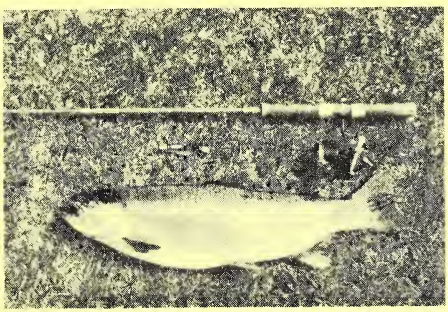
FORT PECK FISHERY HABITAT EVALUATION AND IMPROVEMENT STUDY

Annual Milestone



Prepared By:

Kenneth J. Frazer

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ABSTRACT

This milestone reports the results of the second field season of a fisheries study being conducted below Fort Peck Dam. This study was designed to identify and evaluate the impacts of the current operation of Fort Peck Dam on the down stream fishery, and test methods of overcoming these impacts through improved water management and habitat enhancement.

Minimum daily discharges from Fort Peck Dam were maintained above historic levels during the recommended period for rainbow trout spawning and rearing in 1986. However, minimum daily discharges were maintained above the absolute minimum recommended level for only 22% of this period. Habitat enhancement completed in the fall of 1985 made up for this lack of flow until mid-September, when extremely low discharges totally dewatered the habitat.

The habitat enhancement project completed in 1985 involved the addition of both spawning and rearing habitat in an area where rainbow spawning had occurred in the past. This project was evaluated in 1986.

Sedimentation studies showed a significant accumulation of fine substrate in new spawning gravel the first year it was in the river. Rainbow trout used the new habitat for both spawning and rearing in 1986. Almost 35% of the rainbow redds counted in 1986 were in this new habitat. Egg survival was better in the new gravel than in existing gravel, both in natural and artificially planted redds. The number of young-of-year (YOY) rainbow rearing in the east side channel increased almost 50% in August 1986 over the next best year. Almost 57% of the YOY rainbow collected in August were using the new rearing habitat, and they were significantly larger and in better condition than YOY rainbow collected from natural rearing habitat during the past four years.

Walleye, sauger and northern pike numbers were low in 1986. No walleye spawning occurred in the Missouri River above the Milk. The number of ripe male and gravid female sauger was up in the dredge cuts in the spring, but no ripe females were collected and no spawning was documented. Low water levels in the spring of 1986 did not provide spawning habitat for northern pike. Both ripe and spent northerns were collected during spring trapping, but no evidence of successful reproduction was found.

An experimental plant of marked walleye was made in the dredge cuts in the fall to evaluate the potential of stocking as a means of developing a resident walleye population in the study area.

The forage fish population below Fort Peck Dam looked better in 1986 than it did in the previous four years. YOY cisco were collected below the dam for the first time. Mature cisco were also collected indicating that natural reproduction was a possibility below the dam in 1986. Spottail shiners appeared to be well established throughout the study area. YOY yellow perch were collected in the dredge cuts indicating that successful reproduction occurred during high water levels in 1985. Rainbow smelt numbers were the highest recorded since seasonal gill netting was initiated in 1983.

In 1986, GEOMAX consulting completed a report on a proposal to use weirs in

the river below Fort Peck to increase minimum flows in the east side channel. This proposal proved to be unfeasible as proposed, but the report did show the potential of this type of project for improving flow conditions below Fort Peck Dam.

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INTRODUCTION

The tailwater area and the Missouri River downstream from Fort Peck Dam provide a valuable fisheries resource in eastern Montana. They contain a variety of habitat features and a mixture of warm- and coldwater fish providing an important and somewhat unique fishery.

Fort Peck Dam is the farthest upstream of a series of dams on the Missouri River operated by the U.S. Army Corps of Engineers (COE), Missouri River Division (MRD). The COE develops, controls, maintains and conserves water resources in the Missouri River to fulfill authorized project purposes of flood control, water quality, navigation, power generation, recreation and fish and wildlife conservation. In the past, fish and wildlife have received little consideration in the operation of the Fort Peck project. Within the constraints of available water, Fort Peck Dam has been operated to produce peaking power, resulting in large daily fluctuations in water levels below the dam. Recent studies have indicated that these fluctuations are responsible for a number of adverse impacts on the downstream fishery (Frazer 1985). These problems and a limited supply of quality habitat have prevented the fishery below Fort Peck Dam from reaching its maximum potential.

The Montana Department of Fish, Wildlife and Parks (DFWP) has tried to improve the fishery below Fort Peck Dam by introducing new forage species better adapted to the conditions there and by stocking chinook salmon in an attempt to develop a tailwater chinook fishery. The DFWP reduced the rainbow trout limit below Fort Peck Dam in 1984 to protect this trophy fishery in the face of increased public interest.

The COE has joined with the state in trying to identify and alleviate many of the fisheries problems below Fort Peck Dam. It has funded a fisheries study through the DFWP to identify and evaluate the impacts of the current operation of the Fort Peck project on the downstream fishery, and to test methods of reducing or eliminating these impacts through improved water management and habitat enhancement.

This milestone reports the results of the second field season of this study. Progress has been made in adjusting the discharges at Fort Peck for the benefit of the downstream fishery. Discharge patterns in 1986 were below the recommended minimum levels, but above historic levels. A major habitat enhancement project was completed in the fall of 1985, and its effectiveness was evaluated in 1986.

DESCRIPTION OF STUDY AREA

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

Fort Peck Dam is a large, earth-filled dam located at river mile 1771.6 on the Missouri River in northeast Montana. Completion of the dam in 1937 backed water 134 miles upstream to near Zortman, Montana. Four large penstock tubes withdraw water 185.5 feet below the top of the dam. Two penstocks are used for power generation and have a maximum discharge capacity of about 17,000 cfs. The generating capacity of the two powerhouses is 185 megawatts. The total discharge capacity of 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 operated as a combined base-load and peaking plant. The amount of peaking depends on water availability and power demand. Fort Peck Dam has altered the natural temperature and flow of the Missouri River downstream.

Habitat

The study area below the dam exhibits several habitat features (Figure 1). The tailrace area immediately below the dam consists of a shallow shelf of large boulders which drop off into a pool approximately 40 feet deep. Numerous large boulders have been placed in the channel to dissipate energy from dam discharges. In the center of the channel the spaces between the boulders have filled with gravel and silt, but boulders along the edges are not silted in and provide fish habitat. The banks just downstream of the dam have been riprapped, while those in the remainder of the study area are mostly steep sand and silt banks and very unstable. The bottom in the tailpool area consists of sand and silt. Most of the tailpool is less than 10 feet deep, and there are a number of shallow mud flats. There are two 30- to 40-foot deep holes three to four miles below the dam. Nine-tenths of a mile below the dam the tailpool is split by two large islands. The main flow follows the west channel. Near the upstream end of Duck Island, the velocity in the west channel increases as the river passes through a narrow, rocky chute. Downstream, numerous gravel bars and small gravel points are interspersed with a sand and silt bottom.

The side channel east of Duck and Scout islands provides critical habitat for spawning, incubation, and rearing of rainbow trout. This channel is about 2.5 miles long, and carries about 1 to 10% of the water discharged from the dam. The bottom at the upper end of this channel is predominately sand and silt, with gravel and cobble becoming progressively more prevalent downstream. Two large riffle areas in the lower quarter mile of the channel provide the major spawning and rearing habitat for rainbow.

A unique habitat feature is the dredge cut ponds, which were excavated to obtain fill during construction of the dam. They are connected directly to the main river, and their water levels are influenced by changing discharges from the dam.

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

The Nelson dredge cut, 6 miles downstream, consists of one 66-acre pond with a maximum depth of 28 feet. The opening to Nelson dredge is larger than the one to the upper dredge cuts, facilitating an exchange of water with the river. The main channel just downstream from Nelson dredge has been enlarged by dredging, creating a large bay. The bottom and banks in these areas are similar to those in the upper dredge cut.

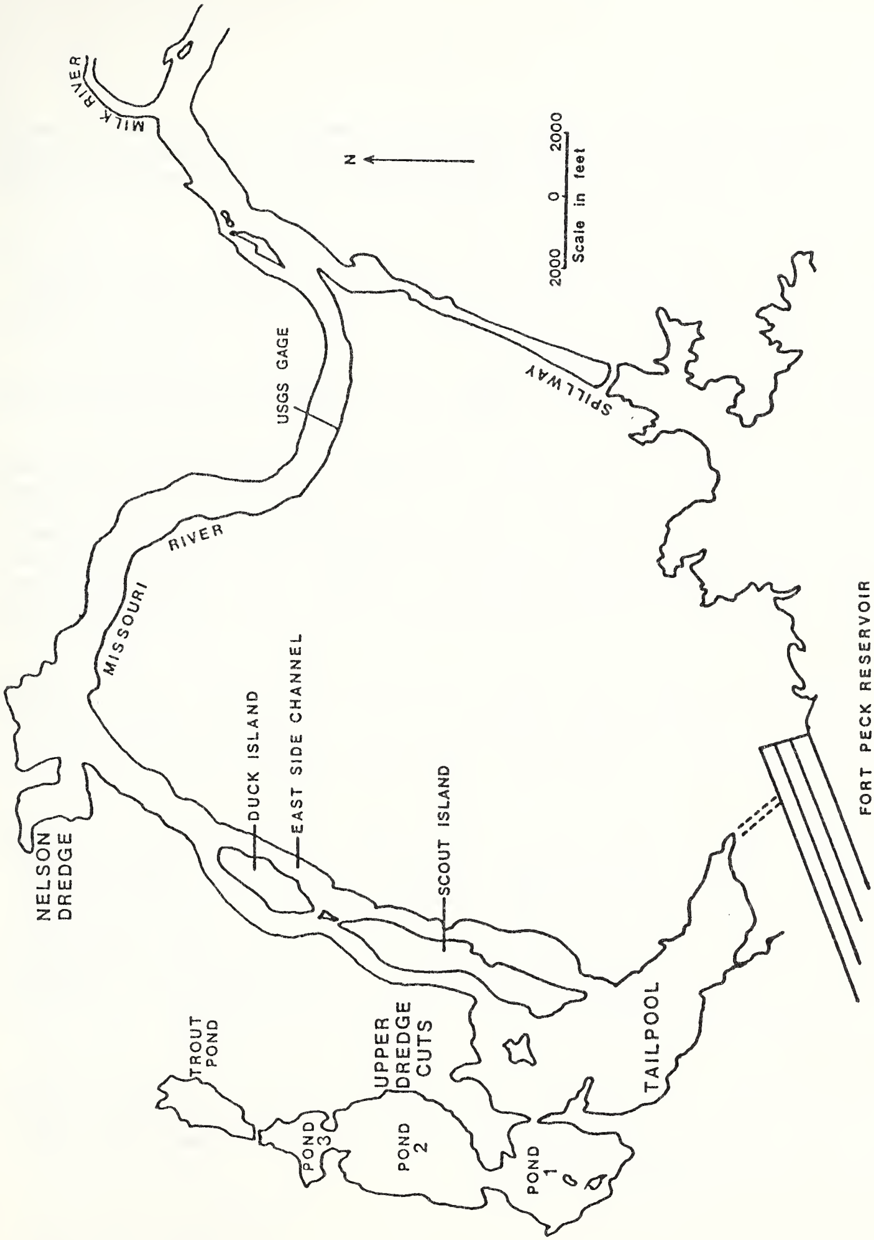


Figure 1. Study Area

Fisheries

The variety of habitat found in the study area has resulted in a diverse fishery. Forty species of fish representing 14 families have been collected in the study area (Table 1). Several other species have been reported from the Missouri River or its tributaries between Fort Peck and Garrison Reservoirs (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 area but appear to favor certain habitats. Most walleye and sauger in the area are migratory fish. Some walleye and sauger spawning does occur in the study area.

Northern pike, another popular game fish, are found predominantly in the dredge cuts. Pike spawn in the dredge cuts, but their success is limited by water level fluctuations and the resulting lack of shoreline vegetation.

Trophy-sized rainbow trout inhabit the study area and spawn successfully in the east side channel and in the main river. Rainbow spawning was first documented in 1979 (Stewart 1980), but local residents have reported catching rainbow in the area for many years. Both the study area and Garrison Reservoir have been stocked with limited numbers of rainbow in the past. However, the actual origin of this rainbow population is unknown. 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 inhabits the tailpool area below the dam. These fish provide a limited 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 whether the lake trout spawn below Fort Peck Dam or whether the population depends entirely on recruitment from the reservoir.

Paddlefish also are present in the study area. In late June and early July 1978, their numbers were estimated at approximately 3,400 paddlefish in the upper dredge cut. Another 500 were thought to dwell in Nelson dredge (Needham 1979). Tag- return data indicate these fish are part of a paddlefish population that inhabits Garrison Reservoir and migrates up the Missouri and Yellowstone rivers. Paddlefish in the study area apparently prefer the dredge cut areas, especially the upper one, but they also use the tailpool on a seasonal basis. The dredge cuts appear vital to maintaining a paddlefish population in the area. Sampling results indicate that part of the paddlefish population remained in the study area for extended periods.

Chinook salmon were first planted below Fort Peck Dam in the spring of 1983; annual plants have continued since that time. The first spawning run was anticipated below Fort Peck in the fall of 1986 but did not materialize. Other game fish found in the study area include channel catfish, burbot, shovelnose sturgeon, and an occasional brown trout.

Table 1. Fish species found in the Fort Peck Tailwater/Dredge Cut Study Area.

Family and Scientific Name	Common Name
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 1/	Cisco (C)
Coregonus clupeaformis	Lake whitefish (R)
Salmo gairdneri	Rainbow trout (C)
Salmo trutta	Brown trout (R)
Salvelinus namaycush	Lake trout (C)
Oncorhynchus tshawytscha 2/	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)
Notropis hudsonius 3/	Spottail shiner (C)
Hybognathus argyritis	Western silvery minnow (C)
Pimephales promelas	Fathead minnow (R)
Rhinichthys cataractae	Longnose Dace (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)

Table 1. (Continued)

Family and Scientific Name	Common Name
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[4/]	White bass (R)
CENTRARCHIDAE (Sunfish family)	
Micropterus dolomieui	Smallmouth bass (R)
Pomoxis annularis	White crappie (R)
PERCIDAE (Perch family)	
Perca flavescens	Yellow perch (C)
Stizostedion canadense	Sauger (C)
Stizostedion vitreum	Walleye (C)
SCIAENIDAE (Drum family)	
Aplodinotus grunniens	Freshwater drum (R)

*(A) = abundant
(C) = common
(R) = rare

[1]First planted in Fort Peck Reservoir in 1983.
[2]First planted in study area in 1983.
[3]First planted in Fort Peck Reservoir in 1982.
[4]Three have been captured in the dredge cuts; two in the spring of 1986.

METHODS

Most equipment and methods used were described in previous reports (Frazer 1985, 1986). Only new techniques and equipment will be discussed here.

Rainbow Redd Experiments

Rainbow eggs collected in the spring of 1986 for artificial egg plants were water hardened for two hours before being placed in bags and emergence traps. Two lines of eight egg bags (50 eggs per bag, two bags per redd) were placed in the spawning gravel put out in the fall of 1985. One line of eight bags was placed in existing natural gravel.

Emergence traps were built using a design described by Fraley, Gaub and Cavigli (1986). The bottoms of five of these traps were enclosed with fiberglass screen. These traps were partially filled with gravel from the area where they would be planted, and 200 fertilized eggs were enclosed in each trap. Seven other emergence traps were placed at random in areas containing natural redds. The traps were checked periodically until the first fry was collected; then they were checked every other day.

A wooden incubation box was built to act as a control chamber to evaluate egg mortality due to handling. This box contained five chambers and was designed to allow water to flow through it when placed in a stream. It was submerged in Duck Creek, a seep water stream below the dam with a constant flow of about 4 cfs. The first chamber of the box was filled with large gravel to dissipate flow through the box. Eight egg bags of 50 eggs each were placed in the other four chambers. These bags were handled the same as bags buried in the artificial redds.

Electrofishing

A new 20-foot inboard jet boat was used for shocking in 1986. Pulsed DC current was used for sampling adult rainbow, but the pulse rate was increased to 200 pulses/second to approximate straight DC current.

Gill Nets

Seven additional 1/2-inch monofilament gill nets were fished overnight in early September- four in the upper dredge cuts and three in Nelson dredge. These nets were set on the bottom in deep water.

Trap Nets

Frame traps measuring 3- x 4-foot with 1/4-inch square mesh netting were used to sample for forage fish and small game fish in the upper dredge cuts. One trap was fished for five days in the spring; two traps were fished for eight days in the fall.

Spawning Substrate Sampling and Analysis

Gravel samples consisting of approximately 30 pounds of substrate each were collected using a bucket and shovel. Three samples of purchased spawning gravel were collected from gravel piles on the riverbank shortly after being dumped from the truck. Four samples of the new spawning gravel were collected in the fall of 1986 after being in the channel for approximately a year. Three samples of natural spawning substrate from the side channel were collected from areas where spawning had been documented in the past. All samples from within the channel were collected during low flows when sample sites were totally dewatered. The shovel was used to dig a representative sample down to a depth of about eight inches.

Samples were separated by washing them through 63.5, 25.4, 12.7, 6.35, 2.0 and .074 mm sieves. Samples from the 6.35 mm and larger sieves were measured by volumetric displacement using techniques modified from McNeil and Ahnell (1964). Samples from the two smaller sieves were dried and weighed to avoid the large error associated with wet analysis of such small sizes (Shirazi and Seim 1979).

Rock densities were calculated for each particle size for both new and natural gravel by dividing dry weight of material in grams by its displaced volume in cubic centimeters. These density values were then used to convert all volumes to dry weight for final analysis.

RESULTS AND DISCUSSION

Fort Peck Dam historically has been operated for peaking power production. Discharges have been maintained at high levels during the day, then dropped at night, resulting in large daily water level fluctuations below the dam. These fluctuations had several impacts on the downstream fishery. Figure 2 shows minimum and maximum average daily discharges during the spring and early summer of 1983. This pattern was typical of historic water-level fluctuations occurring below Fort Peck Dam, and had two major impacts on the downstream fishery: 1) Daily water-level fluctuations in the tailpool and dredge cuts caused a sterile fluctuation zone along the shoreline where no shoreline or rooted aquatic vegetation could become established. Forage and game fish in the area need vegetation for spawning and security cover. 2) Fluctuating water levels in the river severely inhibited rainbow trout spawning and rearing success (Frazer 1985,1986). Highly erosive shorelines in the tailpool and dredge cuts and the limited amount of trout spawning and rearing habitat available below the dam intensified these problems.

One of the purposes of this study was to work with the COE to develop an improved discharge plan for Fort Peck Dam that would take fishery needs into account. Improved water-level management could then be combined with habitat improvement to try to overcome some of the major problems affecting the downstream fishery. Progress was made in both areas in 1986.

Water Level Management

In March 1986, the DFWP recommended to the COE the same minimum discharges for Fort Peck Dam that it had a year earlier. The department asked for a preferred minimum instantaneous discharge of 6,700 cfs with an absolute minimum instantaneous discharge of 4,500 cfs, from April 1 through September 15. These recommendations were based primarily on the flow requirements needed for rainbow trout spawning and rearing below Fort Peck Dam, but the recommendations made for rainbow were also expected to benefit other fish species.

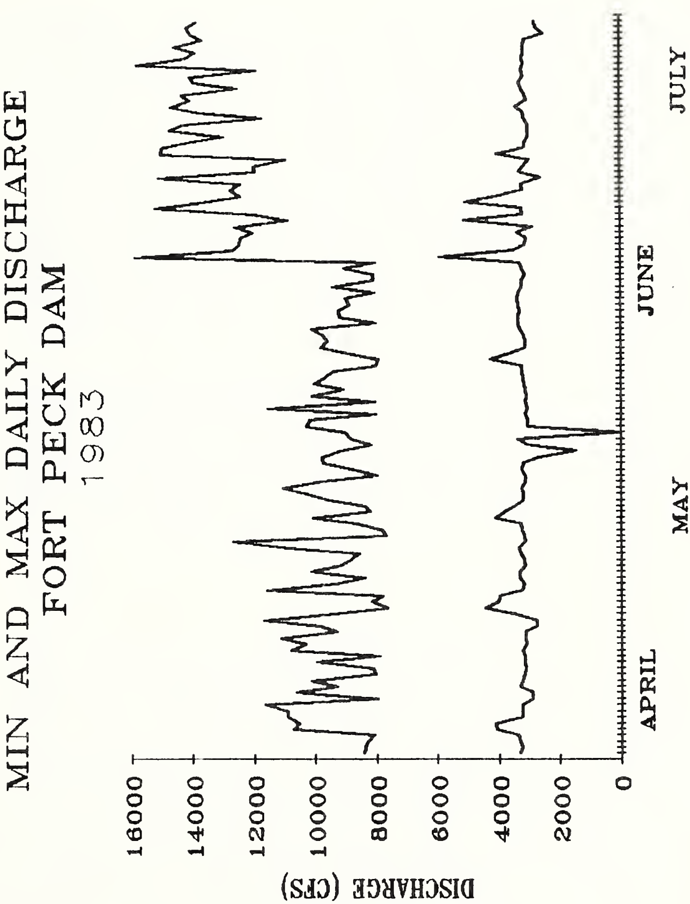


Figure 2. Minimum and maximum daily discharges from Fort Peck Dam during the spring and early summer, 1983.

Figure 3 is a graph of the minimum daily discharges at Fort Peck Dam during the recommended period in 1986. Although discharge levels were higher than those historically occurring during this time, they were not as high as the minimum recommended levels. On only one day during the 168-day recommendation period did the minimum daily discharge remain above 6,700 cfs. There were only 37 days when the minimum daily discharge remained above 4,500 cfs.

A minimum instantaneous discharge of 4,500 cfs is still considered to be the absolute minimum instantaneous discharge acceptable for rainbow trout spawning and rearing below Fort Peck Dam. This recommendation is based on field observation of key spawning areas during periods of low discharge. A discharge of 4,500 cfs maintains a flow of only about 60 cfs in the east side channel, yet a wetted perimeter/inflection point analysis conducted in 1984 found that a minimum flow of 250 cfs is necessary to maintain good spawning and rearing conditions for rainbow there. Based on the flow-discharge relationship curve developed in 1984, a minimum discharge of 6,700 cfs is required to maintain this flow in the side channel. Additional flow data was collected in 1986, and a new flow-discharge curve was plotted for this report using improved computer capabilities (Figure 4). Based on the new curve, minimum discharge of approximately 7,800 cfs is needed to maintain a flow of 250 cfs in the east side channel. This new value will be used when making recommendations for preferred minimum discharge levels in 1987.

In 1985 and 1986 the DFWP asked that the recommended minimum flow be maintained through September 15. This recommendation was based on the theory that YOY rainbow rearing below Fort Peck Dam could handle normal fluctuating flows after that date. Abnormally heavy rainfall in the Missouri drainage in the fall of 1986 resulted in a significant change from the normal discharge pattern at Fort Peck in mid-September. This had a major impact on the recruitment of rainbow below Fort Peck. This problem will be discussed in detail in the rainbow section.

Habitat Improvement Projects

In the fall of 1985, a major habitat project was completed in the east side channel near one of the major rainbow spawning areas. It was designed to complement the flow conditions anticipated below Fort Peck Dam under the new discharge recommendations by providing as much usable habitat as possible over the widest range of flows possible. Two rock dikes were constructed and spawning gravel was placed in the channel. Figure 5 shows the approximate location of this work and a diagram of the project. Each dike was approximately 50 yards long, 24 to 36 inches high and built diagonally across the flow. Anderson, Ruediger and Hudson (1984) compared several different designs for instream habitat structures and found the diagonal to be the best. They also found that structures constructed of boulders worked as well in large streams as rock-filled gabions. The dikes installed below Fort Peck Dam were a modification of Anderson's design as they were not tied into the stream bank. This revision was possible because the maximum flow below Fort Peck Dam was known and could be planned for. Such a design may not hold up in a natural stream that experiences high seasonal flows.

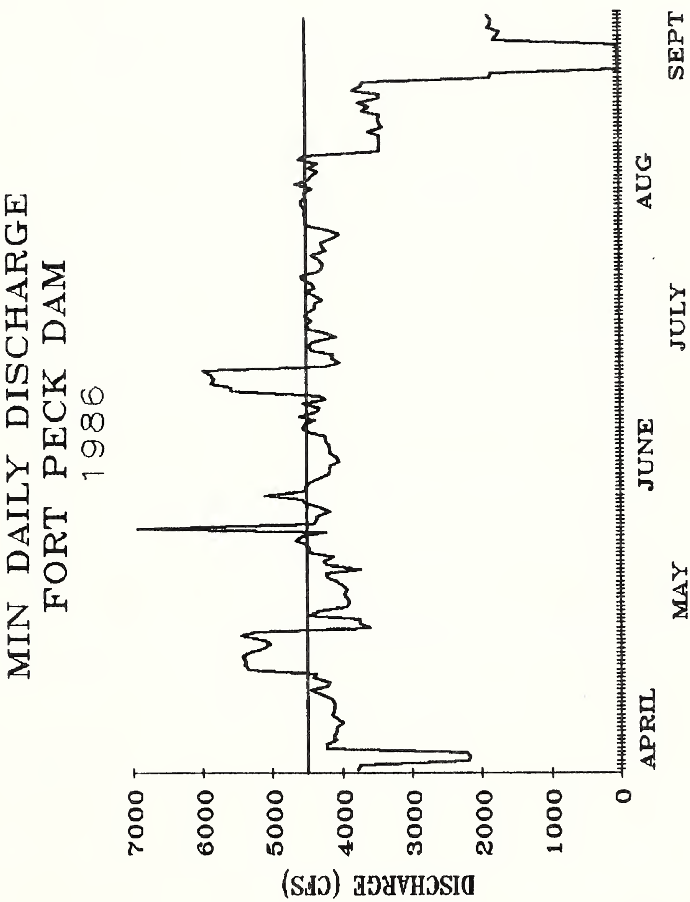


Figure 3. Minimum daily discharges from Fort Peck Dam, April 1 through September 15, 1986 compared to the recommended <u>absolute</u> minimum discharge of 4500 cfs,

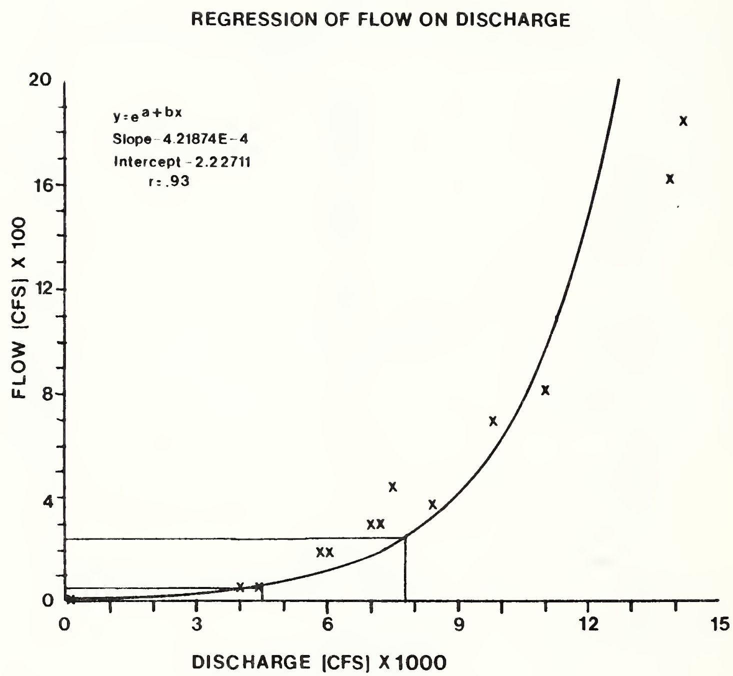


Figure 4. Regression curve of flow in the east side channel to discharge from Fort Peck Dam.

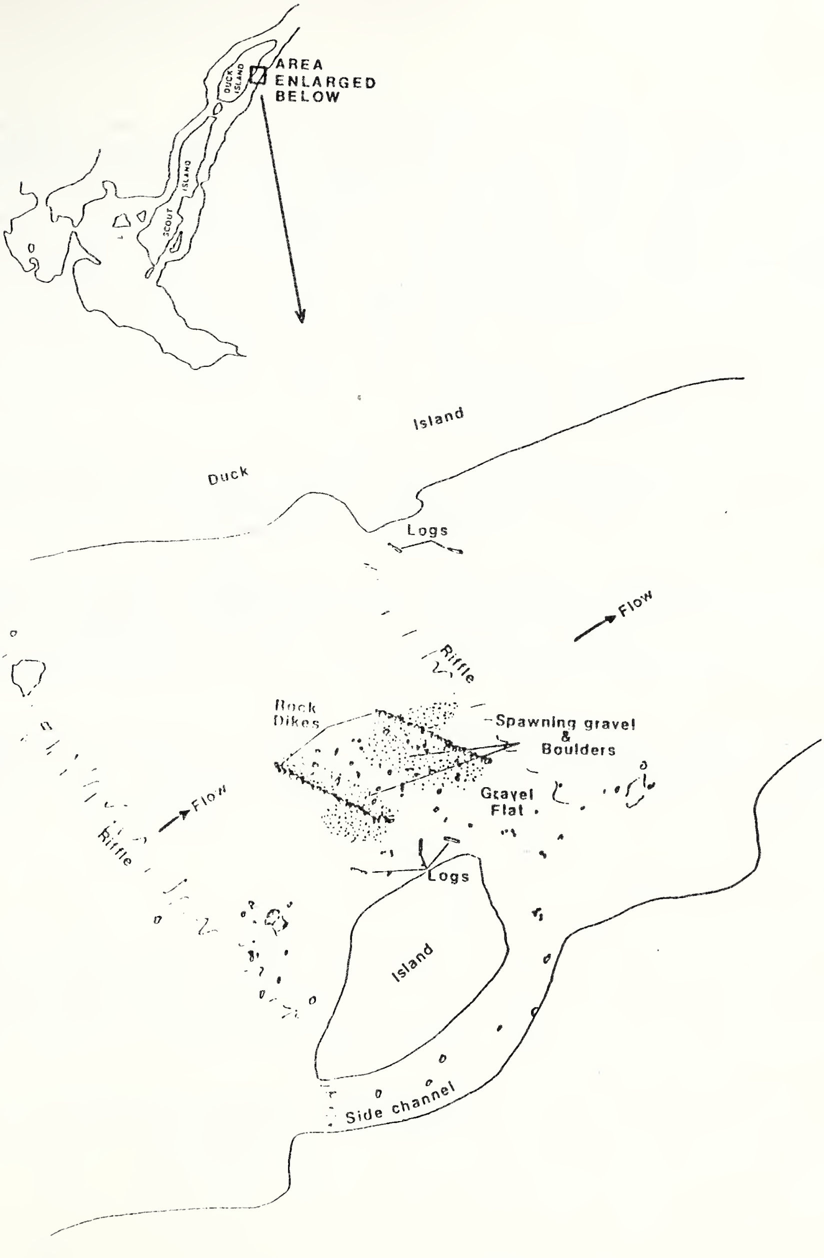


Figure 5. Location and diagramatic sketch of habitat work completed in the east side channel in 1985.

The dikes were designed with several purposes in mind: 1) They were to act as partial dams to reduce current velocities in the center of the channel, thus allowing spawning gravel to deposit and remain in the channel and spawning fish to use the area during high flows. 2) They were to provide instream rearing cover that would remain watered at recommended low flows, and they were to provide a break in the current so that small fish could remain in the center of the channel during periods of high flow. 3) They were to provide good habitat for aquatic invertebrates, increasing the food supply available for rainbow rearing in the area. 4) They were to force deeper water over the large gravel flat at their downstream end (Figure 5). This area contained good natural spawning gravel,but the water was usually too shallow under normal flow conditions to be used by spawning fish. Many of the large boulders embedded in the gravel flat were dug up and placed on top of the gravel to help reduce bottom armoring and to provide additional rearing habitat.

Approximately 80 cubic yards of washed 3/4- to 2 1/2-inch spawning gravel was placed in the channel above and between these dikes. No major effort was made to spread the gravel, since the high discharges from the dam that normally occur in the winter were likely to do the job better than a machine.

Once the gravel was placed, boulders ranging from about 1 to 2 feet in diameter were arranged individually and in groups between the dikes. These were to provide additional cover for adult fish that moved into the area to spawn. Anderson et al. (1984) found that spawning fish avoided open gravel bars created by structures if hiding cover was insufficient. The boulders also were intended to provide additional rearing cover for YOY rainbow.

Other habitat work completed in 1986 included the addition of approximately 350 Christmas trees to the upper dredge cuts with the help of the Big Muddy Sportsman Club and Wolf Point Chapter of Walleye Unlimited. The trees were submerged in the same bay where Wolf Point Walleye Unlimited placed a tree reef in 1985.

Sedimentation Studies

Clean water released from Fort Peck Dam is highly erosive on the unstable, vertical banks downstream. Erosion is greatest during periods of high discharge which are common during winter months. Bare shale hills behind the powerhouse are also highly erosive. Snow melt and heavy rains, such as those in the spring and fall of 1986, carry large amounts of sediment from these hills into the upper end of the side channel.

The slower current caused by the dikes built in 1985 allowed much of the finer sediment suspended in the water to settle out, resulting in an increase of fine in the new spawning gravel.

In October 1986, four randomly distributed substrate samples were collected from the new spawning gravel so that the accumulation of fine material during the first year could be evaluated. Figure 6 compares the composite composition of these samples to the composition of natural spawning substrate from the area and purchased gravel from the gravel pit. The figure shows a significant increase in the amount of fine substrate in the new spawning gravel after one year in the river. The gravel, when purchased, contained less than 2% by weight of substrate less than 12.7 mm (1/2 inch) in diameter. After a year, the samples collected from the river consisted of more than 16% substrate less than 12.7 mm; most of this new substrate was less than 2 mm in diameter.

The adverse effects of fine substrate on salmonid embryo and fry survival have been well documented. Fine sediments fill interstitial spaces reducing gravel permeability, apparent velocity and dissolved oxygen. This in turn creates stress resulting in premature fry emergence and reduced fry length. It also traps larvae trying to emerge (Coble 1961, Cordone and Kelley 1961, Peters 1962, Koski 1965, Witzel and MacCrimmon 1980, 1982). The accumulation of fines in the natural gravel of the side channel has already resulted in serious compaction of much of this gravel making it unusable for spawning.

An abnormally heavy rain in the fall of 1986 caused excessive erosion in the hills near the head of the east side channel, resulting in the formation of large silt deltas where major coulees dump into the channel. After heavy spring and fall rainstorms in 1986 there also was a noticeable increase in the number and size of shallow areas that showed up during low water in the center of the channel near the upper end.

The rapid deposition of sediment in the upper end of the side channel in 1986 and the significant increase in fine substrate in the new spawning gravel during the first year are evidence of how serious the sedimentation problem is below Fort Peck Dam. This will be a major factor affecting the long-term success of the habitat enhancement under way in the side channel. The accumulation of sediment near the upper end of the side channel is affecting the amount of water that flows through it. If deposition continues at the rate seen in 1986, the side channel could become completely blocked, eliminating all flow to the major rainbow spawning and rearing areas. At best, the continued accumulation of sediment in the new spawning gravel will affect future egg survival, and the gravel eventually may become unusable.

Future studies should concentrate on identifying and eliminating the major sources of sediment input to the side channel. Ways of removing some of the existing sediment deposits should also be investigated.

Impacts of Improved Discharges & Habitat Improvement on Rainbow Trout Fishery

Rainbow trout reproduction below Fort Peck Dam was first documented in 1979 (Stewart 1980). This fishery has been the subject of continuous study since 1983. A small population of trophy-sized fish resides year-round in the first 10 miles of river downstream from the dam. It depends entirely on natural reproduction to sustain itself; no rainbow have been planted below the dam since 1981. Adult rainbow sampled since 1983 have weighed an average of more than 4.0 pounds, and very few fish shorter than 18.0 inches total length have been captured. A limited study of the age and growth of these rainbow revealed they have a very good growth rate and good longevity (Frazer 1985).

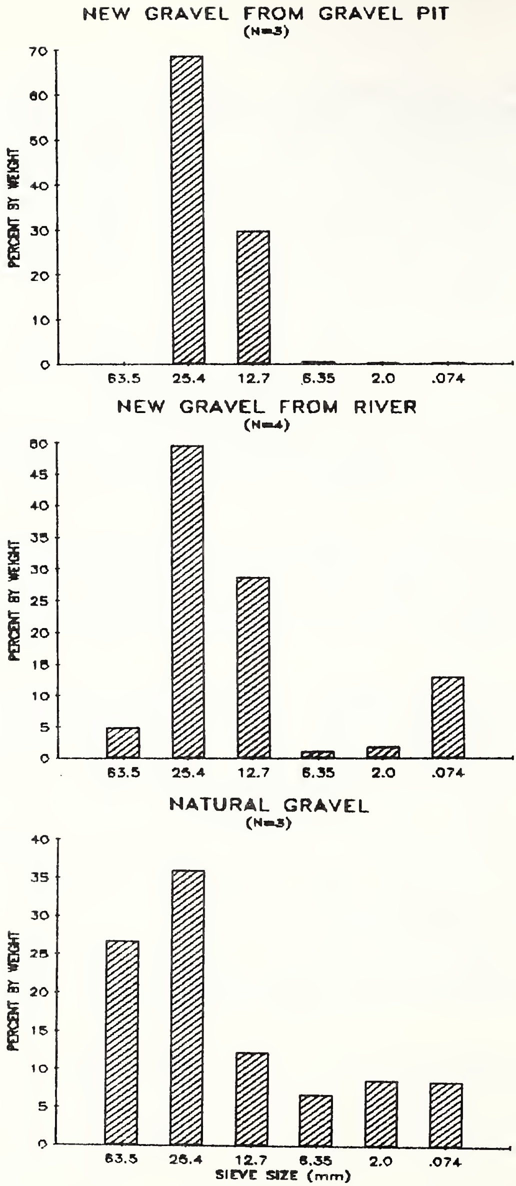


Figure 6. Composite substrate composition by day weight of new spawning gravel from the gravel pit and after being in the river one year and of natural gravel from spawning areas in the east side channel.

This rainbow fishery has received little publicity in the past, and fishing pressure has been light as a result. Almost all angling has occurred during the spring spawning run, and the few anglers who really spent time fishing for these rainbow have released most of the fish they hooked. As a result, this fishery has survived despite poor flow conditions and limited, poor quality habitat. However, in the past couple of years, the popularity of this fishery has been increasing. The major emphasis of this study has been on improving spawning and rearing conditions for rainbow trout below Fort Peck Dam. Natural rainbow recruitment must be improved to help sustain this fishery against increasing fishing pressure.

Dam discharges during the rainbow spawning and rearing period in 1986 were far from optimum. Minimum daily discharges were maintained above 4,500 cfs- the level considered to be the absolute minimum needed for reasonable rainbow production- only 22% of the time from April 1 to September 15. Despite these low flows, rainbow production in 1986 was the best since studies were initiated in 1983, apparently because of the habitat work completed in the fall of 1985. Abnormally low discharge levels in late September severely affected rainbow recruitment in 1986. However, spring and summer sampling results showed that habitat enhancement can have a significant impact on rainbow production.

Forty-seven adult rainbow trout were sampled in 1986. The mean length and weight of these fish was 20.9 inches and 3.69 pounds. This was the first time since 1983 that the average size of the adult rainbow sampled during a field season dropped below 4.0 pounds. Although any conclusions drawn from these data would be premature, this trend should be monitored closely in the future.

Spawning

Table 2 shows the total number of rainbow redds counted throughout the study area each year from 1983 through 1986. The 1986 redd count was similar to those made in 1984 and 1985. Reasons for the lower count in 1983 have been detailed in Frazer(1986). Figure 7 shows the number of redds counted at various locations during 1986. Redds were concentrated in three areas that previously had been identified as major spawning areas. Spawning rainbow appeared to select the same spawning areas each year, but the distribution of redds within these areas was affected by flows. In the past, strong current velocities associated with higher minimum daily discharges during the spawning season have forced spawning fish out of the center of the channel. Spawning has been concentrated in a few isolated areas of marginal habitat in shallow shoreline areas. This has caused several real and potential problems. A majority of redds were susceptible to loss due to dewatering if discharge levels decreased at any time before emergence. Concentrating all spawning in a few isolated areas resulted in significant superimposition of new redds over existing ones which in turn had an impact on overall egg survival.

Table 2. Total number of rainbow trout redds counted below Fort Peck Dam, 1983-1986.

	1983	1984	1985	1986
Total Count	187	246	291	263

The habitat work completed in 1985 was designed to overcome these problems, and redd sampling in 1986 indicated it was working. Minimum daily discharge levels in 1986 were only slightly lower than those in 1985, when most rainbow spawning was concentrated in shallow shoreline areas. In 1986, 91 redds- or 34.6% of the total count- were in the new gravel in the center of the channel. Most of them were spread between the two dikes; a few were above the upper dike and below the lower dike. Although there were some areas of concentration where superimposition did occur, this problem was much less severe than in 1985.

High winter flow had the desired effect of distributing and stabilizing new spawning gravel so it was ready for use the following spring.

Incubation and Emergence

Incubation success was evaluated in both natural redds and artificial egg-bag plants to compare survival between existing natural spawning habitat and artificially placed spawning gravel. Seven natural redds from the new spawning gravel and five from natural gravel were sampled. One sample from each ares was not used due to the small number of eggs recovered. Table 3 shows the results of this sampling. Survival ranged between 1.6% and 85.5% in redds from the new gravel and 18.5% to 63.5% in those from natural spawning gravel. In the redd from the new gravel with the lowest survival rate, eggs were buried under more than 12 inches of gravel compared to 4 to 8 inches for other redds. Most of these eggs appeared to have died shortly before being collected; several of the dead eggs were eyed. This redd apparently was disturbed either by other spawning activity or by gravel moving in the current; it probably did not provide a true representation of egg survival in the new gravel.

In Table 4, live and dead eggs and sac fry from each of the redd samples were combined to produce single survival percentages for each type habitat. The results were compared with similar data from natural redd sampling conducted in previous years. The 1985 data are of limited value because of the small number of eggs and sac fry collected that year. These data show a significant difference in combined survival between redds sampled in new and natural gravel areas in 1986. The combined survival from natural gravel in 1986 is very comparable to the combined survival seen in 1984. Combined survival in natural redds from the new gravel compares favorably to the final survival seen in artificial egg plants made in the new gravel in 1986.

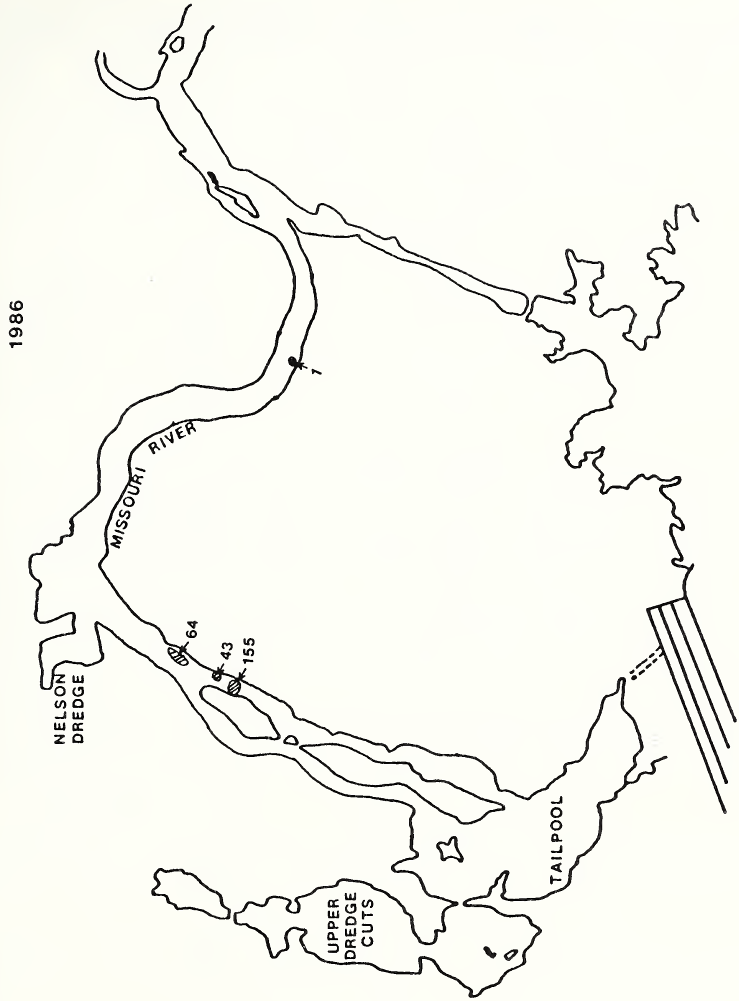


Figure 7. Numbers and distribution of rainbow redds counted in 1986.

Table 3. Number of live and dead eggs and sac fry and percent survival in 10 natural rainbow redds excavated from new spawning gravel and natural spawning gravel in 1986.

Number					Percent	
Live Eggs Eyed	Live Eggs Uneyed	Live Sac Fry	Dead Eggs	Dead Sac Fry	Live	Dead
			New Gravel			
3	-	1	244	-	1.6	98.4
229	115	3	59	-	85.5	14.5
-	-	13	90	6	11.9	88.1
53	16	2	68	-	51.1	48.9
28	53	-	14	-	85.5	14.5
-	-	4	14	-	22.2	77.8
313	184	23	489	6	51.2	
			Natural Gravel			
-	-	25	46	5	32.9	67.1
-	96	17	64	1	63.5	36.5
-	-	65	149	3	30.0	70.0
26	2	20	195	16	18.5	81.5
26	98	127	454	25	34.4	

Table 4. Combined numbers of live and dead eggs and sac fry and combined percent survival for natural rainbow redds sampled 1983-1986.

Gravel Habitat and Date	No. Redds Sampled	No. Live	No. Dead	Percent Survival
Natural 1984	10	622	1177	34.6
Natural 1985	12	60	90	40.0
Natural 1986	4	251	479	34.4
New 1986	6	520	495	51.2

Table 5 presents results from artificial egg-bag experiments conducted in 1986. The eggs were placed in the gravel May 9, but no attempt was made to sample them until May 21 so that they would have times to eye-up before being disturbed. Half of the egg bags planted in natural gravel areas were subjected to severe dewatering before the first sampling date. These bags were planted in a major natural spawning areas at an elevation where natural spawning had occurred. Minimum daily discharges dropped as low as 3,600 cfs one day, but minimum discharges averaged around 4,000 cfs during this time. All eggs in these dewatered bags were dead when first checked; they are not included in Table 5. The first time the egg bags were checked, survival in the bags from the new gravel was still greater than 99% compared to 60% survival in bags from the natural gravel areas. Good survival in the control bags showed that handling mortality was not a problem. Twelve days later, the remaining three bags were pulled from the natural gravel; only 9% of these eggs were still alive. On the same date, 72% of the eggs in bags from the new gravel were still alive. By June 23, when the last bags were removed from the new gravel, almost 95% of the eggs had hatched and survival was still 56.8%. This was comparable to the 51.2% combined survival observed in the natural redds from the new gravel.

Table 6 shows the results of emergence experiments conducted in 1986. Several problems experienced during the study limit the value of the results. Sample bottles were temporarily lost from two traps after emergence had started. These traps showed the lowest total return of fry, indicating that some fry probably escaped while the bottles were missing. When the enclosed traps were placed in the stream water was extremely turbid due to recent rains. It was impossible to observe the eggs in these traps as they were placed in the gravel. Some eggs were likely smashed or damaged by rocks and gravel moving in the traps at that time. Other eggs probably settled on top of the gravel in the traps and were washed away as current velocities increased. When the traps were pulled on July 18 there were few remnants of dead eggs left inside. It appeared that all of the mortality had occurred early, probably as the traps were put out. Although the traps did accumulate algae and sediment, there did not appear to be any problem with suffocation. All of the fry that did survive were in excellent condition, and there were no recently killed eggs or sac fry present to indicate that suffocation was occurring.

Seven additional emergence traps were put out over apparent natural redds in 1986 to try and capture fry as they emerged. Five fry were collected in three of these traps July 3; another was collected in one of the same traps on July 8.

Data from the emergence-trap and egg-bag experiments were compared with temperature data collected in the side channel to develop Table 7. Values determined in this study were similar to those reported for rainbow trout by Embody (1934). Table 8 presents estimates of timing to various stages of rainbow egg development below Fort Peck Dam. The estimates were made on the assumption that spawning began April 1 and peaked May 1. These dates were selected based on past redd count data. The dates reported in Table 8 were calculated using accumulated temperature units based on 1986 temperature data. They will vary some depending on spring weather conditions and discharge patterns, but they can be used to help identify critical development stages when trying to regulate discharges during low water years.

Table 5. Survival results for aritficial rainbow egg bag plants made in 1986. All eggs planted May 9.

Date	Habitat	No. Eggs Sampled	Percent Live	Percent Hatched
	Natural Gravel	50	60.0	0
5/21	New Gravel	156	99.4	0
	Control	117	95.7	0
	Natural Gravel	146	8.9	0
6/2	New Gravel	221	72.2	0
	Control	40	80.0	0
6/10	New Gravel	99	58.9	22.4
	Control	104	61.5	0
6/16	New Gravel	83	45.8	86.9
	Control	42	73.8	35.5
6/23	New Gravel	95	56.8	94.4

Table 6. Results of fry emergence trap sampling 1986. Each trap was planted with 200 green eggs on 4/9/86.

Habitat Area	Trap No.	6/27	6/30	7/3	7/8	7/14	7/18	Total Catch	% Return
	3	-	10	15	13	4	9	51	25.5
New Gravel	5	-	-	-	Bottle Gone	-	2	2	1.0
	10	-	-	13	10	-	14	37	18.5
Natural	2	4	5	4	4	-	2	19	9.5
Gravel	12	3	2	2	Not Checked	Bottle Gone	1	8	4.0

Table 7. Comparison of fahrenheit temperature units to various stages of development for rainbow trout below Fort Peck Dam in 1986. One ^{o}F temperature unit equals $1^{o}F$ over 32^{o} for a 24 hour period.

	Eyed	Hatched		Emerged from Gravel	
	80%	22%	94%	6%	87%
Days	21	32	45	49	70
Temp. Units	379	589	822	902	1,323

Table 8. Estimated dates for various stages of development for rainbow trout incubating below Fort Peck Dam.

Development Stage	Estimated Date April 1 Spawning Date	Estimated Date May 1 Spawning Date
First Eye-up	April 28	May 18
100% Eye-up	May 14	May 31
First Hatching	May 16	May 31
100% Hatched	June 3	June 19
First Emergence	June 5	June 22
100% Emergence	July 1	July 15

During early stages of incubation, salmonid eggs can tolerate some dewatering as long as the gravel remains damp and air temperatures do not drop low enough to freeze the eggs. Reiser and White (1981a) reported that incubating eggs from steelhead and spring chinook were able to tolerate long periods of dewatering if the gravel remained damp. Hawke (1978) found high survival of pre-eyed and eyed eggs that were stranded up to three weeks in damp gravel. But both studies reported that the alevin (posthatch phase) were much less tolerant of dewatering than eggs. Becker, Neitzel and Fickelsen (1982) reported that the demand for dissolved oxygen by chinook salmon was greatest immediately before hatching. They also found that chinook eggs (prehatch phase) could tolerate dewatering better than alevins.

A number of the dead rainbow eggs collected below Fort Peck Dam during redd sampling in 1984 appeared to have died just at hatching, indicating they had died from oxygen stress during this critical period. Over 37% of the sac fry collected from redds in 1984 were also dead, indicating that even many of the eggs that hatched successfully were not able to tolerate the periodic dewatering that was occurring (Frazer 1985).

Numerous 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). Therefore, every effort must be made to maintain minimum discharges at high enough levels to prevent dewatering once spawning has started. If discharges must be reduced in years of extremely low water to maintain water levels for the fisheries in the reservoir, plans should be made to maintain minimum discharges at least during the critical hatching and pre-emergence stages. Based on Table 8, this would be from mid-May through early July.

Rearing

Survival of YOY rainbow once they emerge from the gravel is a major factor limiting recruitment to the rainbow population below Fort Peck Dam. The east side channel appeared to be the primary rearing area for YOY rainbow. This area contained little natural instream structure to provide rearing habitat. As a result YOY rainbow in this area relied heavily on filamentous algae to provide the necessary rearing cover. Gardner and Berg (1983) found similar conditions in the Marias River downstream from Tiber Dam. They found that YOY rainbow rearing downstream from Tiber Dam were dependent on mats of filamentous algae, and that the availability of this algae was a major factor limiting the distribution of these fish. Past work has shown that fluctuating water levels can have a significant impact on the algae below Fort Peck Dam (Frazer 1985). Low minimum daily discharges have resulted in almost total elimination of algae from the side channel. This was an important consideration in the DFWP's minimum discharge recommendations to the COE.

Even when algae was abundant, it did not provide enough cover for small rainbow to remain in the open channel during higher discharges. Past sampling of YOY rainbow has shown that they move in and out daily with changing water levels trying to stay out of the current. This can be very stressful, as the small rainbow must expend considerable energy doing so. As the fish move into shallow shoreline areas, they risk being stranded if water levels suddenly drop.

This apparently was the fate of three YOY rainbow and a small sucker which were found dead on the gravel near the new habitat in August 1986. Daily discharges were fluctuating between about 4,300 cfs and 11,000 cfs at the time, but discharges were peaking at midday, then dropping gradually during the afternoon. With this pattern, releases were only dropping about 4,000 cfs late in the evening as discharges were reduced to night time levels. Stranding would have been much worse if discharges were dropping rapidly from 11,000 cfs in the evening.

Tests in the spring of 1985 showed that YOY rainbow would use log structures for instream rearing cover when available. YOY rainbow collected from a deep log structure averaged 0.6 inches longer than those from other areas (Frazer 1986), indicating that size and condition of rearing fish could be improved if they had instream cover that let them avoid moving with changing water levels. The dikes completed in the fall of 1985 were designed to provide this type of rearing habitat.

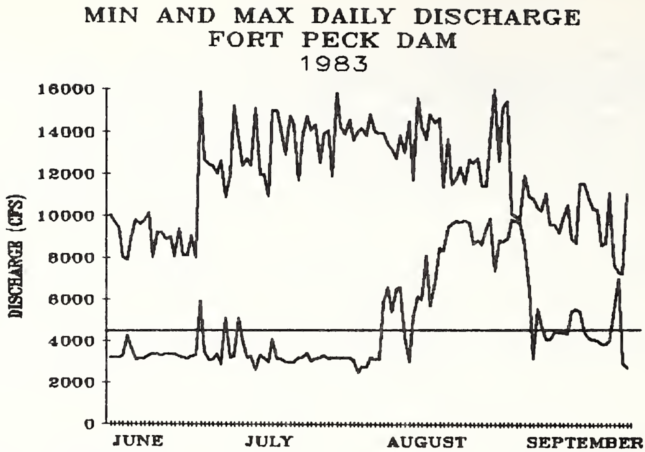
August sampling results for YOY rainbow in 1986 were very encouraging. They showed that the fish would use and even prefer instream cover when it was available. The results also verified the 1985 findings that this type of rearing habitat could have a significant effect on the growth rate and condition of rearing fish.

Table 9 presents sampling data for August electrofishing for YOY rainbow conducted in the east side channel from 1983 to 1986. The data show the effects of both improved water levels and habitat improvement on the total recruitment of rainbow below Fort Peck Dam. Figures 8 and 9 show the minimum and maximum daily discharges during the rearing period for each of these years, compared to the recommended absolute minimum discharge of 4,500 cfs.

Table 9. Number of YOY rainbow trout collected during electrofishing in the east side channel during late August, 1983-1986.

	1983	1984	1985	1986
Total Catch	32	140	245	364

Discharges during the spring and early summer of 1983 were fairly representative of those historically occurring at Fort Peck. Minimum daily discharges averaged around 3,000 cfs from late March through July, and maximum discharge levels averaged over 10,000 cfs. Minimum daily discharges increased considerably in August and remained above 4,500 cfs through mid-September, but by this time low minimum daily discharges in July had eliminated filamentous algae from the east side channel. When electrofishing was conducted in late August, no natural rearing cover was available. Only 32 YOY rainbow were collected from the entire lower side channel and the main river channel west of Duck Island.



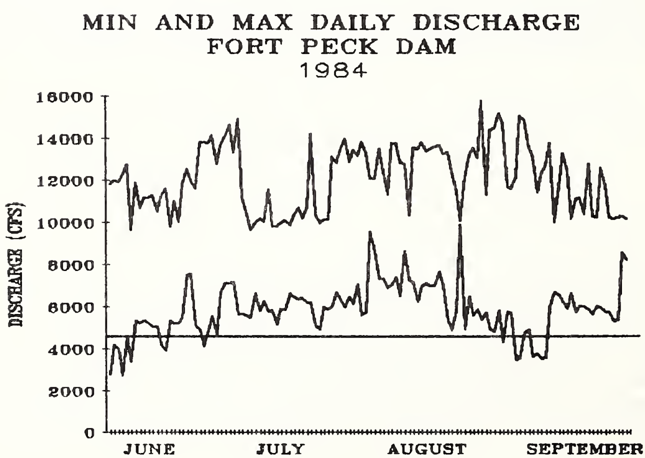
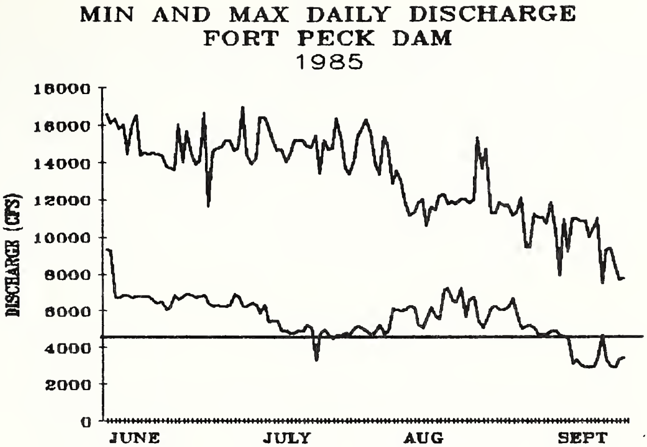


Figure 8. Minimum and maximum daily discharges from Fort Peck Dam during the 1983 and 1984 rainbow rearing period compared to the recommended absolute minimum level of 4500 cfs.



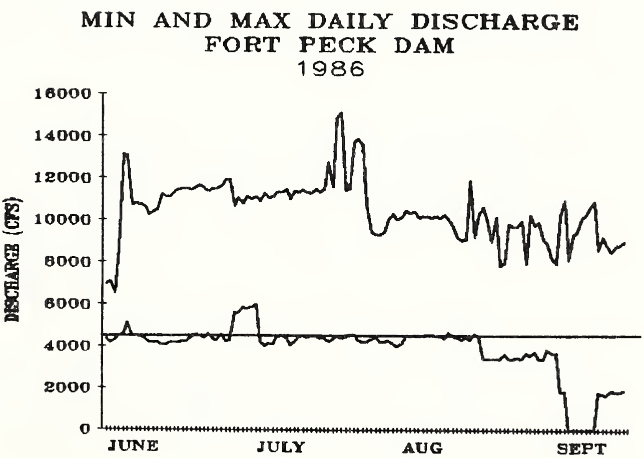


Figure 9. Minimum and maximum daily discharges from Fort Peck Dam during the 1985 and 1986 rainbow rearing period compared to the recommended absolute minimum level of 4500 cfs.

Minimum daily discharges were maintained well above 4,500 cfs throughout the rearing period in 1984, because the COE was working on downstream projects and had to increase power production at Fort Peck. The higher flows had a major impact on available rearing cover, and thick mats of filamentous algae remained in the east side channel throughout the summer, even along the shorelines. When the lower side channel was electrofished in late August, 140 YOY rainbow were sampled, four times as many as in 1983 even though less area was actually sampled. More rainbow were probably present but not seen due to the algae. Almost any algae cover in and around riffle areas held YOY rainbow. Shocking was conducted as water levels were rising; most rainbow were collected from shallow shoreline areas in algae that had just recently been flooded. This indicated that the fish were moving in with rising water levels.

1985 was the first year the DFWP made specific minimum discharge recommendations to the COE for the fishery below Fort Peck. The COE made a sincere effort to follow these recommendations, and with the exception of a couple of days in July, minimum daily discharges were maintained above 4,500 cfs through the entire spawning and rearing period. When sampling was conducted in late August, algae conditions were similar to those in 1984. Several log structures were also placed in the side channel in 1985 to provide additional instream rearing habitat (Frazer 1986). The number of YOY rainbow sampled in 1985 was up 75 % from 1984.

In 1986 the DFWP made the same discharge recommendations to the COE. As mentioned earlier, minimum daily discharge levels were maintained higher than historic levels, but they were maintained above the recommended absolute minimum level of 4,500 cfs on only 22% of the days from April 1 to September 15. As a result, flow conditions in 1986 were not quite as good as they had been in 1984 and 1985, but the additional spawning and rearing habitat put out in the fall of 1985 more than made up for these deficiencies.

Algae conditions in 1985 and 1986 were similar. In 1986 there was some reduction in algae in the shallow shoreline areas that had been critical in the past, but there was a good accumulation of algae along the downstream side of both new dikes. The dikes themselves also provided excellent instream rearing habitat. The YOY rainbow catch in 1986 was up almost 50% over the 1985 catch. The most important aspect of this increase was that, of the 364 YOY rainbow sampled during 1986, 206 or 56.6% were using the two new dike structures for rearing. YOY rainbow were collected along the full length of both dikes. Some fish were under the large mats of algae along the lower edges of the dikes, but most were right in among the large boulders in the dikes.

Numerous 2- to 6-inch suckers and approximately 15 longnose dace were also collected from the two dikes. Only two longnose dace had been collected during all previous sampling conducted in the study area since 1983. Only one YOY rainbow was collected from behind the boulders that had been placed on the gravel between the dikes.

Rainbow collected from the dikes were larger and in obviously better condition than those collected from natural rearing habitat. This verified a theory postulated after collecting larger rainbow from one of the instream log structures in 1985. Table 10 presents a comparison of the mean total length of rainbow collected from the dikes to the length of rainbow collected from all other rearing habitat during the past four years. From 1983 to 1986, the mean total length of YOY rainbow collected from natural habitat in August has been approximately 2.0 inches. By comparison, nine rainbow collected from one log in 1985 and 85 collected from the upper dike in 1986 averaged 2.6 inches total length. Rainbow collected from the lower dike in 1986 appeared to be even larger, with five of the largest averaging 3.5 inches. The two largest of the five were 3.7 inches long. The largest rainbow collected during August 1985 was only 3.1 inches long, and this fish was collected from one of the log rearing structures. Only one of 126 YOY rainbow collected from natural rearing cover in 1985 measured more than 2.6 inches in total length. The rainbow collected from the dikes in 1986 were also noticeably heavier for their length then those collected from other habitat.

Table 10. Comparison of mean total length of YOY rainbow collected from natural and new rearing habitat during August electrofishing, 1983-1986.

	Natural Habitat			New Habitat		
Date	No. of Fish	Mean Length (in.)	Length Range (in.)	No. of Fish	Mean Length (in.)	Length Range (in.)
1983	32	2.0	1.4 - 2.6	---	---	---
1984	140	2.0	1.4 - 3.1	---	---	---
1985	126	1.9	1.3 - 3.1	9	2.6	1.7 - 3.1
1986	95	2.1	1.5 - 3.1	85	2.6	1.8 - 3.5[1]

[1]Two rainbow measured from the lower dike were 3.7 inches long; these fish were not used in the average.

The importance of rearing structure was also exemplified in another spawning area at the downstream end of the side channel. The area provided good spawning habitat but contained almost no instream or shoreline cover for rearing fish once they emerged. In 1986, one small dead tree extending out from the bank had collected a large mat of floating algae; this was the only cover available. Thirty-three YOY rainbow were collected in the area in August, more than had been sampled from this area during any previous year. All but one were collected near this tree.

The new dikes should provide rearing habitat for rainbow at least through the first winter. Two yearling rainbow were collected from the dikes in early May 1986 while shocking for adult rainbow. They apparently had moved to the dikes after construction was completed in the fall of 1985 and remained through the winter. The low discharges in September 1986 totally dewatered the dikes and killed or forced all YOY rainbow away from the area. The only rainbow wintering near the dikes in 1986-87 were fish that moved back into the area after discharges increased.

Sampling results in 1986 showed that properly designed habitat enhancement projects can have a major impact on rainbow production below Fort Peck Dam, especially when combined with improved discharges from the dam. Unfortunately, abnormally low discharges in the fall of 1986 negated most of the gains made in rainbow production during the spring and summer. Record rainfall throughout the upper and middle Missouri River drainage in the fall of 1986 resulted in increased discharges from many of the downstream reservoirs. As a result, Fort Peck Dam was not needed for power production, and water was held back for flood control. On September 17, two days after the recommended discharge period ended, nighttime discharges from Fort Peck dropped to nothing without warning and remained at that level for about six hours. This same pattern continued for a week before a minimum discharge of approximately 1,800 cfs was established for the rest of the month. This discharge pattern dried up the lower end of the east side channel where most rainbow were rearing. The side channel was first checked on the third morning of this discharge pattern. During the following several days, numerous small suckers and minnows were found stranded and dead throughout the side channel. One morning, five 15- to 16-inch river carpsuckers were found stranded in one riffle area. With water levels dropping fast enough to strand large fish, the smaller fish did not have a chance. No dead rainbow were observed in the side channel, but most probably died the first night the side channel was dewatered and then were washed away by rising water levels the next day.

To check the effects these low discharge levels had on the fish population in the side channel, the two dikes were electrofished again in mid-October. One longnose dace was collected from the upper dike and one western silvery minnow from the lower dike; no other fish were seen. One YOY rainbow was collected and two others observed during electrofishing for chinook salmon in the tailrace immediately below the dam in late November. While some YOY rainbow did undoubtedly survive in 1986, the number was very small compared to what it would have been if normal discharges had been maintained in the fall.

The disastrous discharges in the fall of 1986 occurred because Reservoir Control misunderstood the discharge recommendations made by the DFWP. As discussed earlier, the department asked for minimum discharge levels to be maintained through September 15. This date was selected to restrict the COE as little as possible yet still protect the fishery. The department thought that, by mid-September, the YOY rainbow rearing in the side channel would be mobile enough to handle the kind of discharge fluctuations that historically have occurred below Fort Peck Dam in the fall. In the past, minimum discharges have dropped to about 2,700 to 3,000 cfs at night during the fall. By late November or early December, discharges have started to increase towards high winter levels.

Reservoir Control did not understand that extremely low discharges after September 15 could still jeopardize young rainbow. They maintained a minimum discharge through the recommended period then felt they were safe to reduce discharges to nothing without having any negative impacts. No one was warned of this change in the normal fall discharge pattern, and, as a result, the damage was done before anyone realized what was happening. The problem has been rectified, and discharge recommendations in the future will specify a minimum maintenance discharge throughout the fall and winter.

Walleye and Sauger

Abundance

Table 11 shows the numbers and mean size of walleye and sauger captured during seasonal gill netting below Fort Peck Dam over the past four years. Catches of both species were down in 1986; the walleye catch was the lowest recorded during this time for all three netting periods. The spring sample in 1983 was the only time the sauger catch was below the 1986 level. The sauger catch in 1986 was down considerably when compared to the increasing numbers of sauger seen during the previous two years. These low catch rates probably were related to the flow and discharge conditions in the spring of 1986. The walleye and sauger fishery below Fort Peck Dam consisted predominately of fish that migrate into the area in conjunction with spawning migrations from Garrison Reservoir. The number of walleye and sauger migrating up the Missouri River apparently is affected by spring runoff. Stewart (1983) saw a large increase in 1982 in the number of walleye and sauger in the Missouri River between the mouth of the Milk and the North Dakota border. He related this to high spring flows that year in the tributary streams of the Missouri. In the spring of 1986, the Milk River and many of the downstream tributaries flooded at the same time that very low discharges were occurring below Fort Peck. Apparently, the migrating walleye and sauger that reached the mouth of the Milk River in 1986 were attracted by the large volume of warm water coming out of the Milk. They migrated up that drainage rather than continuing up the Missouri into the study area. Anglers reported catching large numbers of walleye in the Milk River in 1986, and no walleye or sauger spawning run occurred at a gravel bar just upstream from the Milk where spawning normally occurs. Table 12 compares the summer gill net catch for walleye and sauger from 1979 to 1986. Again, the numbers captured in 1986 were the lowest for both species during this eight year period.

Table 11. Summary of seasonal walleye and sauger catches in ten 125-foot experimental gill nets fished at standard locations, 1983-1986.

		Spring			Summer			Fall		
Date	Species	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)
1986	Walleye	6	17.2	2.10	1	18.6	1.90	2	15.0	1.45
	Sauger	12	16.5	1.25	6	16.7	1.35	8	16.6	1.48
1985	Walleye	10	17.4	1.85	6	14.1	0.82	8	17.3	1.82
	Sauger	21	16.4	1.54	41	14.4	0.93	40	16.0	1.27
1984	Walleye	10	17.3	1.64	8	13.6	0.92	4	14.1	0.85
	Sauger	29	13.4	0.63	14	12.6	0.50	44	14.1	0.91
1983	Walleye	11	17.9	2.05	8	17.2	1.58	4	16.7	1.40
	Sauger	1	18.7	1.79	12	14.3	0.92	18	14.1	0.86

Table 12. Summary of walleye and sauger catch from ten 125-foot experiemental gill net sets during the summer in Fort Peck dredge cut/tailwater area, 1979-1986.[1]

	Walleye			Sauger		
Year	No.	Mean Length (in.)	Mean Weight (lbs.)	No.	Mean Length (in.)	Mean Weight (lbs.)
1979	8	16.4	1.48	7	15.3	0.96
1980	27	16.8	1.80	.67	14.7	1.03
1981	9	17.4	1.86	47	15.0	0.93
1982	7	18.3	1.82	9	16.1	1.06
1983	8	17.2	1.58	12	14.3	0.92
1984	8	13.6	0.92	14	12.6	0.50
1985	6	14.1	0.82	41	14.4	0.93
1986	1	18.6	1.90	6	16.7	1.35

[1]1979-1982 data from Needham and Gilge, 1983.

Spawning

In 1986 walleye and sauger spawning in the study area was extremely limited. In Table 13, the numbers, mean size and spawning condition of walleye and sauger collected during 1986 spring electrofishing are compared with similar data from previous years. The data indicate that for the first time since 1983, no spawning run occurred at the USGS gravel bar located eight miles downstream from Fort Peck Dam. Several nights of electrofishing in this area in early May produced only two male walleye. Kick sampling for eggs in mid-May failed to produce any walleye or sauger eggs. In contrast, 75 mature walleye and 13 sauger were collected in the area during spring electrofishing in 1985 despite boat problems that prevented sampling during the main part of the run. And egg sampling showed that extensive spawning had occurred at the gravel bar. Again difference between 1985 and 1986 spawning can be related to spring flow and discharge patterns. As discussed above, high spring flows in the Milk River and low flows above it apparently caused most migratory walleye and sauger to go up the Milk River in 1986. The previous year, spring flows in the Milk were very low while discharges from Fort Peck were abnormally high. As a result a major part of the flow in the Missouri came from above the Milk River, attracting large numbers of walleye and sauger into the study area and resulting in the best spawning run recorded to date at the USGS gravel bar.

In contrast to spring electrofishing and gill net data, 1986 trap netting results showed a large increase in the number of sauger collected in the dredge cuts during the spring (Table 14). As in previous years, these sauger consisted of ripe males and gravid females; no ripe females were collected. Sauger were first found concentrated over two gravel points in the dredge cuts in 1984. At that time, based on the presence of ripe and gravid fish and the capture of two spent females, sauger spawning was presumed to be occurring in these areas

(Frazer 1985). No spawning has ever actually been documented , and no ripe females have yet been captured. But three more spent females were collected in 1986, indicating that spawning had occurred somewhere in the area. Considering the increasing number of sauger seen during seasonal gill netting in 1984 and 1985, the large number collected in the trap nets in 1986 was not a real surprise. The gill net data indicate that an increasing number of sauger were remaining in the study area throughout the year. However, if this was the case, it is difficult to account for the drop in sauger catch seen in the 1986 gill net data. Apparently sauger moved out of the study area in the spring of 1986, possibly as a result of the low spring discharges.

Table 13. Numbers, mean size and spawning conditions of walleye and sauger collected by electrofishing in the Missouri River downstream from Fort Peck Dam during the spring, 1983-1986.

					Spawning Condition[1]				
			Mean Length	Mean Weight	Males	Females			Unknown
Date	Species	No.	(in.)	(lbs.)	Rp	Gr	Rp	Sp	
1986	Walleye	2	19.6	2.5	2	--	--	--	--
	Sauger	0	---	---	--	--	--	--	--
1985	Walleye	75	19.3	2.96	59	13	3	--	--
	Sauger	13	16.0	1.27	7	2	--	1	3
1984	Walleye	22	20.2	2.87	19	2	1	--	--
	Sauger	4	15.7	1.09	1	1	--	--	2
1983	Walleye	21	18.8	2.25	17	1	2	--	1
	Sauger	5	19.0	1.94	--	3	--	--	2

[1] Rp=ripe, Gr=gravid, Sp=spent.

Table 14. Numbers, mean size and spawning condition of walleye and sauger collected during spring trap netting below Fort Peck Dam, 1984-1986.

					Spawning Condition[1]					
			Mean Length	Mean Weight	Males		Females			Unknown
Date	Species	No.	(in.)	(lbs.)	Rp	Sp	Gr	Rp	Sp	
1986	Walleye	1	19.7	2.70	--	--	1	--	--	--
	Sauger	64	15.0	1.32	29	--	20	--	3	12
1985	Walleye	0	--	--	--	--	--	--	--	--
	Sauger	15	14.9	0.95	9	--	4	--	2	--
1984	Walleye	3	17.9	2.45	1	--	2	--	--	--
	Sauger	25	14.2	0.83	19	--	3	--	1	2

[1] Rp=ripe, Gr=gravid, Sp=spent.

Stocking Experiment

The 1986 walleye and sauger catch data show the effects that external factors, such as spring flow conditions, have on the fishery below Fort Peck Dam when the fishery depends totally on migratory fish. Previous studies have indicated that a lack of forage was one of the major factors preventing the development of a resident walleye or sauger population below Fort Peck Dam (Frazer 1985). When the forage base improved in 1986, the DFWP capitalized on the fact by planting approximately 1500 walleye fingerlings in the upper dredge cuts. The fish had been raised in a rearing pond all summer, then were trapped and transplanted to the dredge cuts in late September. They averaged approximately 3.2- inches long, and each was marked by fin-clipping before release. The department plans to evaluate the contribution of these planted fish to the walleye fishery below Fort Peck by watching for marked walleye during future sampling. If sampling results show that planted walleye remain in the area, stocking efforts may be expanded as more walleye become available.

Impacts of Improved Discharges and Habitat Enhancement

The modified discharge pattern of 1986 had little positive effect on the walleye or sauger fishery below Fort Peck Dam. In fact, the low average discharge combined with high runoff in the Milk River actually resulted in few walleye or sauger moving into the study area that year. If spawning did occur the minimum discharge levels recommended to the COE for rainbow would benefit walleye and sauger spawning in both the dredge cuts and main river by maintaining higher minimum water levels at spawning areas thus decreasing the chance that eggs would be dewatered. As minimum water levels increase in the dredge cuts, less shoreline gravel would be subject to scouring by wave action resulting in better egg survival. Since little spawning occurred in 1986, the impacts of flow regulation were minimal.

The major habitat work in 1986 that might have been expected to benefit walleye and sauger was the addition of more Christmas trees to the dredge cuts. However, attempts to determine whether fish used these reef were unsuccessful. The trees put out in 1985 were inspected using SCUBA right after ice-out in the spring of 1986. They were in good condition, still had most of their needles and looked as though they would provide excellent cover for large and small fish. No fish were observed using the reefs, but the divers could see only about two feet while underwater and any fish using the area probably were spooked before they could be spotted. Several attempts at electrofishing over the reefs, both during the day and at night, were unsuccessful. One angler did report catching some nice walleye in the vicinity of the reefs during the summer.

Northern Pike

Abundance

Table 15 compares the number, size and spawning condition of northern pike captured during trap netting in the dredge cuts over the past three springs. The number captured in 1986 was down more than 50% from the previous year. Spring water levels in the dredge cuts in 1986 were less favorable for pike spawning than they were in 1985. Northern pike require flooded vegetation in areas of calm, shallow water for spawning (Williamson 1942; Clark 1950). In May 1985, daily discharges from Fort Peck Dam were averaging around 14,000 cfs, and minimum daily discharges were dropping to about 9,000 cfs. These high discharge levels flooded much of the vegetation along the shores of the dredge cuts, providing good spawning habitat for pike. Since pike do not spawn at night (Clark 1950), spawning occurred when water levels were at or near their maximum levels. For successful pike production, the spawning habitat must remain flooded, not only as eggs develop, but also through the embryo and fry stages (Frost and Kipling 1967; Hassler 1970). A YOY northern pike was captured in the dredge cuts in July 1985 indicating that minimum daily water levels remained high enough in the spring to protect at least some spawning areas. In May 1986, daily discharges averaged around 6,000 cfs; minimum daily discharges were dropping to about 4,000 cfs. These water levels were not high enough to flood much shoreline vegetation. Many of the northerns captured toward the end of trapping in 1986 were spent, indicating that spawning was occurring somewhere, probably during maximum daytime water levels. But all eggs were probably dewatered when water levels dropped at night. It is unlikely that any successful northern pike reproduction occurred in the study area in 1986.

Table 15. Number, mean size and spawning condition of northern pike collected during spring trap netting in the dredge cuts, 1984-1986.

				Spawning Condition[1]				
		Mean Length	Mean Weight	Males		Females		
Date	No.	(in.)	(lbs.)	Rp	Sp	Gr	Rp	Sp
1986	28	26.7	6.28	12	4	2	4	6
1985	57	25.6	4.56	35	3	--	17	2
1984	15	27.6	5.65	9	--	2	1	3

[1] Rp=ripe, Gr=gravid, Sp=spent.

Impacts of Improved Discharge and Habitat Enhancement

Since water levels in the dredge cuts in 1986 did not get high enough to create good spawning habitat, northern pike did not benefit at all from the higher minimum daily discharges maintained that year or the reduced daily water-level fluctuations. The habitat work completed in 1986 did not directly benefit the pike. The Christmas tree reefs were too deep to provide pike spawning habitat, and without reproduction there were no small pike to use the added cover.

Forage Fish

Abundance

Previous work indicated that a lack of forage fish has been a major factors limiting the development of a resident game fish population below Fort Peck Dam. The poor forage fish population was attributed to daily water level fluctuations below Fort Peck Dam which created an unstable zone along the shore where no vegetation could grow (Frazer 1985). The only established shoreline vegetation in the study area was in the dredge cuts, near the upper edge of the fluctuation zone. This vegetation flooded only at high water, and usually was dewatered at night as water levels fell. Yellow perch, one of the major forage species in Fort Peck Reservoir in the past, require littoral vegetation (either aquatic or flooded terrestrial) for spawning (Clady and Hutchinson 1975). For perch to reproduce successfully this vegetation must remain flooded long enough after spawning for the eggs to hatch. Vegetation is also important as security or escape cover for most small forage and game species.

The spawning of emerald shiners, another important forage species in the area, was affected by fluctuating water levels even though these fish do not require flooded vegetation for spawning. Emerald shiners move into shallow water to deposit their demersal eggs over a sand or firm mud bottom (Pfleiger 1975). Most of the shoreline of the dredge cuts provided good spawning habitat for emerald shiners, but because the eggs were deposited in shallow water, they were subject to dewatering when water levels fell.

In the past, small suckers were the most common forage species collected in the study area. Longnose, white and shorthead redhorse suckers all spawn in rocky riffle areas of streams (Brown 1971), and all three species have been observed in the east side channel in the spring while electrofishing for adult rainbow. Sucker eggs were collected several times while sampling for rainbow eggs, and many small suckers were observed while sampling for YOY rainbow during late summer. Because of their spawning habits, suckers would be affected by fluctuating water levels in much the same way as rainbow. Presumably, most of the small suckers collected in the dredge cuts came from spawning in the river. Flooded vegetation in the dredge cuts appeared to be very important to these small suckers for rearing (Frazer 1985).

Better water level management and habitat enhancement had some effect on the forage fish population below Fort Peck Dam in 1986, but the DFWP's program to introduce new forage species into Fort Peck Reservoir had a greater impact.

Table 16 presents the numbers of different forage species collected by various sampling methods in 1986. It does not include a large number of small suckers or the longnose dace seen while sampling for YOY rainbow in the east side channel in August. The most important change seen in the forage-fish situation below Fort Peck in 1986 was a large increase in cisco. Cisco were first planted as a new forage species in Fort Peck Reservoir in 1984 by the DFWP. Approximately 9.4 million cisco fry were planted in 1984, 10 million in 1985 and 14 million in 1986. It appeared that cisco spawning occurred in Fort Peck Reservoir in the fall of 1984 and again in 1985 (Wiedenheft 1987). The first live cisco were collected below Fort Peck Dam in 1985, when four 10.5- inch fish were captured during summer gill netting; another cisco was collected during fall netting. In 1986, two 13.0- inch cisco were collected during spring gill netting, and 12 more averaging 13.5- inches were collected during summer sampling. All were mature fish that would have been ready to spawn by fall.

Table 16. Species and numbers of forage fish collected by various sampling methods in 1986.

Species	Seining	1/4-inch Trap Net	Gill Nets
Spottail Shiners	426	143	2
Cisco			
(Adults)	---	---	133
(Yearling)	---	---	14
Suckers[1] White & Longnose	16	163	3
Yellow Perch	12	4	10
Rainbow Smelt	---	---	54
Western Silvery Minnows	---	1	4
Emerald Shiners	44	8	---
Fathead Minnows	---	2	---
Flathead Chub	---	1	---
Longnose Dace	---	1	---

[1]Less than 8-inches long.

YOY cisco were collected for the first time below Fort Peck Dam in 1986 during summer gill netting. One 1/2- inch monofilament gill net set in the upper dredge cut contained 21 cisco ranging from 4.0- to 5.2-inches total length. Two more small cisco were regurgitated by goldeye as they were removed from gill nets. These cisco were either from 1986 spring plants or from natural reproduction in 1985. Four additional monofilament gill nets were set in the upper dredge cuts and three in Nelson dredge in early September to sample for small cisco. A total of 133 more YOY cisco were collected from these nets indicating that large numbers of cisco were beginning to pass through the dam. Nine more YOY cisco were collected during fall gill netting. In early November, 1986 several hundred 5- to 7- inch cisco were found dead along the rip-rap below the dam after a day of strong northwesterly wind. These fish apparently had been killed or weakened while passing through the dam and had been forced into shore by the wind. The same thing happened in early February, when a couple thousand dead cisco were concentrated along the rip-rap by strong winds. Local divers and sportsmen reported finding dead cisco in the tailwater area all winter, indicating that numerous YOY cisco were passing through the dam during the winter. Since previous sampling showed that live cisco could pass successfully through the dam, it is likely that many of the cisco passing through in 1986 survived. Based on the capture of maturing cisco during the summer of 1986, it was possible that some natural reproduction may have occurred below Fort Peck in the fall of 1986.

Spottail shiners were the most numerous forage species collected from the study area in 1986. Spottail also were introduced into Fort Peck Reservoir in 1982 and 1983 by the DFWP to improve the forage base. Seining results indicated they were well established in the reservoir by the fall of 1983 (Weidenheft 1984). Since spottail normally occupy the shallow littoral areas of lakes, they were not expected to pass through the dam in any numbers. However, during spring seining in 1984, large numbers of spottail were collected in both the upper and Nelson dredge cuts, indicating they were passing through the dam. In the fall of 1985 YOY spottail were collected by seining in all three ponds of the upper dredge cut, indicating that natural reproduction was occurring below Fort Peck Dam. The large number of spottail sampled in 1986 showed that recruitment from natural reproduction and/or through the dam was good in 1985. No fall seining was conducted in 1986 to determine if spottail reproduction was successful.

Both the spottail and the cisco should contribute significantly to the forage base below Fort Peck Dam. As their numbers increase in the reservoir, they will continue to pass through the dam to the downstream area.

The rainbow smelt catch in 1986 was the highest it has been since seasonal gill netting was started in 1983. Twenty-five smelt were captured during normal seasonal netting, all in 1/2- inch monofilament nets. Twenty-nine more were captured in seven additional 1/2- inch nets set for cisco in early September. The last major smelt run occurred below Fort Peck Dam in 1980 (Needham and Gilge 1981). At that time 29 rainbow smelt were captured in 10 experimental gill nets set during the summer at the same sites sampled seasonally in 1986. No 1/2- inch monofilament nets were used in 1980. The smelt collected in 1986 were probably not remnants of the 1980 run, as only two rainbow smelt were collected in all sampling below Fort Peck in 1985. These data indicate that small smelt runs must occur periodically to maintain smelt below the dam.

Yellow perch collected in the dredge cuts during 1986 spring seining and trap netting averaged about 2.5- inches long and were probably yearling fish. In the spring of 1985, the Big Muddy Sportsman Club transplanted approximately 15,000 ripe perch from the Dredge Cut Trout Pond to the upper dredge cuts. At that time, water levels were high enough in the dredge cuts to flood some vegetation and provide perch spawning habitat. The capture of yearling perch in 1986 indicated that some spawning was successful. Big Muddy Sportsman planned on moving more perch in the spring of 1986, but weather conditions apparently interrupted perch spawning in the Trout Pond, and no perch were collected. Spring water levels in the dredge cuts in 1986 were too low to flood any shoreline vegetation, so that perch spawning habitat would have been extremely limited even if large numbers of ripe perch had been transplanted.

Overall, the forage-fish situation below Fort Peck Dam looked better in 1986 than it had since studies were initiated in 1983. This can be attributed primarily to the healthy spottail and cisco populations, which should continue to improve in the future, making it easier to develop a resident game-fish population below Fort Peck Dam.

Impacts of Improved Discharge and Habitat Enhancement

The DFWP expected its recommendations on minimum discharges from Fort Peck Dam to provide some benefits for forage fish. When the COE maintained minimum spring discharges at the preferred recommended level as they did in 1985, enough shoreline vegetation was flooded to provide spawning habitat for perch and security cover for other forage fish. Minimum daily water levels remained high enough in 1985 to allow some successful perch production. Although minimum daily discharges in 1986 were maintained above the absolute recommended minimum level on only 21 days during the 3 month spring period, they still were above historic spring levels. As a result, more shoreline remained flooded, reducing the likelihood that eggs deposited in shallow water would be dewatered. This improved the chances of successful reproduction of shallow spawners such as the emerald shiner and spottail shiner. Spring discharges in 1986 averaged around 6,000 - 7,000 cfs with maximum daily discharges reaching only 8,000 - 9,000 cfs. The minimal fluctuations in daily water levels also improved conditions for shallow spawners. But even maximum water levels in 1986 were not high enough to flood much shoreline vegetation for perch spawning. If perch had spawned on the limited vegetation flooded at peak water levels, all of the eggs would still have been dewatered when the water levels dropped at night.

The Christmas tree reefs placed in the dredge cuts in the spring of 1986 were intended to provide both spawning habitat and security cover for forage fish. The trees were placed in 7 - 13 feet of water. Yellow perch are reported to spawn in 3 - 12 feet of water as long as they have flooded vegetation or other substrate on which to spawn (Krieger, Terrell & Nelson 1983). With the low water levels and lack of flooded shoreline vegetation in the dredge cuts in 1986, the Christmas tree reefs provided the best perch spawning habitat available. Because of the depth at which they were located, these trees were not subject to dewatering even when water levels dropped. Any eggs deposited on them had a good chance of surviving. The trees also provided the only good security cover in the dredge cuts in 1986.

The habitat work and improved flow conditions in the east side channel in 1986 should have benefited the forage fish population below Fort Peck Dam. In the past, small suckers have been the most common forage species collected in the study area. Suckers spawn over gravel beds in fairly swift water (Brown 1971), and the addition of new spawning gravel and holding cover, along with better water levels in the side channel, improved spawning and rearing conditions for suckers in 1986. In August large numbers of small suckers were collected from the new habitat during electrofishing, especially near the dikes. The dikes also appeared to provide good habitat for longnose dace, as the number of dace collected in 1986 was greater than any previous sampling. The YOY suckers and the longnose dace seen in the side channel in August were severely impacted by the extremely low discharges that occurred in mid-September 1986. Many were probably stranded and killed before they could make a contribution to the downstream forage base.

Chinook Salmon

Chinook salmon were first planted below Fort Peck Dam in the spring of 1983 in an attempt to develop a spawning run in the tailwater area. At that time, approximately 45,000 3- to 5- inch pre-smolt chinook were planted. This was the first experience with chinook for the hatchery, and most of these fish were in very poor condition when planted. If any of these fish survived and were going to spawn in their fourth year, they would have returned to Fort Peck in the fall of 1986. The tailrace area and main river were electrofished on several occasions between mid-October and late November, yet no chinook were collected or seen. An angler caught one chinook weighing more than 6 pounds in the tailrace in mid-October, and there was an unconfirmed report of a second chinook catch. It is impossible to say whether these fish had returned to Fort Peck from downstream or whether they had been residents of the tailwater/dredge cut area since being planted.

Approximately 94,000 3- to 4- inch chinook in apparently good condition were planted in the tailwater in March 1986. One was recaptured during electrofishing in the east side channel in late April. Four small chinook were captured and two others observed during shocking for adult rainbow near the new dikes in early May. These chinook had moved to the side channel after being planted and were using the dikes for cover. A 6.0- inch chinook was captured while electrofishing for walleye in late May, and a 7.2- inch chinook was captured in a gill net in mid-August. These incidents prove that all the chinook did not migrate downstream immediately after planting.

The habitat enhancement completed for rainbow also was designed to provide spawning and rearing habitat for chinook if a spawning run occurred. The capture of planted chinook near the dikes indicates that naturally produced chinook would probably use these structures for rearing.

Approximately 216,000 chinook were planted below Fort Peck Dam in 1984, the largest plant to date, and these fish appeared to be in excellent condition. Fish from this plant should return to the Fort Peck tailwater area to spawn in the fall of 1987. If a chinook run does not materialize then, the chances are greatly reduced that a chinook fishery ever will be developed in the downstream area.

Potential Long Term Plans

In the 1986 milestone report a large scale habitat enhancement project involving the construction of weirs in both the main west channel and the east side channel was described (Frazer 1986). The final report for the project was completed by the GEOMAX consulting firm in 1986 (Baxter 1986). This study determined that it would be necessary to raise the base surface elevation of the tailpool 0.8 feet to maintain a minimum flow of 300 cfs in the east side channel during normal low discharges. This would provide near optimum spawning and rearing conditions for rainbow in the side channel, and could be accomplished with the construction of a small underwater weir in the west channel near the lower end of Scout Island. Due to the minimum size requirement of material needed to construct a stable structure in this area, this weir would be approximately 15 feet wide, 1.5 to 2 feet high and span the entire channel. This type of structure would raise the base surface elevation of the tailpool approximately 1.5 feet. To reduce peak flows in the east channel to less than 10,000 cfs, this preliminary plan also called for the construction of a weir in the east channel. The structure was to contain 11 36-inch culverts and one baffled 48-inch culvert to allow low flows to pass through and to facilitate fish passage.

When this plan was first proposed, the consultants said this type of project would reduce or totally eliminate daily water-level fluctuations in the tailpool/dredge cut area. This would have been extremely beneficial to the fisheries in the area, and it would have helped to solve serious bank-erosion problems. But after analyzing all flow and water-fluctuation data, the consultants determined that the plan would not reduce these daily water level fluctuations in the tailpool or dredge cuts but would raise the base surface elevation by 1.5 feet. This would have serious negative impacts on the downstream area. Bank erosion already is a serious problem in the tailpool/dredge -cut area even though the banks have reached some equilibrium with existing water-level fluctuations. A rise of 1.5 feet in the base surface elevation with the same magnitude of fluctuations would cause a drastic increase in shoreline erosion until the banks readjusted to the new water level. Additional land would be lost, and the downstream siltation problem would intensify. Higher water levels also would inundate most of the swimming beaches in the dredge cuts. These problems and a cost higher than originally estimated made this plan unfeasible. However, the study did show there are ways to work with the major flow-related problems below Fort Peck Dam, and this type of study should not be abandoned.

The siltation problem documented in the east side channel in 1986 indicated that high flushing flows were needed to help keep spawning gravel clean. This eliminated the need for the weir in the east channel proposed by GEOMAX, and would greatly reduce the cost of this proposed project. Other ways of increasing minimum flows in the east side channel without increasing downstream erosion should be explored.

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