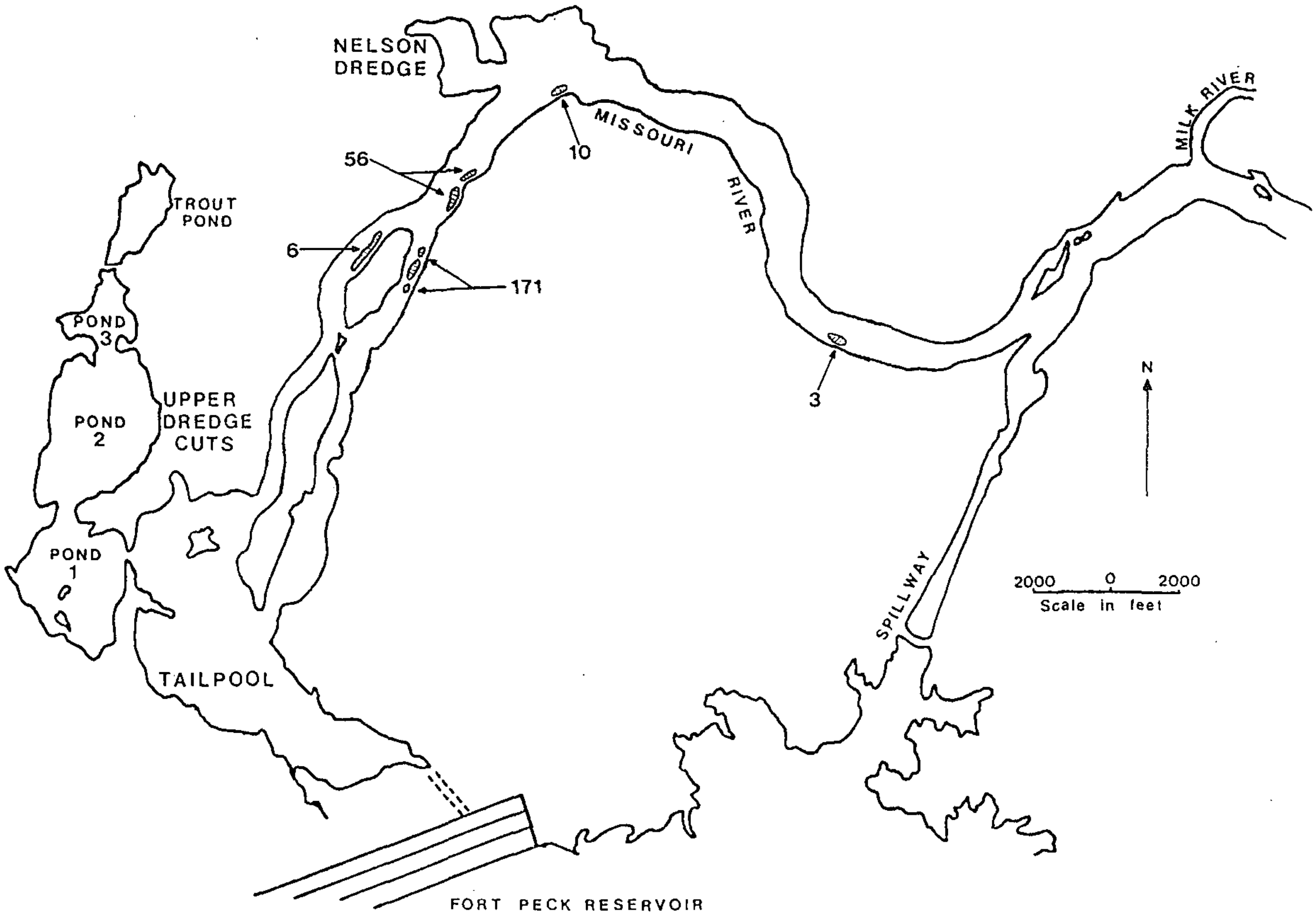

Figure 15. Location of rainbow redds counted in the study area in 1984.

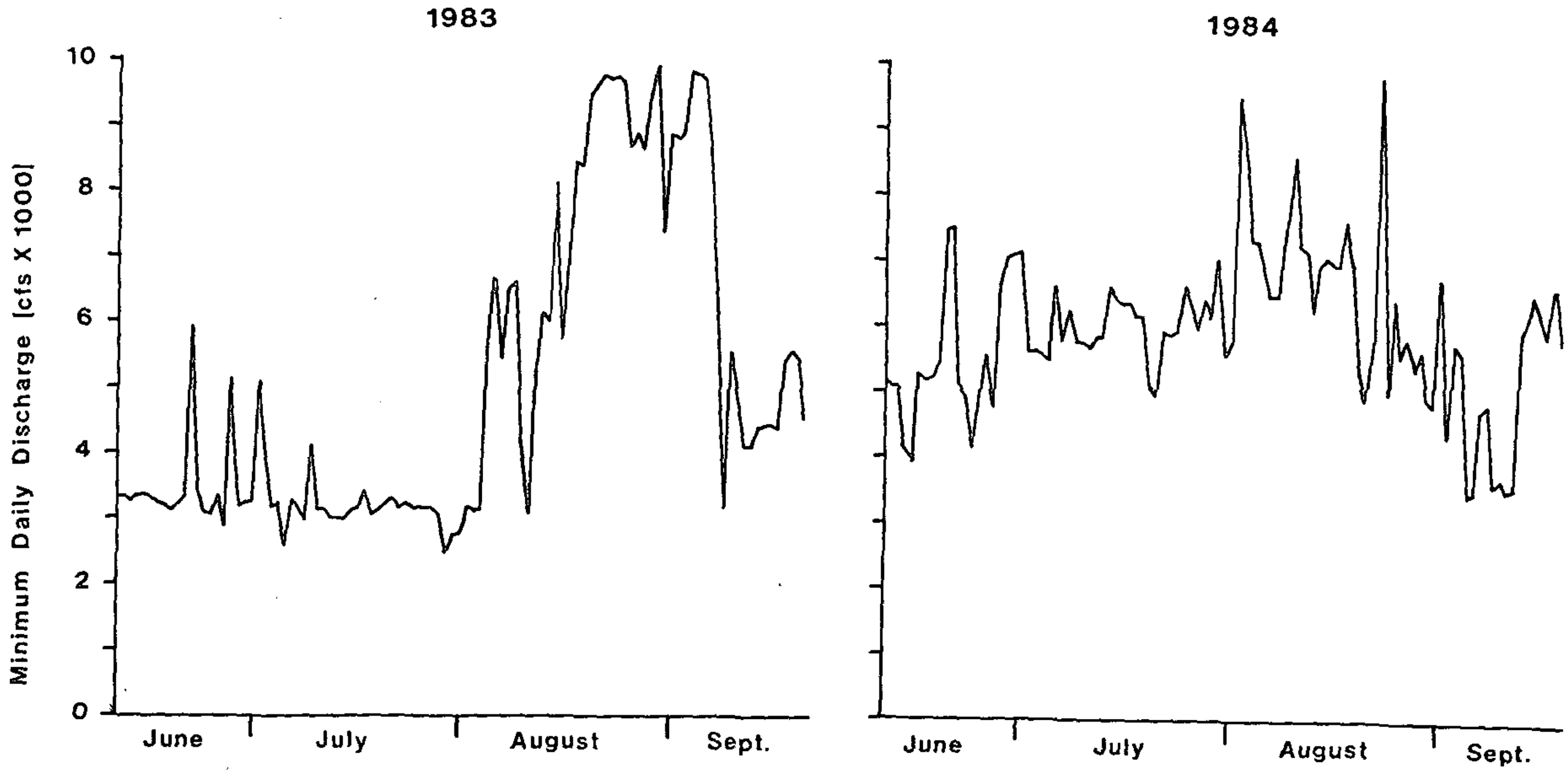

Figure 16. Maximum, minimum and average daily discharges from Fort Peck Dam observed during the rainbow spawning seasons in 1983 and 1984.

Based on the relationship developed in Figure 9, a flow of 169 cfs was probably comparable to the normal flow that occurred in the side channel during the spawning season in 1983. A flow of 545 cfs was probably comparable to the normal side channel flow during the later part of the spawning season in 1984. Because the relationship in Figure 9 is based on constant discharges it does not present a true representation of the flow-discharge relationship during changing discharges. Because the low average daily discharges were accompanied by very low minimum discharges in 1983 (Figure 16) the normal flow was probably lower than would be indicated by Figure 9. In 1984, the higher average daily discharges were accompanied by higher minimum discharges (Figure 16) so the normal flow was probably higher than indicated by Figure 9.

A majority of new redds located during latter May and early June in 1984 were in areas that had been mostly dewatered earlier in the spawning season. Figures 19 and 20 show the locations of major concentrations of rainbow redds in the upper spawning riffle in the east side channel during 1983 and 1984. A comparison of spawning activities in this riffle between years showed that many of the additional redds constructed in 1984 were located along the shallow edges of the riffle in areas that would have been dewatered at normal 1983 flows (Figure 17). Some 1984 redds were located in areas that were subject to dewatering at 1984 discharge levels. These results indicated that rainbow would use more of the side channel for spawning if substrate was made available by maintaining higher water levels.

Incubation

When high daily discharges resulting from extreme peaking are accompanied by low minimum daily discharge levels such as occurred during early May 1984 (Figure 16) other problems occurred. These included stranding of adult fish by rapidly dropping water levels and dewatering of eggs that were deposited in shallow areas. The lower the minimum daily discharge accompanying high peaking, the more severe these problems would be.

During both 1983 and 1984, rainbow redds were located that experienced occasional or even nightly dewatering depending on the flow pattern and their elevation. In 1983 a study was designed to investigate the extent and consequences of chronic redd dewatering. The water surface elevations were determined for 43 redds located near the upper side channel riffle. Individual elevation measurements were taken at the top of the gravel mound behind each redd. It was felt that if water covered the highest portion of the redd, there probably was enough flow circulating through the gravel where the incubating eggs were located. Based on the initial measurements, water surface elevation conditions at each redd could be determined for a variety of side channel flows by using the WETP hydraulic simulation program to project water surface elevations. Results of these projections are given in Table 16. Approximately 50% of the surveyed redds were projected to be dewatered at flows of 90 cfs. According to the relationship developed between dam discharge and side channel flow (Figure 9) a discharge of about 5000 cfs would be required to maintain a side channel flow of 90 cfs. The major incubation period of rainbow trout in the side channel was from late April through early July. During this period 96.3% of the days in 1983 and 49.4% of the days in 1984 exhibited hourly discharge of less than 5000 cfs. No redd elevations were surveyed in 1984, but based on the observation that a majority of the 1984 redds were located in shallower areas than 1983 redds (Figure 19), it would have required a discharge greater than 5000 cfs to maintain water over 50% of the 1984 redds.

Table 16. The relationship between the east side channel flow and number of 1983 sampled redds which would be watered by the given flows as predicted by the WETP hydraulic simulation program. (Forty-three redds were surveyed.)

Side Channel Flow (cfs)	Cumulative Number Redds Watered	Percent of Redds Watered
21	5	12
30	10	23
40	11	26
50	15	35
60	20	47
70	20	47
80	21	49
90	21	49
100	22	51
120	24	56
140	25	58
160	25	58
180	26	60
200	29	67
250	30	70
300	32	74
350	37	86
400	40	93
450	40	93
500	41	95
550	43	100

A number of studies have shown that even partial dewatering of salmonid eggs can cause severe stress resulting in high egg mortality, delayed hatching, and the production of small, weak sac fry (Corning 1955; Silver, Warren and Doudoroff 1963; Shumway, Warren and Doudoroff 1964; Becker, Neitzel and Fickelsen 1982). An attempt to evaluate the effects of water level fluctuations on rainbow egg survival in the side channel met with limited success. Table 17 shows the percent of live eggs in two bags at the 14th and 33rd day. When bags were checked on the 47th day nearly all the eggs were dead. A thick mat of algae and silt had collected on the protective grill over these bags. It appeared that this unnatural accummulation over the artificial redds had smothered the eggs so the experiment was terminated. The data collected early in the experiment indicated that fluctuating water levels did have a detrimental effect on the incubating eggs in the shallow bags. Only 52% of the eggs in these bags were alive after 14 days and almost 100% mortality had occurred by day 33. Some mortality occurred in the other bags by day 33, but it was not as extreme as in the shallow bags. Table 18 presents the range of depth and velocity measurements observed at the three experimental elevations between 5 May and 21 June. Since these experimental redds were not monitored continuously, it was not known what percent of the time the shallow area was dewatered.

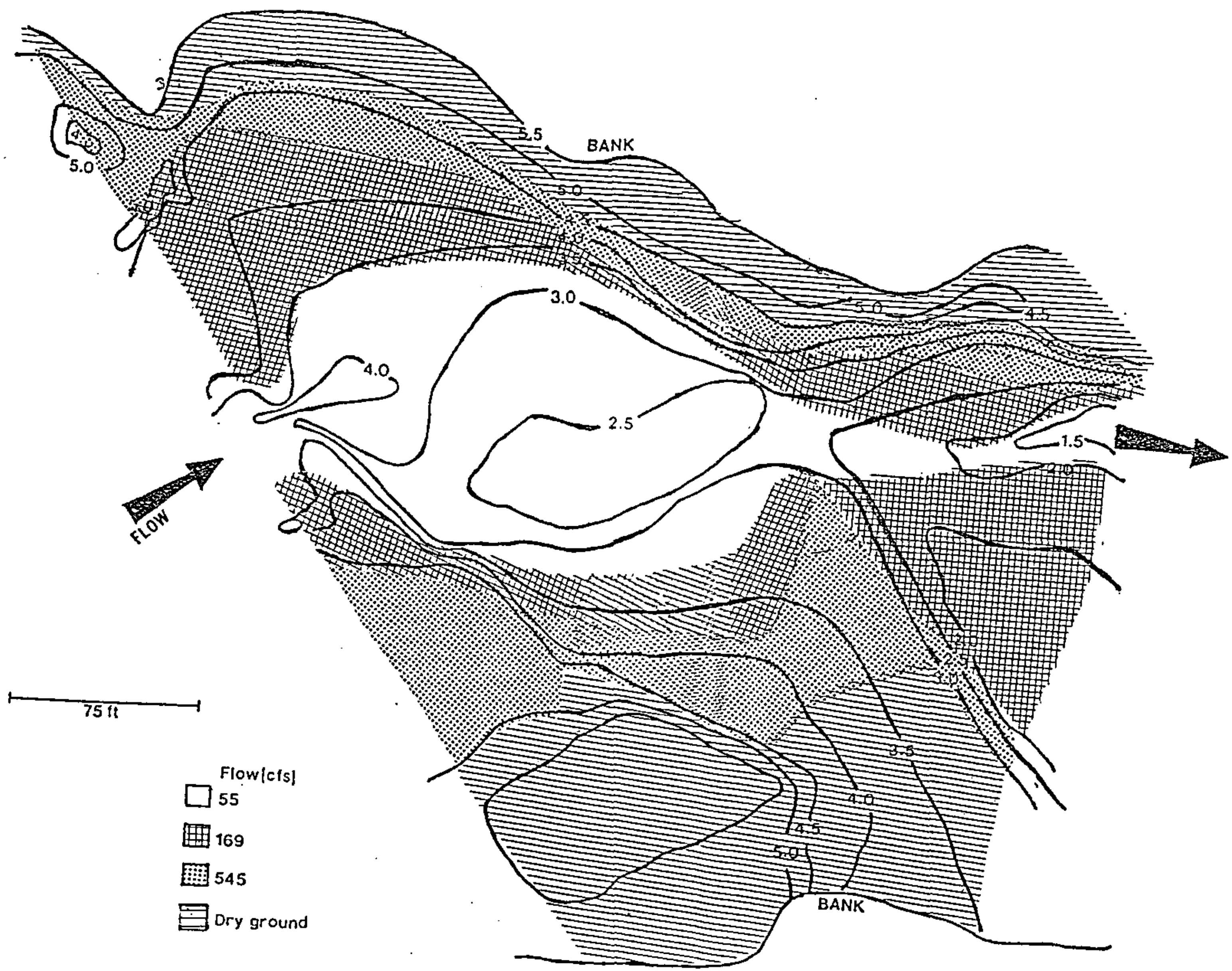

Figure 17. Amount of bottom substrate in the upper riffle of the east side channel that would be flooded at medium (545 cfs), low (169 cfs) and extremely low (55 cfs) flows.

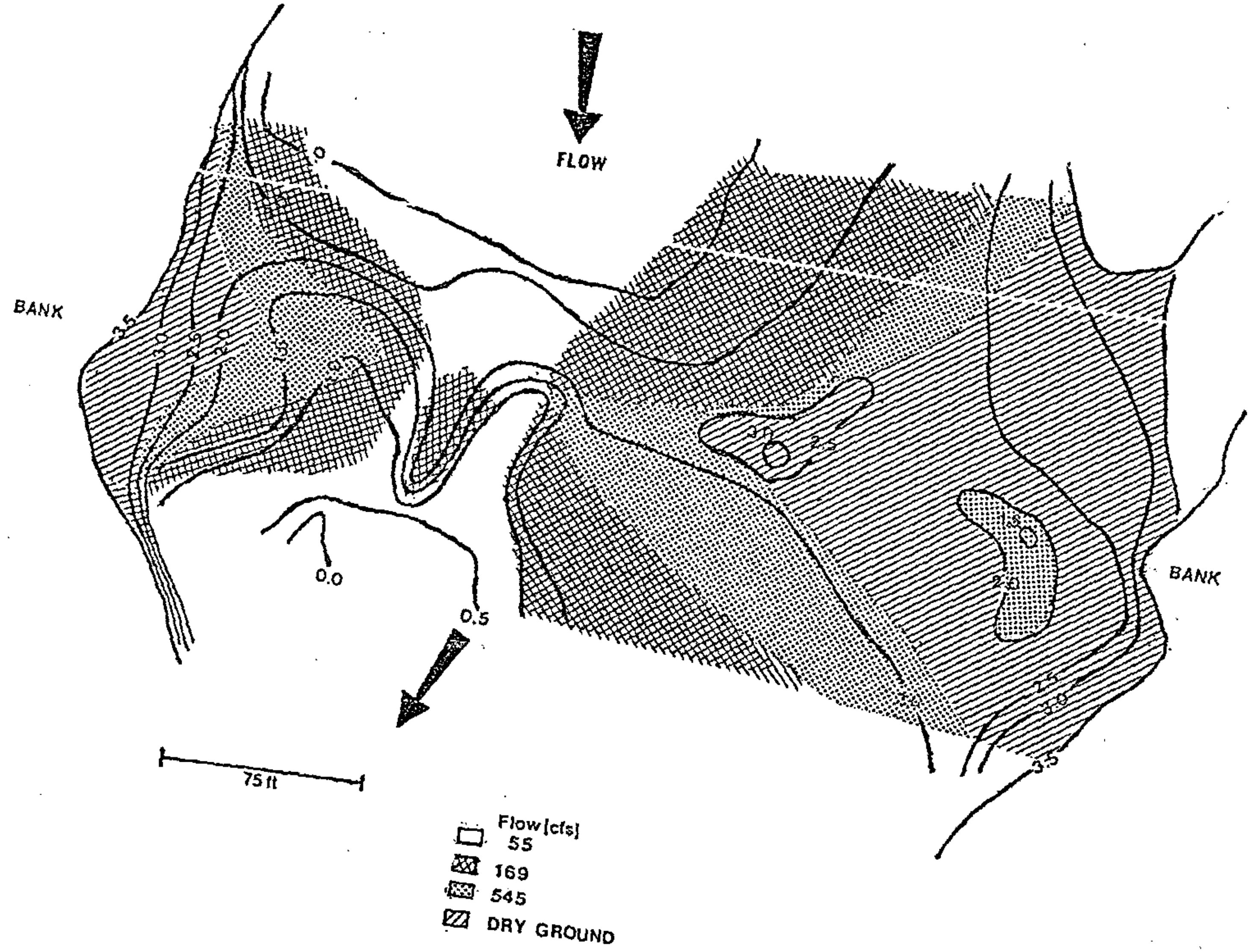

Figure 18. Amount of bottom substrate in the lower riffle of the east side channel that would be flooded at medium (545 cfs), low (169 cfs) and extremely low (55 cfs) flows.

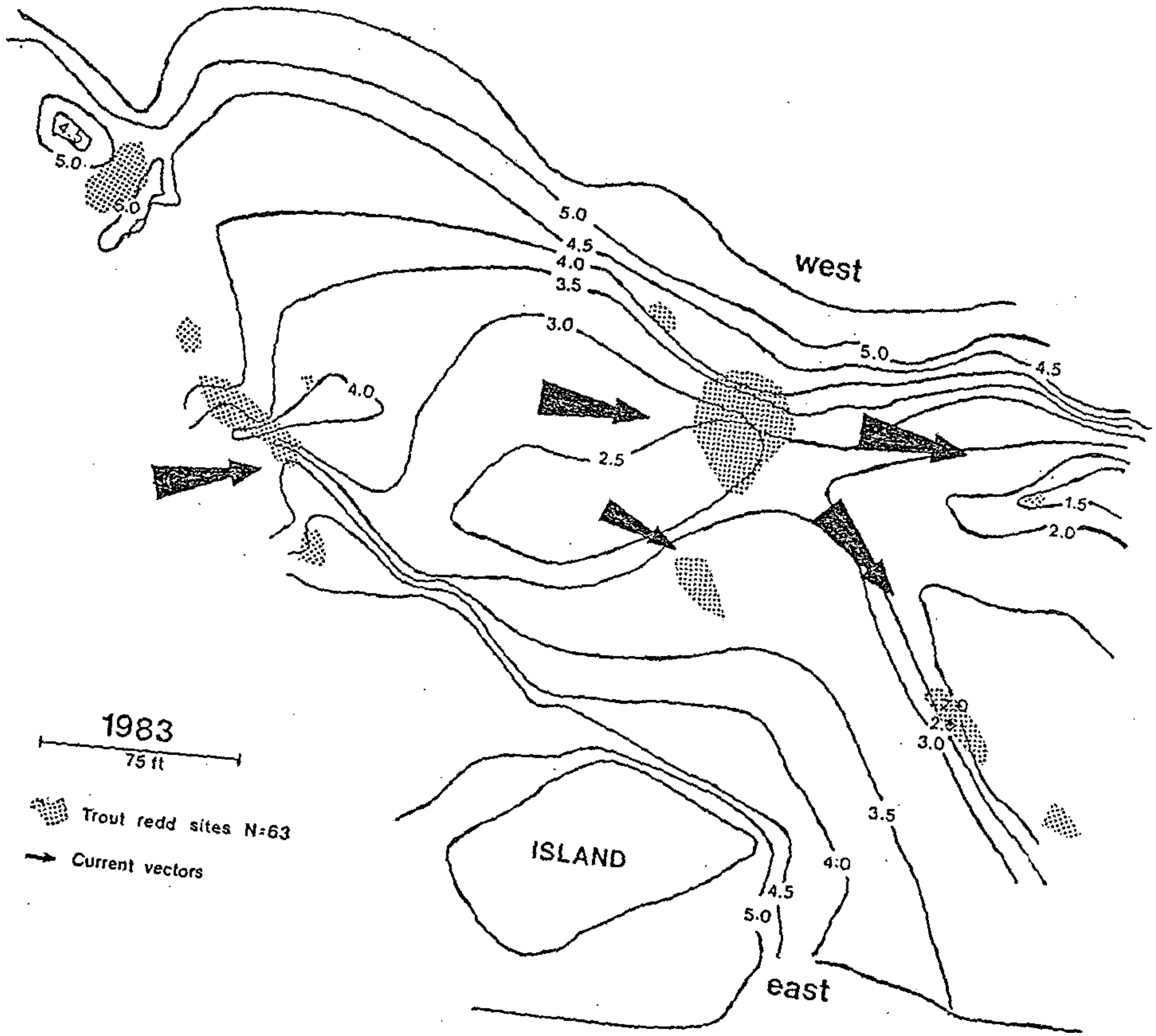

Figure 19. Locations of major concentrations of rainbow redds in the upper spawning riffle of the east side channel during 1983.

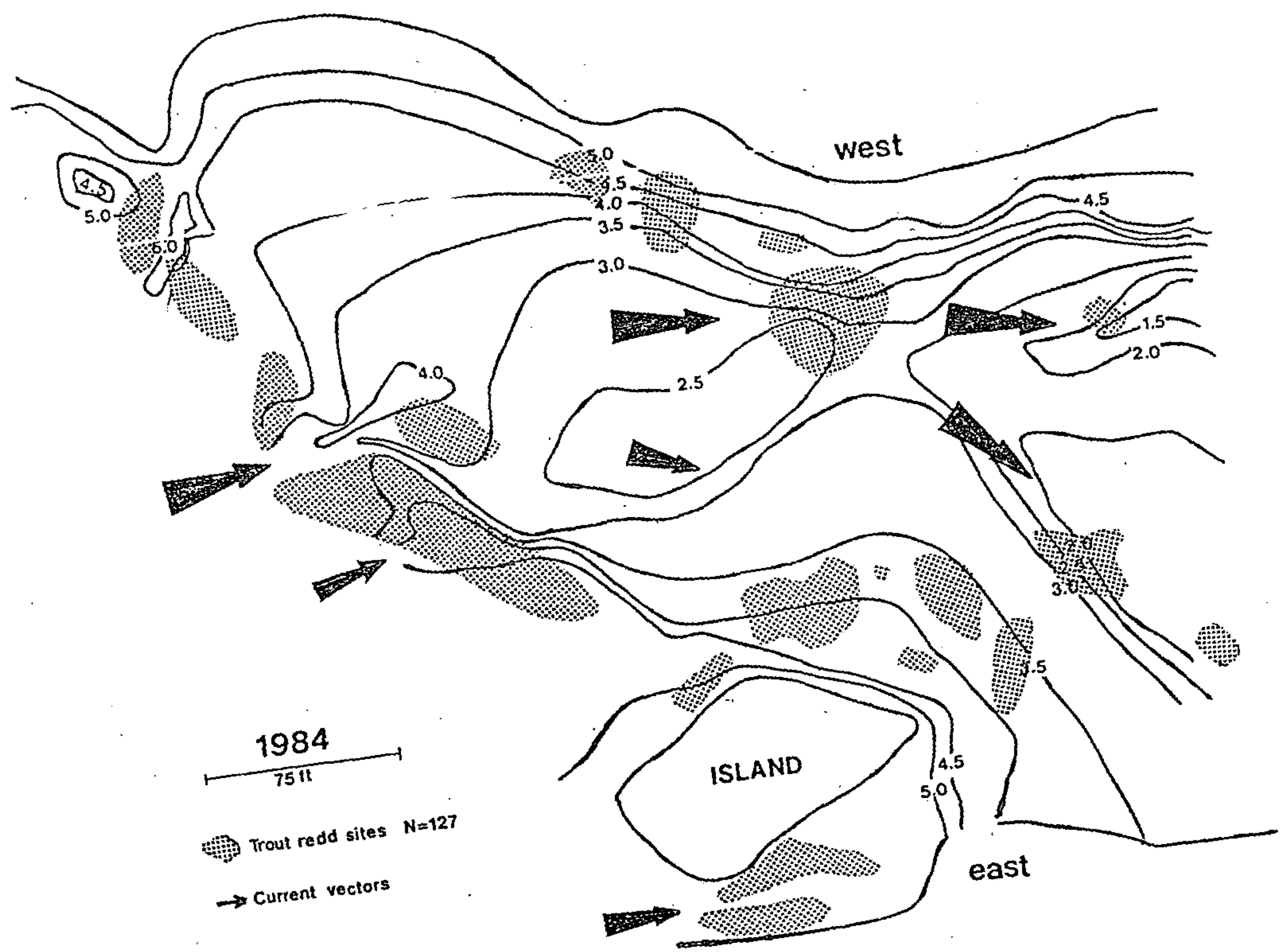

Figure 20. Locations of major concentrations of rainbow redds in the upper spawning riffle of the east side channel during 1984.

Table 17. Percent survival of rainbow trout embryo in experimental redds at three elevations after given number of days.

Redd Location	14 days	33 days	47 days
Shallow	52%	0.5%	Smothered (No data)
Moderate	93%	63.5%	---
Deep	93.5%	72%	---

Table 18. Ranges of depth and velocity measurements observed at experimental redds during monitoring period 5 May - 21 June (not necessarily maximum that occurred).

Redd Location	Depth (ft.)	0.4 Bottom Velocity (cfs)
Shallow	dry - 0.6	0 - 1.2
Moderate	0.1 - 1.0	Trickle - 1.8
Deep	0.5 - 1.3	1.2 - 2.2

Thirteen natural rainbow redds were sampled in 1984 to determine egg survival (Table 19). Eggs were collected from 10 of these redds; sac fry from 6. Total survival ranged from 0.5% to 86.7% with a mean survival of 34.6%. Becker et al. (1982) reported that the demand for dissolved oxygen for chinook salmon eggs was greatest immediately before hatching. He also reported that chinook salmon eggs (prehatch phase) were more tolerant to dewatering than were alevins (posthatch phase). A number of dead rainbow eggs collected in this study appeared to have died just at hatching. Only 62.5% of the sac fry collected were alive. Based on these data, it appeared that survival to emergence would be much lower than 34%. The three redds where no eggs were collected were located in shallow areas that were not spawned until late in the season after discharge levels had increased. Fish may have been forced out of these areas by dropping water levels before they completed spawning. Several samples contained eyed and uneyed eggs plus sac fry. This provided good evidence that superimposition was occurring in some areas which could result in high mortality of early spawned eggs. The depth of water over redds during sampling ranged from 9 inches to 2 feet 4 inches. The discharge during this time was 9400 cfs, so several of these redds were probably dewatered during low discharges. These data indicated that there were several factors affecting egg survival in the natural redds.

Rearing

Fluctuating water levels caused by peaking may be even more detrimental to rainbow fry than to incubating eggs. As fry swim up from the gravel, they normally move towards cover in shallow water. If large numbers of fry moved in to shallow areas during high discharge, many of them could be stranded and lost as water levels dropped. Even if most fry were able to migrate with changing water levels, this continual daily movement could be very stressful on these small fish causing many of them to move out of the side channel. Once in the main river, these fry would be more vulnerable to predation by other fish and piscivorous birds.

Table 19. Number of live and dead eggs and sac fry and percent survival in 10 rainbow redds excavated in the east side channel in 1984.

	NUMBER					PERCENT	
	LIVE EGGS		LIVE	DEAD	DEAD		
	EYED	UNEYED	SAC FRY	EGGS	SAC FRY	LIVE	DEAD
	6		2	25	1	23.5	77.5
	2		1	192	1	1.5	98.5
	99	3	--	136	--	42.9	57.1
	70	11	15	256	18	25.9	74.1
	72	37	27	211	13	37.8	62.2
	8	--	--	15	--	34.8	65.2
	142	16	4	65	5	69.8	30.2
	19	4	7	18	--	62.5	43.9
	44	8	--	8		86.7	13.3
	---	1	--	203	--	0.5	99.5
TOTAL	462	80	80	1129	48	34.6	65.4

Fluctuating water levels also affected fry rearing success by preventing the development of a good growth of filamentous algae in the side channel area. Sampling data indicated that filamentous algae was very important for providing rearing cover for fry. Gardner and Berg (1983) found the YOY rainbow were dependent on mats of filamentous algae in the Marias River downstream from Tiber Dam. They found availability of filamentous algae was a major factor in limiting the distribution of YOY rainbow in this river. Corning (1955) determined that fluctuating water levels could be very detrimental to the development of aquatic vegetation in trout streams. Based on observations of filamentous algae in the side channel during 1983 and 1984, it appeared that minimum daily flows were the critical factor in determining the amount of algae that developed and remained during the rearing period. Figure 21 compares the minimum daily discharges recorded during the rearing period for 1983 and 1984. There was a marked difference in release patterns between these two years. During 1983, the minimum daily discharge from the dam remained just over 3000 cfs during most of June and July, discharges dropped as low as 2500 cfs in late July. In comparison, in 1984 the minimum daily releases started to increase in early June and remained high through most of August. After mid June, when most rainbow fry were emerging, there were only nine days through the end of August

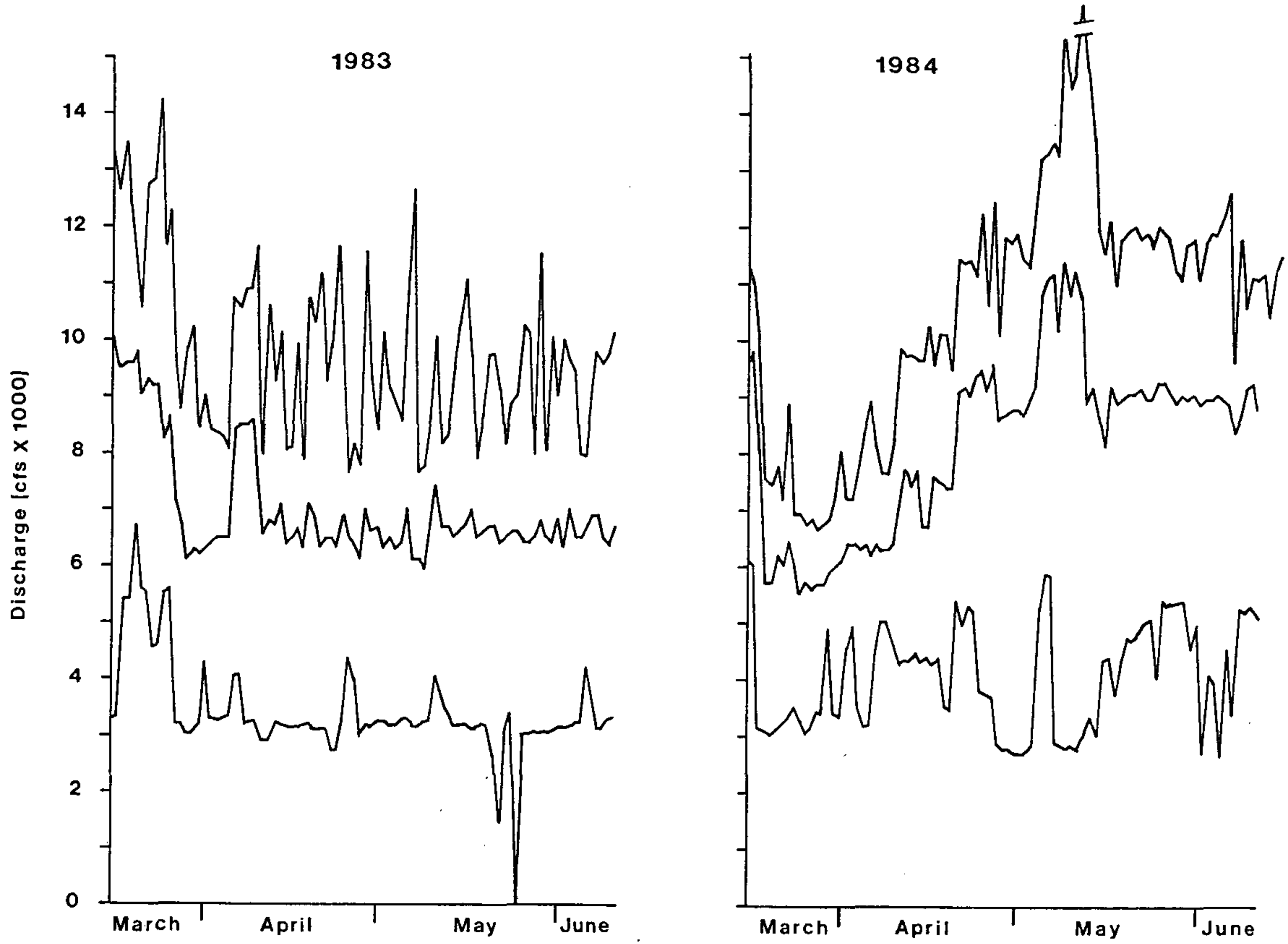

Figure 21. Minimum daily discharge from Fort Peck Dam observed during the 1983 and 1984 rainbow rearing season.

when minimum discharges dropped below 5000 cfs. This compares to 1983 when there were only five days in June and July that minimum discharges were above 4000 cfs. The effects of these different release patterns on the filamentous algae in the side channel and on the rearing of YOY rainbow were obvious.

Filamentous algae growth started to increase in the side channel during late May. In 1983, all algae growth was restricted to the center of the channel in deeper areas which were always wetted. Very little filamentous algae developed along any of the shallower riffle or shoreline areas. Little time was spent in the side channel area during July or early August in 1983, but no obvious increase in shoreline algae was observed. When the side channel was first electrofished for YOY rainbow on 21 August, there was no filamentous algae left, even in the deeper areas. In 1984, large masses of filamentous algae became attached to all available substrate in the side channel in both deep and shallow areas. This algae continued to colonize new shoreline areas as the minimum daily discharges continued to increase. Mats of algae were present along the shorelines of the side channel wherever substrate was available. Algae growth extended down to the main river channel near the mouth of the side channel. A water level recorder was checked on a weekly basis in the side channel in 1984. This thick filamentous algae cover remained throughout the summer. While wading out to check the water level recorder, several small fish were usually observed swimming between algae covered boulders. On 23 July, a fine-mesh dip net was used to catch some of these fish to determine if they were rainbow trout fry. Approximately 20 YOY rainbow were caught in the upper and lower riffle areas of the side channel and another 11 near the tall pilings in just a short time. It appeared that fry could be caught in just about any eddy area where filamentous algae provided cover.

Table 20 presents the results of electrofishing conducted for YOY rainbow during 1983 and 1984. Electrofishing for YOY was first attempted in the east side channel on 21 August 1983. All available cover in and around riffle areas in the side channel from near the lower end of Scout Island to the main river were electrofished. Because of the low minimum daily discharges that had occurred in June and July there was no algae in the side channel at this time; pockets behind large boulders and interstitial spaces between cobble provided the only cover. Thirty-two YOY rainbow were collected in about two hours of electrofishing. A couple of riffle areas in the main channel outside of Duck Island were also electrofished, but only one more YOY rainbow was caught. The side channel and river were again electrofished on 3 October 1983 for YOY rainbow; five were caught in the side channel and one outside Duck Island in the main channel. the gauge house gravel bar approximately 8 miles downstream from the dam was also electrofished in October. Four YOY rainbow were caught in this area.

Electrofishing for YOY rainbow in the side channel was conducted on 20 and 21 August 1984. The large amount of filamentous algae present made it difficult to see and capture small fish when they were shocked. This algae also created considerably more cover than had been present in 1983. It took seven hours of electrofishing to cover only part of the side channel that had been electrofished in two hours in 1983. During this time, 140 YOY rainbow were captured and more were missed or never seen because of the algae. Almost any place there was algae cover in and around riffle areas there were YOY rainbow. The sizes of these YOY rainbow were similar to the 1983 fish.

Table 20. Results of electrofishing conducted for YOY rainbow in the east side channel and main river during 1983 and 1984, total length and range of fish caught.

DATE	NO. FISH CAUGHT	MEAN LENGTH (INCHES)	LENGTH RANGE (INCHES)
8/21/83	32	2.0	1.4-2.6
10/3/83	10	3.0	2.2-3.5
8/20 & 8/21/84	140	2.0	1.4-3.1
9/17/84	20	2.4	2.0-2.9

On 19 and 20 August, the minimum daily discharge from Fort Peck Dam decreased from an 18-day period of over 6000 cfs to about 5000 cfs. This change dewatered shallow filamentous algae that had developed during the higher minimum daily discharges. Even though discharges only dropped to this level for a short time, detrimental effects of this dewatering were apparent the following day. As dewatered algae was reflooded, some of it broke loose and started to drift downstream. It was obvious that if dewatering was accompanied by peaking conditions that rapidly reflooded these areas with a strong current, all algae would be eliminated in a short time. By 21 August much of the algae that remained in shallow areas was in floating mats with little attachment to the substrate. While electrofishing, rainbow were collected from these algae mats shortly after they were flooded. It appeared that the young rainbow were migrating in with the rising water levels.

The side channel was electrofished again on 17 September 1984. Twenty YOY rainbow were collected in the same area that had been shocked in August. There was still good filamentous algae cover on most of the rocks in the channel, but a majority of the large mats of algae that had been present along the shoreline in August were gone. Maximum daily discharges had increased about 1500 cfs at the end of August and minimum daily discharges dropped to about 3500 cfs for several days in early September (Figure 35). This was enough to eliminate most of the filamentous algae from the shoreline areas. Many of the areas that had been most productive for YOY rainbow in August had no filamentous algae cover in September and contained no fish.

Study results yielded several important facts concerning the rearing of YOY rainbow in the side channel area:

a) Large mats of filamentous algae were very important to rearing YOY rainbow trout in the side channel. The presence of a good growth of filamentous algae in the side channel in 1984 resulted in a 437% increase in the catch of YOY rainbow over the 1983 catch.

b) The establishment of a good filamentous algae crop in the side channel appeared to depend on higher minimum daily flows and less extreme daily peaking. With the low daily minimum discharges and extreme peaking observed in 1983, the only filamentous algae that did establish was in the fast, deep areas in the center of the channel. The current in these areas was probably too strong for newly emerged fry to tolerate during higher flows. Fry that moved to slower water along the shallow shorelines had to contend with extreme fluctuations in water levels and poor cover. The higher minimum discharges in 1984 allowed filamentous algae to develop in shallower areas of the side channel which contained more slow water areas for fry. More of these areas remained wetted due to lower daily fluctuations in discharge.

c) It appeared that dewatering of filamentous algae caused much of it to break loose from the substrate so it could be flushed downstream by high flows. Based on observations during this study, it appeared that a minimum daily discharge of 6000 cfs or above from mid-June through early September would be good for rearing of rainbow fry in the east side channel. This corresponds very well to the discharge needed to maintain the minimum flow determined for the side channel using the wetted perimeter method of instream flow analysis (Figure 9). It appeared that a minimum daily discharge of somewhere between 4000 and 5000 cfs during the rearing period was the lowest discharge level that would maintain a reasonable amount of rearing cover in the side channel. It also appeared that even one or two days of lower minimum daily discharge could be very detrimental to the filamentous algae that had developed in the shallow areas, especially if these low minimum discharges were accompanied by high peaking discharges.

PADDLEFISH

The paddlefish was formerly abundant in large streams of the Mississippi and adjacent Gulf coastal drainages. Their native range extended up the Missouri River into Montana (Carlson and Bonislawsky 1981). Under natural conditions paddlefish relied on oxbows and backwater areas in large, freeflowing rivers for feeding and on extensive gravel bars for spawning. Due to widespread channelization and impoundment of these river systems, much of the natural paddlefish habitat has been lost (Pflieger 1975). Most paddlefish are now restricted to isolated populations between dams where the man-made impoundments provide necessary feeding habitat. There are two such paddlefish populations in Montana. One inhabits the upper Missouri River above Fort Peck Dam; the second inhabits the Missouri and Yellowstone Rivers between Fort Peck and Garrison Dams.

Paddlefish are an important game fish in Montana and provide a unique fishing opportunity in the state. This is especially true of the paddlefish population downstream from Fort Peck Dam. These paddlefish are largely residents of Garrison Reservoir. They migrate up both the Yellowstone and the Missouri Rivers in the spring. Intake diversion on the Yellowstone River downstream from Glendive, Montana, sustains a major paddlefish snagging fishery (Stewart 1984). Other smaller paddlefish fisheries exist at the confluence of the Missouri and Yellowstone Rivers and at various places upstream in the Missouri River, including the Fort Peck dredge cuts. The paddlefish in the dredge cuts provide a very unique fishing opportunity since the primary method of harvesting these fish is to hunt them with a bow and arrow.

The dredge cuts downstream from Fort Peck Dam apparently provide habitat similar to natural oxbow lakes used by paddlefish in the past. These dredge cuts appear to hold a substantial number of paddlefish on a year-round basis. A mark-and-recapture population estimate conducted in June and July of 1978 found there were 3,406 (±736 C.I. 80% level) paddlefish in the upper dredge cuts at that time (Needham 1979). This estimate did not include paddlefish in the tailwater area or Nelson dredge.

Catch Rates

Table 21 presents the results and catch rates for seining conducted during 1983 and 1984. A total of 375 paddlefish were caught in gill nets during this study. Catch rates for seining in the upper dredge cuts in 1983 increased from 3 paddlefish per haul in mid-July to about 10 paddlefish per haul in late July and August. Although seining in October was conducted in the same bays that had been most productive in July and August, the catch rate dropped to 0.3 paddlefish per haul for 6 hauls.

Paddlefish catch rates in the upper dredge cuts were considerably higher in 1984 than in 1983. They reached a high of 16.2 paddlefish per seine haul in late May and remained high through mid-July. No seining was conducted in August. By early September, catch rates had decreased substantially indicating that paddlefish may have started moving out of the shallow bays. Fall catch rates continued to decrease and by mid-October an average of only 1.6 paddlefish per haul were caught in 5 seine hauls.

Table 21. Sampling dates and seining catch rates for paddlefish seining conducted in the upper and Nelson dredge cuts during 1983 and 1984.

Date	Location	No. Seine Hauls	No. Paddlefish Caught	Paddlefish per Seine Haul
07-13-83	Upper Dredge	3	9	3.0
07-26-83	Upper Dredge	5	55	10.0
08-16-83	Upper Dredge	6	59	9.8
10-05-83	Upper Dredge	6	2	0.3
07-28-83	Nelson Dredge	2	2	1.0
08-19-83	Nelson Dredge	4	6	1.5
04-11-84	Upper Dredge	5	37	7.4
05-22-84	Upper Dredge	5	81	16.2
06-01-84	Upper Dredge	2	10	5.0
07-18-84	Upper Dredge	5	80	16.0
09-06-84	Upper Dredge	5	16	3.2
10-11-84	Upper Dredge	5	8	1.6
07-19-84	Nelson Dredge	4	7	1.8
10-12-84	Nelson Dredge	3	3	1.0
Total		60	375	

Table 22. Comparison of combined spring and summer paddlefish catch rates for seining conducted in the upper dredge cuts during 1983 and 1984 and during earlier years.

Year[1] Haul	Sampling Period	No. Seine Hauls	No. Paddlefish Caught	Average Catch per Seine
1984	mid-April - mid-July	17	208	12.2
1983	mid-July - mid-August	14	123	8.8
1979	mid-July	12	180	15.0
1978	late June - late July	44	561	12.7
1977	late July	5	42	8.4
1976	early August	9	16	1.8
1974	mid-August	18	201	11.2

[1] Data from 1974 to 1979 from Bob Needham, Montana Department Fish, Wildlife and Parks.

Table 22 compares the spring and summer catch rates for 1983 and 1984 seining with catch rates for seining conducted in the upper dredge cuts in previous years (Needham, MDFWP, unpublished data). The catch rates observed during this study were within the range of catch rates recorded in the past. No seining was conducted after late August in previous years to indicate whether catch rates dropped off in the fall.

Habitat Preference

Seining results conducted during 1983 and 1984 indicate that paddlefish preferred the upper dredge cut to Nelson dredge (Table 21). In 1983, six seine hauls were made in Nelson dredge during July and August. This effort caught a total of 8 paddlefish for an average catch rate of 1.3 fish per haul. This compared to a combined 1983 summer catch rate of 8.8 fish per haul in the upper dredge cuts. In 1984, 4 seine hauls in Nelson dredge in July caught 7 paddlefish for a catch rate of 1.75 fish per haul. This compared to an average catch rate of 16.0 paddlefish per seine haul for 5 hauls made in the upper dredge cuts the previous day. Three seine hauls made in Nelson dredge in October, one day after catch rates in the upper dredge reached their lowest recorded level, still caught an average of one paddlefish per haul. This catch rate was not significantly different from the 1983 or 1984 summer catch rates for Nelson dredge. These data indicated that there was probably a small number of paddlefish utilizing Nelson dredge at any time. Paddlefish use of Nelson dredge may have increased late in the fall when paddlefish moved out of the upper dredge cuts. No sampling was conducted after 12 October to test this.

Several differences existed between Nelson and the upper dredge cuts that may have influenced paddlefish use. The opening between Nelson dredge and the river was larger and more direct than the opening between the upper dredge cuts and the river. This resulted in a better exchange rate of river water through Nelson dredge. The restricted necks between ponds in the upper dredge cuts further inhibited circulation of water through this area. This difference in water exchange resulted in several differences between dredge cut areas. Water temperatures remained colder in Nelson dredge during the summer and water did not stratify to as great an extent (Appendix B). During most sampling periods total plankton densities remained lower in Nelson dredge than in either upper dredge sample site. Major plankton peaks occurred later in Nelson dredge than in the upper dredge cuts (Figure 10). Based on these data, it appeared that Nelson dredge provided habitat more closely resembling the tailpool than the upper dredge cuts.

Size and Population Structure

Table 23 presents the mean eye-to-fork length, mean weight and size ranges of paddlefish collected by seining during this study. This table also compares the sizes of paddlefish collected during 1983 and 1984 with sizes of paddlefish collected in the upper dredge cuts in 1963 and 1965. There was very little change in the average size of paddlefish found in the dredge cuts during the past 20 years. Figure 22 compares the weight distributions of paddlefish collected from the dredge cuts during 1963 and 1965 and during this study. There was some increase in the number of paddlefish greater than 30.0 pounds, but the general pattern remained consistent from the early 1960's to the present. The majority of paddlefish collected from the dredge cuts during both sampling periods were less than 30.0 pounds.

In contrast, there was a continual increase in the average size of paddlefish collected at Intake on the Yellowstone River between 1963 and 1983 (Table 24). The average size of paddlefish collected at Intake and in the dredge cuts were similar in the early 1960's. However, the average size of Intake paddlefish increased annually until stabilizing in the early 1980's (Stewart 1984). The average size of paddlefish collected at Intake in 1983 was considerable larger than the paddlefish collected from the dredge cuts during this study.

Growth data for paddlefish collected between 1963 and 1965 showed that the growth rates for all age groups of paddlefish collected at Intake were greater than growth rates for comparable age group of paddlefish from the dredge cuts. The average calculated growth increment for paddlefish from Intake was 2.2 inches per year compared to an actual average growth increment of 0.7 inches per year for dredge cut paddlefish (Robinson 1966). The good growth rate observed in Intake paddlefish probably related to the higher productivity of Garrison Reservoir as compared to the dredge cuts.

The increase in average size of Intake paddlefish has been related to the maturing of the paddlefish population that developed above Garrison Dam after 1955 (Elser 1983, Stewart 1984). The paddlefish sampled at Intake in the early 1960's consisted of predominantly young males. The male:female sex ratio for 1,403 paddlefish collected at Intake between 1963 and 1965 was 35.9:1, approximately 83 percent of these paddlefish that were aged were in age classes 7-12 (Robinson 1966). Since that time, the number of female paddlefish in the Intake population has increased from less than 3 percent between 1963 and 1967 to over 80 percent in 1983 (Stewart 1984). This has resulted in an overall increase in the size of paddlefish collected at Intake since the females are usually the largest fish.

Table 23. Mean eye-to-fork length, mean weight, and ranges of paddlefish caught in the upper dredge cuts in 1983, 1984, and in 1963 and 1965.

Year	Number of Fish	Mean Eye-to-Fork Length (inches)	Mean Weight (pounds)	Length Range (inches)	Weight Range (pounds)
1983	133	33.8	28.6	20.5 - 45.0	7.0 - 72.0
1984	242	34.7	24.0	21.5 - 46.5	5.0 - 65.0
Combined	375	34.4	25.9	20.5 - 46.5	5.0 - 72.0
1963 and 1965[1]	109[2]	33.9	21.0	22.1 - 42.9	6.5 - 42.7

[1]Needham, MDFWP, unpublished data.
[2]Weight is for 74 fish.

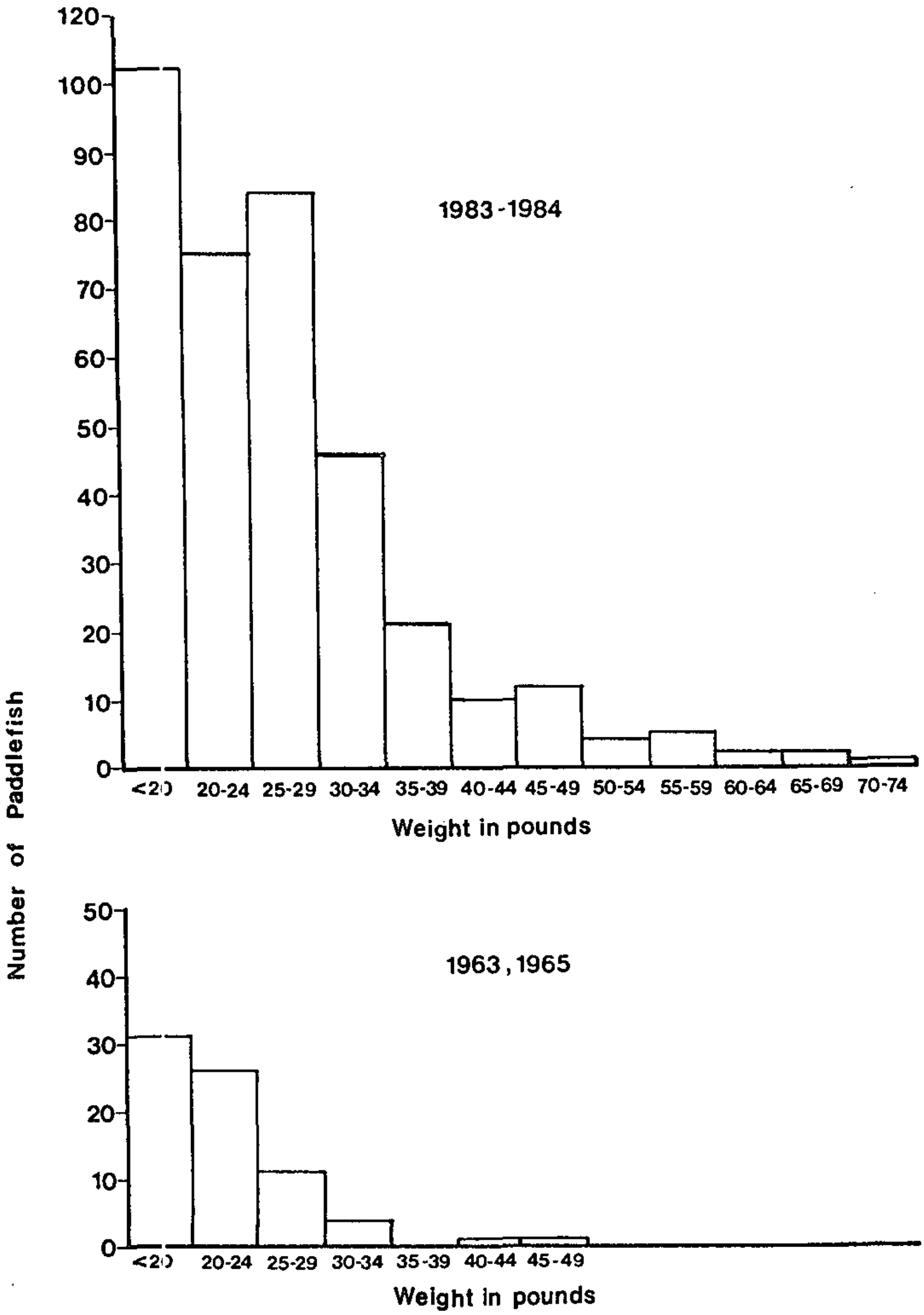

Figure 22. Weight distribution of paddlefish collected from the Fort Peck dredge cuts during 1963 and 1965 and during 1983 and 1984.

Table 24. Summary of paddlefish measurements obtained at Intake, Yellowstone River, 1963-1983[1].

Year	Number of Fish	Mean Eye-to-Fork[2] Length (inches)	Mean Weight (pounds)
1963	46	28.0	29.6
1964	920	32.3	21.0
1965	453	33.8	21.3
1966	28	32.7	21.2
1967	123	34.0	21.8
1968	149	35.4	25.0
1969	499	34.8	23.4
1970	700	34.9	25.6
1971	1,136	35.8	30.8
1972	1,678	37.7	34.0
1973	1,696	36.4	33.1
1974	1,910	37.4	35.6
1975	1,158	39.2	42.3
1976	940	39.4	47.4
1977	1,003	39.9	48.2
1978	809	37.8	43.0
1979	637	41.4	50.4
1980	---	40.0[3]	49.1[4]
1981	2,428	42.8	46.7
1982	2,004	42.4	45.1
1983	1,400	44.3	50.2

[1]From Stewart 1984.
[2]Converted from total lengths.
[3]Based on 61 measurements.
[4]Based on 131 measurements.

Data from paddlefish collected in the dredge cuts in 1963 and 1965 indicated that this area already contained a mature paddlefish population. Approximately 61 percent of the paddlefish aged from the dredge cuts were in age classes 17-24, the male:female ratio for 75 paddlefish was 2.5.1 (Robinson 1966).

No paddlefish have been aged from either of these areas since 1966. Sexual development was checked on 13 of the largest paddlefish collected while seining in the dredge cuts in May 1984. Ovaries were identified in five of these paddlefish; four were immature black and white granular masses, the fifth fish appeared to be mature and ready to spawn that spring. No sexual development could be determined in the other eight paddlefish checked. One other mature female was caught in a gill net in the tailpool in the fall of 1984, and would have been ready to spawn the following spring. Even though only the largest of 81 paddlefish collected were checked for sexual development, the average size of the five verified females was still well below the average size of female paddlefish collected at Intake between 1971 and 1983.

A comparison of data on the paddlefish from the dredge cuts and from Intake indicated that the paddlefish in the dredge cuts in the early 1960's were part of the old Missouri River paddlefish population that had been in the dredge cuts since before Garrison Dam was closed in 1953. On the other hand, the paddlefish collected at Intake in the early 1960's consisted of the first mature males of a new paddlefish population that developed in Garrison Reservoir after Garrison Dam was closed. It appears that the paddlefish in the dredge cuts exhibit a different growth pattern and possibly different behavioral characteristics than the paddlefish in the rest of the Garrison Reservoir population. Based on the consistency in the size of paddlefish in the dredge cuts between 1963 and 1984, it appears that these paddlefish have continued to maintain some uniqueness.

Movement

Tag Return Data

Paddlefish tag return data yielded two major facts about the dredge cut paddlefish population, many of these paddlefish apparently remained in the dredge cut area for extended periods of time; there was a continual exchange of paddlefish between the dredge cuts and Intake on the Yellowstone River. Seventeen (12.8 percent) of the 133 paddlefish caught in the dredge cuts in 1983 were previously tagged. All of these fish had been tagged in the dredge cuts between 1969 and 1979 (Table 25). Thirty-three (12.9 percent) of the 255 paddlefish collected in 1984 were previously tagged. Two of these fish had been tagged at Intake; the rest were tagged in the dredge cuts between 1969 and 1979 (Table 25). At least five paddlefish punch-marked in the upper dredge cuts in 1983 were recaptured in the same area in 1984. One of these fish had originally been tagged in the dredge cuts in 1979. A sixth punched fish was recaptured in Nelson dredge in 1984. Three other punched fish caught late in 1984 may have originally been marked in 1983 or early 1984. While seining to make a paddlefish population estimate in the dredge cuts in 1978, 25 paddlefish were recaptured that had originally been tagged in the dredge cuts in 1974. By expanding the percent of 1974 tagged fish recaptured in 1978 to the total number of paddlefish estimated to be in the dredge cuts at that time, it appeared that most of the paddlefish tagged in 1974 were still in the dredge cuts in 1978 (Needham, MDFWP, personal communications). Three paddlefish tagged in 1974 and recaptured in 1978 were recaptured again during this study; one in 1983 and two in 1984. One paddlefish tagged in the dredge cuts in 1977 and recaptured in 1978 was recaptured again in 1984. Approximately 61 percent of the paddlefish collected from the dredge cuts in 1963 and 1965, only 10 to 12 years after Garrison Dam was closed, were between ages 17 and 24. This meant that these paddlefish were residents of the dredge cuts or Missouri River above Garrison Dam for several years before Garrison Dam was built. These results provided good evidence that some paddlefish remained in the dredge cut area for extended periods of time.

Table 25. Numbers of tagged paddlefish recaptured in the dredge cuts and tailpool in 1983 and 1984 compared to the total number tagged.

Year	Total No. Tagged[1] in Dredge Cuts	Total No. of Tagged Paddlefish Recaptured	
		1983	1984[2]
1968	12	-	-
1969	94	3	2
1970	5	-	-
1974	189	4	9
1976	48	2	4
1977	40	1	5
1978	162	3	3
1979	151	4	7

[1]From Needham 1983.
[2]Number could not be read on one tag. Two paddlefish originally tagged at Intake in 1964 and 1972 were also recaptured.

The paddlefish population in the dredge cut area depends on recruitment from downstream in order to maintain a viable population. Paddlefish cannot spawn in the dredge cuts or tailpool, so mature paddlefish must be able to migrate downstream to find suitable spawning habitat, paddlefish must also be able to migrate to the study area from downstream to maintain a population. Tag return data indicated there was an active interchange of paddlefish between the dredge cuts and downstream areas. To date, 102 paddlefish originally tagged in the dredge cuts have been harvested by fishermen; 57 (55.9 percent) from the dredge cuts and 45 (44.1 percent) in the Yellowstone River, primarily at Intake. In 1984, 12 paddlefish that had been tagged in the dredge cuts were harvested, 11 of these were caught at Intake (Needham 1984). At least 32 paddlefish tagged at

Intake have been recaptured in the Fort Peck dredge cuts. Most of these have been captured while seining. Two paddlefish tagged at Intake were caught while seining in 1984; one had originally been tagged in 1964, the other in 1972. The extremely large differential in paddlefish fishing pressure between Intake and the dredge cuts makes it impossible to derive any meaningful information from these tag returns concerning the magnitude of paddlefish movement between areas.

Seasonal Movements

Sampling results indicated that there was a major movement of paddlefish in the fall from the upper dredge cuts to the tailpool. Seining catch rates in the upper dredge cuts decreased significantly in the fall during both 1983 and 1984 (Table 21).

No attempt was made to determine where paddlefish had moved once seining catch rates decreased in 1983; however, two paddlefish were seen in the tailpool while electrofishing on 4 October one day before seining catch rate dropped to 0.3 paddlefish per haul. This was the only time paddlefish were seen in the tailpool in 1983. In 1984, seining catch rates appeared to be decreasing by early September and continued to decrease through the last seining in mid-October. Three large-mesh gill nets were set overnight in deep areas of the upper dredge cuts in early September, two days after the decrease in seining catch rates was first observed. Four paddlefish were captured in one of these nets. On 4 October, 10 to 12 paddlefish were observed in the main channel of the tailpool approximately 2 miles below the dam. Attempts to locate more paddlefish in this same area by electrofishing later the same day proved unsuccessful. Approximately two hours of night electrofishing in mid-September and another three and a half hours in mid-October in the tailpool and upper dredge cuts failed to locate any paddlefish. Considerable effort was spent electrofishing around Park Grove bridge as water was flowing out of the dredge ponds to determine if paddlefish were concentrating in this area to feed on plankton being flushed out. Lack of positive results indicated that electrofishing for paddlefish in deep water, as was the case here, was probably not very effective since paddlefish were known to be in the area during some electrofishing.

On 20 November, one 150-foot gill net set in the tailpool caught one paddlefish, and two nets totaling 250 feet set overnight in the upper dredge cuts caught no paddlefish. On 29 November, equal sets of 400 feet of gill nets were fished overnight in both the tailpool and upper dredge cuts. Eight paddlefish were caught, all in the tailpool nets. These results indicated that a majority of paddlefish had moved out of the upper dredge cuts and were concentrating in the tailpool. More study is needed to fully understand the paddlefish movement in the study area. Information collected during this study indicated there was some correlation between decreasing water temperatures in the fall, changing plankton populations and the fall migration of paddlefish to the tailpool.

In 1983, paddlefish catch rates in the upper dredge ponds dropped from 9.8 fish per net in mid-August to 0.3 fish per net in early October. Between late August and mid-September surface water temperatures in the upper dredge cuts dropped 5 to 6.5°C and the dredge pond almost completely destratified (Appendix B). At this same time, Fort Peck Reservoir was turning over which caused a slight increase in the water temperatures near the bottom of the reservoir (Wiedenheft 1984). This caused an increase in water temperature at the tailpool sample site

(Appendix B). Water temperature at the tailpool sample site was 0.5 to 1.0°C warmer than any of the dredge cut sample sites by early October when two paddlefish were seen in the tailpool. Water temperatures remained warmer in the tailpool through the last sampling date on 19 October.

In 1984, a large drop in seining catch rates occurred between mid-July and early September. Catch rates continued to decrease through the last seining in mid-October. Water temperatures in the dredge cuts were just beginning to cool in early September and the stratified layer of warm water was crowded close to the surface (Appendix B). By mid-September the dredge ponds were almost completely destratified (Appendix B), and fall turnover of Fort Peck Reservoir was occurring (Wiedenheft 1985). On 4 October, the same day 10 to 12 paddlefish were observed in the tailpool, water temperature in the tailpool was the same as or warmer than water temperatures in ponds 1, 2 or 3 (Appendix B). The tailpool water temperature was 3.5 to 4°C warmer than the upper dredge ponds by mid-October and remained warmer through the last sampling date on 28 November.

Seasonal concentrations of zooplankton at different sampling sites are affected by changing water temperatures and by the turnover of Fort Peck Reservoir. Changing plankton concentrations appeared to be related to paddlefish movement within the study area. Fort Peck Reservoir is a bottom withdrawal reservoir and this has a major impact on the amount of zooplankton being flushed through the dam at different times of the year. A number of factors interact to influence the stratification of plankton within a water column (Ruttner 1974). Under normal conditions, when water temperatures become stratified in Fort Peck Reservoir during the summer, most plankton should remain at or above the thermocline; very little would be present in the deep water near the penstock intakes. During spring and fall turnover, the circulation of water distributes plankton throughout the water column. This increases plankton concentrations near the penstock intakes which results in increased flushing of plankton through the dam. This was apparent in the plankton data collected during this study. The highest total concentration of zooplankton in the tailpool in 1983 was found on the last sampling date in October (Appendix D). The concentrations of three of the four major groups of zooplankton were increasing in the tailpool at this time; concentrations of Daphnia retrocurva, the only major organism more common below the dam than in the reservoir, was declining. Total zooplankton concentrations were declining in the dredge cuts at this time (Figure 11). The greatest zooplankton concentrations found in the tailpool in 1984 occurred in the spring before the reservoir started to stratify and in the fall after turnover began (Figure 13). Major zooplankton population peaks occurred in the dredge cuts during July and August of 1984 (Figure 12). The concentrations of all organisms were decreasing in both dredge cut sampling sites in early September at the same time they were increasing in the tailpool. This shift in zooplankton concentrations corresponds with the apparent movement of paddlefish out of the dredge ponds and into the tailpool. Because the total concentration of zooplankton in the tailpool at its highest level was still well below the total concentration in the dredge cuts, it is doubtful that change in total plankton concentrations alone caused paddlefish to move out of the dredge ponds. The change in the composition of the plankton population may have been an important factor. Cyclops was the main organism that maintained high zooplankton concentrations in the dredge cuts during the spring and fall; concentrations of Daphnia and Diaptomus were low at this time (Figure 12). Daphnia and Diaptomus concentrations were highest in the tailpool during the spring and fall (Figure 13). These organisms were generally much larger than

Cyclops and may have been preferred as food by paddlefish. As concentrations of *Daphnia* and *Diaptomus* increased in the tailpool in the fall, paddlefish may have started moving out of the dredge cuts to feed on them. There were probably a number of factors that influenced paddlefish movement within the study area; it appeared that water temperature and zooplankton concentrations were two of these.

In summary, data indicated that the paddlefish in the study area constituted a distinct part of the paddlefish population isolated between Fort Peck and Garrison Dams. Many of these paddlefish apparently remained in the study area for extended periods of time. They used the dredge cuts, especially the upper dredge cuts, during most of the year but moved to the tailpool area in the fall. There was a continual exchange of paddlefish between the dredge cuts and the Yellowstone River indicating that the dredge cut paddlefish were an active part of the total Garrison Reservoir paddlefish population. The lack of usable paddlefish spawning habitat in the study area above the Milk River made the dredge cut paddlefish population totally dependent on downstream areas for spawning and for recruitment of new paddlefish in the area.

WALLEYE AND SAUGER

Walleye and sauger are currently the preferred game fish in the study area. Walleye were native to the lower and middle Missouri River, however, their native range did not extend as far upstream as Montana (Brown 1971). Walleye have been stocked in the Missouri River drainage in Montana downstream from Fort Peck since 1947. A large number of walleye were stocked in the Milk River between 1955 and 1963. Ten thousand walleye fry were stocked directly in the Missouri River downstream from the Milk River in 1956 and 50,000 more were stocked in 1958. It is likely that the first walleye in the study area moved into the study area from downstream. Walleye were first introduced into Fort Peck Reservoir in 1951 and have been present in the reservoir since. Some of these walleye probably pass through the dam into the study area.

The present walleye population in the study area relies predominantly on the migration of walleye upstream from Garrison Reservoir. A limited amount of walleye spawning does occur in the study area. Walleye are caught throughout the year in the study area, but good fishing can be spotty and somewhat seasonal.

Sauger are native to the Missouri River and have been present in the study area since before Fort Peck Dam was built (Brown 1971). The construction of Fort Peck Dam undoubtedly blocked the upstream movement of a large number of fish. Because sauger are a migratory fish many sauger undoubtedly concentrated below the dam after it was closed accounting for the early reports of excellent sauger fishing below the dam. Sauger still provide good fishing in the study area at times, but not at the historic levels of the past. Sauger numbers normally decline in tailwater areas within a few years after a dam is closed (Nelson and Walburg 1977). This is a result of the cold clear water being released through the dam; sauger prefer more turbid, warmer, riverlike habitat (Ali, et. al. 1977; Nelson and Walberg 1977).

Sizes

Gill netting was the best method for sampling walleye and sauger throughout the year. Electrofishing and trap nets were effective in the spring when the fish were concentrated for spawning.

Beginning in the summer of 1979, a series of experimental gill nets were set overnight in the dredge cut/tailwater area. This gill netting has been continued in the same locations each summer since. Table 26 presents the walleye and sauger catch data for this gill netting. The sauger catch rates for 1979 and 1982 through 1984 are essentially the same. There was a slight increase in 1983 and 1984, but this was not significant with this small sample size. The walleye catch rates were almost identical for 1979 and 1981 through 1984. The increased walleye and sauger catch rates in 1980 were associated with a run of rainbow smelt that migrated to Fort Peck Dam from Garrison Reservoir that year (Needham and Gilge 1983). Smelt provided a forage base which was normally lacking and was responsible for holding walleye and sauger in the study area all summer. The high sauger catch rate in 1981 was probably also related to this smelt run since a number of smelt remained in the area that year. The average size of the walleye and sauger captured in gill nets remained quite constant from 1979 to 1983. In 1984 it appeared that the average size decreased for both species.

Table 26. Summary of the walleye and sauger catch from ten 125 foot experimental gill net sets in the Fort Peck dredge cut/tailwater area, 1979-1984[a].

Species	1979			1980			1981			1982			1983			1984		
	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)
Walleye	8	16.4	1.48	27	16.8	1.80	9	17.4	1.86	7	18.3	1.82	8	17.2	1.58	8	13.6	0.92
Sauger	7	15.3	0.96	67	14.7	1.03	47	15.0	0.93	9	16.1	1.06	12	14.3	0.92	14	12.6	0.50

a/ 1979-1982 data from Needham and Gilge 1983.

Seasonal Patterns

During 1983 and 1984, spring and fall gill net series were fished in the same locations as the summer sets to determine seasonal variations in the fish populations. Table 27 compares the seasonal walleye and sauger catches for these two years. The seasonal catch rates for walleye were almost identical during 1983 and 1984. Catch rates were highest in the spring and decreased through the summer and fall. This same pattern was evident in the 1983 electrofishing data (Table 28). Walleye catch rates in 1983 decreased from 1.9 fish per shocking hour in the spring to 0.1 fish per hour in the summer and fall. No summer or fall electrofishing was conducted for walleye in 1984, but the spring catch rate for 1984 was almost the same as the 1983 spring catch rate. This seasonal pattern was probably related to the migratory nature of the walleye population in the study area. A majority of these fish migrated to the study area in the spring from down river to spawn. Although some walleye remained in the study area all summer, most of them return downstream shortly after spawning. A walleye tagged on 17 May 1983 approximately 8 miles downstream from Fort Peck Dam was recaptured in Garrison Reservoir in August of the same year. Two walleye tagged in the same area on 10 May 1984 were recaptured in Garrison Reservoir in July. A third walleye tagged on this same date in 1984 was recaptured in Nelson dredge on 1 September 1984. Other tag return data indicated that there was some movement of walleye in and out of the study area throughout the year (Gardner and Stewart 1985).

Seasonal trends for sauger followed the opposite pattern of walleye. Sauger numbers were lowest in the spring and increased towards the fall. In 1983 the sauger gill net catch increased from 0.1 sauger per net in the spring to 1.8 sauger per net in the fall. The sauger catch rates for both spring and fall were greater in 1984 as compared to 1983. A seasonal pattern of higher catch rates in the fall as compared to the spring was noted for both years. The summer gill net catch rate was lowest of the three 1984 seasonal sets, and was similar to previous summer catch rates. The seasonal catch rate for electrofishing increased slightly from spring to fall during 1983 (Table 28). The overall catch rate of sauger was considerable higher during the spring of 1984. This corresponded to the increased sauger catch rate seen in the gill net data. Stewart (1981 and 1982) reported that few sauger remained in the Missouri River during the winter, and that movement of sauger into the river out of Garrison Reservoir appeared to be related to the spring runoff entering the Missouri River from its tributaries. During years of low runoff sauger appeared to be slow to move up the Missouri River resulting in low sauger catch rates in the spring with catch rates increasing later in the season. There was little spring runoff during 1983 or 1984 to attract sauger up the Missouri River. This may account for the gradual increase in sauger numbers seen throughout the season.

The overall increase in sauger numbers observed in 1984 may have been related to the exceptionally low flow conditions in the Milk River during 1983 and 1984. The extremely dry conditions observed in 1983 and 1984 may have forced many of these smaller nonmigratory sauger out of tributary streams, especially the Milk River, and into the Missouri. These fish may have moved upstream and become concentrated in the study area below Fort Peck Dam.

Table 27. Comparisons of seasonal walleye and sauger catches from experimental gill nets fished at standard locations in the tailpool and dredge cuts during 1983 and 1984, mean total length, weights and catch per effort.

Species	Spring				Summer				Fall			
	No.	Mean Length (inches)	Mean Weight (pounds)	Catch Per Net	No.	Mean Length (inches)	Mean Weight (pounds)	Catch Per Net	No.	Mean Length (inches)	Mean Weight (pounds)	Catch Per Net
1983												
Walleye	11	17.9	2.05	1.2	8	17.2	1.58	0.8	4	16.7	1.40	0.4
Sauger	1	18.7	1.79	0.1	12	14.3	0.92	1.2	18	14.1	0.86	1.8
1984												
Walleye	10	17.3	1.64	1.0	8	13.6	0.92	0.8	4	14.1	0.85	0.4
Sauger	29	13.4	0.63	2.9	14	12.6	0.50	1.4	44	14.1	0.91	4.9

Table 28. Walleye and sauger caught by electrofishing during 1983 and 1984, mean sizes, ranges and catch per effort.

Species	Number	Mean Length (inches)	Mean Weight (pounds)	Length Range (inches)	Weight Range (pounds)	Catch Per Hour
			Spring 1983 (4/7-5/25)			
Walleye	21	18.8	2.24	15.1 - 22.4	1.00 - 3.90	1.9
Sauger	7	18.7	1.78	17.3 - 21.2	1.30 - 2.60	0.6
			Summer and Fall 1983 (6/15-11/3)			
Walleye	2	24.7	5.07	22.5 - 26.8	3.20 - 6.94	0.1
Sauger	14	14.0	0.84	10.1 - 18.8	0.26 - 1.79	0.7
			Spring 1984 (4/30-5/18)			
Walleye	23	19.8	2.75	10.3 - 22.9	0.18 - 4.54	1.0
Sauger	12	13.4	0.67	9.8 - 20.6	0.31 - 2.30	1.8

Habitat Preference

The 1983 and 1984 gill net data was analyzed according to habitat type to determine habitat preference of walleye and sauger (Table 29). From these data it appeared that both walleye and sauger preferred the environments of Nelson dredge and the tailpool to the habitat of the upper dredge cuts. The only exception to this was the large number of sauger caught in the upper dredge cuts during spring of 1984. Other sampling data indicated there were sauger spawning in the upper dredge cuts during the spring of 1984. Some of these fish may have still been in the dredge cuts when the spring gill net sampling was conducted.

Spawning

Sampling results indicated that walleye and sauger spawning occurred in the study area during 1983 and 1984. Table 30 presents the size and spawning condition of walleye and sauger captured by various methods during the spring spawning periods of 1983 and 1984.

Three electrofishing trips between 3 May and 17 May, 1983 caught 21 walleye and 5 sauger including 2 ripe and 1 gravid female walleye, 17 ripe male walleye, and 3 gravid sauger. Most of these fish were caught near a gravel bar by the USGS gauge house approximately 8 miles downstream from the dam. Kick sampling on this gravel bar on 4 May produced seven Stizostedion sp. eggs. Based on the larger number of walleye captured, it was assumed these were walleye eggs.

Water temperatures recorded at a thermograph located in the east side channel ranged from 5.5° to 12.5°C between 1 May and 17 May. Optimum fertilization temperatures for walleye range from 6.0° to 12.0°C, and the optimum temperature for sauger is 9°C (Koenst and Smith 1976). Water temperatures at the side channel site first warmed up and stayed within these ranges from about 21 April until about 23 May. Large daily fluctuations in water temperature were observed in the side channel. Daily fluctuations would be less in the main river near the gauge house bar, but the average daily temperatures would be similar. The side channel may have warmed up slightly sooner than the main river. Spawning conditions were checked on five walleye caught in gill nets in the upper tailpool on 26 and 27 May. Four of these were ripe males. Two sauger from these same nets were gravid females. One spent female walleye was caught in a gill net near Nelson dredge on 8 June. Two frame trap nets were set on 9 May and fished overnight on the gravel point between pond 1 and pond 2 of the upper dredge cuts; no walleye or sauger were caught.

Drift nets were placed in the river just downstream of the gauge house gravel bar on 13 days between 17 May and 14 July in an attempt to collect larval walleye or sauger. A few larval suckers and several eggs presumed to be carp eggs were collected, but no walleye or sauger larva were caught.

A number of mature walleye were again found concentrated near the gauge house gravel bar in 1984. No fish were observed during the first electrofishing effort in the area on 1 May. On 9 May four walleye including one ripe female and three ripe males were captured and several other fish were noted. On 10 May, 18 walleye and 4 sauger including 2 gravid walleye and 1 gravid sauger were caught. Based on the large proportion of males collected, it was assumed that spawning was just starting. When the area was electrofished again four days later no fish were observed. These fish had apparently moved into the area

Table 29. Catch distribution of walleye and sauger caught in seasonal experimental gill net sets during 1983 and 1984 broken down by major habitat areas.

Season	Species	Upper Dredge		Nelson Dredge		Tailpool	
		No. Fish	No. Nets Fished	No. Fish	No. Nets Fished	No. Fish	No. Nets Fished
1983							
Spring	Walleye	1	3	3	4	7	2
	Sauger	0		0		1	
Summer	Walleye	2	3	3	4	3	3
	Sauger	7		3		2	
Fall	Walleye	1	3	0	4	3	3
	Sauger	1		7		10	
1984							
Spring	Walleye	2	3	7	4	1	3
	Sauger	13		7		9	
Summer	Walleye	0	3	7	4	1	3
	Sauger	2		10		2	
Fall	Walleye	0	2	1	4	3	3
	Sauger	4		27		13	
Total	Walleye	6	17	21	24	18	17
	Sauger	27		54		37	
Fish/Net	Walleye	0.35		0.84		1.06	
	Sauger	1.59		2.25		2.18	

Table 30. Walleye and sauger collected by various methods during the spring of 1983 and 1984, mean size and spawning condition.

Sampling Method	Species	Number	Mean Length (inches)	Mean Weight (pounds)	Spawning Condition[a/] Male				
					Male	Female			Unknown
					Rp	Rp	Gr	Sp	
			1983						
Electrofishing (River)	Walleye	21	18.8	2.25	17	2	1	-	1
	Sauger	5	19.0	1.94	-	-	3	-	2
Gill Nets	Walleye	6	18.9	2.15	4	-	-	1	1
	Sauger	2	19.9	2.43	-	-	2	-	-
			1984						
Electrofishing (River)	Walleye	22	20.2	2.87	19	1	2	-	-
	Sauger	2	15.7	1.09	1	-	1	-	2
Electrofishing (Dredge Cuts)	Walleye	0							
	Sauger	6	13.1	0.54	2	-	-	1	3
Trap Nets (Dredge Cuts)	Walleye	3	17.9	2.45	1	-	2	-	-
	Sauger	25	14.1	0.84	19	-	3	1	2
Total	Walleye	52	19.3	2.51	41	3	5	1	2
	Sauger	42	14.6	1.00	22	-	9	2	8

a/ Rp = ripe, Gr = gravid, Sp = spent

between 1 and 9 May, and left by 14 May. A thermograph was placed in the main river across from Duck Island on 18 May. Water temperatures were ranging between 7° and 9°C at that time and were above the optimum range for walleye and sauger spawning by about 27 May.

More effort was made to sample walleye and sauger in the upper dredge cuts in the spring of 1984. Three sauger were collected by electrofishing on 30 April. Two were caught over the gravel point between ponds 1 and 2; one of these was a ripe male. Two other sauger were seen but not collected. Water temperatures recorded on 30 April were 5.5°C in pond 1 and 6.5°C in pond 2 at the standard sampling stations.

One frame trap net was set on the gravel point in pond 1 on 2 May; a second was set on the gravel point between ponds 1 and 2 on 4 May. Both traps were fished until 10 May. Water temperatures during this time ranged from 8° to 8.5°C. Three walleye and 25 sauger were trapped including 2 gravid female and 1 ripe male walleye, 3 gravid and 1 spent female and 19 ripe male sauger. All but three of these fish were caught in the frame trap in pond 1. The upper dredge cuts were electrofished again on 18 May. Water temperatures had risen to 12.8°C which was above the optimum spawning temperatures for walleye and sauger. Four sauger were caught in the narrows between ponds 1 and 2 including one spent female and one ripe male, and two fish in which sex could not be determined. No attempt was made to collect eggs or fry from spawning areas in the dredge ponds. However, data did indicate that sauger could have spawned in the dredge cuts: sauger were concentrated over the best spawning habitat available during the time the water temperatures were optimum for spawning; most of the fish caught were mature and both gravid and spent females were captured in the area.

Although sampling results indicated that walleye and sauger spawning in the study area was limited, the presence of any spawning could be very significant to the total walleye and sauger population in the Missouri River downstream from Fort Peck Dam. Gardner and Stewart (1985) reported that walleye and sauger spawning areas in this section of the Missouri River were limited to the Milk River, Milk/Missouri River confluence area and eight isolated spawning reefs located between Wolf Point and the Montana-North Dakota border. They concluded that walleye and sauger spawning areas were few in number and limited in distribution for this extensive reach of the Missouri River.

The presence of spawning habitat would also be important to the long-range potential of the walleye and sauger fishery in the study area. Study data indicated that the present walleye and sauger fishery in the study area depended predominantly on migratory fish from downstream. It appeared that the lack of a good forage fish population was one of the main factors limiting the presence of a resident walleye and sauger fishery in the study area. Current management plans being implemented by the Montana Department of Fish, Wildlife and Parks have the potential of improving the forage fish situation below Fort Peck Dam. If this occurs, the presence of usable spawning habitat in the local area would be extremely beneficial to the rapid development of a resident walleye and sauger population.

FORAGE FISH

The study area downstream from Fort Peck Dam contains a variety of forage fish, but in very low numbers. Habitat conditions in the study area were not conducive to the development of a strong forage fish population. It appeared that most of the resident forage species were unable to establish and maintain a healthy population in the area. Continually fluctuating water levels in the tailpool and dredge cuts combined with the extremely unstable shoreline areas severely limit the establishment of shoreline and littoral aquatic vegetation. Many forage fish species require shoreline vegetation for spawning. Most forage species also require some form of vegetation to provide escape cover from predators which include not only other fish, but also a large number of piscivorous birds that inhabit the area during the summer.

Sampling Results

1983

Table 31 compares the total catch of forage and YOY game fish using a number of sampling methods during 1983 and 1984. These results are also compared to the catch from forage fish seining conducted in the study area in 1979.

The largest number of forage fish collected in 1983 were caught using a 100-foot x 1/4-inch seine. Thirteen hauls made in mid and late August, 1983 caught 79 forage fish and 2 YOY game fish. Ninety percent of these fish were caught in a single haul through one of the few areas in the upper dredge cuts that had flooded aquatic vegetation. This indicated the importance of cover to the forage fish that were present. Seining sites selected in 1983 were similar to those seined in 1979. In 1979, 20 seine hauls with a 100-foot x 1/4-inch seine caught 213 forage fish and one 1.8-inch lake trout (Needham 1980). In late September, 1983, 11 seine hauls made in the upper dredge cuts with a 50-foot x 1/4-inch seine failed to capture any fish. At this time the average daily discharge from the dam was approximately 7000 cfs and the resulting water levels in the dredge cuts were too low to reach shoreline vegetation. Eleven shoreline tows in the fall of 1983 in the upper and Nelson dredge cuts using an otter trawl caught 41 fish. A total of 10 forage fish and 1 YOY game fish were caught in 37 experimental and 11 1/2-inch monofilament gill nets fished in the study area during 1983. Thirty-eight forage fish and 4 YOY rainbow were collected in over 20 hours of boat electrofishing during the summer and fall of 1983. Most of these fish were caught in the tailpool and river. A total of 168 forage fish and 6 YOY game fish were collected by all sampling methods during 1983. This compares to forage fish and YOY game fish catch rates ranging from 45 fish per haul for 39 hauls to 206 fish per haul for 55 hauls in different areas of Fort Peck Reservoir during the fall of 1983 using a 100-foot x 1/4-inch seine (Wiedenheft 1984). Fort Peck Reservoir is considered to have a poor forage fish population. By comparison the total forage fish population in the study area was extremely low.

1984

The total catch of forage fish for 1984 was almost six times as great as the 1983 catch; however, this catch was still well below the catch rates experienced in Fort Peck Reservoir. Several factors contributed to this increased catch. In 1983 the first forage fish seining was not conducted until late September.

Table 31. Total catch of forage and YOY game fish by various methods during 1983 and 1984, compared to 1979 seine catch[a].

Species	1983 Catch						1984 Catch					1979
	Seine 100 ft.	Seine 50 ft.	Otter Trawl	Gill Nets	Electro-Fishing	Total	Seine 50 ft.	Otter Trawl	Gill Nets	Electro-Fishing	Total	Seine 100 ft.
Suckers (white & longnose)	7		39	2	22	70	240	1	1	100+	342+	13
River carpsucker										9	9	
Emerald shiner	15		1		5	21	24			10	34	30
Spottail shiner							275			1	276	
Fathead minnow							23			9	32	6
Western silvery minnow				4	2	6			3	300+	303+	138
Lake chub	14				3	17	3				3	23
Flathead chub							1				1	
Northern redbelly dace							1				1	
Carp												1
Goldeye					2	2						
Rainbow smelt				4		4			19		19	
Yellow perch	43				4	47	11	1	2	1	15	2
Walleye	1					1						
Smallmouth bass	1					1						
Rainbow trout					4	4						
Lake trout												1
Chinook Salmon				1		1			3	3	6	
Total	81	0	40	11	42	174	578	2	28	433	1,041	214

[a] 1979 data from Needham 1980.

In 1984 seining was started on 27 June. Over half of the forage fish that were collected were caught during early sampling. At this time average daily discharges were approximately 11,000 cfs. This inundated most of the shoreline vegetation around the dredge ponds. All of the fish that were caught were found in areas where there was good shoreline cover. The same higher minimum daily discharge levels that improved the rainbow rearing in the side channel also helped maintain wetted shoreline vegetation in the dredge ponds during a greater percent of the summer in 1984. A 50-foot x 1/4-inch seine was found to work well in flooded shoreline vegetation. Because of less set-up time with this seine, many more sites could be sampled in a given time period than with the 100-foot seine. For these reasons, the 50-foot seine was used exclusively in 1984. Twenty-one seine hauls made in the upper dredge cuts on 27 June caught 323 fish. This catch included 202 spottail shiners and 93 emerald shiners. Spottail shiners were introduced in Fort Peck Reservoir in 1982 and 1983. Seining results indicated that they were well established in the reservoir by the fall of 1983 (Wiedenheft 1984). Because spottails normally inhabit the shallow littoral area in lakes, it was not expected that many of them would be deep enough to get near the intake structure of Fort Peck Dam. However, seining results in the spring of 1984 indicated that a number of spottail had passed through the dam and found their way into the dredge cuts. Spottail were caught in almost every seine haul in the upper dredge cut in which any fish were caught. They were collected throughout the dredge cuts wherever there was flooded shoreline vegetation. A small sample of these spottails were measured and ranged from 2.1 to 2.6 inches total length. Spottails are supposed to reach sexual maturity by the time they are 2.6 inches long (Carlander 1970). Approximately a dozen of the largest spottails were examined, but none of them showed any sign of sexual maturity. Emerald shiners were the second most common forage fish caught during this seining. Several of the larger fish were examined and found to be gravid females. The following day seven seine hauls were made in Nelson dredge. Even at the higher discharge levels, sites with wetted shoreline vegetation were limited. Fish were caught in three of seven seine hauls. A total of 324 forage fish were caught. Ninety-three percent of these were caught in one seine haul through a good area of flooded vegetation. Small suckers were the most common species caught; these included both white and longnose suckers. A small subsample of these suckers ranged from 1.7 to 3.2 inches total length; they had probably hatched the preceding spring (Brown 1971). Both species of suckers have similar spawning habits. Spawning usually occurs from April to June. Ripe fish seek out gravel beds in fairly swift water to deposit their adhesive eggs (Brown 1971). While sampling rainbow redds in the spring of 1984, one sample contained hundreds of live sucker eggs along with rainbow eggs. Much excellent sucker spawning habitat exists in the east side channel and in the main river from the riffle at the head of Duck Island downstream. Adult suckers were usually caught while gill netting in the area. These data indicated that lack of spawning was not the main factor limiting the development of a good sucker population in the study area. The fact that most small suckers caught while seining in Nelson dredge were collected in a single seine haul through submerged vegetation indicated that vegetation cover was very important to them. When water levels dropped below available shoreline vegetation, suckers were forced out into open water. This lack of escape cover was probably a major factor limiting the sucker population.

The second most common fish caught while seining in Nelson dredge was the spottail shiner. Seventy-two were caught; all in one seine haul through good cover. Some of these spottails were smaller than the ones caught in the upper dredge cut. The size of a subsample ranged from 1.3 to 2.6 inches total length. No mature fish were found. The capture of spottail in both Nelson and the upper dredge cuts was good evidence that spottail were coming through the dam from Fort Peck Reservoir.

The upper dredge cuts were seined again on 29 August. Thirty-one forage fish were caught in 12 seine hauls. Emerald shiners were the most common species caught. Most of these averaged about 1.6 inches total length, which indicates they were probably one-year-old fish (Brown 1971, Carlander 1970). One emerald shiner collected was only 0.7 inches total length, and was probably a YOY fish (Carlander 1970). This indicated that some successful emerald shiner spawning did occur in the dredge cuts in 1984. Only one spottail was caught in this August seining. Large numbers of spottail were collected by seining at this time of year in Fort Peck Reservoir (Wiedenheft 1984). This indicated that if spottail were still present in the dredge ponds, more should have been caught. No other spottail were collected by any method in the dredge ponds after the spring seining. Survival of spottail shiners in the dredge cuts may have been very low over the summer. This was probably related to the total lack of escape cover in the dredge ponds once water levels dropped and dewatered existing shoreline vegetation. Also, because of the small numbers of prey fish that were available, they probably received intense pressure from existing predators. The lack of spottails later in the summer also indicated that very few passed through Fort Peck Dam during the summer. Most of the spottail that were found in the spring of 1984 probably came through the dam during spring and fall turnover and after an inverse stratification developed in the reservoir during the winter. Once the reservoir began to stratify in the summer, spottails probably remained in the warmer shoreline areas and did not get close to the intake structure at the bottom of the dam.

Five tows with an otter trawl in early August and five tows in mid-September in the upper dredge ponds caught one 6-inch yellow perch and one 3-inch longnose sucker. More effort was spent in 1984 trawling in the open water areas of the dredge cuts in an attempt to locate cisco if they were present; none were captured. Six 14- to 16-inch river carpsuckers and one 35-inch (eye-to-fork length) paddlefish were caught while trawling indicating that the trawl was effective if fish were available. A total of 28 small forage and YOY game fish were caught in 29 experimental and 12 ½-inch monofilament gill nets set during 1984. All but two of these were caught in the monofilament "smelt" nets. The most common species caught was rainbow smelt. Nineteen smelt ranging from 5.5 to 7.5 inches were caught in the summer and fall smelt net sets; 10 during the summer and 9 in the fall. During 1983, only one smelt was caught in 11 monofilament smelt nets set during the year; three more were caught in 37 experimental gill-net sets. The largest rainbow smelt catch in the study area occurred in 1981 when 39 smelt were caught in four 1/2-inch monofilament smelt nets (Needham and Gilge 1983). Smelt nets were not used in 1980, the year the major smelt run occurred in the area. During the summer of 1980, 29 smelt were caught in 10 experimental gill nets (Needham and Gilge 1981).

Most electrofishing conducted in 1984 was centered in the upper tailpool and upper dredge cuts. Very little electrofishing was done in the main river except early in the spring to look for spawning walleye. Much of the electrofishing in the tailpool and dredge cuts was done in the fall in an attempt to locate paddlefish. Some effort was also made to electrofish the shoreline areas of the upper dredge cuts using a handheld electrode. This late paddlefish shocking and the bank shocking in the dredge ponds added greatly to the 1984 forage fish count. On 10 October, approximately 3½ hours of effort was spent electrofishing in the tailpool and upper dredge cuts looking for paddlefish. During this electrofishing, large numbers of western silvery minnows and several small suckers were sighted. No attempt was made to collect these fish, but it was estimated that at least 250 to 300 western silvery minnows and over 100 small suckers were seen. The western silvery minnows appeared to run between 3.0 and 5.0 inches long. Most of them were seen in schools in pond 1 and 2 of the dredge cuts; a few were seen in the tailpool. The suckers appeared to be 2.0 to 3.0 inches long and were seen in the dredge cuts. One local fisherman reported that he had seen similar concentrations of western silvery minnows in the fall of 1982, but had not seen any in 1983. Only six western silvery minnows were collected by all methods in 1983. Three western silvery minnows were caught in gill nets in 1984. Four more were collected while electrofishing; one along the shoreline of the upper dredge ponds in August and three in the tailrace in September. Several more were seen while electrofishing in the tailrace in September. Western silvery minnows reach sexual maturity after one year at between 2 and 3.5 inches length (Brown 1971). Therefore all the fish seen in the fall were probably mature fish. No evidence of successful reproduction was found, except for one gravid female caught in Nelson dredge during the spring. One spottail shiner was caught while electrofishing in pond 1 of the upper dredge cuts on 18 May. This was the first spottail found in the study area. Three chinook salmon from the spring plant were collected in the upper dredge cut in late April. Table 32 shows the numbers and sizes of forage fish caught while eletrofishing the shoreline areas of the upper dredge cuts in August. Based on these results, it appeared there was some successful reproduction of fathead minnows, emerald shiners and river carpsuckers in the dredge cuts in 1984.

Table 32. Numbers and sizes of forage fish caught while electrofishing the shoreline areas of the upper dredge cuts in August 1984.

Species	No.	Mean Total Length (inches)	Mean Length Range (inches)
Western silvery minnow	1	3.0	
Longnose sucker	1	4.0	
River carpsucker	9	1.1	0.9 - 1.4
Fathead minnow	8	1.3	1.0 - 2.3
Emerald shiner	10	1.1	1.0 - 2.3

Cisco

In early January of 1985, three cisco were found floating in the tailrace of Fort Peck Dam. Four more were collected in the same area on 1 March. These fish had apparently been killed while passing through the dam. They ranged from 6.5 to 7.7 inches total length. Cisco (Coregonus artedii) were first introduced to the area in 1984 when approximately 9.4 million fry were planted in Fort Peck Reservoir in an attempt to establish a new forage fish population. Cisco are pelagic fish that prefer cold, deep, open-water habitat. Because of this habitat preference they are susceptible to passage through the dam. They should be able to establish good populations in the deep water of the tailpool and in the dredge cut ponds. Because they inhabit open water areas and can spawn over any hard surface at almost any depth (Scott and Crossman 1979), cisco should be able to do well in the study area even without shoreline cover. Also, once cisco become established in Fort Peck Reservoir, there should be a continual influx of new fish into the study area.

Summary

It is doubtful that there has ever been a good forage fish population in the study area since Fort Peck Dam was built. In the past, yellow perch had been the major forage fish in Fort Peck Reservoir. Even if large numbers of perch had passed through the dam, they could never have developed a good reproducing population because of their requirements for shoreline spawning vegetation. The Fort Peck Trout Pond provides an example of how perch can do in the downstream area without fluctuating water levels. This pond was originally part of the Fort Peck dredge cuts (Figure 1) and experienced the same kind of water fluctuations now experienced by the rest of the dredge ponds. In 1963 a dike was built to isolate this pond from the rest of the dredge cuts. This dike limited water fluctuations caused by changing discharge patterns from the dam. Since being isolated, a heavy growth of shoreline and aquatic vegetation has become established in the trout pond. This pond now supports a large perch population as well as a number of other fish species. In contrast, yellow perch are rare in the rest of the dredge cuts and no evidence of reproduction has been found.

Lack of forage fish is probably one of the main factors preventing the development of a good game fish population in the study area. It appears that game fish will utilize and remain in the area if food is available. This was evident when rainbow smelt migrated from Garrison Reservoir to the study area during 1980. Walleye and sauger fishing in the tailpool and dredge cuts were excellent throughout the summers of 1980 and 1981. The majority of these fish that were examined were feeding on smelt (Needham, MDFWP, personal communications). Numbers of walleye and sauger decreased in response to declining smelt numbers. Figure 23 shows the close relationship between numbers of walleye and sauger and numbers of smelt caught in a series of 10 experimental gill nets fished in the tailpool and dredge cuts during the summers. The increased walleye and sauger catch observed in 1984 may have been partially related to other factors as explained in the walleye and sauger section of this report. Although the smelt catch in experimental gill nets was down during the summer of 1984, the catch for four 1/2-inch monofilament gill nets was the highest recorded since these nets were first used in 1981. Sampling results from this study indicated that the forage fish population in the study area was very small. There was a limited amount of reproduction of some resident forage species in the study area. Environmental conditions, especially the lack of shoreline and aquatic vegetation as a result of continually fluctuating water levels, prevented the development of good populations of any of these species. It appeared that both spottail shiners and cisco, from plants made in Fort Peck Reservoir, were passing through the dam into the study area. Both of these species have the potential for increasing the forage base in the study area. The development of a good forage base in the area below Fort Peck Dam could have a significant impact on the entire fishery of the area. If the forage fish population increased, it is likely that the population of resident game species would also increase.

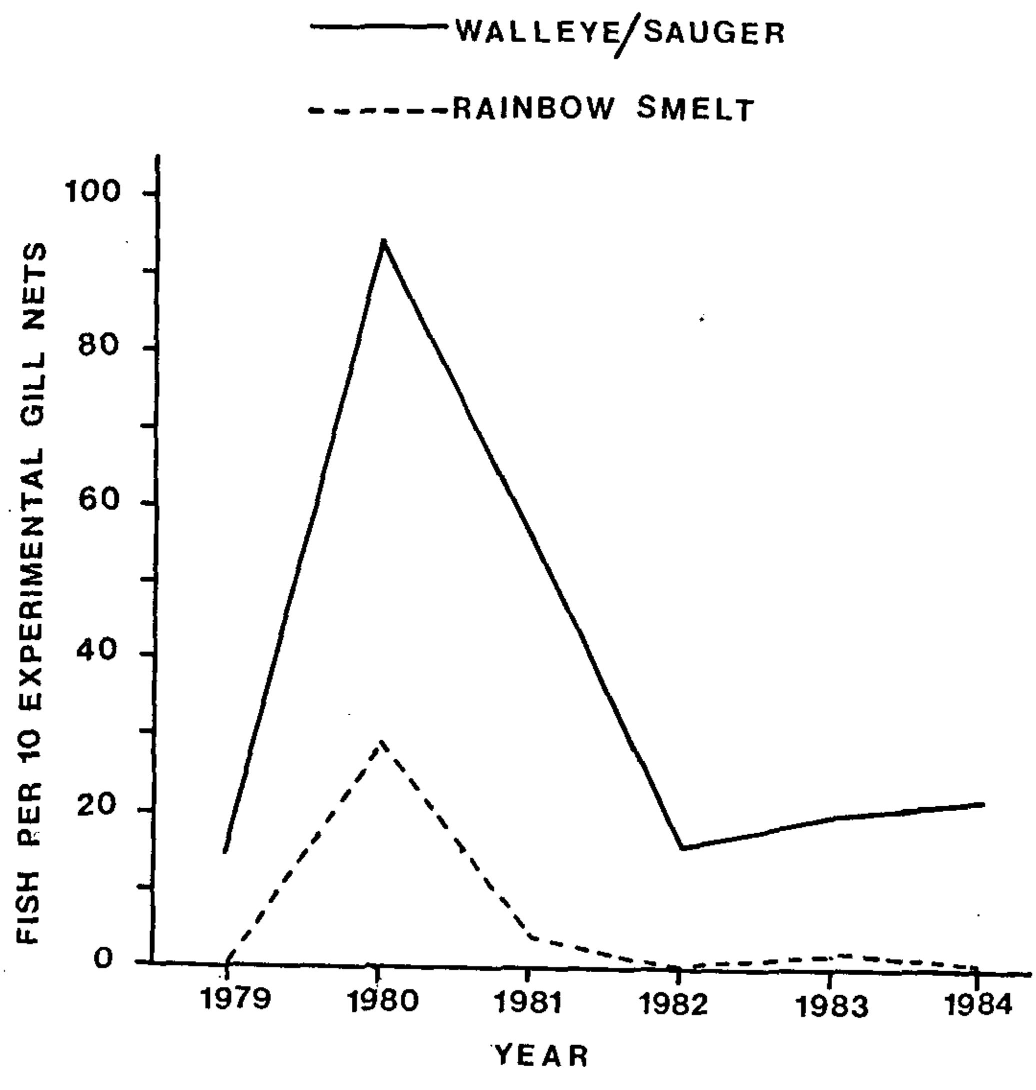

Figure 23. Relationship between the number of walleye/sauger and number of rainbow smelt caught in 10 experimental gill nets fished in the dredge cut/tailwater area during the summer, 1979 to 1984.

OTHER SPECIES

Several other species of game fish and a number of nongame fish were collected during this study.

Northern Pike

Northern pike are not native to the Missouri River drainage in Montana. They were first planted in Fort Peck Reservoir in 1951 and have been present in the reservoir since. A number of other small reservoirs, especially in the Milk River drainage were also stocked with northern pike in the 1950's. The only record of northern pike being planted below Fort Peck Dam was in 1964 when 8,600 three inch northern pike were planted in a pond just below the dam. It is not known if any of these pike actually entered the river system. Most of the northern pike in the study area probably originated from the plants made in Fort Peck Reservoir.

Northern pike are an important game fish in the study area. They provide considerable fisheries recreation both during the summer and through the ice. Most of the pike collected during this study were caught in the upper and Nelson dredge cuts. A few were caught in gill nets in the tailpool and an occasional pike was seen while electrofishing in the main river.

Table 33 presents size data on the northern pike caught in standard gill net sets during 1983 and 1984. There was no obvious differences in catch rates or size between the two years or between seasons within a year. The summer catch rates observed during this study was similar to catches reported in comparable gill net sets from 1979 to 1982 (Needham and Gilge 1984).

The northern pike population in the study area is limited by downstream water level fluctuations. Water level fluctuations limited forage fish production as was discussed in a previous section. Fluctuating water levels also impact northern pike reproduction. Pike spawn in the spring shortly after ice out; they require flooded vegetation in which to deposit their adhesive eggs. Eggs require about two weeks to hatch. Very little pike spawning habitat was available in the study area because of water level fluctuations. During daily high water levels, there was enough flooded vegetation in both the upper and Nelson dredge cuts to support some pike spawning, but none of it remained flooded during the daily cycle of low water. Two frame trap nets were fished in the upper dredge cuts in the spring of 1984; a total of 15 northern pike were caught. All of the pike caught between 2 May and 7 May were ripe fish; three of the females caught on 10 May were spent. This indicated that pike spawning did occur in the area. Attempts to collect YOY pike later in the year by seining and electrofishing shoreline vegetation was unsuccessful. Some of the most extreme water level fluctuations observed during the study occurred during early May of 1984. It is likely that the pike spawned in vegetation flooded during high water and that the eggs were dewatered by dropping water levels and were lost.

The development of a good population of cisco and/or spottail shiners in the study area would definitely benefit the northern pike, but the pike population will not reach its full potential without water level and/or habitat management to provide spring spawning conditions.

Table 33. Northern pike caught in seasonal gill nets set at standard locations during the spring, summer and fall of 1983 and 1984, mean length and weight and size ranges.

Season	No.	Mean Length (inches)	Mean Weight (pounds)	Length Range (inches)	Weight Range (pounds)
			1983		
Spring	6	30.1	6.89	24.3 - 35.0	3.09 - 10.50
Summer	4	23.8	3.46	20.3 - 29.1	1.80 - 6.50
Fall	8	29.4	8.22	22.2 - 38.0	2.66 - 17.5
			1984		
Spring	8	26.2	4.75	21.6 - 31.5	3.09 - 7.41
Summer	3	31.0	8.1	25.4 - 40.0	3.60 - 17.05
Fall	5	31.2	___ a/	25.6 - 36.0	3.90 - 15.0

a/ Three of the five fish were greater than 6 pounds and couldn't be weighted.

Lake Trout

Lake trout are not native to the Missouri River drainage in Eastern Montana. They were first introduced into Fort Peck Reservoir in 1953 and a natural reproducing population has existed in the reservoir since. No lake trout have ever been planted below Fort Peck Dam; the lake trout present in the study area originated from Fort Peck Reservoir.

Lake trout provide an important fishery in the study area, especially in the spring and fall when they are caught in the tailrace immediately below the dam. Lake trout are also caught in the upper dredge cuts through the ice during the winter.

Very little is known about the lake trout population in the study area. They appear to remain in the tailrace immediately below the dam during most of the year moving into the upper dredge cuts only during the winter. No lake trout were captured in any area other than the tailpool during this study. Six lake trout were captured while electrofishing immediately below the dam in 1983 (Table 34). One 1.8 inch lake trout was caught in a gill net in the lower tailpool approximately 2 miles below the dam in November of 1984. An ice fisherman contacted on pond 1 of the upper dredge cuts during the winter of 1983 had one lake trout and reported his party had caught several other lake trout during previous weeks. Needham (MDFWP) captured three lake trout in a series of experimental gill nets set under the ice in the upper dredge cuts in March of 1979. It is not known how important the winter dredge cut habitat is to the survival of the lake trout in the study area or what causes them to move out of the tailraces area, but it appears that the upper dredge cuts do provide winter habitat for lake trout.

There is no evidence available to indicate that lake trout are reproducting naturally below Fort Peck Dam. The tailrace was snorkeled during the fall of 1983 and spring of 1984 to try and locate potential lake trout spawning habitat.

Table 34 Mean lengths and weight and size range of lake trout captured below Fort Peck Dam by electrofishing in 1983.

No.	Mean Total Length (inches)	Mean[a/] Weight (pounds)	Length Range	Weight Range
6	22.2	2.76	16.4 - 31.0	1.30 - approx. 10.0

[a/] Weight for five smaller fish, weight had to be estimated for largest fish.

Lake trout broadcast spawn their eggs over rocky shoal areas where the eggs settle and develop in rock crevices (Brown 1971). Very little potential spawning habitat was identified in the study area. The rip rap along the dam west of the powerhouses extends only a couple of feet below waters surface at normal pool. Most of the spaces between the larger boulders placed in the main channel are filled with silt and shale. The rip rap along the east bank just downstream from the powerhouses may provide some limited spawning habitat, but this area consists of very large boulders stacked almost vertically from the bottom to the surface and would be hard to spawn over. Needham (1980) did capture a 1.8 inch lake trout in Nelson dredge in a minnow seine in the fall of 1979. This fish was probably a YOY fish and may have come from spawning that occurred below the dam; but it appears that the majority of the lake trout found in the study area are probably recruited through the dam from Fort Peck Reservoir. The total number of lake trout in the population below Fort Peck Dam is probably small. Two of the six lake trout captured and tagged in 1983 were recaptured by anglers in 1984; one in May and one in June.

Chinook Salmon

Chinook salmon are a new introduction to the study area. Chinook were first planted in the tailwater area downstream from Fort Peck Dam in the spring of 1983. On 5 April, 45,000 3 to 5 inch fingerlings were released near Scout Island. In 1984 an additional 216,000 3 to 5 inch chinook were planted in the tailpool between 13 March and 13 April. These fish were planted as pre-smolts in hopes that they would imprint to the Fort Peck tailwater area, then migrate downstream to Garrison Reservoir to mature. It is hoped that once they mature, they will return to the Fort Peck tailwater in the fall to spawn.

Chinook have similar spawning habits to rainbow trout and require the same kind of spawning habitat. Therefore, if a run of chinook does develop below Fort Peck Dam, they will probably spawn in the same areas now used by rainbow trout. Chinook would spawn in the fall, eggs would incubate in the gravel all winter and hatch early in the spring. Young salmon would rear in the study area until they reached a size large enough to smolt, then they would migrate downstream.

Two chinook from the 1983 spring plant were captured while electrofishing late in the fall of 1983. A chinook caught 7 September measured 8.9 inches total length and weighed 0.3 pounds; one caught 20 October was 10.7 inches long and weighed 0.5 pounds. Both of these fish were in excellent condition. Plans are to continue stocking chinook in the study area to develop a natural reproducing population. If mature chinook salmon do return to the Fort Peck tailwater area, this could develop into a very important fishery and greatly increase the recreational use of the downstream area.

Shovelnose Sturgeon

Shovelnose sturgeon are native to the Missouri River in Montana; a large number inhabit the study area below Fort Peck Dam. Shovelnose are sometimes caught by anglers, but few fishermen actually fish specifically for sturgeon. Nothing is known about the life history or spawning habits of the sturgeon population below Fort Peck Dam. It is very unlikely that any spawning occurs in the study area because of the cold water temperatures. Shovelnose sturgeon from the study area probably migrate downstream to spawn.

The numbers of sturgeon present in the study area appeared to fluctuate on a seasonal basis. Table 35 presents the numbers of shovelnose sturgeon caught in standard gill net series fished during the spring, summer and fall of 1983 and 1984. There was a large decrease in the sturgeon catch during both years from

Table 35. Seasonal catch of shovelnose sturgeon in standard gill net sets fished during the spring, summer and fall of 1983 and 1984, mean lengths and weights and size ranges.

Season	No.	Mean Total Length (inches)	Mean Weight (pounds)	Length Range	Weight Range
			1983		
Spring	67	26.8	2.30	21.3 - 31.1	0.60 - 4.48
Summer	30	26.1	2.28	22.0 - 29.4	1.08 - 3.58
Fall	28	26.6	2.29	22.0 - 36.2	1.05 - 6.50
			1984		
Spring	65	26.0	2.23	21.9 - 31.0	1.10 - 3.97
Summer	54	26.8	2.55	21.8 - 34.7	0.75 - 6.25
Fall	17	25.9	2.21	21.3 - 30.6	1.48 - 3.53

spring to fall. Shovelnose were found throughout the study area during all seasons. The average size of sturgeon caught during this study was similar to the size of sturgeon caught in a series of summer gill nets fished in the study area from 1979 to 1982 (Needham and Gilge 1984).

Others

Table 36 presents the numbers and size range of other fish caught in standard experimental gill net sets during this study. No attempt was made to capture or count nongame fish seen while electrofishing or during any other sampling.

Channel catfish provide some fishing opportunities in the study area. They were found in the upper dredge cuts and in the main river. Very little is known about their spawning habits or life history within the study area. The lake whitefish captured during the summer of 1984 was the first fish of this species reported in the area. Lake whitefish are known to be in the Milk River drainage. The reproduction of some of the nongame species is discussed in the forage fish section.

Table 36. Total numbers and size ranges of other fish species caught in standard gill net sets fished during 1983 and 1984.

Species	No.	Range	
		Total Length (inches)	Weight (pounds)
White sucker	33	7.4 - 19.5	0.11 - 3.15
River carpsucker	116	13.8 - 20.0	0.96 - 4.12
Longnose sucker	15	8.4 - 20.0	0.10 - 3.62
Blue sucker	6	26.3 - 32.0	4.91 - 10.0
Shorthead redhorse	25	9.7 - 16.9	0.44 - 1.86
Smallmouth buffalo	8	14.6 - 22.8	1.38 - 6.50
Carp	18	13.4 - 20.0	0.92 - 3.98
Goldeye	1,400[a]	7.9 - 15.0	0.14 - 1.18
Channel catfish	15	14.4 - 21.1	0.77 - 3.36
Burbot	1	24.2	2.98
Lake whitefish	1	23.0	6.58

[a] Sizes for subsample of 811.

Potential Impacts of Increased Hydropower Production at Fort Peck Dam on the Downstream Fisheries

A Review Report submitted to the Chief of Engineers in Washington, DC, in 1977 concluded that additional hydropower could be generated at Fort Peck Dam (U.S. Army Corps of Engineers, 1977). This report recommended that a more detailed study be conducted and presented a plan that would increase power production at Fort Peck by 185 megawatts (MW) by adding two 92.5 MW powerhouses to the two existing flood control tunnels at Fort Peck Dam. To minimize downstream fluctuations that would result from increased power production, this plan called for the construction of a reregulation dam approximately 8 miles downstream from Fort Peck Dam. Since that time, the Planning Division, US Army Corps of Engineers, Omaha District has presented six additional preliminary plans for increasing hydropower production at Fort Peck Dam. Table 37 presents basic information on each plan. Figure 24 shows the general locations of the six proposed reregulation dams. More detailed maps for each plan are presented in the discussion.

Data from this study and from past work on the study area downstream from Fort Peck Dam showed that this area contained a diverse and somewhat unique fishery. This area provided habitat for a variety of different game fish. No detailed recreational use data is available for the study area, but the downstream fishery does provide considerable recreational opportunities. New management plans being implemented by the Montana Department of Fish, Wildlife and Parks and a fisheries study being funded by the Natural Resource Branch, COE have the potential of greatly increasing the fishery and recreational opportunities downstream from Fort Peck Dam.

All of the preliminary plans presented by the COE for increasing hydropower production at Fort Peck Dam would potentially impact the downstream fishery. Although some segments of this fishing may benefit from certain plans, the potential negative impacts on the total fishery outweigh the positive effects that could be expected.

Original Plan (Reregulation Dam 8 miles downstream)

This was the preferred plan for increasing hydropower production at Fort Peck Dam that was first presented in the 1977 Review Report (US Army Corps of Engineers 1977). This plan called for the addition of two 92.5 MW hydropower units at Fort Peck Dam to increase the plant capacity by 185 MW. The maximum discharge capacity of the Fort Peck powerplant would be increased from 15,200 cfs to 32,600 cfs.

In order to minimize downstream water level fluctuations this plan called for the construction of a reregulation dam 8 miles downstream from Fort Peck Dam (Figure 25). The reregulation pool would have a maximum pool elevation of 2039 feet M.S.l. and a minimum pool elevation at the rereg dam of 2020 feet M.S.l. Under this plan Fort Peck would be operated to provide peak power during seven hours of peak demand for six days a week with no generation on Sunday. This would result in a daily rise of 10 to 12 feet in the rereg pool with water levels dropping 8 to 8½ feet daily at the end of the peaking discharge. The reregulation dam would provide full downstream reregulation during this time. On Saturday afternoon the discharge from the reregulation dam would be decreased

Table 37. Facts about seven major proposals for increasing hydropower production at Fort Peck Dam as presented by the COE.

TITLE OF PROPOSAL	LOCATION OF REREG DAM	REREGULATION POTENTIAL	INCREASED POWER PRODUCTION	INVOLVEMENT OF UPPER DREDGE CUTS
Original Plan	USGS Gage house 8 miles downstream	Fall reregulation during week - 1 foot fluctuation between week and weekend	185 MW	Flow control structure at mouth
Scenario 1	Range 3 Just above Nelson dredge	Full reregulation No downstream fluctuations	120 MW	Flow control structure at mouth
Scenario 2	Range 2 Across downstream end of Scout Island	Partial reregulation fluctuations similar to present	120 MW	Would be part of rereg. pool
Scenario 3	Range 1 Across middle of Scout Island	Partial reregulation fluctuations similar to present	120 MW	Would be part of rereg pool
Scenario 4	No rereg dam	None	120 MW	Would experience large increases in fluctuation
Scenario 5	Range A Just upstream of upper dredge cut-down and across center of Scout	Partial reregulations less fluctuation than present	105 MW	Rereg dam upstream of dredge cuts
Scenario 6	Range B Across middle of Scout Island	Partial reregulation less fluctuation than present	105 MW	Pond 1 part of rereg pool half mile long Channel cut from downstream of rereg dam to center of pond 2

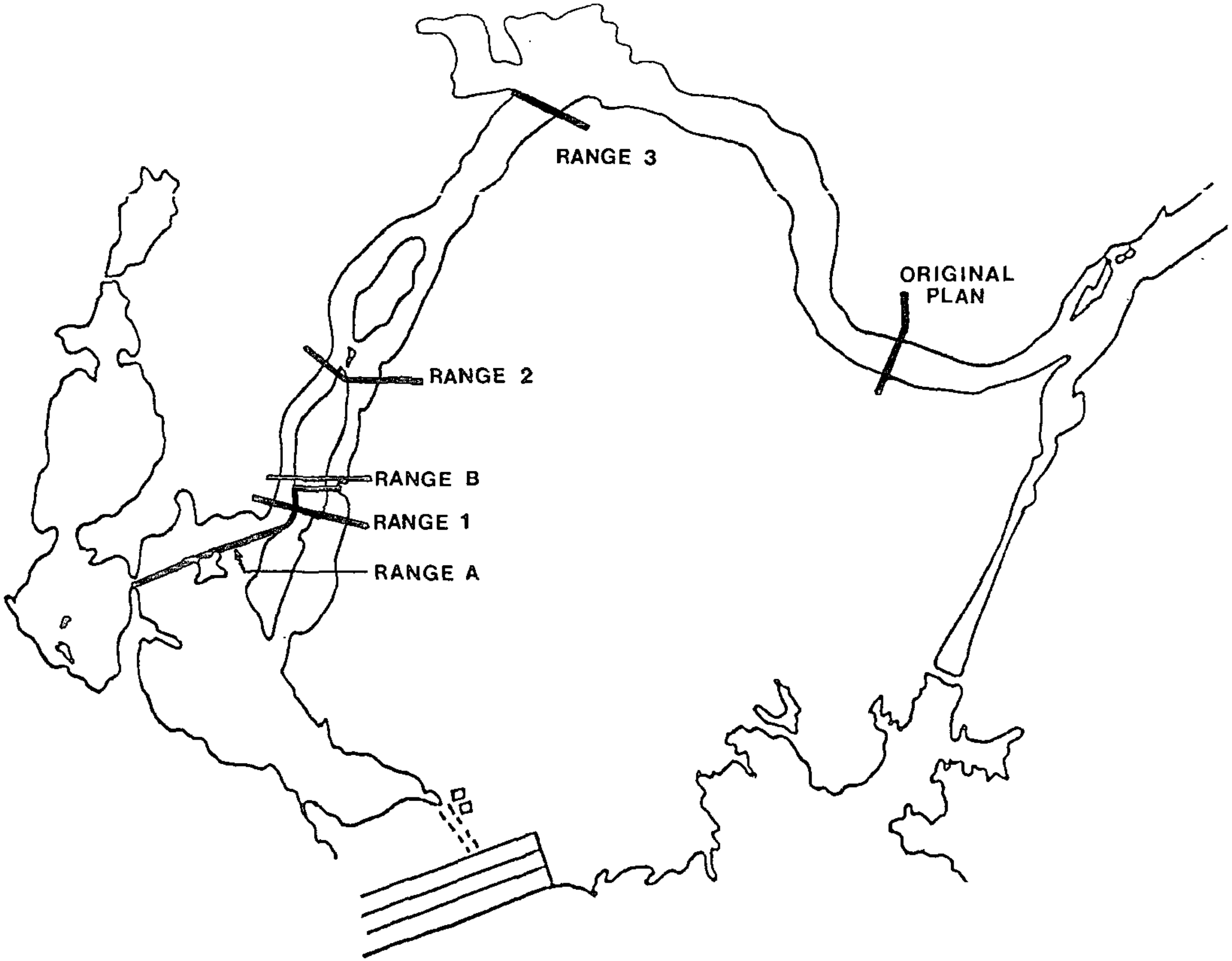

Figure 24. Locations of the six proposed reregulation dams in the study area.

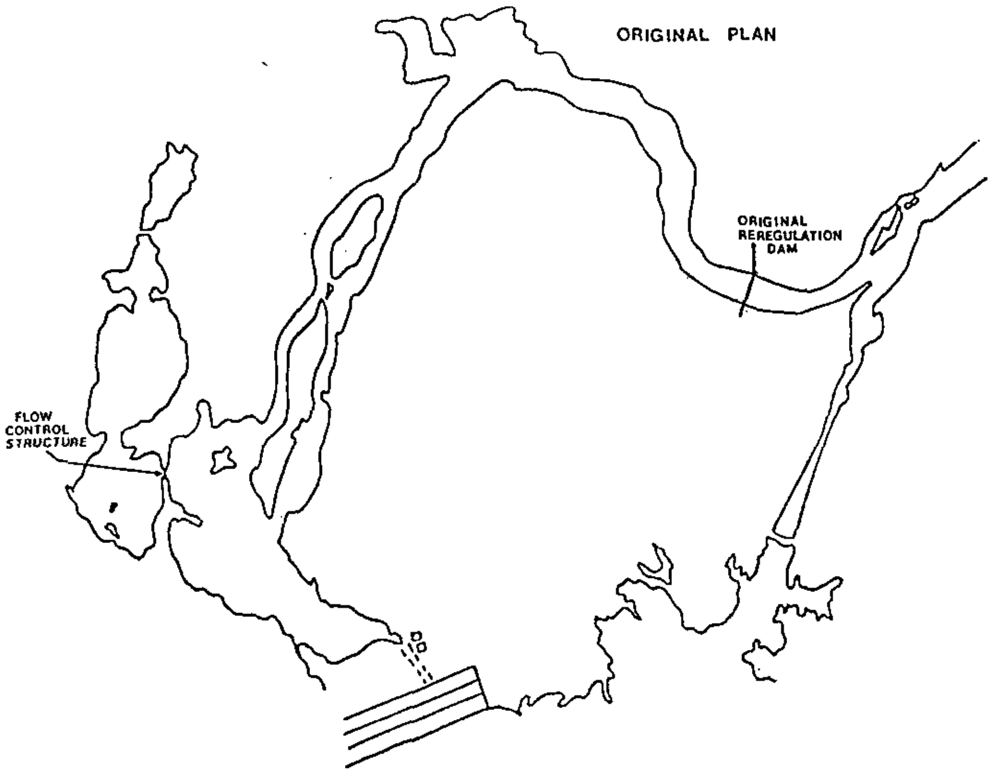

Figure 25. Map of the proposed location of a reregulation dam in the Original Plan.

to draw the rereg pool down to its minimum elevation. This would result in downstream water levels from Saturday evening to Monday noon about 1 foot lower than during the rest of the week.

This plan called for the construction of a flow control structure at the opening to the upper dredge cuts to prevent stage fluctuations in the dredge cuts.

Potential Impacts

Paddlefish

This plan would result in the elimination of paddlefish from the study area. Paddlefish that inhabit the study area below Fort Peck Dam depend on downstream areas to provide spawning habitat and to provide recruitment of new paddlefish to the area. The reregulation dam in this plan would block movement of paddlefish between the study area and downstream areas. Paddlefish trapped above the reregulation dam would not have access to any spawning areas. New paddlefish could not be recruited to the area from downstream to maintain the existing population. Without new recruitment, the isolated paddlefish population trapped above the reregulation dam would disappear over time.

Study results showed that there was a seasonal movement of paddlefish between the dredge cuts and the tailpool. The significants of this movement is not fully understood, but the flow control structure at the mouth of the dredge cuts would prevent this seasonal movement of paddlefish trapped in the dredge cuts or tailpool.

Rainbow Trout

This plan would inundate all known rainbow spawning and rearing habitat and most of the area where adult rainbow trout were found. This would result in the elimination of natural rainbow trout reproduction in the study area and would cause the eventual loss of a unique strain of rainbow trout. The large daily water level fluctuations above the reregulation dam would create an unproductive pool which would not support much of a fish population. It is unlikely that a natural rainbow fishery could be maintained in the rereg pool.

Chinook Salmon

Chinook salmon require approximately the same spawning habitat as rainbow trout. The loss of existing rainbow spawning areas would eliminate the possibility of developing a naturally reproducing chinook salmon population below Fort Peck Dam.

Lake Trout

Lake trout would be trapped in the rereg pool by this plan. It appeared that the majority of lake trout below Fort Peck Dam were recruited to the area through the dam. As long as lake trout continued to pass through the dam, it may be possible to maintain a limited lake trout population in the rereg pool. The lower productivity of the rereg pool as a result of large daily water level fluctuations would probably be very limiting on this lake trout population. The reregulation dam would prevent migration of fish such as rainbow smelt and small game fish to the rereg pool from downstream. The water level fluctuations would prevent any natural production of forage fish in the rereg pool. If a lake trout population was to maintain itself it would have to depend entirely on recruitment of forage through the dam. This could occur if cisco became well established in the reservoir. However, even if lake trout and forage fish did continue to pass through the dam it is not known how the large daily water level fluctuations in the rereg pool would affect their survival.

The flow control structure at the opening to the dredge cuts would prevent the seasonal movement of lake trout from the rereg pool to the dredge cuts in the winter. It is not known how important this seasonal movement is to the survival of the lake trout. Even if this structure did not affect lake trout survival it would eliminate the winter lake trout fishery that now exists in the dredge cuts.

Walleye and Sauger

The walleye and sauger populations in the study area appeared to consist almost entirely of migratory fish. This plan would block the movement of walleye and sauger into the study area from downstream. The reregulation dam in this plan would be built right at the walleye spawning area located 8 miles downstream from Fort Peck Dam. This spawning area appeared to be one of the few walleye spawning areas in the Missouri River between Fort Peck Dam and Garrison Reservoirs. The loss of this area could affect not only the study area but downstream areas as well. This plan would also block access of downstream fish to the spawning area identified in the upper dredge cuts.

The flow control structure at the opening to the upper dredge cuts would create an isolate lake system in which water levels could be controlled and maintained constant. With constant water levels in the dredge cuts it would be possible to establish a good growth of shoreline and aquatic vegetation. This would provide spawning habitat for forage fish and northern pike and escape cover for forage and small game fish. With the establishment of a good forage base it may be possible to develop and maintain a good walleye fishery in this area by stocking.

There may be a problem with water quality in the upper dredge cuts if they were isolated from the main river. There does not appear to be much natural groundwater movement in this area, and there is no inlet or outlet other than the connection to the river. If this opening was blocked so that there was no exchange of water through the dredge cuts the water quality in the dredge cuts could change.

Northern Pike

The northern pike population in the study area appeared to be restricted to the upper and Nelson dredge cuts and the upper tailpool. Fluctuating water levels in these areas already limit forage fish and northern pike production. This plan would include Nelson dredge and the tailpool in the rereg pool. The large and consistent water level fluctuations and the lower productivity of the rereg pool would probably eliminate northern pike from these areas. The flow control structure at the opening to the upper dredge cuts would make it possible to maintain constant water levels in this area. This would result in an increased production of vegetation and in turn forage fish. The increased vegetation would provide spawning habitat for northerns. It would probably be possible to develop a naturally reproducing northern pike fishery in the isolated dredge cuts. However, there may be problems with water quality in the isolated dredge cuts as mentioned in the walleye and sauger section.

Forage Fish

The inundation of 8 miles of river habitat and Nelson dredge would eliminate the limited forage fish production that now occur in these areas. The reregulation dam would block the upstream migration of forage fish such as rainbow smelt to the upper study area. The flow control structure at the opening to the dredge cuts would prevent movement of forage fish from the dredge cuts to the rereg pool. This structure would also prevent forage fish such as spottails and cisco that passed through the dam from getting into the upper dredge cuts. The total productivity of the rereg pool would probably be less than the productivity of the present river system.

with the plan it would be possible to develop a good forage fish population in the isolated upper dredge cuts which could be used to support a game fish population in this area. However, this may be limited by water quality problems as indicated above.

Shovelnose Sturgeon

This plan would result in the eventual elimination of shovelnose sturgeon from the study area. Because of the cold water immediately below the dam it is very unlikely that any sturgeon reproduction occurs in the study area. It appears that the sturgeon population below the dam depends on downstream areas to provide spawning habitat and recruitment of new fish to the area. The construction of a reregulation dam would isolate sturgeon trapped in the rereg pool from necessary spawning habitat and would prevent recruitment of new sturgeon to the area. This would result in the eventual elimination of all sturgeon above the reregulation dam.

Possible Mitigation

It may be possible to develop a fishery for trout and salmon in the tailpool below the reregulation dam through an intense stocking program. It is very unlikely that any natural reproduction of these species would occur with this plan. A walleye and northern pike fishery could be developed in the isolated dredge cuts if water level fluctuations were eliminated. This would require stocking of both species to establish these fisheries, northern pike may be able to maintain themselves through natural reproduction. The available walleye spawning habitat in the dredge cuts could be expanded and some walleye reproduction may occur but this fishery would probably have to be maintained by stocking. It would be possible to develop a water exchange system in order to maintain good water quality in the isolated dredge cuts if water quality becomes a problem.

Scenario 1 (Reregulation Dam at Range 3)

This plan called for the addition of a third powerhouse at Fort Peck with an output capacity of 120 MW. This would increase the maximum discharge capacity of the Fort Peck power plant to about 25,600 cfs.

This plan called for the construction of a reregulation dam at Range 3 (Figure 26). The maximum elevation of the rereg pool in this scenario would be about 2038 feet M.S.l. and would occur at a mean daily discharge of 14,000 cfs. Figure 27 shows the minimum and maximum pool elevations that would occur in the rereg pool at mean daily discharges up to 25,600 cfs. The largest water level fluctuations in the rereg pool would occur at a mean daily discharge around 12,000 cfs; fluctuations would be about 11 feet. This reregulation dam would provide total reregulation so no fluctuations would occur downstream. Pool levels in the rereg pool would fluctuate continuously every day.

This plan would include a flow control structure at the opening to the upper dredge cuts to prevent stage fluctuations in the dredge cuts.

Potential Impacts

Paddlefish

The impacts of this plan on paddlefish would be similar to those described for the Original Plan. The only difference is that a reregulation dam at Range 3 would not inundate the Nelson dredge cut area. This may make it possible to maintain a few paddlefish in this area. Study results showed there were a few paddlefish that utilized Nelson dredge, but the numbers were very small compared to the numbers found in the upper dredge cuts. Nelson dredge was less productive and had consistently colder water temperatures than the upper dredge cuts during this study. It is not known what effect the release from the reregulation dam right at the opening to Nelson dredge would have on this area. By building the reregulation dam so water was released along the south bank it may be possible to reduct the rapid circulation of water through Nelson dredge.

Even with this design the productivity of Nelson dredge would probably remain very poor. Therefore, it is unlikely that many paddlefish would use this area even though it was available.

Rainbow Trout

The impacts of this plan on rainbow would be similar to those described for the Original Plan. The rereg pool in this plan would inundate all major rainbow spawning and rearing areas. One minor spawning area located 8 miles downstream near the USGS gage would be below the reregulation dam. This area contributed very little to the total rainbow spawning in the past two years and it lacks necessary rearing habitat. The use of this area by rainbow may increase some if all other spawning areas were lost, but it would not be enough to maintain a naturally reproducing rainbow population. Therefore, this plan would result in the eventual loss of the unique rainbow strain that inhabits the study area.

Chinook Salmon

With the loss of most of the usable salmonid spawning areas this plan would eliminate the possibilities of developing a naturally reproducing chinook run below Fort Peck Dam.

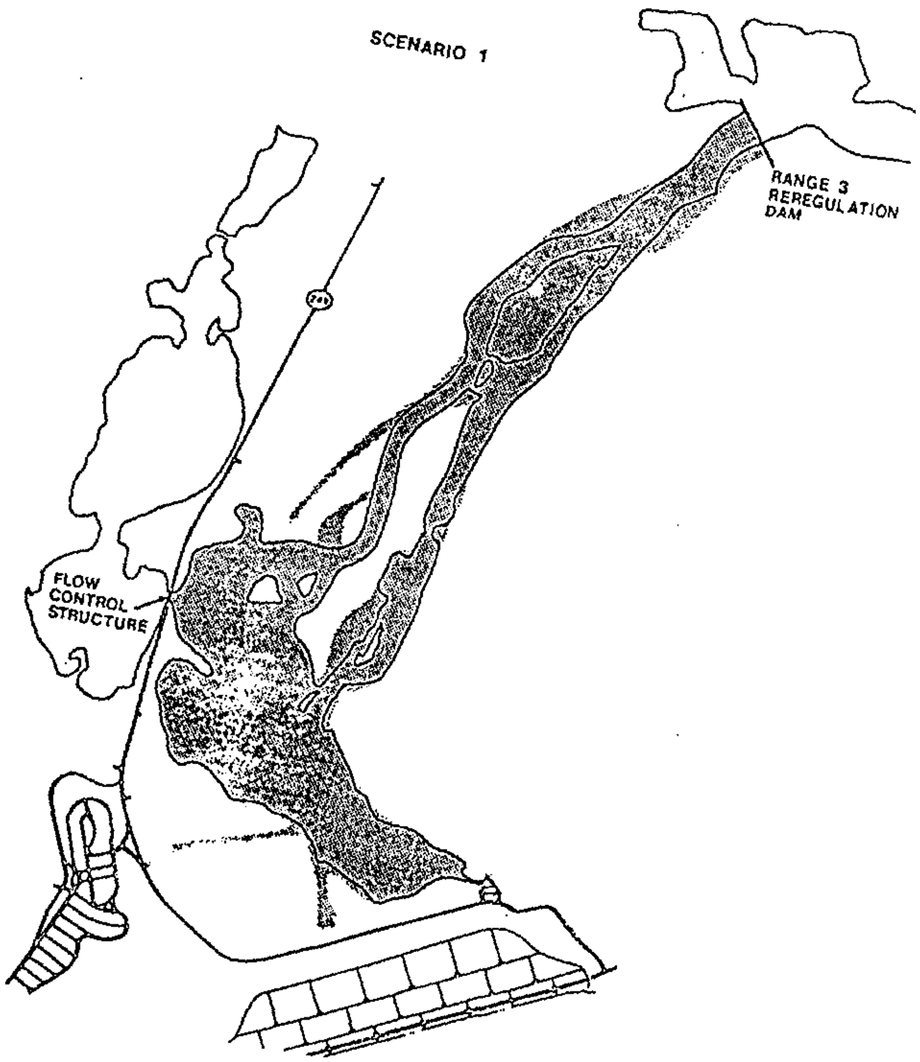

Figure 26. Map of the proposed location of a reregulation dam in Scenario 1. Shaded area indicates approximate area that would be inundated.

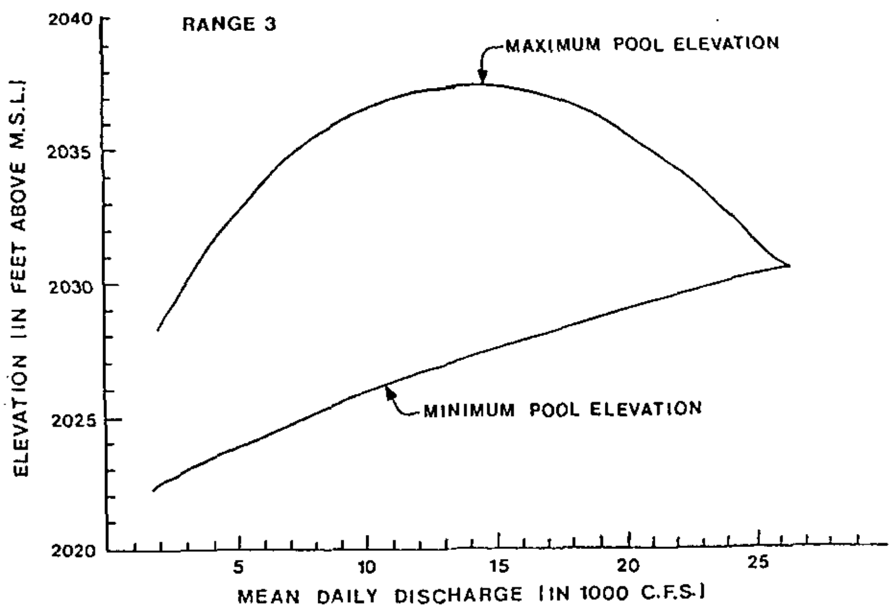

Figure 27. Proposed minimum and maximum pool elevations at different mean daily discharge levels for the reregulation pool behind a dam at Range 3. From COE project description.

Lake Trout

The impacts of this plan would be the same as described for the Original Plan for lake trout.

Walleye and Sauger

The impacts of this plan would be similar to those explained for the Original Plan. The reregulation dam at Range 3 would not cause the loss of the walleye spawning area located 8 miles below Fort Peck Dam. The total elimination of downstream water fluctuations would probably improve this spawning area which would probably benefit the downstream areas more than the area above the Milk River. Depending on how the reregulation dam affected water temperatures and productivity of the Nelson dredge cut area, it may be possible to maintain some walleye and sauger in this area. The lack of fluctuating water levels in Nelson dredge may allow the development of some shoreline and aquatic vegetation which would improve the production of forage fish in the area. It is not known how the reregulation dam would affect the passage of cisco or spottails from the reservoir down to the Nelson dredge area. If it was possible to develop a good forage fish population in Nelson dredge it may be possible to establish a resident walleye and sauger population.

The flow control structure at the openings to the dredge cuts would have the same impacts as discussed in the Original Plan. It would probably be possible to develop a walleye fishery in the isolated dredge outs by stocking, but there may be a problem with water quality in this isolated area.

Northern Pike

The major northern pike habitat would be maintained in this plan. The upper tailpool habitat would be lost, but both dredge cut areas would still be usable by northerns. As discussed in the Original Plan, it would probably be possible to develop a reproducing northern pike population in the isolated dredge cuts if good water quality was maintained. Without any water level fluctuations in Nelson dredge it would probably be possible to establish some shoreline and aquatic vegetation. This would benefit northern pike by increasing forage fish production and by providing spawning and rearing habitat for northerns.

Forage Fish

The impacts of this plan on forage fish would be similar to the impacts indicated in the Original Plan. The main difference with this plan is that Nelson dredge would not be included in the rereg pool and it would not experience any fluctuating water levels. It should be possible to establish more vegetation in the area than currently exists. Increased vegetation would increase spawning and escape cover for forage fish and would result in an increased production of forage fish in Nelson dredge. The reregulation dam may prevent cisco and spottails that passed through Fort Peck Dam from reaching Nelson dredge. This could have a negative impact on the forage fish population in this area.

Shovelnose Sturgeon

This plan would again result in the eventual elimination of sturgeon from the area above the reregulation dam as indicated in the Original Plan.

Possible Mitigation

It may be possible to develop a limited trout or salmon fishery below the reregulation dam. There may be a limited amount of natural reproduction in this area, but it is unlikely it would be enough to maintain a population. Stocking may be necessary. A walleye and northern pike fishery could be developed in the isolated dredge cuts and possibly in Nelson dredge. This may require the development of some kind of water exchange for the isolated dredge cuts. If the reregulation dam was built so water was released along the south side of the river the flushing of water through Nelson dredge should be decreased, this may increase the productivity of this area. It may be possible to improve the walleye spawning area located 8 miles below Fort Peck Dam through bank stabilization and by adding additional spawning substrate and holding cover. It may be possible to increase this walleye run through stocking.

Scenario 2 (Reregulation Dam at Range 2)

This plan called for the addition of a third powerhouse at Fort Peck with an output capacity of 120 MW. This would increase the maximum discharge capacity of the Fort Peck power plant to about 25,600 cfs. A reregulation dam would be built at Range 2 (Figure 28). The maximum elevation of the rereg pool in this scenario would be about 2037 feet M.S.l. and would occur at a mean daily discharge of about 15,000 cfs. Figure 29 shows the minimum and maximum pool elevations that would occur in the rereg pool at mean daily discharges up to 25,600 cfs. The largest water level fluctuations in the rereg pool would occur at a mean daily discharge around 13,000 cfs; fluctuations would be about 7.5 feet. This scenario would be operated under partial reregulation so flows from the reregulation dam would not be constant. Downstream water level fluctuations would be similar to fluctuations that presently occur. This plan would include all of the upper dredge cuts as part of the rereg pool.

Potential Impacts

Paddlefish

The reregulation dam in this plan would block the exchange of paddlefish between the tailpool and upper dredge cuts and downstream areas. This would isolate the paddlefish above the reregulation dam from all available spawning habitat and would block recruitment of new paddlefish to the area from downstream. This would result in the eventual elimination of paddlefish above the reregulation dam.

The inclusion of the upper dredge cuts as part of the rereg pool would likely result in a rapid elimination of paddlefish from above the reregulation dam. The size of paddlefish collected from the study area during this study indicated that food may already be limiting for paddlefish in this area. The large daily water level fluctuations and rapid exchange rate of water in the rereg pool would reduce the productivity of this area. Without a good plankton supply,

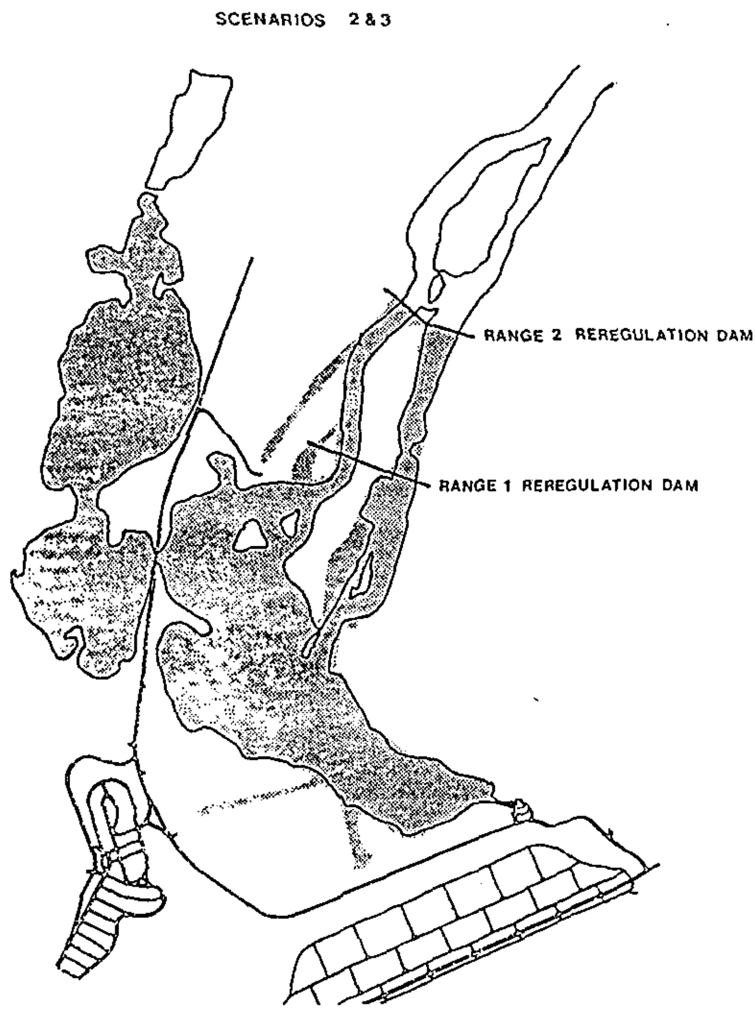

Figure 28. Map of the proposed locations of reregulation dams in Scenarios 2 and 3. Shaded area indicates approximate area that would be inundated.

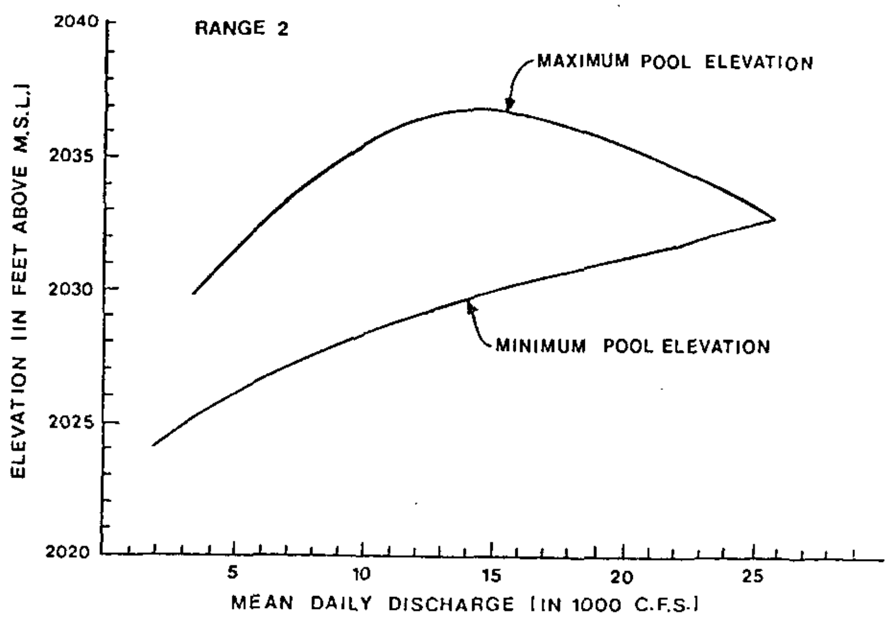

Figure 29. Proposed minimum and maximum pool elevations at different mean daily discharge levels for the reregulation pool behind a dam at Range 2. From COE project description.

paddlefish trapped above the reregulation dam would have difficulty maintaining themselves.

Nelson dredge would still be available to paddlefish with this plan. Paddlefish use of Nelson dredge appeared to be very limited during this study. Water level fluctuations in Nelson dredge with this plan would be similar to what they are now; productivity would probably be less without a source of plankton from the upper dredge cuts. Paddlefish use of Nelson dredge would probably decrease.

Rainbow Trout

The reregulation dam in this plan would be located at the upstream end of the major rainbow spawning area. Some spawning and rearing habitat would be lost by construction of this dam. This reregulation dam would have to be designed with two release gates in order to maintain any rainbow spawning. Without a release directly into the east side channel this channel would be almost totally dewatered and most of the major rainbow spawning area would be lost.

Even with two gate structures, water level fluctuations below the rereg dam could seriously impact rainbow spawning and rearing. Rainbow spawning and rearing success in the east side channel is already limited by present water level fluctuations. Predicted fluctuations below the reregulation dam in this plan would be similar to fluctuations that now occur. However, changes in discharge would be occurring immediately upstream of the spawning and rearing area rather than 4 to 5 miles upstream, and there would be no tailpool or dredge cut area to dampen the effects of these changes. Water level fluctuations would occur more rapidly which could have several impacts. More stranding of adult and YOY rainbow could occur with rapid drops in discharge. Rearing fry could be flushed out of the side channel by rapid increases in flow. Having the reregulation dam site above the spawning and rearing area may increase scouring in this area. Eggs could be scoured from redds. It may be difficult to establish any filamentous algae in the side channel this close to the reregulation dam.

Water releases directly into the east side channel could impact the invertebrate population that provides food for rearing rainbow. Numerous studies have shown that irregular flow patterns below hydropower dams can decrease diversity and increase drift of invertebrates for varying distances below these dams (Radford 1972; Abbot and Morgan 1975; Brusven, Biggan and Black 1976; Ward 1976c; Perry and Graham 1981.)

Chinook Salmon

Since Chinook would probably spawn in the same areas used by rainbow, the impacts of this plan on Chinook would be the same as discussed for rainbow.

Lake Trout

Impacts of this plan on lake trout would be similar to those described in the Original Plan. The water level fluctuations in the rereg pool for this plan would be less than in the Original Plan. Since it is not known how these fluctuations would affect a lake trout population it isn't known how significant these differences would be. This plan would not include a flow control structure at the opening to the upper dredge cuts so lake trout would be able to migrate between the tailpool and dredge cuts. However, by including the dredge cuts as part of the rereg pool the productivity of this area would be decreased and any advantage the lake trout gained by moving to the dredge cuts in the winter may be lost.

Walleye and Sauger

The reregulation dam in this plan would prevent the movement of migratory walleye and sauger to the tailpool and dredge cut areas from downstream. This would prevent these fish from reaching the spawning area located in the upper dredge cuts. The low productivity of the rereg pool would probably make it difficult to maintain any walleye or sauger above the reregulation dam. Walleye and sauger would still be able to reach Nelson dredge and the spawning area located 8 miles below Fort Peck Dam. These areas would be subject to the same kinds of water level fluctuations that presently occur. No forage fish would be produced above the reregulation dam so the forage fish population in Nelson dredge would be lower than it is now. The reregulation dam could affect the movement of forage fish from Fort Peck Reservoir down to Nelson dredge. Without a forage base the number of walleye and sauger remaining in the study area would probably be lower than at present.

Northern Pike

Northern pike would probably be almost eliminated from the study area by this plan. The tailpool and upper dredge cuts, two of the major habitat areas for northerns, would be included in the rereg pool and would no longer be able to support a northern pike population. Nelson Dredge would still be available to northerns, but with the probable decrease in forage fish in this area as discussed under walleye and sauger, the number of northerns this area would support would probably decrease. It would be unlikely that successful northern reproduction could occur in Nelson dredge with the water level fluctuations predicted for this plan. This area would have to depend on recruitment of northern pike from downstream to maintain a population which would be limited.

Forage Fish

Water level fluctuations in the rereg pool would prevent the production of forage fish in the dredge cuts or tailpool area. The releases from the reregulation dam could affect the limited forage fish production that occurs in the lower side channel, especially for suckers which utilize spawning habitat similar to rainbow. These fish could be subject to many of the impacts discussed for rainbow. It is unlikely that many forage fish could be produced in Nelson dredge with the downstream water level fluctuations that would occur with this plan. The reregulation dam could impact the passage of forage fish from Fort Peck Reservoir to the Nelson dredge area. It is unlikely that the rereg pool would have suitable habitat characteristics to support a good spottail or cisco population even if they did pass through Fort Peck Dam in large numbers.

Shovelnose Sturgeon

This plan would again result in the eventual elimination of sturgeon from the area above the reregulation dam as indicated in the Original Plan. It would be possible to maintain some sturgeon in the Nelson dredge cut area.

Possible Mitigation

It may be possible to improve spawning and rearing success of rainbow trout and chinook salmon in this area by making habitat improvements such as adding structure and adding or cleaning existing spawning substrate, and by managing flows in the east side channel for the fisheries.

Scenario 3 (Reregulation Dam at Range 1)

This plan called for the addition of a third powerhouse at Fort Peck with an output capacity of 120 MW. This would increase the maximum discharge capacity of the Fort Peck power plant to about 25,600 cfs. A reregulation dam would be build at Range 1 (Figure 28). The maximum elevation of the rereg pool in this scenario would be about 2039 feet M.S.l. This pool elevation would occur when mean daily discharge was between 9,500 cfs and 21,000 cfs. Figure 30 shows the minimum and maximum pool elevations that would occur in the rereg pool at mean daily discharges up to 25,600 cfs. The largest water level fluctuations in the rereg pool would occur at a mean daily discharge of 9,500 cfs; fluctuations would be about 10 feet. The reregulation dam in this plan would provide full reregulation when mean daily discharges were less than 9,500 cfs and above 21,000 cfs. When discharges were between 9,500 cfs and 20,000 cfs partial reregulation would be provided and downstream fluctuations would be similar to fluctuations that presently occur. This plan would include all of the upper dredge cut as part of the rereg pool.

Potential Impacts

Paddlefish

The impacts of this plan on paddlefish would be the same as those described for Scenario 2.

Rainbow Trout

The impacts of this plan on rainbow would be the same as those described for Scenario 2. The reregulation dam in this plan would be a little further upstream from the rainbow spawning area. Releases from this dam may not have as much of a scouring effect on the spawning area as would releases from a reregulation dam at range 2, however, downstream scouring at this site may cause more siltation problems than would scouring below a dam at Range 2.

Chinook Salmon

Impacts would be the same as discussed above for rainbow.

Lake Trout

Impacts would be the same as described for lake trout in Scenario 2. Predicted water level fluctuations in the rereg pool with this plan would be greater than fluctuations predicted for Scenario 2, but still less than fluctuations that would occur with the Original Plan.

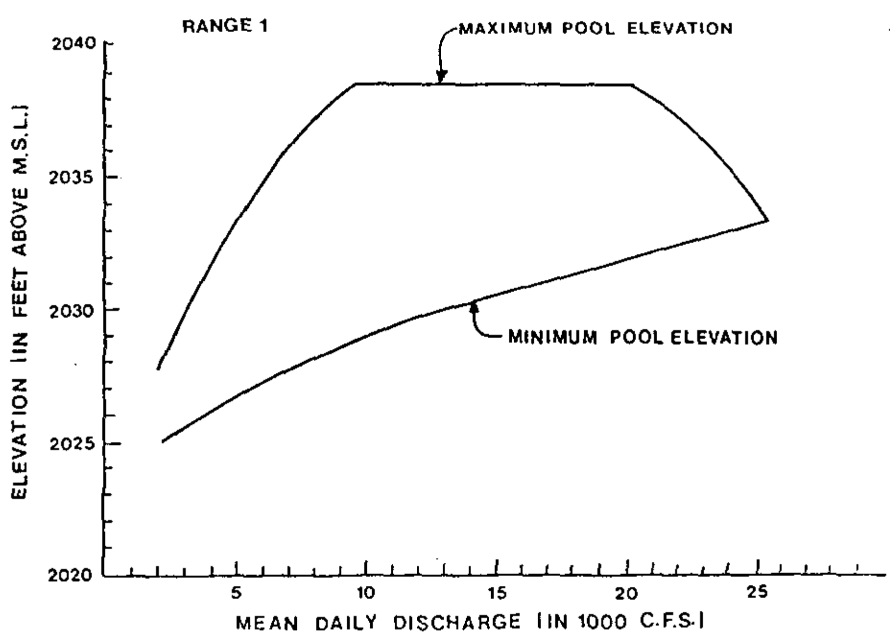

Figure 30. Proposed minimum and maximum pool elevations at different mean daily discharge levels for the reregulation pool behind a dam at Range 1. From COE project description.

Walleye and Sauger

Impacts would be the same as described for walleye and sauger in Scenario 2.

Northern Pike

Impacts would be the same as described for northern pike in Scenario 2.

Forage Fish

Impacts would be the same as described for Forage Fish in Scenario 2.

Shovelnose Sturgeon

Impacts would be the same as described for shovelnose sturgeon in Scenario 2.

Possible Mitigation

Mitigation potentials would be the same as discussed in Scenario 2. With the reregulation dam further upstream in this plan it would be possible to develop a longer spawning channel in the east side channel.

Scenario 4 (no reregulation)

This plan called for the addition of a third powerhouse at Fort Peck with an output capacity of 120 MW. This would increase the maximum discharge capacity of the Fort Peck power plant to about 25,600 cfs. This plan would not include any reregulation dam so extreme daily water level fluctuations would occur below Fort Peck Dam; these extreme fluctuations would slowly attenuate as the surges flowed downstream.

Potential Impacts

Paddlefish

This plan could result in the rapid elimination of a resident paddlefish population from the study area. The higher discharge levels associated with increased power production would result in a more rapid exchange of cold water through the dredge cuts.

The shorter flushing time would decrease the zooplankton production in the dredge cuts and tailpool (Cowell 1967). Based on sizes and growth rates of paddlefish collected from the study area compared to paddlefish collected at Intake, it appeared that the paddlefish food supply may already be somewhat limiting below Fort Peck Dam. If the productivity of the area was decreased even more by large surges of cold water paddlefish growth rates and movements could be further altered. Even if paddlefish did remain in the study area it is not known how increased water fluctuations might affect seasonal paddlefish movement within the study area, or what affect large discharges of cold water associated with greater peaking might have on movement of paddlefish to the study area from downstream. The influence of these large surges of coldwater could extend downstream enough to impact paddlefish fisheries that exist at the mouth of the Milk River and at Frazer.

Rainbow Trout

The rainbow trout population is already being impacted by the current level of water fluctuations that occur below Fort Peck Dam. These fluctuations affect both the spawning and rearing success of rainbow and are probably the main factor limiting the size of the rainbow population in the study area. Any increase in water level fluctuations would increase the impacts that are already occurring. Any further decrease in spawning and rearing success of the existing rainbow population could result in the elimination of rainbow trout from the study area if they were not able to produce enough young to maintain the population.

Chinook Salmon

Since chinook salmon would probably utilize the same spawning areas now used by rainbow trout they would be subject to the same kinds of impacts from water level fluctuations. The increased fluctuations associated with this plan would probably prevent a naturally reproducing chinook salmon run from ever being developed below Fort Peck Dam.

Lake Trout

It is not known how increased water level fluctuations and increased surges of cold water would impact the lake trout population below Fort Peck Dam. Increased water level fluctuations and shorter flushing time would decrease the productivity of the downstream area and further reduce the limited forage fish production that does occur. Any forage fish that passed through the dam could be displaced downstream by peaking flows so they would not be available to lake trout.

Walleye and Sauger

The increased water level fluctuations and decreased productivity of the study area associated with this plan would increase the forage fish shortage that already exists. The increased water level fluctuations would probably eliminate all successful walleye or sauger spawning in the upper dredge cuts and may impact spawning success at the gravel bar 8 miles downstream. The large surges of cold water flowing downstream could affect the upstream movement of walleye and sauger to the study area and to the Milk River.

Northern Pike

The increased water level fluctuations associated with this plan would further reduce the possibility of any successful northern pike reproduction occurring in the study area. The further reduction in forage fish as a result of this plan would make it even more difficult for northerns to maintain a population in the study area.

Forage Fish

Forage fish production in the study area is already severely limited by water level fluctuations. Any increase in downstream fluctuations would increase the existing problems. The lower productivity of the downstream area associated with shorter flushing times would make it more difficult to maintain fish populations in the area. Although the number of spottail and cisco passing through the dam could increase with increased peaking, this additional forage could be rapidly flushed downstream by the large surges of water that would occur with this plan. Even if these fish were not flushed out there may not be enough of a food supply to hold them in the area.

Shovelnose Sturgeon

It is not known how the large water level fluctuation and increased surges of cold water associated with this plan would affect the sturgeon population in the study area or the movement of sturgeon to and from the area.

Possible Mitigation

It would be very difficult to mitigate any of the impacts this type of plan would have on the total downstream fishery.

Scenario 5 (Reregulation Dam at Range A)

This plan called for the addition of a third powerhouse at Fort Peck with an output capacity of 105 MW. This would increase the maximum outflow capacity of the Fort Peck power plant to 24,200 cfs. A reregulation dam would be build at Range 1 (Figure 31). This dam would have two gated outlets. The maximum elevation of the rereg pool in this scenario would be 2050 feet M.S.1. and would occur at average daily discharges between 8,000 cfs and 16,500 cfs. Figure 32 shows the minimum and maximum pool elevations that would occur in the rereg pool at mean daily discharges up to 24,200 cfs. The largest water level fluctuations in the rereg pool would occur at a mean daily discharge of 8,000 cfs; fluctuations would be about 21 feet The reregulation dam in this plan would be operated to provide full reregulation when mean daily discharges were less than 8,000 cfs or more than 16,500 cfs and partial reregulation at discharge between 8,000 cfs and 16,500 cfs. Maximum downstream fluctuations would occur at a mean daily discharge of about 12,500 cfs; fluctuations below the reregulation dam would be about 1 foot.

Potential Impacts

Paddlefish

This plan was designed to allow the movement of fish between the upper dredge cuts and downstream areas. This plan would have less of an impact on the paddlefish than the other options, however it would still result in the loss of most of the tailpool area. Study results indicated that a majority of paddlefish moved out of the dredge cuts to the tailpool in the fall. The importance of this movement to the survival of these paddlefish is not understood so it is not known what impacts the loss of the tailpool habitat would have. The main release gate from the reregulation dam would be just downstream from the opening to the dredge cuts. It is not known how this release of water would affect the movement of paddlefish to the dredge cuts from downstream. By having the releases from the reregulation dam downstream of the opening to the dredge cuts, zooplankton flushed through from the reservoir would not have the opportunity to add to the zooplankton concentrations in the dredge cuts.

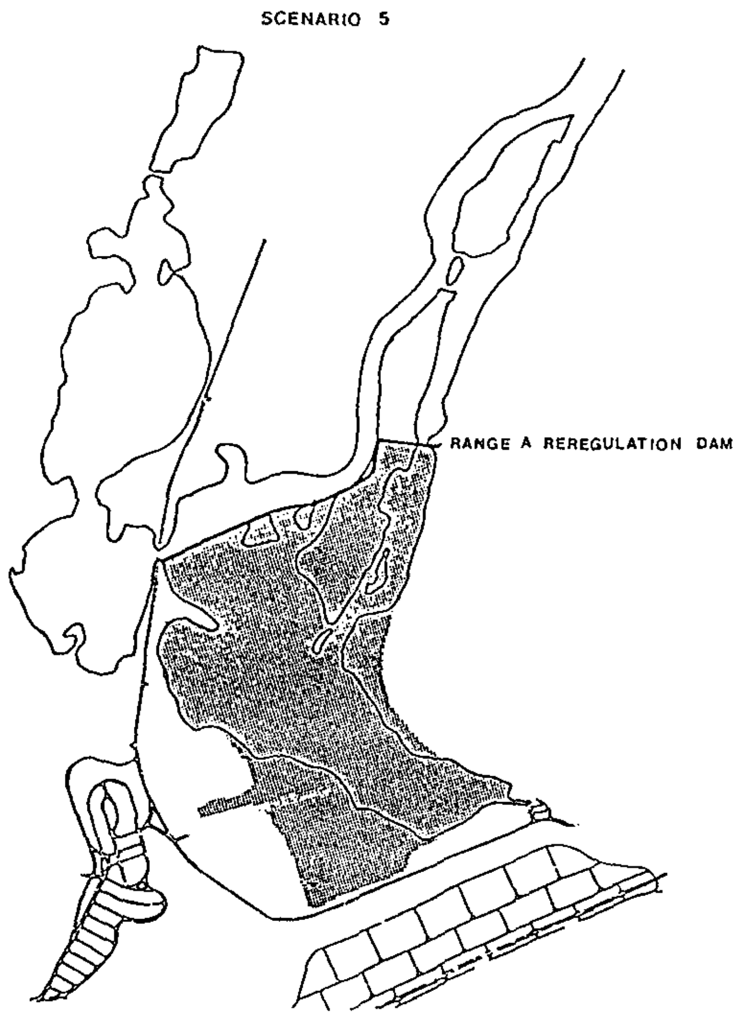

Figure 31. Map of the proposed location of a reregulation dam in Scenario 5. Shaded area indicates approximate area that would be inundated.

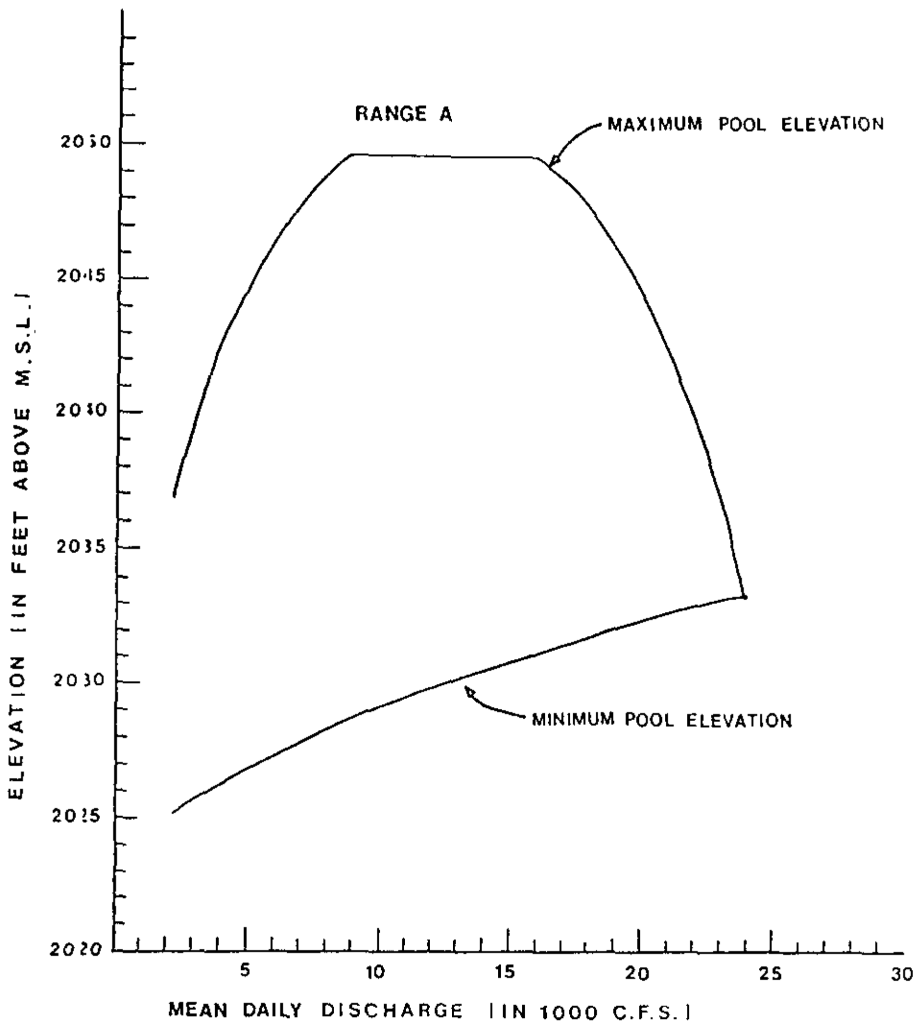

Figure 32. Proposed minimum and maximum pool elevations at different mean daily discharge levels for the reregulation pool behind a dam at Range A. From COE project description.

Rainbow Trout

Impacts of this plan on rainbow trout would be similar to impacts described for Scenarios 2 and 3. Some impacts may not be as severe with this plan since downstream fluctuations would be less than predicted for Scenarios 2 and 3.

Chinook Salmon

Impacts of this plan on chinook salmon would be similar to impacts described for Scenarios 2 and 3. Impacts may not be as severe with this plan since downstream fluctuations would be less than predicted for Scenarios 2 and 3.

Lake Trout

Impacts of this plan on lake trout would be the same as described for the Original Plan. In this plan the reregulation dam would have the same impacts as the flow control structure in the Original Plan.

Walleye and Sauger

This plan could benefit the walleye and sauger fishery in the study area by reducing water level fluctuations below the reregulation dam. Fluctuations predicted with this plan would be less than presently occur. Since the release from the reregulation dam would be downstream from the opening to the dredge cuts, water level fluctuations in the dredge cuts could be even less than predicted for the river. Reduced water level fluctuations could result in the establishment of more aquatic and shoreline vegetation which could result in a better forage fish population to attract and hold walleye and sauger. This plan would allow access of migratory fish from downstream to the spawning area identified in the dredge cuts. With less water fluctuation the possibility of successful walleye or sauger reproduction occurring in this area would increase. Reduced water level fluctuations downstream could also improve forage fish numbers in Nelson dredge.

There are several potential impacts from this plan. A large area of habitat would be lost by blocking off the tailpool. This area appeared to be an important holding area for walleye and sauger. By having the release from the reregulation dam downstream from the opening to the dredge cuts, this plan would reduce the chances of spottail or cisco that pass through the dam from entering the dredge cuts. This could result in the loss of an important forage base to the area and may outweigh the gains in forage fish production that would occur with reduced water level fluctuations. The release of water from the reregulation dam just downstream from the dredge cuts may also affect the movement of walleye and sauger to the dredge cuts.

Northern Pike

The impacts of this plan on northern pike would be about the same as those described for walleye and sauger.

Forage Fish

The impacts of this plan on forage fish have already been discussed under walleye and sauger.

Shovelnose Sturgeon

This plan would result in the loss of the major habitat area used by shovelnose sturgeon below Fort Peck Dam. Sturgeon would eventually be eliminated from the rereg pool. Some sturgeon would probably remain in the study area downstream from the reregulation dam.

Possible Mitigation

With two release gates it would be possible to improve rainbow trout and chinook salmon spawning and rearing success in the east side channel with a combination of flow management and habitat improvements. If water level fluctuations in the upper dredge cuts were reduced enough to allow a forage base to develop, it may be possible to develop a good walleye or sauger and northern pike fishery in this area by stocking. Forage fish such as spottail or cisco could be planted in the upper dredge cuts to make up for the loss of fish passing through the dam.

Scenario 6 (Reregulation Dam at Range B)

This plan called for the addition of a third powerhouse at Fort Peck with an output capacity of 105 MW. This would increase the maximum outflow capacity of the Fort Peck power plant to 24,200 cfs. A reregulation dam would be build at Range B (Figure 33). The maximum elevation of the rereg pool in this scenario would be 2045 feet M.S.l. and would occur at average daily discharges between 9,000 cfs and 15,500 cfs. Figure 34 shows the minimum and maximum pool elevations that would occur in the rereg pool at mean daily discharges up to 24,200 cfs. The largest water level fluctuations in the rereg pool would occur at a mean daily discharge of 9,000 cfs; fluctuations would be about 16 feet. The reregulation dam in this plan would be operated to provide full reregulation when mean daily discharges were less than 9,000 cfs or more than 15,500 cfs and partial reregulation at discharges between 9,000 cfs and 15,500 cfs. Fluctuations downstream from the reregulation dam during partial reregulation would be about 1 foot.

In this plan a flow control structure would be built at the narrows between pond 1 and pond 2 of the upper dredge cuts. Pond 1 would be included as part of the rereg pool. A new channel would be cut from the river below the reregulation dam across to the center of pond 2 (Figure 33). This channel should be about half a mile long and under normal water release conditions, the channel area inundated with water would be about 10 feet deep with a width of 15 feet at the bottom and 75 feet at water surface.

Potential Impacts

Paddlefish

Additional paddlefish studies would be required before the impacts of this plan could be fully assessed. These studies would have to include a plan to evaluate use of artificial channels by paddlefish. If paddlefish would not utilize the channel in this scenario this plan would have essentially the same impacts on paddlefish as outlined in Scenario 1. The paddlefish use in Nelson dredge would be even lower than under Scenario 1 since this plan would not provide full reregulation.

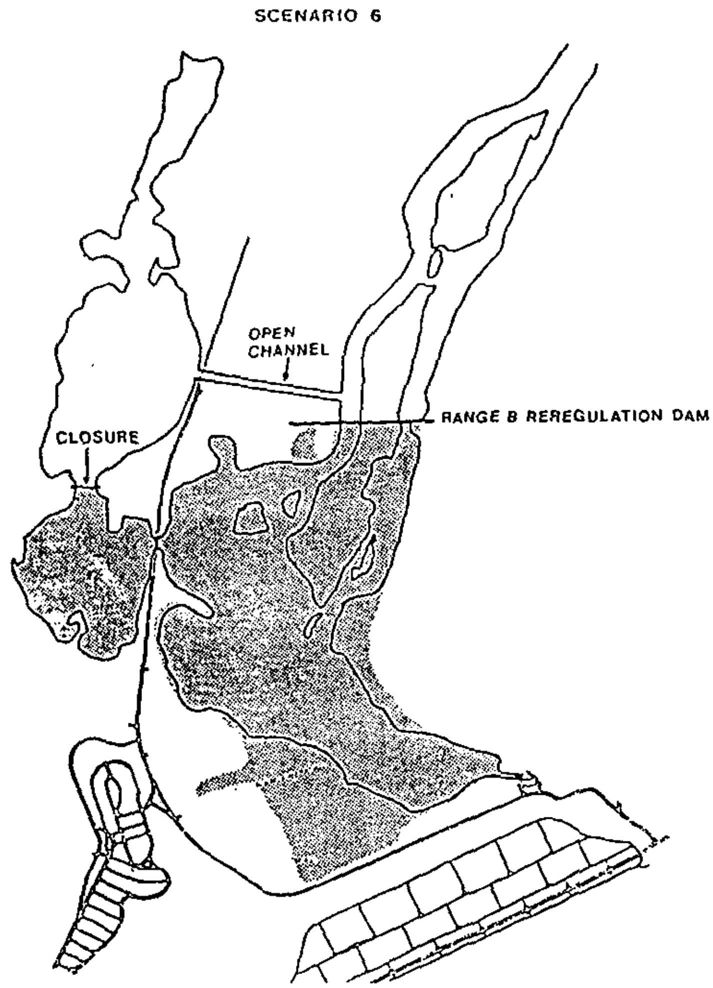

Figure 33. Map of the proposed location of a reregulation dam in Scenario 6. Shaded area indicates approximate area that would be inundated.

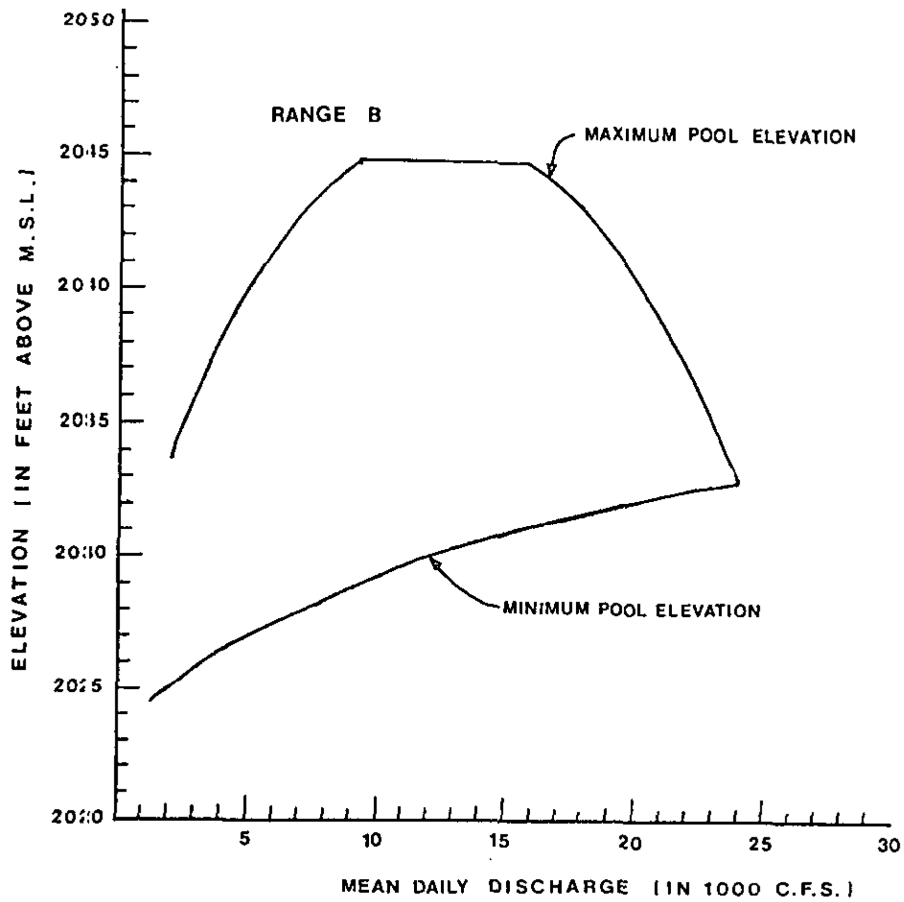

Figure 34. Proposed minimum and maximum pool elevations at different mean daily discharge levels for the reregulation pool behind a dam at Range B. From COE project description.

Even if paddlefish did use the new channel this plan would still impact the resident paddlefish population. Approximately one third of the upper dredge cut habitat would be lost as well as the entire tailpool area. Study results indicated that a majority of paddlefish moved out of the dredge cuts to the tailpool in the fall. Since it is not known how important this seasonal movement is to the resident paddlefish, it is not known what impacts the loss of the tailpool would have. Even if paddlefish would use an artificial channel it is not known how the release from the reregulation dam just upstream from the opening to the channel would affect paddlefish movement to the channel from downstream. It is not known what effects this plan would have on zooplankton and water temperature in the unimpounded dredge cuts. This plan would prevent most plankton from the reservoirs from reaching the dredge cuts.

Rainbow Trout

Impacts of this plan on rainbow trout would be similar to impacts described in Scenarios 2 and 3. Some impacts may not be as severe with this plan since downstream fluctuations would be less than predicted for Scenarios 2 and 3.

Chinook Salmon

Impacts of this plan on chinook salmon would be similar to impacts described for Scenarios 2 and 3. Some impacts may not be as severe with this plan since downstream fluctuations would be less than predicted for Scenarios 2 and 3.

Lake Trout

Impacts of this plan on lake trout would be the same as described in the Original Plan. Lake trout would have access to pond 1 of the upper dredge cuts but since it would be part of the rereg pool it would be as unproductive as the tailpool area.

Walleye and Sauger

Again it is unknown if walleye or sauger would utilize the new channel to the dredge cuts. If they did the impacts of this plan would be similar to those described for Scenario 5. There would be less dredge cut habitat for forage fish production or for developing a game fish population. One spawning area in the dredge cuts would be totally lost and part of the second one would be affected by the flow control structure between ponds 1 and 2.

If walleye and sauger did not use the new channel, this plan would have about the same impacts as described for Scenario 2. There would be less downstream fluctuations than in Scenario 2, but not enough to significantly improve forage fish production in Nelson dredge.

Northern Pike

Northern pike would experience essentially the same impacts as outlined for walleye and sauger. Northern pike would probably be more likely to utilize the artificial channel than walleye and sauger.

Forage Fish

This plan would have about the same impacts on forage fish as discussed in the walleye and sauger section of Scenario 5. The reduced water level fluctuations in the unimpounded upper dredge cuts would probably result in increased forage fish production in this area. The loss of one third of the dredge cut habitat would reduce the potential productivity of this area. The opening to the new channel would be downstream of the release from the reregulation dam but it is still questionable if many spottail or cisco would reach the dredge cuts if they passed through the dam.

Shovelnose Sturgeon

Impacts of this plan on shovelnose sturgeon would be the same as described for Scenario 5.

Possible Mitigation

Mitigation potentials would be the same as discussed for Scenario 5.

IMPACTS OF EXISTING CONDITIONS

A number of problems affecting the existing fishery downstream from Fort Peck Dam were identified during this study. All of these problems are a direct result of or are related to the water level fluctuations that occur below the dam.

One of the primary effects of downstream water level fluctuations is to limit the development of shoreline vegetation. Fluctuating water levels create a zone along the shoreline that is completely devoid of vegetation. Some vegetation has developed along the upper edge of the fluctuation zone, but this vegetation is only flooded during high water levels. Flooded vegetation is required by forage fish in the area to provide spawning and escape cover. The lack of flooded vegetation has resulted in a very low forage fish population in the study area. The lack of a forage base appeared to be one of the major factors preventing the development of a good game fish population in the area. This was exemplified by the increase in game fish that accompanied the rainbow smelt run of 1980 (see walleye and sauger and forage fish sections).

Flooded vegetation can also directly benefit game fish by providing rearing cover. Northern pike require flooded vegetation for spawning. Results of frame trap netting conducted in the upper dredge cuts in May of 1984 indicated that northern pike did spawn in the dredge cuts, but no evidence of successful reproduction was found. Some of the most extreme water level fluctuations observed during this study occurred during early May when northern pike were spawning. Discharge levels fluctuated as much as 13,300 cfs in a 24-hour period. Discharge ranged from less than 3,000 cfs to over 16,000 cfs. Since northern pike require flooded vegetation for spawning they probably spawned during high water, as water levels dropped the eggs were dewatered. Based on sampling results reproduction was poor to nonexistent.

Walleye and sauger were also impacted by the extreme water level fluctuations in May of 1984. Sampling results indicated that walleye were spawning in the main river 8 miles below the dam and sauger were spawning in the upper dredge cuts during early May. Walleye and sauger broadcast spawn their adhesive eggs over gravel substrate in shallow water. When spawning occurred during higher water levels many eggs would be dewatered at low water levels which would result in high mortality. Spawning in the main river occurred over a shallow gravel bar and spawning in the dredge cuts was over gradual sloping gravel points so a small drop in water levels dewatered a large area of bottom. Even eggs that were deposited deep enough in the dredge cuts to stay wetted were impacted by fluctuating water levels. As water levels dropped, deeper areas become susceptible to scouring due to wind and waves. Decker-Hess and McMullin (1983) found that wave action had a major impact on the survival of kokanee salmon eggs along the shoreline of Flathead Lake. They found the affected wave zone moved down with decreasing lake levels. Both spawning areas in the dredge cuts were exposed to prevailing winds.

The rainbow trout that spawned in the east side channel experienced considerable impact from fluctuating water levels. Adult fish had to contend with fluctuating water levels when they moved into the side channel to spawn. Trout usually spawn at night when darkness provides some security to move into shallow water. Under the normal peaking pattern of Fort Peck, water levels are dropping at night when the rainbow are trying to spawn. Under extreme conditions adult rainbow that move into shallow areas to spawn were actually stranded by falling water levels. During the extreme peaking that occurred in May of 1984 a 4 to 5 pound ripe female rainbow was found stranded, still partially alive. Discharge had dropped from 14,880 cfs at 2,200 hours to 2,856 cfs at 2,300 hours. Rapidly dropping water levels had apparently trapped this fish in an area too shallow to escape. This was the only time the side channel was checked early in the morning so it is not known how common this problem was. Even if fish were able to move out with falling water levels this dropping water could interrupt spawning. Three redds that were located in a very shallow area and were sampled for eggs in 1984 did not contain any eggs. Fish may have been forced out of this area before they completed spawning.

Rainbow trout incubation and rearing were also impacted by the current operational patterns of Fort Peck Dam. Fluctuating water levels caused most rainbow to spawn in deeper areas which remained wetted during a greater percent of the time; most fish were attracted to the same limited spawning habitat. This resulted in superimposition of later redds over earlier ones which caused high egg mortality in the early redds, especially if eggs were disturbed before they eyed up. Eggs that were successfully deposited in shallow areas during high flows were subject to periodic or even nightly dewatering which caused stress and high mortality of eggs and pre-emergence sac fry (see rainbow section).

Fluctuating water levels were very stressful on rainbow fry rearing in the side channel. These YOY fish used up considerable energy moving in and out with fluctuating water levels. Many fry were probably lost due to stranding in shallow areas when water levels dropped rapidly. Filamentous algae appeared to be the major rearing cover for YOY rainbow in the east side channel. The discharge pattern of low minimum daily discharges and high peaking discharges that occurred in 1983 totally eliminated all algae growth in the side channel part way through the critical rearing period. Sampling results in 1983 indicated that the number of YOY rainbow rearing in the side channel by late summer was very low. Better discharge patterns in 1984 resulted in good algae growth in the side channel and a 437% increase in the number of YOY rainbow collected in late August as compared to 1983.

Results of this study showed that the Fort Peck tailwater/dredge cut area contains a very diverse and somewhat unique fish population, but that this fisheries is being maintained well below its maximum potential. This study identified many of the problems that are currently impacting this fishery. It appears that many of these problems could be reduced or eliminated through habitat improvement and better water level management. It is important that fisheries studies be continued in this area at this time to investigate these problems and identify potential solutions. Current management practices being implemented by the Montana Department of Fish, Wildlife and Parks have the potential of improving both the forage fish and the game fish populations downstream from Fort Peck Dam. With continued cooperation in the management of this resource, the Fort Peck tailwater/dredge cut area has the potential of becoming a major fishing and recreational area in eastern Montana.

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APPENDIX A:

Sampling sites utilized during 1983 and 1984
fish sampling

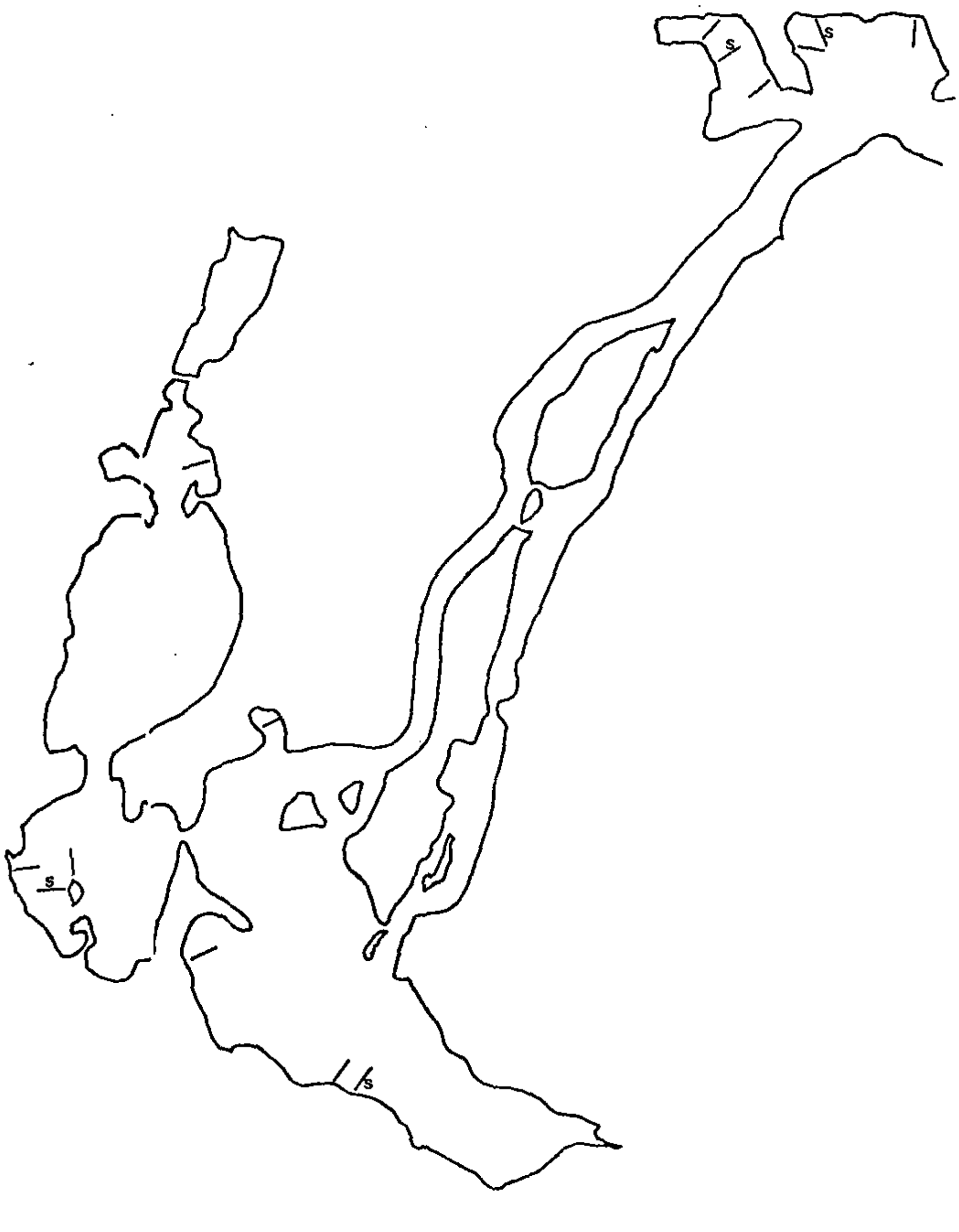

Figure 1. Standard gill netting stations for experimental and ½-inch monifilament (smelt) nets. S = smelt net.

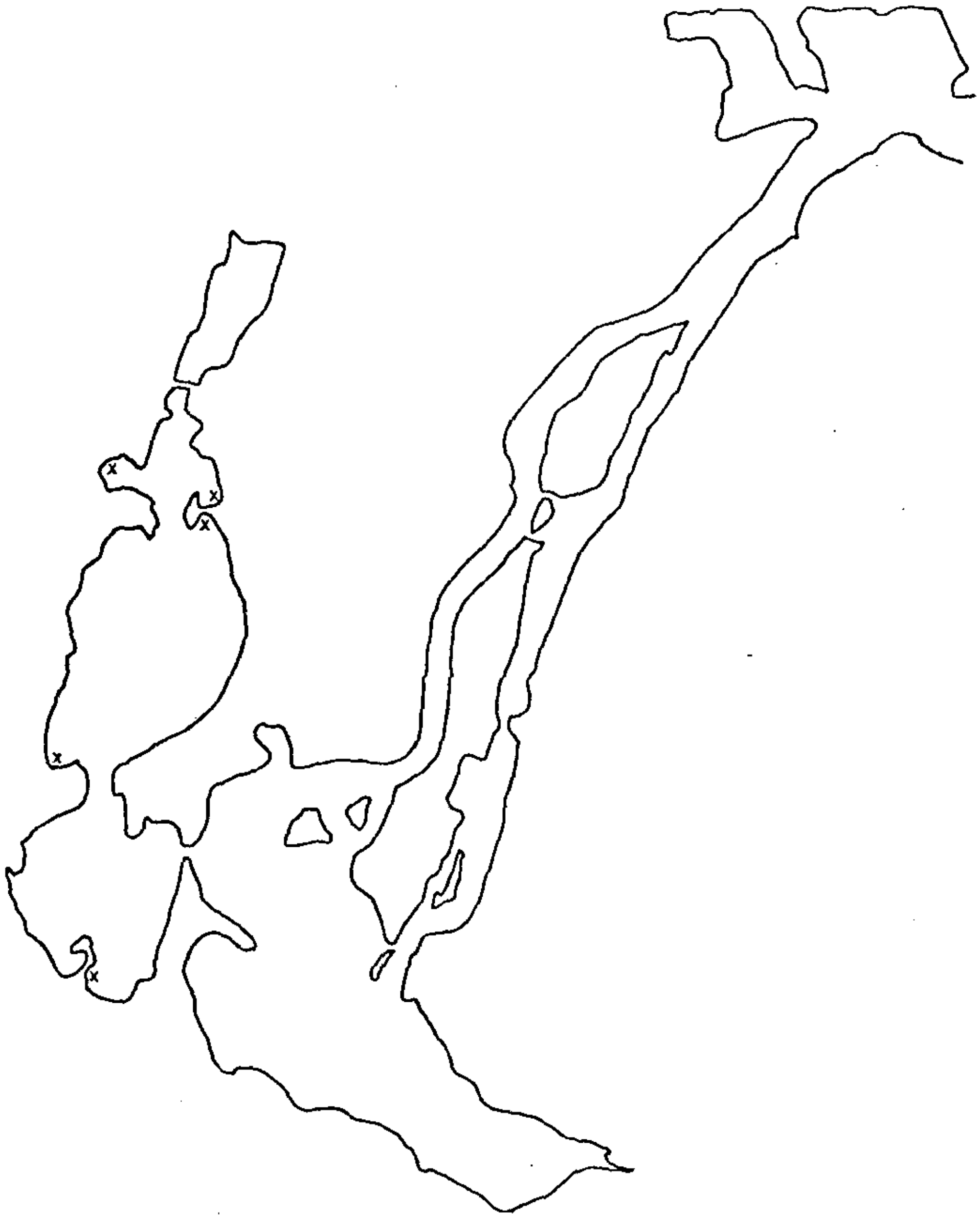

Figure 2. Location of standard paddlefish seining sites established in 1984.

Figure 3. 1983 forage fish seining sites. x = 100 foot seine, 0 = 50 foot seine, numbers indicate multiple 50-foot seine hauls at a single location.

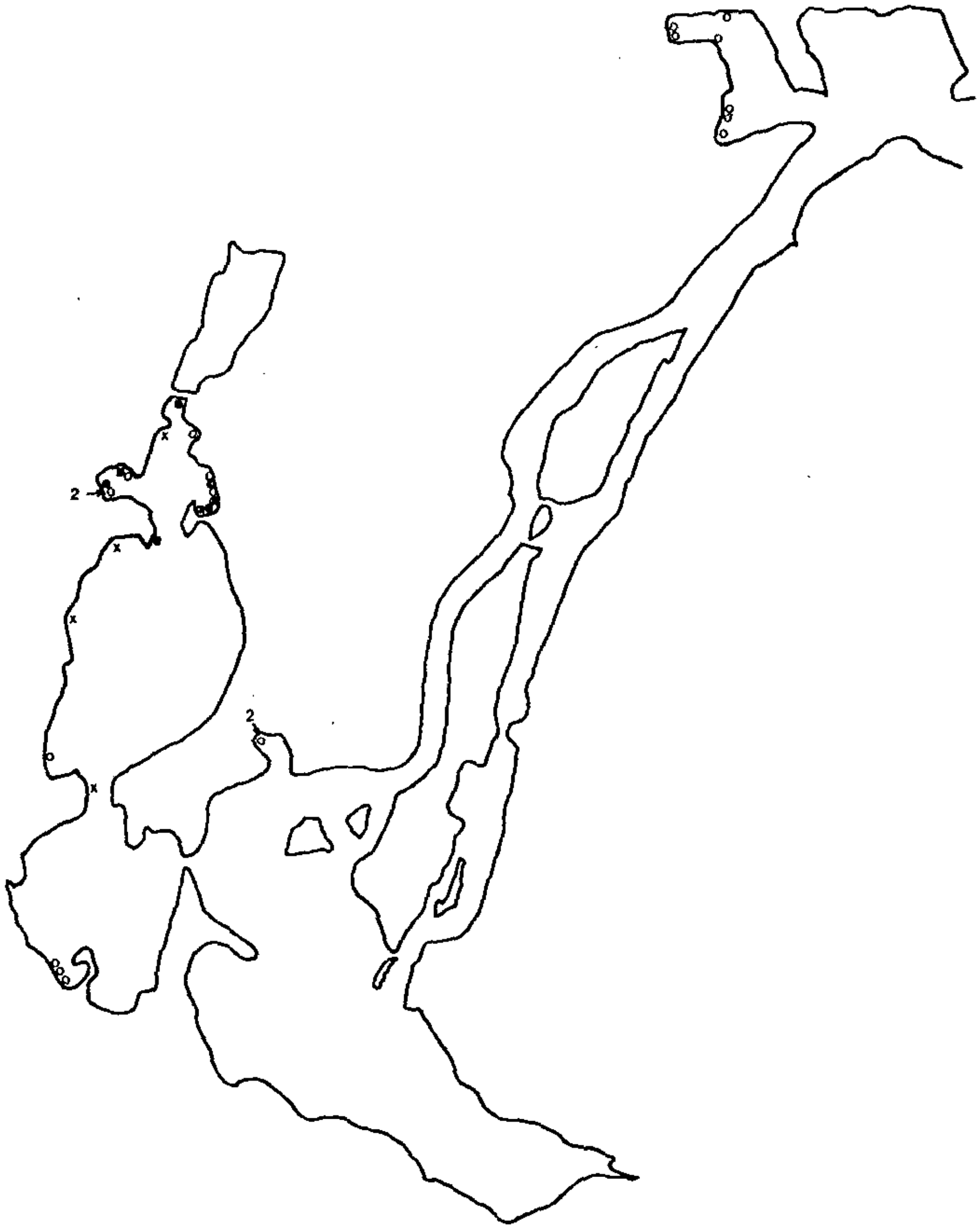

Figure 4. 1984 forage fish seining sites. 0 = seined 6/27, x = seined 8/29. Numbers indicate multiple seine hauls at a single site in June.

APPENDIX B:

Water temperature profiles recorded at five standard sampling sites during 1983 and 1984

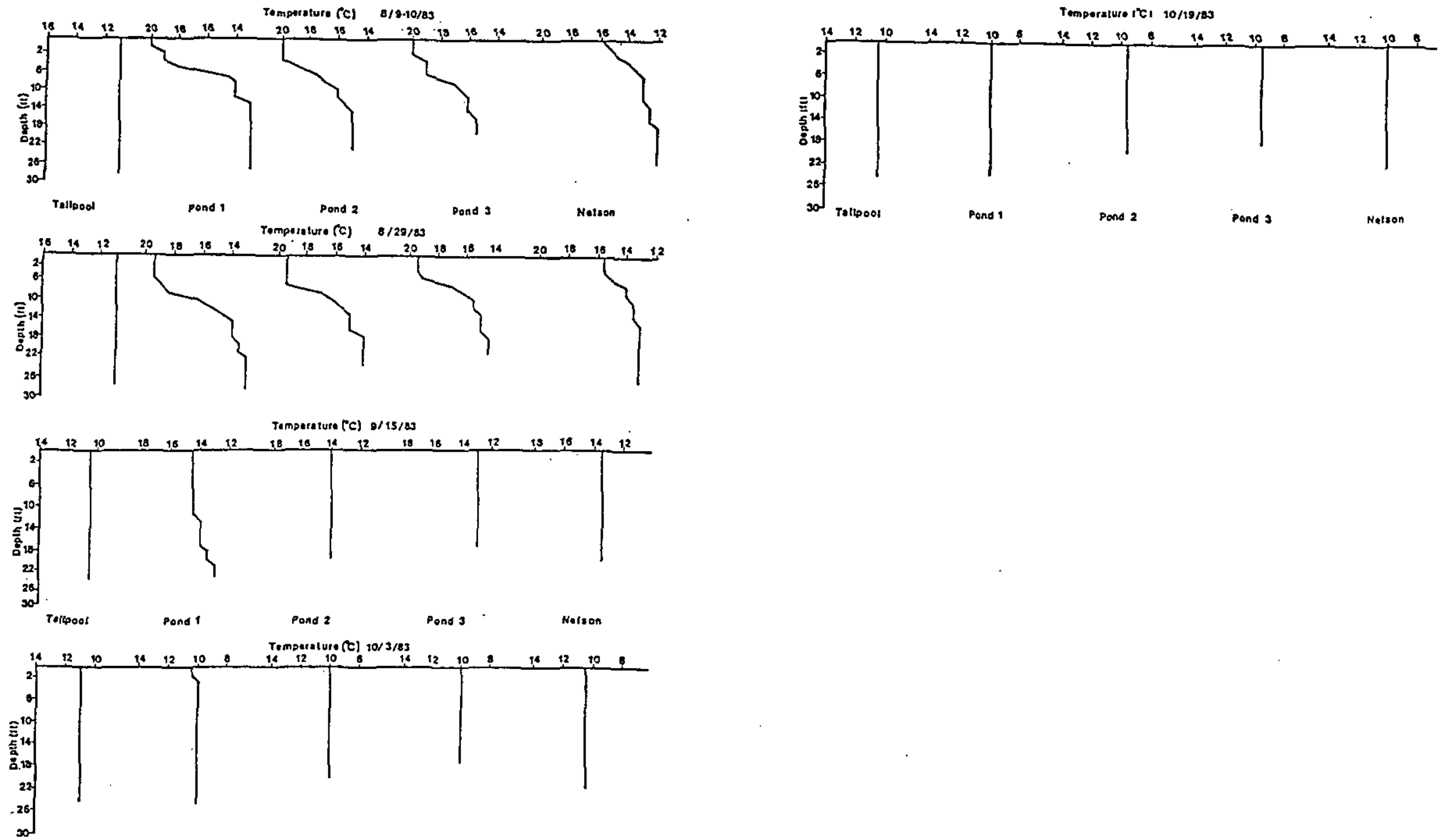

Figure 1. Water temperature profiles recorded at five standard sampling stations during 1983.

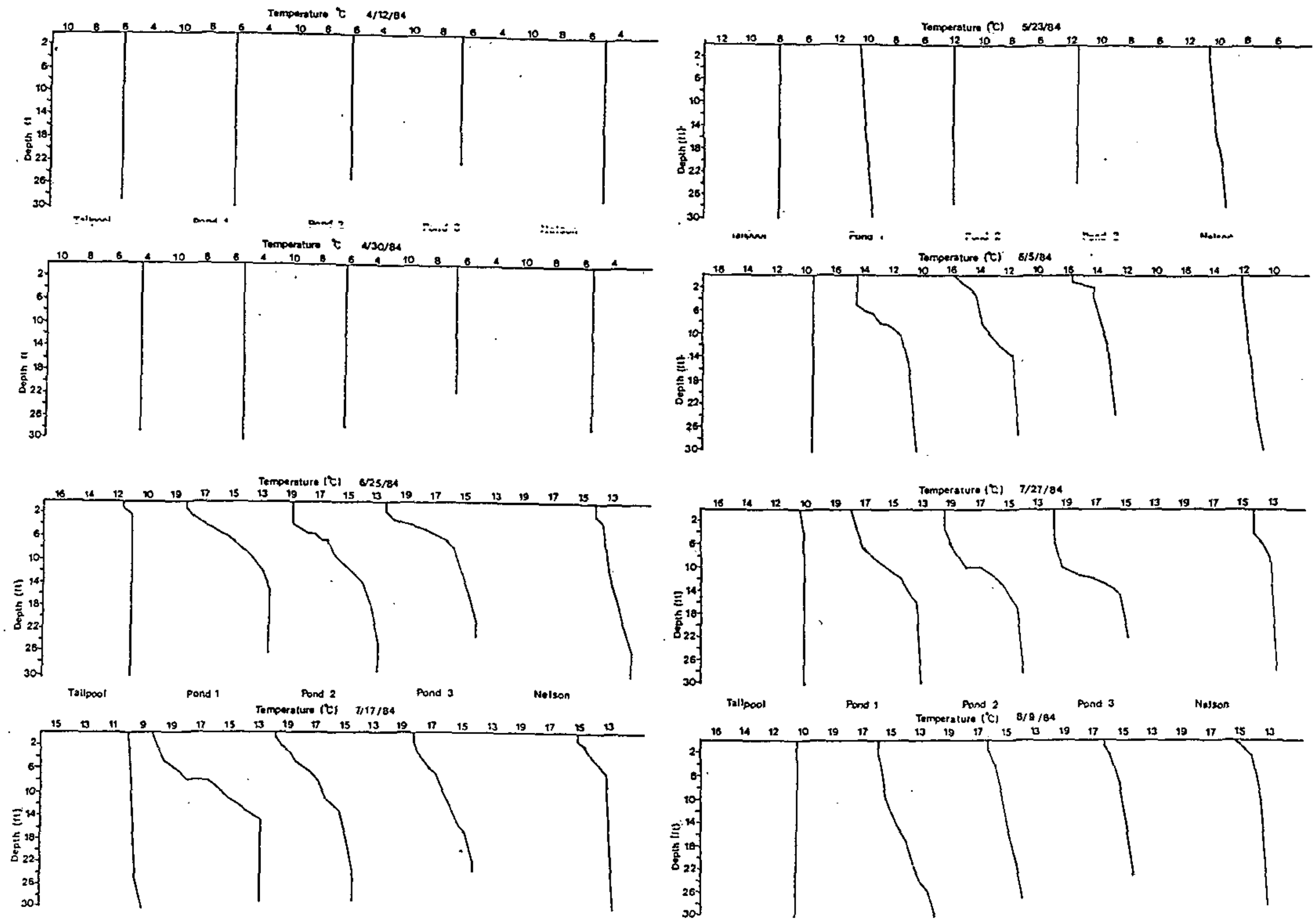

Figure 2. Water temperature profiles recorded at five standard sampling stations during the spring and summer of 1984.

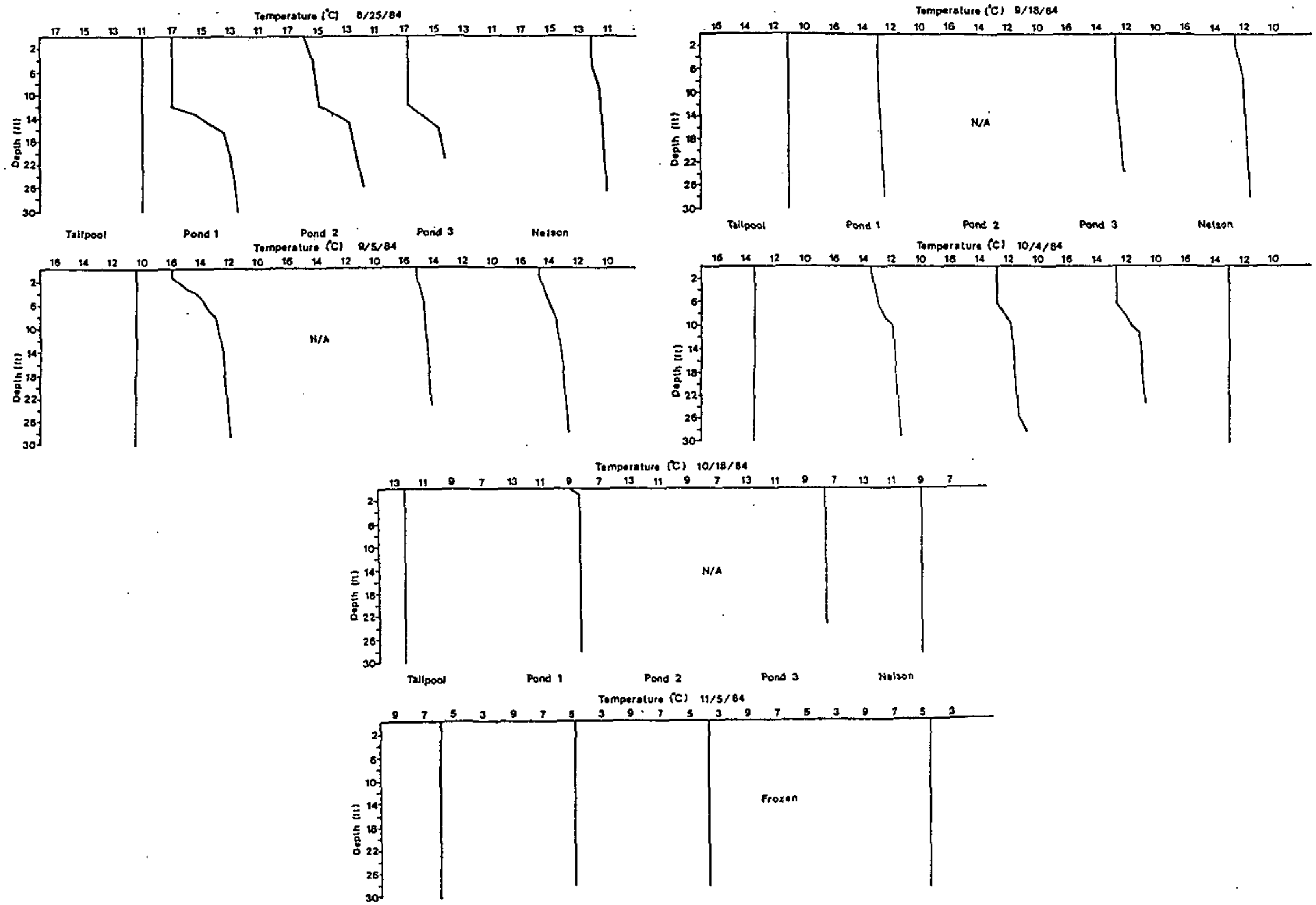

Figure 3. Water temperature profiles recorded at five standard sampling sites during the fall of 1984.

APPENDIX C:

Contour maps of the upper dredge cut ponds

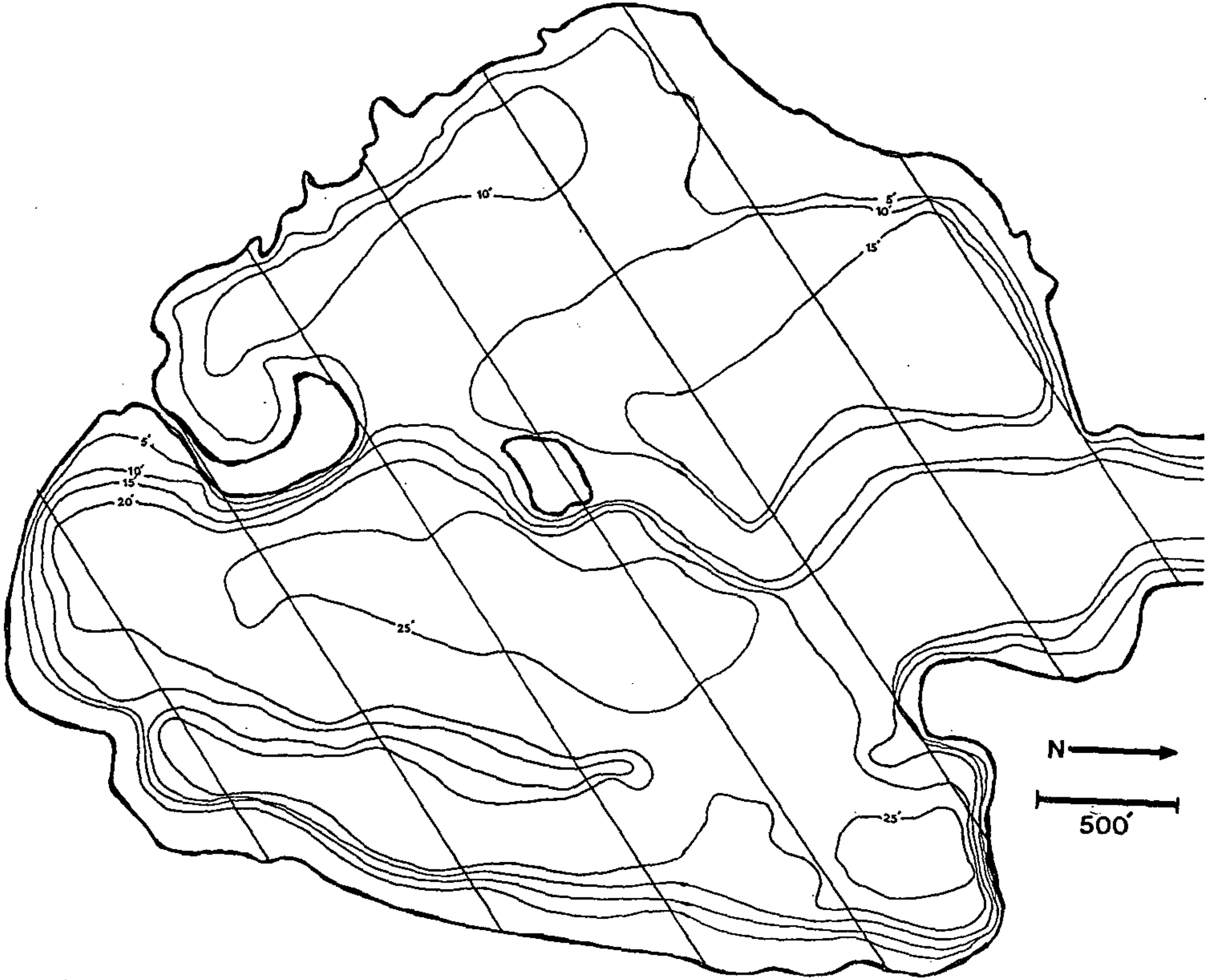

Figure 1. Contour map of pond 1 of the upper dredge cut.

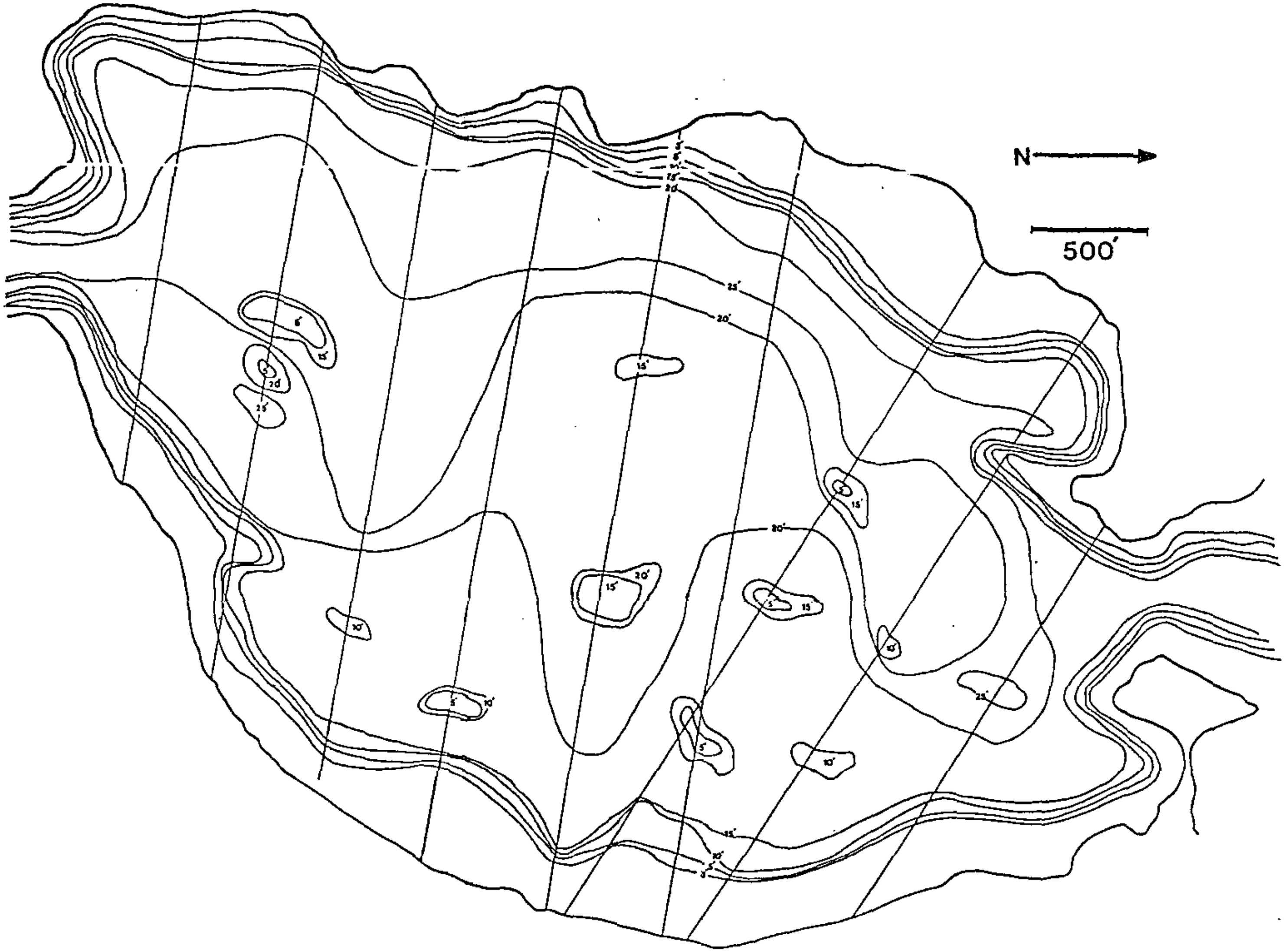

Figure 2. Contour map of pond 2 of the upper dredge cut.

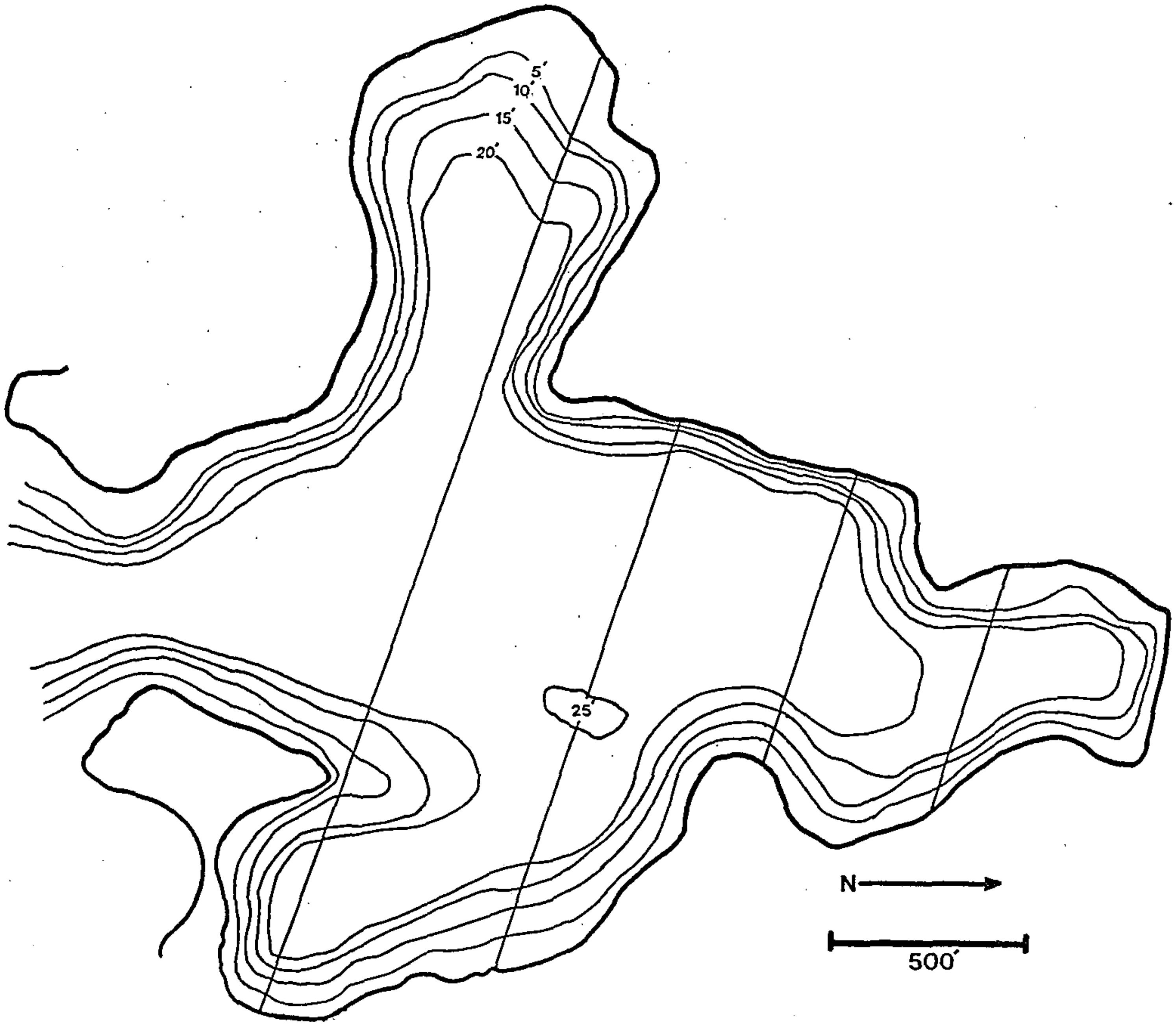

Figure 3. Contour map of pond 3 of the upper dredge cut.

APPENDIX D:

Comparison of 1983 and 1984 combined zooplankton densities (No./l) at four sample sites on different dates.

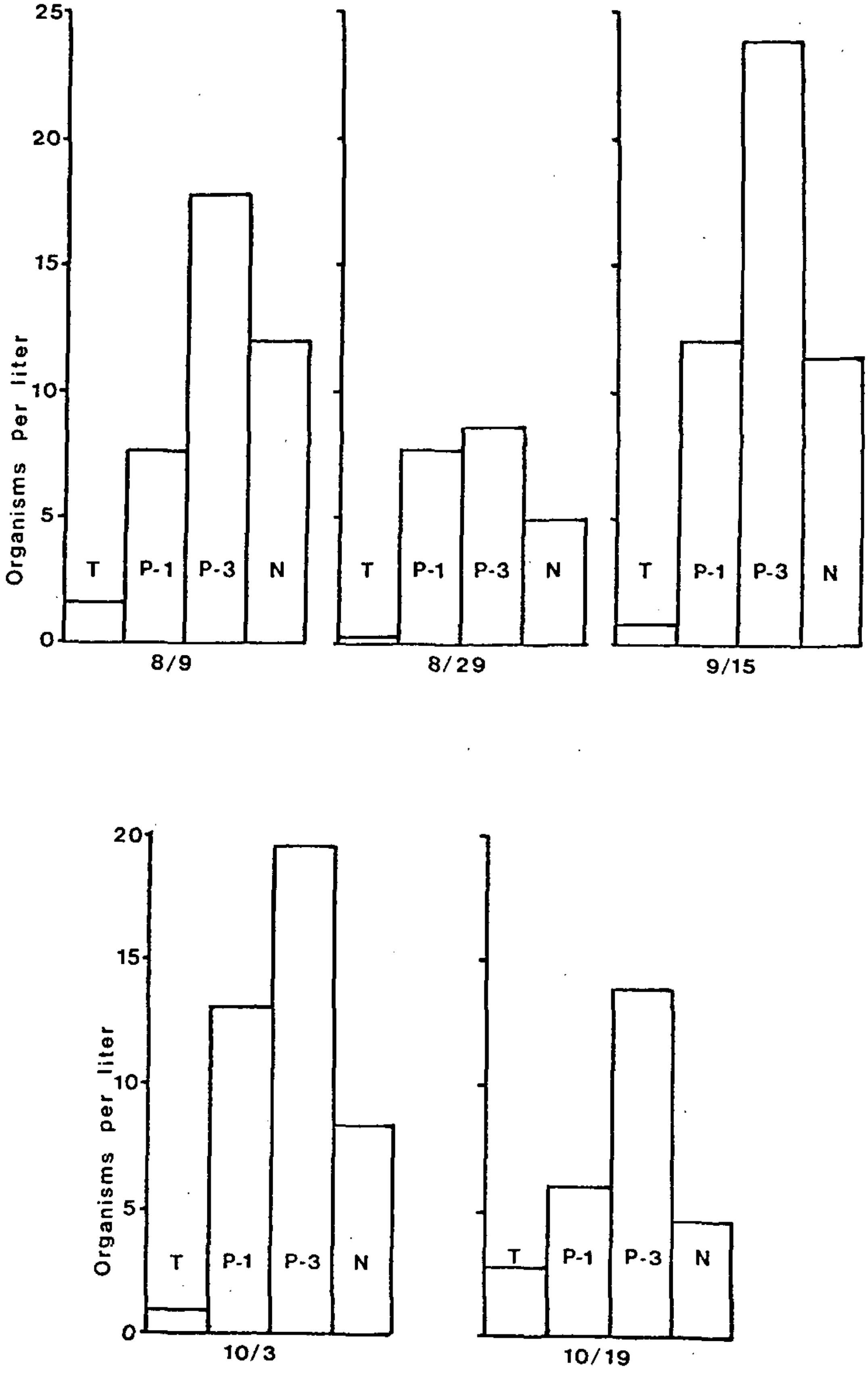

Figure 1. Comparison of 1983 combined zooplankton densities (No./l) at four major sample sites on different dates.

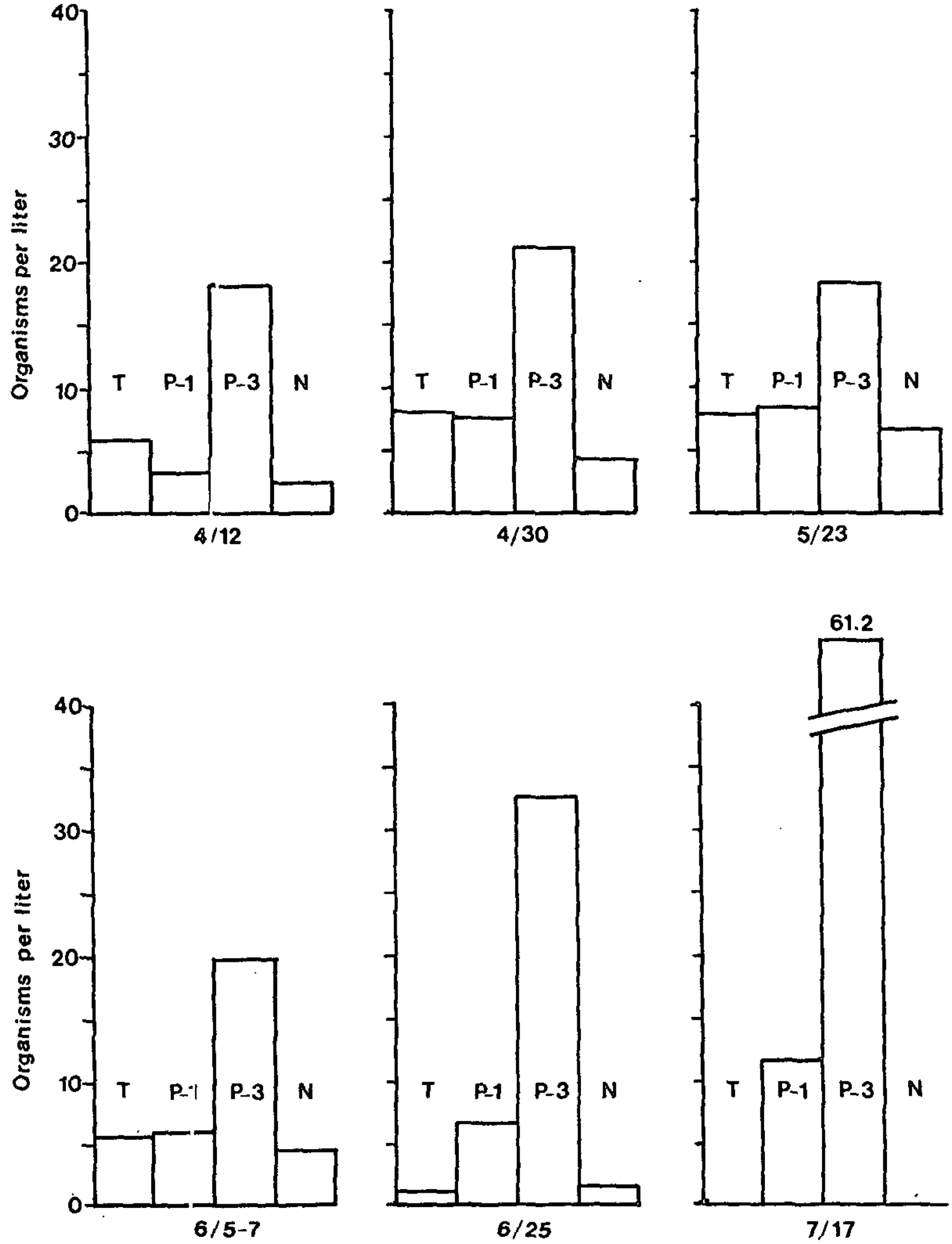

Figure 2. Comparison of 1984 combined zooplankton densities (No./l) at four major sample sites on different dates.

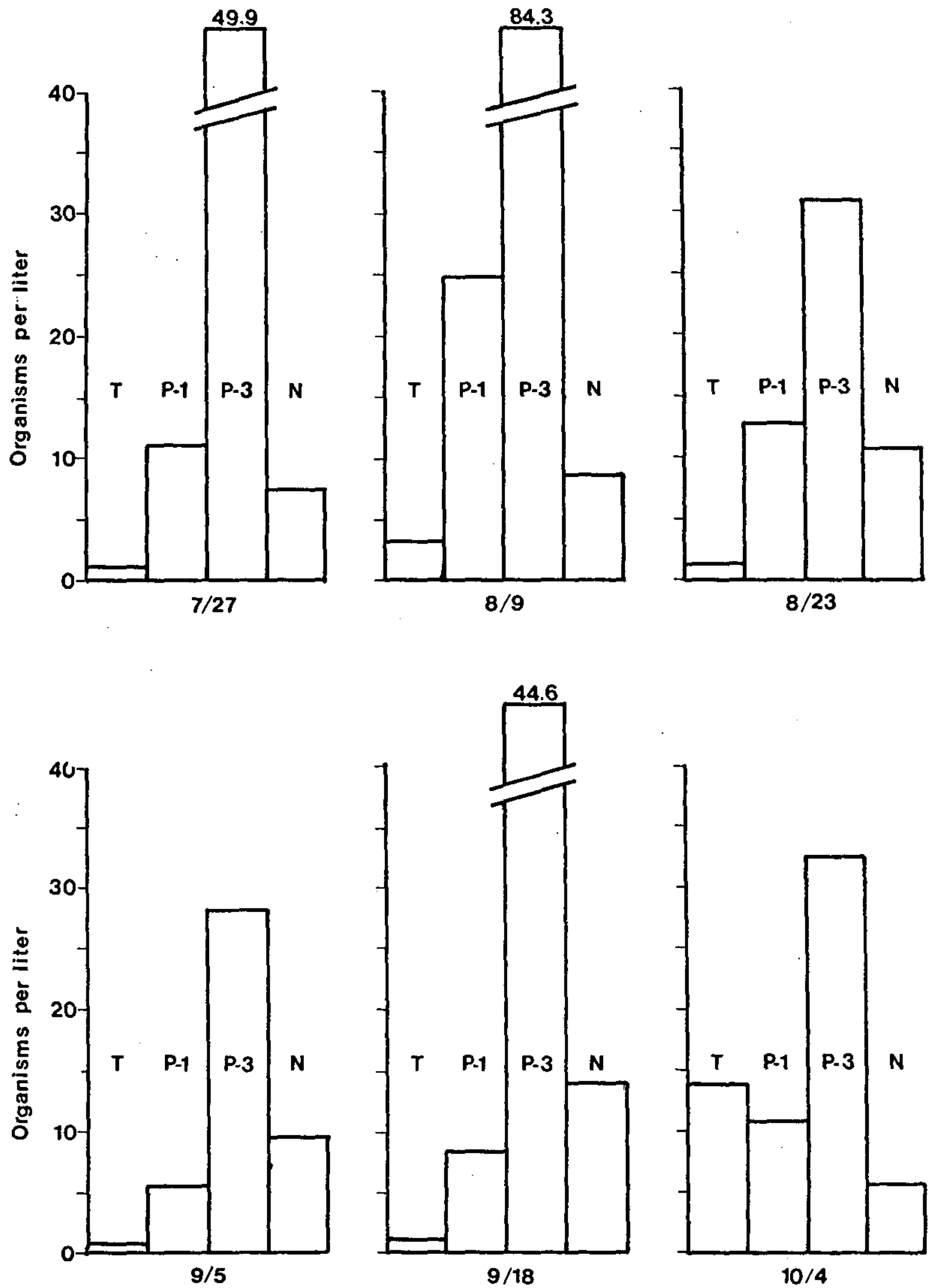

Figure 3. Comparison of 1984 combined zooplankton densities (No./l) at four major sample sites on different dates.

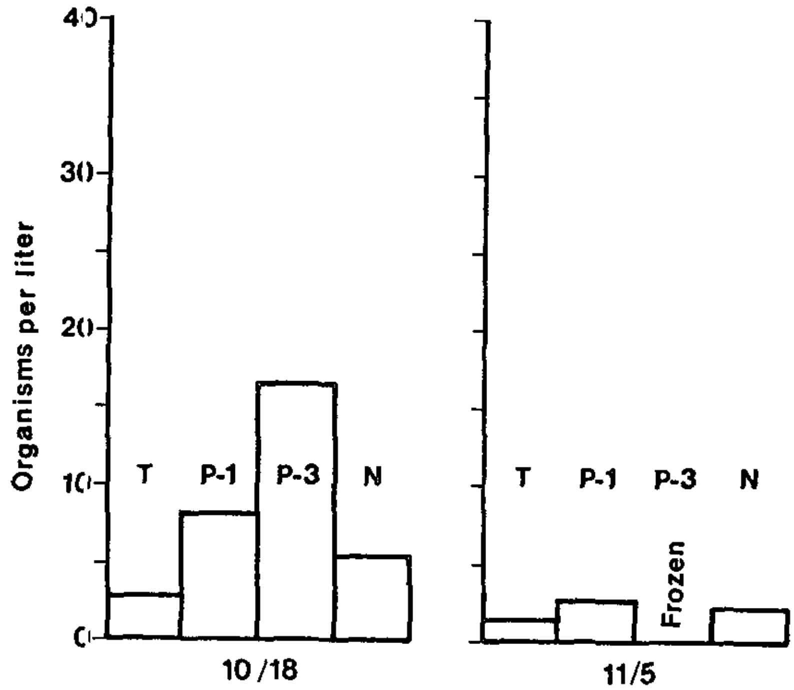

Figure 4. Comparison of 1984 combined zooplankton densities at four major sample sites on different dates.