

**DEVELOPMENT OF A SYSTEMWIDE PREDATOR  
CONTROL PROGRAM: STEPWISE IMPLEMENTATION OF A  
PREDATION INDEX, PREDATOR CONTROL FISHERIES, AND  
EVALUATION PLAN IN THE COLUMBIA RIVER BASIN**

**SECTION I: IMPLEMENTATION**

**1998 ANNUAL REPORT**

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In Cooperation With

Nez Perce Tribe of Idaho  
Oregon Department of Fish and Wildlife  
Washington Department of Fish and Wildlife  
Pacific States Marine Fisheries Commission  
Columbia River Inter-tribal Fish Commission  
Confederated Tribes of the Umatilla Indian Reservation  
Confederated Tribes of the Warm Springs Reservation of Oregon  
Confederated Tribes and Bands of the Yakama Indian Reservation

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# 1998 EXECUTIVE SUMMARY

by Franklin R. Young

We report our results from the seventh year of a basinwide program to harvest northern pikeminnow (*Ptychocheilus oregonensis*) in an effort to reduce mortality due to northern pikeminnow predation on juvenile salmonids during their emigration from natal streams to the ocean. Earlier work in the Columbia River Basin suggested predation by northern pikeminnow on juvenile salmonids might account for most of the 10-20% mortality juvenile salmonids experience in each of eight Columbia and Snake River reservoirs. Modeling simulations based on work in John Day Reservoir from 1982 through 1988 indicated that, if predator-size northern pikeminnow were exploited at a 10-20% rate, the resulting restructuring of their population could reduce their predation on juvenile salmonids by up to 50%.

To test this hypothesis, we implemented a sport-reward angling fishery and a commercial longline fishery in the John Day Pool in 1990. We also conducted an angling fishery in areas inaccessible to the public at four dams on the mainstem Columbia River and at Ice Harbor Dam on the Snake River. Based on the success of these limited efforts, we implemented three test fisheries on a systemwide scale in 1991 - a tribal longline fishery above Bonneville Dam, a sport-reward fishery, and a dam-angling fishery. Low catch of target fish and high cost of implementation resulted in discontinuation of the tribal longline fishery. However, the sport-reward and dam-angling fisheries were continued in 1992 and 1993. In 1992, we investigated the feasibility of implementing a commercial longline fishery in the Columbia River below Bonneville Dam and found that implementation of this fishery was also infeasible. The tribal longline fishery has continued on a very limited basis.

Estimates of combined annual exploitation rates resulting from the sport-reward and dam-angling fisheries remained at the low end of our target range of 10-20%. This suggested the need for additional effective harvest techniques. During 1991 and 1992, we developed and tested a modified (small-sized) Merwin trap net. We found this floating trap net to be very effective in catching northern pikeminnow at specific sites. Consequently, in 1993 we examined a systemwide fishery using floating trapnets, but found this fishery to be ineffective at harvesting large numbers of northern pikeminnow on a systemwide scale.

In 1994, we investigated the use of trapnets and gillnets at specific locations where concentrations of northern pikeminnow were known or suspected to occur during the spring season (i.e., March through early June). In addition, we initiated a concerted effort to increase public participation in the sport-reward fishery through a series of promotional and incentive activities.

Promotional activities and incentives have been adjusted periodically to maintain the desired effort in the sport-reward fishery. Results of these efforts are discussed in Section I,

## Implementation.

Evaluation of the success of test fisheries in achieving our target goal of a 10-20% annual exploitation rate on northern pikeminnow is presented in Section II of this report. Overall program success in terms of altering the size and age composition of the northern pikeminnow population and in terms of potential reductions in loss of juvenile salmonids to northern pikeminnow predation is also discussed under Section II.

Program cooperators include the Columbia Basin Fish and Wildlife Authority (Authority), Pacific States Marine Fisheries Commission (PSMFC), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Columbia River Inter-Tribal Fish Commission (CRITFC), and the four lower Columbia River treaty tribes -- the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe, and the Yakama Indian Nation. The Authority and PSMFC were responsible for coordination and administration of the program; PSMFC is the primary contractor with BPA and subcontracts various tasks and activities to ODFW, WDFW, CRITFC, and the four lower Columbia River treaty tribes based on the expertise each brings to the tasks necessary to implement the program. Objectives of each cooperator were as follows.

1. WDFW (Report A): Implement a systemwide (i.e., Columbia River below Priest Rapids Dam and Snake River below Hells Canyon Dam) sport-reward fishery and operate a system for collecting and disposing of harvested northern pikeminnow.
2. PSMFC (Report B): Process and provide accounting for reward payments to participants in the sport-reward fishery.
3. CRITFC (Report C): Implement a systemwide angling fishery at mainstem dams on the Snake and Columbia rivers.
4. CRITFC (Report D): Implement a gillnet fishery for removing northern pikeminnow near hatchery release sites and at other locations where concentrations of northern pikeminnow are known or suspected to occur.
5. ODFW (Report E): Evaluate exploitation rate and size composition of northern pikeminnow harvested in the various fisheries implemented under the program together with an assessment of incidental catch of other fishes. Estimate reductions in predation on juvenile salmonids resulting from northern pikeminnow harvest and update information on year-class strength of northern pikeminnow.

Background and rationale for the Northern Pikeminnow Management Program study can be found in Report A of our 1990 annual report (Vigg et al. 1990). Highlights of results of our work in 1998 by report are as follows.

**Report A**  
**Implementation of the Northern Pikeminnow Sport-Reward Fishery  
in the Columbia and Snake Rivers**

1. Objectives for 1998 were to (1) implement a recreational fishery that rewards anglers who harvest northern pikeminnow (*Ptychocheilus oregonensis*)  $\geq$  11 inches total length, (2) collect catch data on selected fish species caught by fishery participants while targeting northern pikeminnow, (3) monitor and report incidental catch of sensitive salmonid species by anglers targeting northern pikeminnow and (4) collect, monitor and report data on angler participation, catch and catch per angler day of northern pikeminnow during the season.
2. The northern pikeminnow sport-reward fishery was conducted from May 4 through September 27, 1998. Twelve registration stations were located throughout the lower Snake and Columbia rivers.
3. A total of 108,903 northern pikeminnow  $\geq$  11 inches were harvested during the 1998 season and 21,959 angler days were spent harvesting these fish. Harvest was below the seven-year average of 150,874 while participation was well below the seven-year average of 51,013 angler days. Catch per angler day for all anglers during the season was 4.396 and exceeded the seven-year average of 2.96 northern pikeminnow per angler day.

**Report B**  
**Northern Pikeminnow Sport-Reward Fishery Payments**

1. During 1998 vouchers totaling \$432,760 were paid as rewards for 107,664 fish.
2. A total of 206 vouchers were paid for tagged fish at \$50 per tag for a total of \$10,300.
3. A total of 1,180 promotional coupons were redeemed at \$3 each for a total of \$3,540.
4. A total of \$25,350 was paid out for promotional tournaments.
5. A total of 1,756 anglers received payments.
6. The total for all payments was \$471,950.

**Report C**  
**Controlled Angling for Northern Pikeminnow at  
Selected Dams on the Columbia and Snake Rivers**

1. Dam angling at four dams on the Columbia River during 1998 resulted in a catch of 3,680 northern pikeminnow from June through October which was slightly more than the catch in 1997.
2. Overall catch per angler hour (CPAH) was 1.1 in both 1997 and 1998. Trends in annual catch and CGAH generally show declines from 1991 through 1995, with some variability but little or no trend in the years since.
3. Incidental catch was 3.3% of the total catch; no salmonids were caught.

**Report D**  
**Site-Specific Gillnetting for Northern Pikeminnow Concentrated to  
Feed on Hatchery-Released Juvenile Salmonids in the  
Lower Columbia River**

1. Small-meshed gillnets were used to catch 3,035 predator-size northern pikeminnow during 1998. Compared to 1997, catch increased 7% despite a 21% reduction in effort. Drano Lake and the mouth of the Klickitat River again produced most of the catch.
2. Incidental species composed 52% of the total catch, a reduction for 64% in 1997. Suckers accounted for most of the incidentals caught; 10 juvenile and 69 adult salmon and steelhead composed 1.2% of the catch.

**Report E**  
**Development of a Systemwide Predator Control Program:  
Indexing and Fisheries Evaluation**

1. Objectives were to (1) evaluate northern pikeminnow exploitation and compare catch rate of incidentally-harvested fishes among the three major management fisheries in 1998, (2) estimate reductions in predation on juvenile salmonids since implementation of the fisheries, and (3) update information on year-class strength of northern pikeminnow.
2. Systemwide exploitation of northern pikeminnow  $\geq 250$  mm fork length was 11.1% for sport-reward, 0.1% for dam-angling, and 0.3% for site-specific gill-net fisheries for a total systemwide exploitation of 11.5%. Reservoir exploitation ranged from zero in John Day, Lower Monumental, and Little Goose reservoirs to 13.6% in McNary Reservoir. The

dam-angling fishery had the lowest percentage (3.1%) of incidental catch relative to the total number of fish caught. Incidental catch was 31.1% in the sport-reward fishery and 52.4% in the gill-net fishery.

3. If exploitation rates remain similar to mean 1991-98 levels, we estimate that potential predation by northern pikeminnow on juvenile salmonids in 1999 will be approximately 70% of predation levels prior to the implementation of removal fisheries. Further reductions in predation may be small, unless average exploitation in future years is higher than 1994-98 levels.
4. There is no evidence that year-class strengths of northern pikeminnow have been influenced by the NPMP. Biological response of northern pikeminnow to the program should continue to be monitored and extensive sampling to evaluate response by northern pikeminnow and other predators should be conducted every 3-5 years.



## SECTION I. IMPLEMENTATION

# **REPORT A**

## **Implementation of the Northern Pikeminnow Sport-Reward Fishery in the Columbia and Snake Rivers**

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**1998 Annual Report**

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We are particularly thankful to our office assistant, Wilbert Morrison for his assistance in keeping things running smoothly throughout the year.

## ABSTRACT

We are reporting on the progress of the Northern Pikeminnow Sport-Reward Fishery (NPSRF) in the lower Columbia and Snake rivers for 1998. The objectives of this project were to (1) implement a sport fishery that rewards anglers who harvest northern pikeminnow *Ptychocheilus oregonensis*  $\geq 279$  mm (11 inches) total length, (2) collect catch data on selected fish species caught by fishery participants while targeting northern pikeminnow, (3) monitor and report incidental catch of sensitive salmonid species by anglers targeting northern pikeminnow and, (4) collect, monitor and report data on angler participation, catch and catch per angler day of northern pikeminnow during the season.

A total of 108,903 northern pikeminnow  $\geq 279$  mm were harvested during the 1998 season and 21,959 angler days were spent harvesting these fish. Harvest was below the seven-year average of 150,874 and participation was well below the seven-year average of 51,013 angler days. Catch per angler day for all anglers during the season was 4.96 and exceeded the seven-year average of 2.96 northern pikeminnow per angler day.

Peamouth *Mylocheilus caurinus*, and white sturgeon *Acipenser transmontanus*, were the other species most often harvested by returning NPSRF anglers targeting northern pikeminnow. Harvest of salmonids *Oncorhynchus* spp. by NPSRF anglers targeting northern pikeminnow remained below limits established by the National Marine Fisheries Service (NMFS).

## INTRODUCTION

Northern pikeminnow *Ptychocheilus oregonensis* are the primary predator of juvenile salmonids *Onchorhynchus spp.* in the Lower Columbia and Snake River systems (Rieman et al. 1988). Rieman and Beamesderfer (1990) estimated that predation on juvenile salmonids could be reduced by up to 50% with a sustained exploitation rate of 10-20% on northern pikeminnow >275 mm (11 inches) fork length. The Northern Pikeminnow Management Program (NPMP) was created in 1990 with the goal of maintaining a 10-20% annual exploitation rate on northern pikeminnow within the program area. One component of the NPMP is the Northern Pikeminnow Sport-Reward Fishery (NPSRF) which has consistently achieved the highest rate of exploitation within the NPMP (Friesen and Ward 1998).

The NPSRF encourages recreational anglers to harvest northern pikeminnow  $\geq 279$  mm total length from within program boundaries on the Columbia and Snake rivers by offering cash rewards. The NPSRF provides a tiered reward system that pays recreational anglers \$3 each for their first 100 northern pikeminnow returned in the season, \$4 each from 101-400, and \$5 each over 400. Anglers participating in the program registered at one of 20 registration points (stations or satellites) located throughout the program area and exchanged eligible northern pikeminnow for a payment voucher at the end of their angling day. The NPSRF provides special promotional and incentive activities to anglers in order to encourage additional angler participation, and surveys participants in order to collect catch data needed to monitor the effect of the program on other fish species.

Our objectives were to (1) implement a sport fishery that rewards anglers who harvest northern pikeminnow  $\geq 279$  mm total length, (2) collect catch data on selected fish species caught by fishery participants while targeting northern pikeminnow, (3) monitor and report incidental catch of sensitive salmonid species by anglers targeting northern pikeminnow and, (4) collect and report data on angler participation and catch during the season.

## METHODS OF OPERATION

### Boundaries and Season

The NPSRF is conducted on the Columbia River from the mouth to the boat restricted zone below Priest Rapids Dam, and on the Snake River from the mouth to the boat restricted zone below Hells Canyon Dam (Figure 1). In addition, northern pikeminnow harvested from backwaters, sloughs, and up to 400 feet inside the mouths of tributaries within this area are also eligible for reward payment. Anglers were restricted from fishing in the boat restricted zone below dams within the boundaries of the program. Angler rules for participation remained unchanged from 1996 (Winther et al. 1996). The 1998 NPSRF was fully implemented from

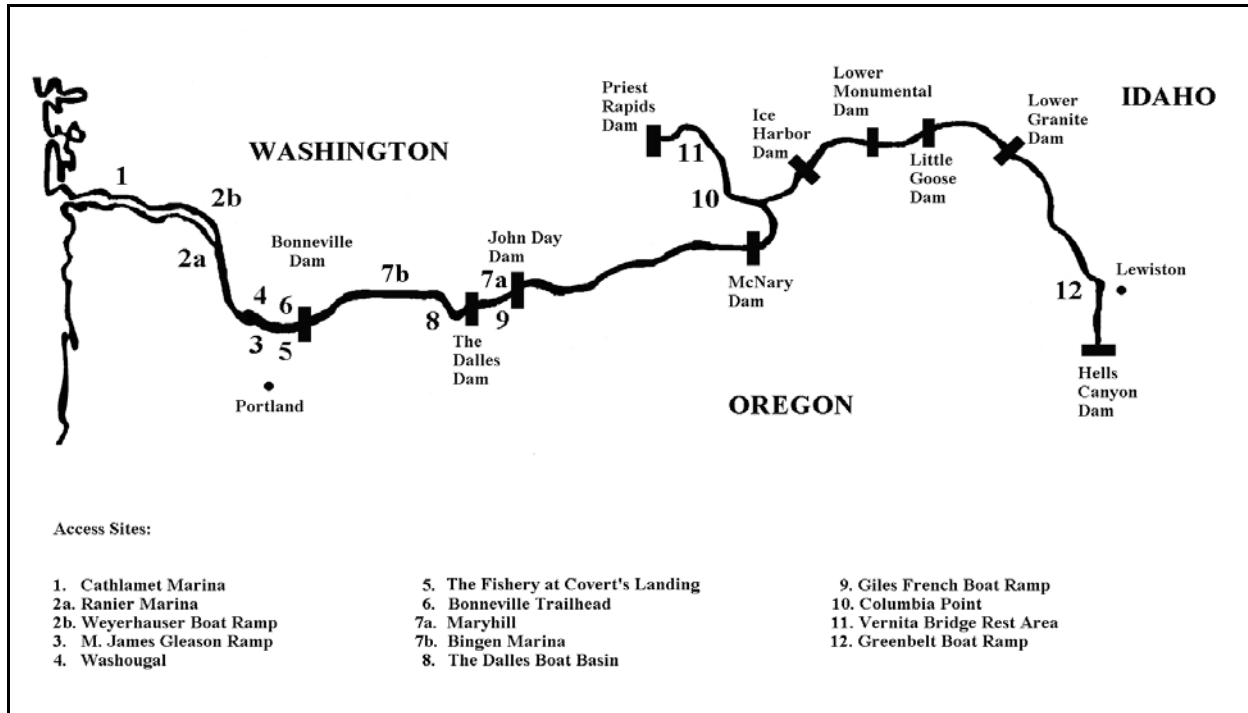
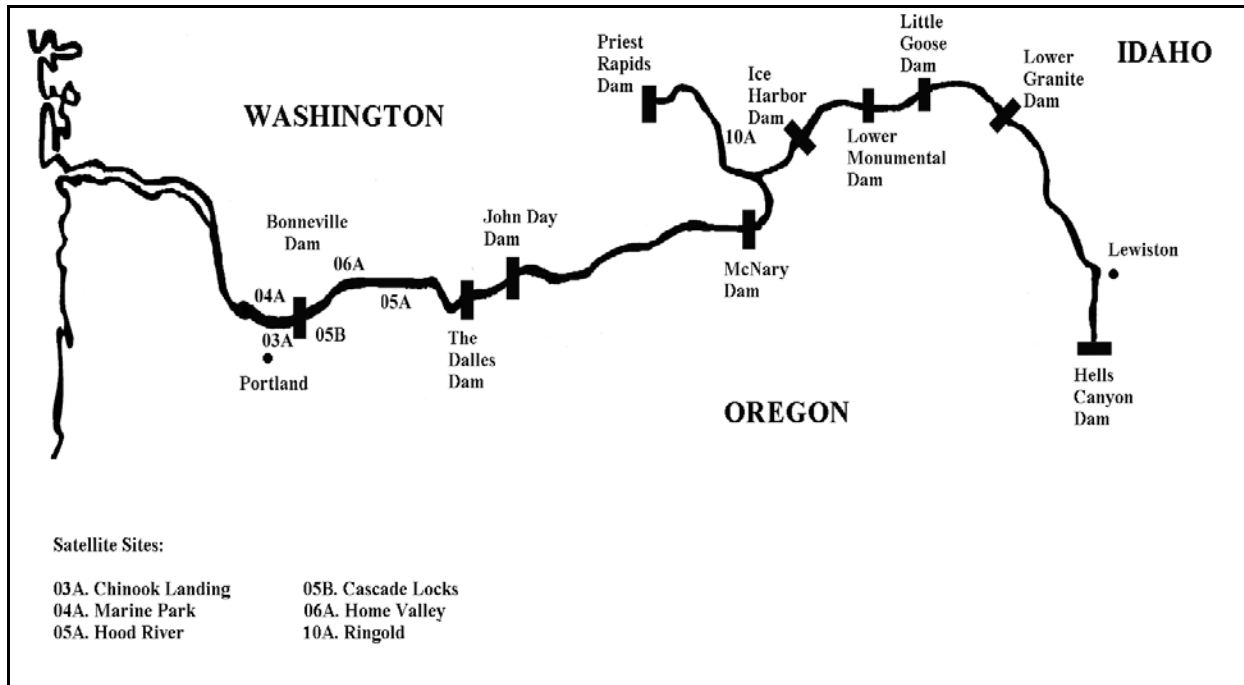


Figure 1. 1998 Northern Pikeminnow Sport-Reward Fishery Registration Stations.

May 4 (week 19) through September 27 (week 38), and was extended at limited stations through October 11 (week 41).

### Registration Stations and Satellites

Twelve registration stations including two hybrid registration stations were located on the Columbia and Snake rivers to provide anglers with access to the NPSRF (Figure 1). Washington Department of Fish and Wildlife (WDFW) technicians set up registration stations from 1 p.m. to 9 p.m. daily, where they completed a registration form for each angler that identified the angler and recorded information pertinent to the angler's fishing day. Rainier/Weyerhaeuser and Maryhill/Bingen hybrid registration stations were full-time stations that split time each day at two locations. Outside of the normal hours of operation, anglers could self-register using registration boxes located at each station. When registered anglers returned to registration stations, technicians conducted an exit interview and issued pay vouchers for eligible northern pikeminnow. In addition to the 12 full-time registration stations used during the 1998 NPSRF, there were six part-time satellites used (Figure 2), which performed the same functions as full-time stations. Satellites operated 1-2 hours per day (using NPSRF vans during off-hours) and were affiliated with a parent registration station as a way to increase their efficiency. Satellites were monitored during the season and those that did not generate sufficient harvest modified their operating schedules, or were discontinued in order to reduce operating costs.



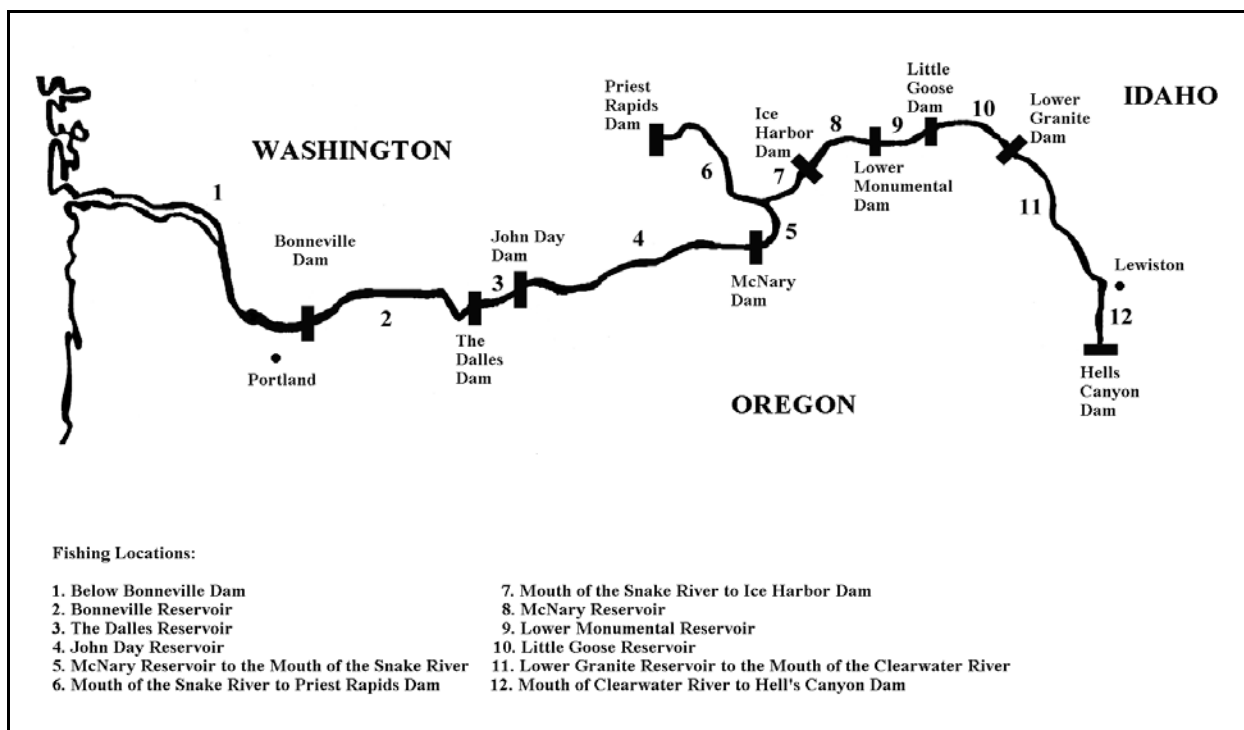
**Figure 2. Northern Pikeminnow Sport-Reward Fishery Satellites for 1998.**

### **Returning Angler Sampling**

Technicians conducted exit interviews with all returning anglers at each registration station. Anglers were asked if they specifically fished for northern pikeminnow at any time during their fishing trip. A "No" response ended the exit interview, and with a "Yes" response, anglers were asked how many of each type of fish were caught and released while they specifically targeted northern pikeminnow. A fish was considered "caught" when the angler touched, released or landed the fish, "released" was defined as those fish returned to the water alive. Starting in 1998, we included fishing location 6 (Figure 3) salmonid catches in our Columbia River salmonid report per agreement with National Marine Fisheries Service (NMFS).

### **Non-Returning Angler Sampling**

A goal of surveying 20% of each week's non-returning anglers by telephone was set to obtain non-returning catch data from anglers targeting northern pikeminnow. To attain our 20% goal, 50% of non-returning angler registration forms was taken from all registration stations each week. Each sample was shuffled to randomize registration dates and times. Technicians called anglers from each random sample until they attained the 20% goal (if the 20% goal was not reached during the first pass through the registration forms, technicians continued to re-call anglers that weren't reached during the first attempt until the goal was met). Anglers were asked: "Did you specifically fish for northern pikeminnow at any time during your fishing trip?" With a



"Yes" response, anglers were asked how many and which species of adult or juvenile salmonids were caught and released while they specifically targeted northern pikeminnow (angler catch and harvest data were not collected from anglers who did not target northern pikeminnow on their fishing trip).

**Figure 3. 1998 Northern Pikeminnow Sport-Reward Fishing Locations.**

harvest data were not collected from anglers who did not target northern pikeminnow on their fishing trip).

### Non-Returning Angler Catch and Harvest Estimates

We sampled 19.49% of non-returning anglers targeting northern pikeminnow and estimated their catch, harvest and effort using a simple estimator (5.13). This simple estimator was based on the sample rate (19.49%) of the known population size of non-returning anglers. This estimator was used with the assumption that the sample taken was representative of the catch, harvest and effort of the population as a whole. Salmonid catch and harvest estimates were reported specifically by river. We reported salmonid catches from all fishing locations in 1998 to show where the NPSRF may affect Snake or Columbia River Endangered Species Act (ESA) listed stocks.

### Northern Pikeminnow Processing

All reward-size northern pikeminnow were caudal-clipped (or eviscerated to determine sex) to indicate processing by NPSRF technicians. Northern pikeminnow were placed in insulated coolers and delivered to designated storage facilities. Rendering companies picked up



stored northern pikeminnow in Pasco, while all other northern pikeminnow were picked up by NPSRF technicians and transported to rendering facilities.

## RESULTS AND DISCUSSION

### Northern Pikeminnow Harvest

The 1998 NPSRF harvested 108,903 northern pikeminnow  $\geq 279$  mm total length. An additional 26,861 northern pikeminnow  $< 279$  mm total length were caught, of which 16,805 were released. Harvest in 1998 was 8.9% lower than 1997 (Petersen et al. 1997), and 27.8% lower than the seven year average of 150,873.

Figure 4 shows the weekly harvest for 1998 compared to the means for each week from the 1991-97 seasons. Mean weekly harvest in 1998 was 4,734 with peak harvest occurring during week 26 (June 22 through June 28). Peak harvest occurred during the same week as the mean peak harvest for 1991-97. The lowest weekly harvest was during week 41 (October 5 through October 11), the last week of the extended fishery.

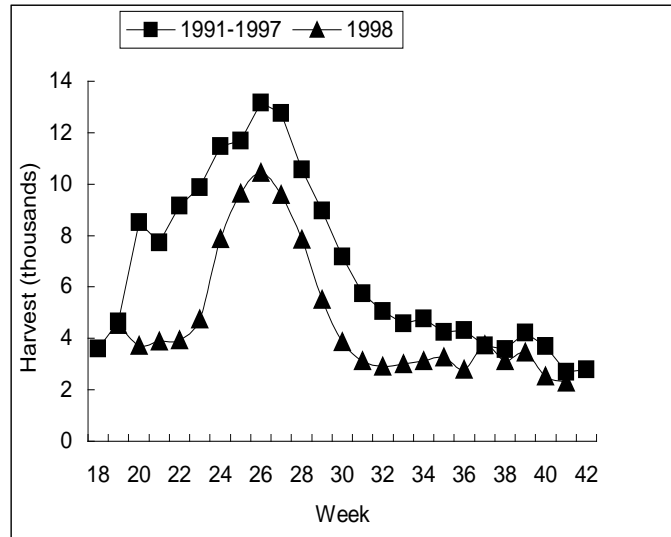
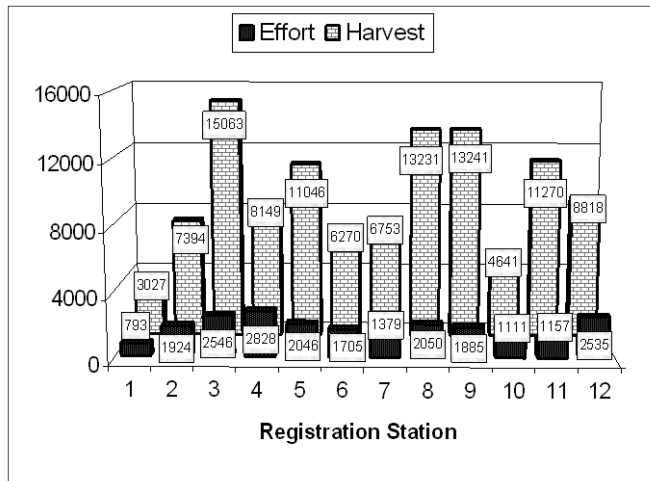


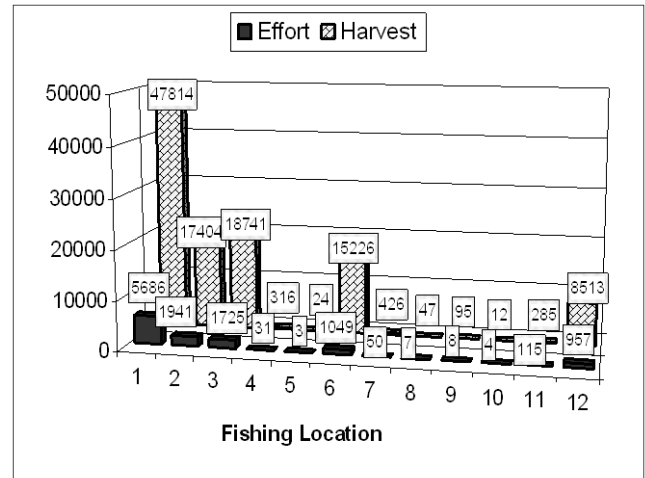
Figure 4 – Mean harvest by week for 1991-1997 and 1998.

Harvest by registration station ranged from 15,063 at Gleason Boat Ramp to 3,027 at Cathlamet (Figure 5). Harvest by fishing location for 1998 ranged from 47,814 below Bonneville Dam (fishing location 1) to 12 northern pikeminnow for fishing location 10 (Figure 6). The greatest change in harvest between 1997 and 1998 was in fishing location 6, where the combined harvest for 1998 was 32% less than 1997. This decrease in harvest can be attributed to a loss of experienced anglers to another predator control program funded by the Grant and Chelan Public Utility Districts in 1998. Fishing locations 1, 2, 3, and 6 all showed harvests over 15,000 northern pikeminnow and their total comprised 91% of the harvest for all fishing locations. Harvest in 1998 translated to an estimated system-wide exploitation of 11.1% (Leader et al. 1998, unpublished).

## Returning Angler Harvest



**Figure 5**-Harvest and effort by registration station. 1-Cathlamet, 2-Ranier/Weyerhauser, 3-Gleason, 4-Washougal, 5-The Fishery, 6-Bonneville Trailhead, 7-Maryhill/Bingen, 8-The Dalles, 9-Giles French, 10-Columbia Point, 11-Vernita, 12-Greenbelt.



**Figure 6**-Harvest and returning angler effort by fishing location in 1998. 1-Below Bonneville Dam, 2-Bonneville Res., 3-The Dalles Res., 4-John Day Res., 5-McNary Dam to Mouth of Snake, 6-Mouth of Snake to Priest Rapids Dam, 7-Mouth of Snake to Ice Harbor Dam, 8-Ice Harbor Res., 9-Lower Monumental Res., 10-Little Goose Res., 11-Lower Granite Res., 11-Lower Granite Dam to Clarkston, 12-Clarkston to Hells Canyon Dam.

Northern pikeminnow  $\geq 279$  mm (107,536) were the most frequently caught species by returning anglers targeting northern pikeminnow, followed by northern pikeminnow  $< 279$  mm, white sturgeon *Acipenser transmontanus* and peamouth *Mylocheilus caurinus* (Table 1). The northern pikeminnow total is different from the overall total harvest of 108,903 because only fish caught while targeting northern pikeminnow were included. Twenty adult chinook salmon *Oncorhynchus tshawytscha*, including 8 chinook jacks, and 21 adult steelhead *Oncorhynchus mykiss* were caught incidentally from the Columbia River by anglers targeting northern pikeminnow (Table 2). No salmonids were reported caught in the Snake River during the 1998 season and could be the result of a later arriving adult steelhead run (Maria Holmes, WDFW, personal communication). Sixty-four percent of salmonids caught by anglers targeting northern pikeminnow were caught below Bonneville Dam. Incidental salmonid catch and harvest of adult and juvenile salmonids by non-returning anglers targeting northern pikeminnow were low when compared to the total number of northern pikeminnow  $\geq 279$  mm caught in the NPSRF, thus impact on salmonids by the NPSRF continues to be minimal.

**Table 1.** Catch and harvest of selected species by returning anglers targeting northern pikeminnow.

| <b>Species</b>                              | <b>Catch</b> | <b>Harvest</b> | <b>Percent Harvested</b> |
|---------------------------------------------|--------------|----------------|--------------------------|
| Northern Pikeminnow $\geq 279$ mm           | 107,536      | 107,518        | 99.9%                    |
| Northern Pikeminnow $\leq 279$ mm           | 26,861       | 10,056         | 37.4%                    |
| Peamouth                                    | 10,177       | 3,050          | 29.9%                    |
| White Sturgeon                              | 2,455        | 36             | 1.5%                     |
| Smallmouth Bass <i>Micropterus dolomieu</i> | 2,384        | 455            | 19.1%                    |
| Channel Catfish <i>Ictalurus punctatus</i>  | 758          | 192            | 25.3%                    |
| Walleye <i>Stizostedion vitreum</i>         | 481          | 254            | 52.8%                    |

**Table 2.** Catch and harvest of adult and juvenile salmonids by returning anglers targeting northern pikeminnow.

| <b>Returning Anglers</b>             | <b>Columbia River</b> |                |                          | <b>Snake River</b> |                |                          |
|--------------------------------------|-----------------------|----------------|--------------------------|--------------------|----------------|--------------------------|
|                                      | <b>Catch</b>          | <b>Harvest</b> | <b>Percent Harvested</b> | <b>Catch</b>       | <b>Harvest</b> | <b>Percent Harvested</b> |
| Chinook Salmon (Adult)               | 12                    | 2              | 16.67%                   | 0                  | 0              | 0.00%                    |
| Chinook Salmon (Jack)                | 8                     | 0              | 0.00%                    | 0                  | 0              | 0.00%                    |
| Chinook Salmon (Juvenile)            | 38                    | 2              | 5.26%                    | 0                  | 0              | 0.00%                    |
| Steelhead Adult (Adipose Absent)     | 10                    | 6              | 60.00%                   | 0                  | 0              | 0.00%                    |
| Steelhead Adult (Adipose Present)    | 11                    | 3              | 27.27%                   | 0                  | 0              | 0.00%                    |
| Steelhead Juvenile (Adipose Absent)  | 13                    | 1              | 7.69%                    | 0                  | 0              | 0.00%                    |
| Steelhead Juvenile (Adipose Present) | 19                    | 1              | 5.26%                    | 0                  | 0              | 0.00%                    |

Columbia River N= 10,858

Snake River N= 1,178

| Non-Returning Anglers                | Columbia River         |            |            |              | Snake River            |            |            |              |
|--------------------------------------|------------------------|------------|------------|--------------|------------------------|------------|------------|--------------|
|                                      | Sample Catch<br>19.49% | Est. Catch | C.I. (95%) | Est. Harvest | Sample Catch<br>19.49% | Est. Catch | C.I. (95%) | Est. Harvest |
| Chinook Salmon (Jack)                | 7                      | 36         | 40         | 0            | 0                      | 0          | 0          | 0            |
| Chinook Salmon (Juvenile)            | 9                      | 46         | 38         | 0            | 6                      | 31         | 47         | 0            |
| Steelhead Adult (Adipose Absent)     | 1                      | 5          | 9          | 5            | 0                      | 0          | 0          | 0            |
| Steelhead Adult (Adipose Present)    | 1                      | 5          | 9          | 0            | 0                      | 0          | 0          | 0            |
| Steelhead Juvenile (Adipose Absent)  | 15                     | 77         | 67         | 0            | 1                      | 5          | 9          | 0            |
| Steelhead Juvenile (Adipose Present) | 12                     | 62         | 57         | 0            | 1                      | 5          | 9          | 0            |
| Coho Salmon (Juvenile)               |                        |            |            |              |                        |            |            |              |
| <i>Oncorhynchus kisutch</i>          | 1                      | 5          | 9          | 0            | 0                      | 0          | 0          | 0            |

Columbia River N= 6,379 n= 1,243

Snake River N= 1,124 n= 219

## Non-Returning Angler Harvest

We estimated that 46 juvenile chinook salmon were caught in the Columbia River and 31 juvenile chinook salmon were caught in the Snake River by anglers targeting northern pikeminnow (Table 2). One hundred percent of the juvenile chinook salmon caught in the Columbia and Snake River were released. Juvenile steelhead was the most frequently caught species, while adult steelhead (adipose absent) were the only salmonid species harvested by non-returning anglers targeting northern pikeminnow.

## Angler Effort

Total effort (number of registered angler days) for 1998 was 21,959 days. This was 5,379 days less than 1997 (Petersen et. al. 1997), and 43% lower than the seven year average of 51,013. Returning angler effort totaled 12,568 angler days, 57% of total angler effort. Peak angler effort occurred during week 26 (June 22 to June 28) (Figure 7). Effort by fishing location for 1998 (returning anglers only) ranged from 6,370 below Bonneville Dam (Fishing location 1) to only 3 in fishing location 5 (Figure 6). The greatest change in effort between 1997 and 1998 was in fishing locations 1 and 6, where the combined returning angler effort for 1997 was 16.5% less than 1997. Effort in 1998 was 5,379 anglers days less than 1997, a 19.7% decrease in participation. The Washougal registration station had the highest total effort (2,828) for the 1998 NPSRF and the next highest station (Greenbelt) had 89.6% of that total (Figure 5).

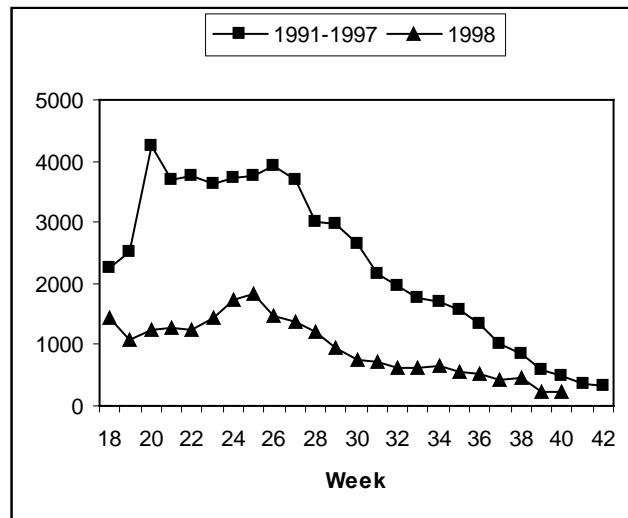


Figure 7- Angler effort by week for 1991-1997 and 1998.

## Catch Per Angler Day

Combined returning and non-returning catch per angler day (CPUE) in 1998 was 4.96 northern pikeminnow  $\geq 279$  mm. This exceeded the 1991-97 mean CPUE of 2.96. The tendency of the weekly CPUE to increase as the season progresses was consistent with 1997 (Petersen et al. 1997), and the CPUE each week was much higher overall than the mean 1991-97 weekly CPUE (Figure 8). CPUE (returning anglers only) ranged from

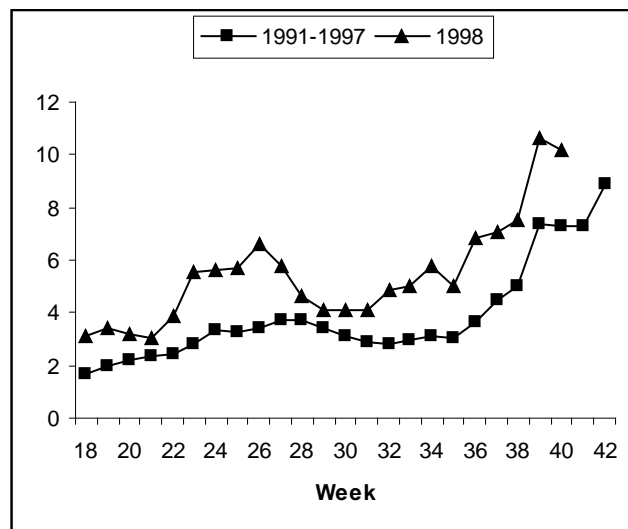
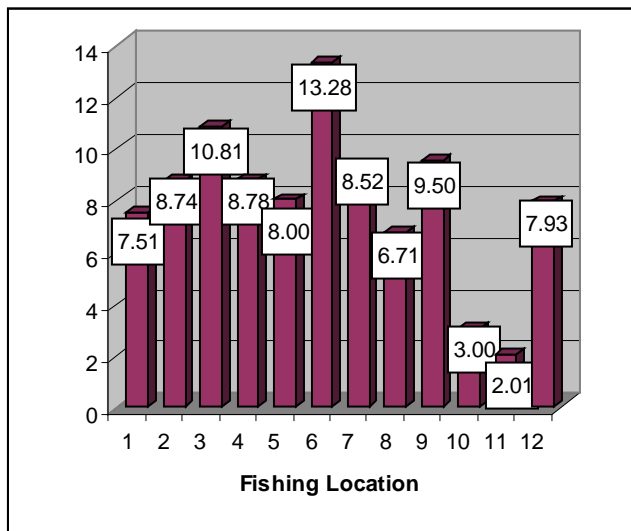


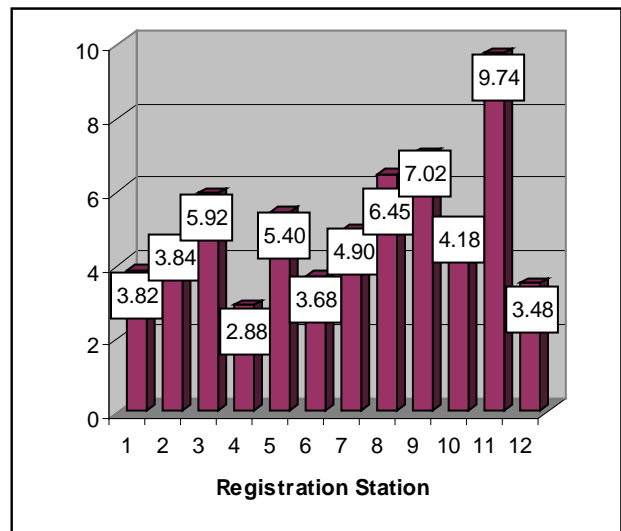
Figure 8- CPUE (fish/angler day) by week for 1991-1997 (mean) and 1998.

13.28 fish per angler day in fishing location 6, to 2.01 in fishing location 11 (Figure 9). Anglers utilizing the Vernita registration station had the highest CPUE with 9.74 and the Washougal registration station had the lowest with a CPUE of 2.88 (Figure 10). When we exclude non-returning anglers, CPUE for returning anglers was 8.7 northern pikeminnow per angler day in 1998, which was up slightly from 8.6 in 1997.

Factors that may contribute to annual variations in returning angler CPUE are: anglers spending fewer hours fishing each day (effort in hours), level of angler experience, northern pikeminnow recruitment levels or environmental conditions such as inclement weather or high spring flows. The lower overall harvest and effort for 1998 made little difference in the success rate (measured by CPUE) for returning anglers, yet the overall effect of the decline in effort is important. If 1998 effort would have equaled that of 1997 and CPUE remained constant; we estimate that an additional 26,679 northern pikeminnow would have been harvested.



**Figure 9-** CPUE of returning anglers by fishing location in 1998. 1- Below Bonneville Dam, 2- Bonneville Res., 3- The Dalles Res., 4- John Day Res., 5- McNary Dam to Mouth of Snake, 6- Mouth of Snake to Priest Rapids Dam, 7- Mouth of the Snake to Ice Harbor Dam, 8- Ice Harbor Res., 9- Lower Monumental, 10- Little Goose Res., 11- Lower Granite Dam to Clarkston, 12- Clarkston to Hells Canyon Dam.



**Figure 10-** CPUE of anglers by registration station in 1998. 1- Cathlamet, 2- Ranier/Weyerhauser, 3- Gleason, 4- Washougal, 5- The Fishery, 6- Bonneville Trailhead, 7- Maryhill/Bingen, 8- The Dalles, 9- Giles French, 10- Columbia Point, 11- Vernita, 12- Greenbelt.

## **SUMMARY**

The reduction in harvest from 1997 to 1998 can be attributed to a drop in effort. The level of participation prior to northern pikeminnow spawning has always been a very important factor in determining overall NPSRF harvest (Klaybor et al. 1993). Participation during this period of the 1998 NPSRF was well below mean 1991-97 levels, most likely a result of very high spring flows in both the Columbia and Snake rivers which made northern pikeminnow more difficult to locate. Water conditions and angling limitations were consistent in 1998 with the 1997 season (Petersen et al. 1997). Participation levels throughout the 1998 NPSRF did not approach mean 1991-97 levels. Since returning anglers catch approximately eight northern pikeminnow per angler day, continued measures must be taken to recruit and educate new anglers in order for the NPSRF to take full advantage of this success. Past years experience suggests that the NPMP may best accomplish this through the use of newspaper advertising and by strengthening incentive and/or promotional activities.

The trend in weekly CPUE for the 1998 NPSRF, as well as the mean CPUE for 1991-1997 showed an increase in CPUE throughout the season, especially toward the latter part of September and early October. Although effort declines considerably by this time, CPUE for this late portion of the season is greater than any other time period during the season. Efforts to increase participation during this time period may be more beneficial for increasing harvest than earlier in the season, especially during years with high spring flows.

## **RECOMMENDATIONS FOR THE 1999 SEASON**

1. Improve advertising and promotions to recruit additional anglers to the NPSRF.
2. Begin the 1999 NPSRF on May 3 (week 19), and continue through September 26 (week 38), 1999.
3. Retain the option to extend the NPSRF at selected stations if harvest and CPUE warrant.
4. Continue a telephone survey of non-returning anglers (20%) to estimate incidental salmonid catch.
5. Continue to implement hybrid registration stations and satellite sites as needed to increase cost efficiency.

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## **REPORT B**

### **Northern Pikeminnow Sport Reward Payments - 1998**

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February, 1999

## **INTRODUCTION**

The Pacific States Marine Fisheries Commission(PSMFC) provided fiscal services for payment of the northern pikeminnow sport rewards. Anglers registered and subsequently checked in their catch at the Washington Department of Wildlife field stations where they received a voucher for all eligible fish checked in. Standard vouchers were issued for all fish over 11 inches that were not tagged. The number of fish turned in was recorded on the voucher and verified by the creel clerk. Tagged fish received a special tagged voucher. Tagged vouchers were issued for each individual tagged fish turned in. The following sections summarize the vouchers paid this year.

## **VOUCHER PAYMENTS**

The vouchers were sent by the angler to our Sport Reward post office box in Oregon City. Vouchers were received and paid during the fishery from May through October. This year, rewards were paid on a tiered structure of from \$3.00 - \$5.00 per fish. Anglers received a reward of \$3.00 per fish for their first 100 fish, then \$4.00 per fish up to 400 fish. The reward went to \$5.00 per fish for all fish caught in excess of 400. The PSMFC maintained an accounting during the season by computer for all anglers submitting vouchers for payment to properly determine their tier payment level for all fish submitted for payment. A cut off date of November 15, 1997 was established as the final date vouchers needed to be postmarked to receive payment from PSMFC. Vouchers representing 107,664 fish were paid on standard vouchers representing rewards of \$432,760. A coupon good for one free \$3.00 reward was provided to anglers this season. The coupon could be used with one or more qualifying fish to obtain credit for one additional fish toward the tiered reward structure and an additional \$3 reward. A total of 1,180 coupons were redeemed during the season for a total value of \$3,540.

## **TAGGED VOUCHERS**

Tagged vouchers were sent to the Oregon Department of Fish and Wildlife(ODFW) post office box by the angler for verification. The angler attached the tag to the voucher in a small envelope provided at the check station. Verified tag vouchers were delivered to PSMFC for payment. Tag vouchers were paid at \$50 per tag and rejected tag vouchers were paid at the standard reward depending on the payment tier for that angler. A total of 206 tag vouchers were received for total payments of \$10,300 in 1998.

## **SPECIAL DRAWINGS & TOURNAMENTS**

A series of five special nine day tournaments were held from the upper river areas through Portland from June 19 – June 28, 1998 and in the lower river from July 17 - July 25, 1998. Prizes of \$500, \$250 and \$100 were paid for the three biggest northern pikeminnow caught, and merchandise was awarded by the radio station sponsors for each of the five tournaments. At mid season, six tags were drawn from all tags turned in through July 20, 1998. A prize of \$1,000 each was awarded to the

anglers whose tags were drawn. At the end of the season five tags were drawn from all tags turned in from July 21 through the end of the season. The five anglers were each awarded a prize of \$1,000. In addition one regular voucher from all vouchers turned in during the season was drawn and the angler was issued a special prize of \$5,000. Tournaments and drawing prizes issued for the year totaled \$25,350.

The attached table summarizes the payments, vouchers and tournament winnings during the 1998 season.

## **MISCELLANEOUS WORK**

All Internal Revenue Service Form 1099-Misc. statements were sent to the qualifying anglers for tax purposes the third week in January, 1999. Appropriate reports and copies were provided to the IRS.

## 1998 SPORT REWARD PAYMENTS SUMMARY

The following is a summary of the vouchers received and paid for the 1998 Season.

**TOTAL REWARD DOLLARS PAID: \$471,950**

|                                        |                | <u>\$ Amount</u> |
|----------------------------------------|----------------|------------------|
| Number of fish paid @ Tier 1 (\$3.00): | 35,956         | \$107,868        |
| Number of fish paid @ Tier 2 (\$4.00): | 33,648         | \$134,592        |
| Number of fish paid @ Tier 3 (\$5.00): | <u>38,060</u>  | <u>\$190,300</u> |
| <b>Totals:</b>                         | <b>107,664</b> | <b>\$432,760</b> |

|                   |       |                  |
|-------------------|-------|------------------|
| Tags Returned:    | 206   | <b>\$ 10,300</b> |
| Coupons Returned: | 1,180 | <b>\$ 3,540</b>  |

Tournament winnings (including all drawings): **\$ 25,350**

|                            |                  |                                         |              |
|----------------------------|------------------|-----------------------------------------|--------------|
| Number of anglers @ Tier 1 | <b>1,558</b>     | Number of anglers with 10 fish or less: | <b>1,145</b> |
| Number of anglers @ Tier 2 | <b>132</b>       | Number of anglers with 2 fish or less:  | <b>622</b>   |
| Number of anglers @ Tier 3 | <u><b>66</b></u> |                                         |              |
| Number of separate anglers | <b>1,756</b>     | Number of Predacards Issued:            | <b>815</b>   |

| <u>TOP TEN ANGLERS</u> | <u>Total Fish</u> | <u>Tags/Tournaments</u> | <u>BALANCE</u>   |
|------------------------|-------------------|-------------------------|------------------|
| 1. MILLER,EARL D       | 2,564             | 4/ \$ 500               | \$ 15,170        |
| 2. GARRICK, TERRY W    | 2,434             | 6/ \$ 0                 | \$ 13,970        |
| 3. DOUGLAS,THOMAS J    | 2,334             | 1/ \$ 0                 | \$ 13,216        |
| 4. PAPST,THOMAS H      | 1,905             | 3/ \$ 0                 | \$ 11,175        |
| 5. LEITCH, GARY L      | 1,663             | 3/ \$ 0                 | \$ 9,965         |
| 6. SCHUR,KENYON E      | 1,503             | 6/ \$ 0                 | \$ 9,315         |
| 7. SHIMP,LARRY B       | 424               | 0/ \$5,000              | \$ 8,620         |
| 8. HOLSCHER,ERIC G     | 1,264             | 2/ \$ 0                 | \$ 7,912         |
| 9. REAGAN, PATRICK L   | 1,025             | 2/ \$1,000              | \$ 7,721         |
| 10. MUCK,JAMES E       | <u>1,140</u>      | <u>1/ \$ 250</u>        | <u>\$ 7,496</u>  |
| <b>TOTALS:</b>         | <b>20,273</b>     | <b>28/ \$6,750</b>      | <b>\$104,560</b> |

# **REPORT C**

## **Controlled Angling for Northern Pikeminnow at the Four Lower Columbia River Dams in 1998**

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**1998 Annual Report**

## **ACKNOWLEDGMENTS**

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Personnel from the U.S. Army Corps of Engineers assisted in providing access for the crews to work at Corps dams: Jim Kuskie and Dennis Schwartz (Bonneville Dam); Bob Cordie (The Dalles and John Day dams); and Brad Eby (McNary Dam).

Funding for this work was provided by the Bonneville Power Administration (John Skidmore, COTR) through the Pacific States Marine Fisheries Commission (Russell Porter, Program Manager) with coordination from the Columbia Basin Fish and Wildlife Authority (Frank Young, Program Manager).

## **ABSTRACT**

Controlled angling for northern pikeminnow *Ptychocheilus oregonensis* (Npm) was conducted for the ninth consecutive year at Bonneville, The Dalles, John Day, and McNary dams from June to October 1998. A total catch of 3,680 Npm was produced in 3,553 angler·hr of effort, for a 1.1 catch per angler hour (CPAH). Compared to 1997, both total effort and total catch increased; CPAH remained at 1.1. Very limited (2 d) boat angling at McNary Dam was no more productive than angling from the dam in the same week. There was no volunteer angling this year. Trends in annual catch and CPAH generally show declines from 1991 through 1995, with some variability but little or no trend in years since. Bycatch in 1998 was only 3.3% of the total catch; no salmonids were caught.

## INTRODUCTION

The eight hydroelectric dams and their reservoirs on the lower Columbia and Snake rivers provide predatory fishes with favorable conditions for feeding on juvenile salmonids (Raymond 1979; Rieman et al. 1991), many populations of which are now protected by Endangered Species Act listings. A principal predator – northern pikeminnow *Ptychocheilus oregonensis* – is being controlled in the lower Columbia and Snake rivers by fisheries implemented through the Northern Pikeminnow Management Program.

Angling at mainstem dams by crews of technicians has been employed as one of the control methods since the Program's inception in 1991 (Vigg et al. 1990; Beaty et al. 1993; Parker et al. 1993; CRITFC 1994, 1995; Collis et al. 1997). Other existing fisheries include an extensive sport reward fishery, conducted by the Washington Department of Fish and Wildlife, and a small gillnet fishery implemented by the Columbia Basin treaty tribes at selected sites, primarily in Bonneville reservoir. The continuing mission of the dam angling fishery is to efficiently remove northern pikeminnow from areas near dams using hook and line angling, while keeping the catch of incidental species, particularly salmonids, at a minimum.

## METHODS

As in 1998, dam angling was conducted only at the four U.S. Army Corps of Engineer dams on the lower Columbia River (Figure C-1). Our angling was confined to the boat-restricted zones (BRZ) at these dams, with most effort focused in the tailraces.

The angling season was from June through October with differences among dams. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) crew began work at McNary Dam in June, whereas the other crews began fishing at Bonneville, The Dalles, and John Day dams in early July, when their site-specific gillnet fisheries ceased (Fig. C-1). Although the CTUIR crew fished exclusively at McNary, the crews from The Confederated Tribes of Warm Springs Reservation of Oregon and from The Yakama Indian Nation moved about among the three lower dams to identify and to exploit productive fishing sites. Fishing continued well into October at The Dalles and John Day dams to explore late-season success during the outmigration of juvenile American shad (*Alosa sapidissima*).

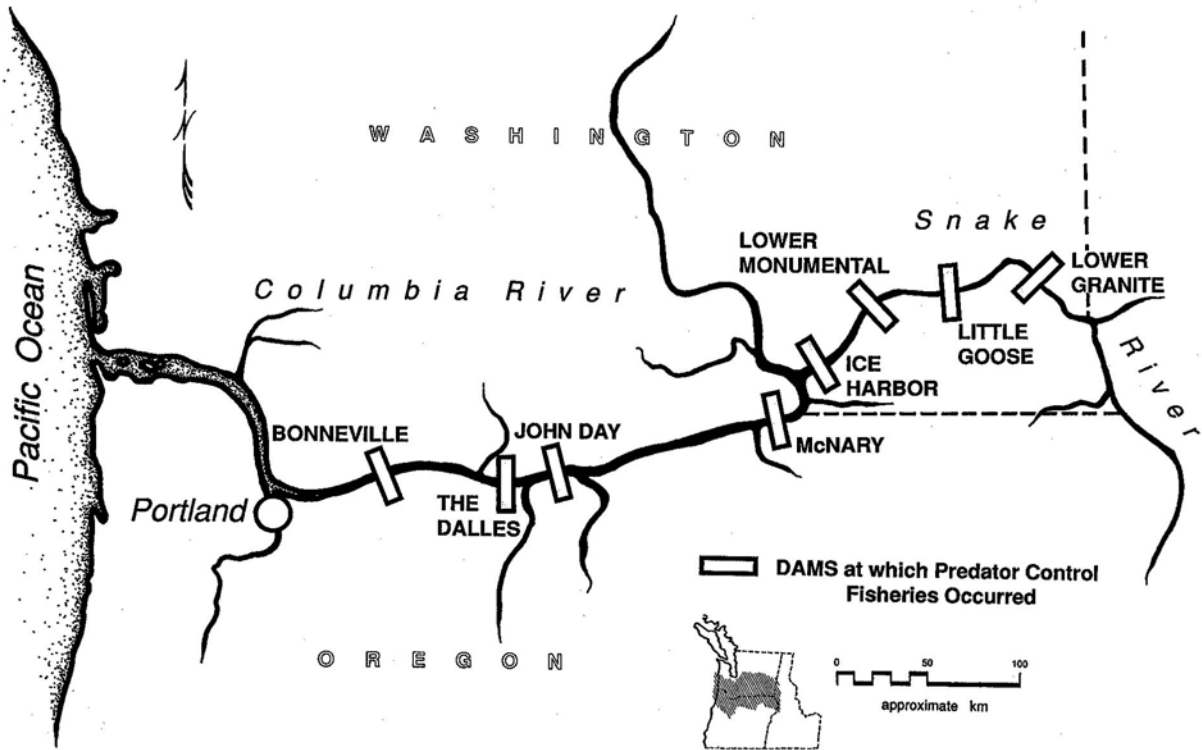
There was no volunteer angling in 1998, and boat angling in the Boat Restricted Zone was limited to two days at McNary Dam.

Field procedures were essentially the same as in years past: anglers fished the most favorable daytime and/or nighttime hours, explored and exploited fishing sites as conditions (e.g., spill)



changed and success varied, and used their choice of baits/lures and angling techniques. Anglers were encouraged to experiment and to innovate.

Data were collected initially on the handheld electronic data recorders used in previous years (Parker et al. 1993), although most crews switched to paper data forms as their electronic systems failed during the season. Electronic data were transmitted via modem to the CRITFC host computer in Portland, and paper data were transmitted to us via fax. Then we transferred or entered the data into spreadsheet (MS Excel) and database (MS Access) files and summarized them for weekly reports.



**Figure C-1.** Dams at which controlled angling for NPM has been conducted between 1991 and 1998.

## RESULTS AND DISCUSSION

In 1998 angling crews caught 3,680 predator-size northern pikeminnow in 3,553 hours of fishing, for a seasonal catch per angler hour (CPAH) of 1.1 (Table C-1). Both catch and effort increased slightly from 1997 (5% and 10%, respectively), and CPAH was stable. Substantial increases in effort, catch, and CPAH at McNary Dam offset declines at the other three dams. Nevertheless, catch rates (CPAH) were still lowest at McNary Dam (0.8) and highest (1.5) at Bonneville Dam (Table C-1). More effort could have been deployed at Bonneville Dam to take advantage of the higher productivity (i.e., CPAH) there. Late-season fishing at The Dalles and John Day dams was relatively productive (Table C-2) and produced fish that were considerably larger than those caught earlier in the season (as noted in photos and observations of anglers).

The success of two days (8/19 and 8/20) of boat angling in the tailrace BRZ at McNary Dam was similar to that of dam-based angling at McNary Dam during the same week (statistical week 34). Boat anglers caught 13 Npm (0.35 CPAH); dam-based anglers caught 25 Npm (0.33 CPAH).

Greater than 99% of the catch was taken from the tailraces of the dams; hence, catches listed for each dam (Table C-1) were largely from the reservoir or river reach downstream of the dam. Distribution of catch among Bonneville Dam tailrace and the four reservoirs is provided in Table C-3.

Trends in annual catch and CPAH – for individual dams and for all dams – show similar patterns since 1991: declining to 1995 and remaining at relatively low levels since then (Fig. C-2). In general, total catches have varied within the range of 3,500 to 5,200 since 1995, and seasonal CPAHs have tended to be slightly above 1.0 (Fig. C-2, Table C-1). Total CPAH for all dams has been maintained at levels > 1.0 since 1995 (Fig. C-2) in part through reduced effort (Table C-2). Exceptions to the general CPAH patterns are evident for John Day Dam (variable between 1.0 and 2.0 throughout the 8-yr period) and McNary Dam (typically below 1.0 and rather variable).

These general patterns suggest that the predator “populations” we are exploiting were “fished down” during the first four management years (1991-94), and that since then our efforts (i.e., those of all fisheries) have been maintaining the populations at some lower – but dynamic – equilibrium level. If true, we might expect to see these same general levels of catch and CPAH continuing (with some variability) indefinitely into the future, given similar levels of effort and vulnerability. Interestingly, it took only two years (1991-92) to achieve the same effect (i.e., relatively low and stable catch and CPAH) at the Snake R. dams (Table C-2), suggesting that predator “populations” in those reservoirs were smaller and more vulnerable to exploitation than those at lower Columbia R. dams. Higher flow and spill conditions in recent years probably also have limited the fishery’s success.

The dam angling fishery remains relatively “clean” of incidental impacts. Incidental species composed only 3.3% of the total 1998 catch, down from 6.8% in 1997 (Table C-4). No salmonids were caught this year. Prevalence of incidentals was highest in the catch at The Dalles (8.0%) and lowest at John Day (0.7%).

**Table C-1.** Northern pikeminnow (NPm) catch, effort (angler hours), and catch per angler hour (CPAH) for dam-based and boat angling (combined), by statistical week at Columbia River dams in 1998. First and last fishing days are shown in parentheses beside dam names. Rounding may cause some apparent discrepancies.

| Statistical Week |                     | Bonneville (7/6-9/29) |              |            | The Dalles (7/7-10/21) |              |            | John Day (7/6-10/21) |              |            | McNary (6/10-8/20) |               |           |
|------------------|---------------------|-----------------------|--------------|------------|------------------------|--------------|------------|----------------------|--------------|------------|--------------------|---------------|-----------|
| No.              | Dates               | NPm                   | Effort       | CPAH       | NPm                    | Effort       | CPAH       | NPm                  | Effort       | CPAH       | NPm                | Effort        | CPAH      |
| 23               | 6/01/98 – 6/07/98   | –                     | 0            | –          | –                      | 0            | –          | –                    | 0            | –          | –                  | 0             | –         |
| 24               | 6/08/98 – 6/14/98   | –                     | 0            | –          | –                      | 0            | –          | –                    | 0            | –          | 5                  | 58.3          | .1        |
| 25               | 6/15/98 – 6/21/98   | –                     | 0            | –          | –                      | 0            | –          | –                    | 0            | –          | 37                 | 71.2          | .5        |
| 26               | 6/22/98 – 6/28/98   | –                     | 0            | –          | –                      | 0            | –          | –                    | 0            | –          | 107                | 105.1         | 1.0       |
| 27               | 6/29/98 – 7/05/98   | –                     | 0            | –          | –                      | 0            | –          | –                    | 0            | –          | 131                | 114.6         | 1.1       |
| 28               | 7/06/98 – 7/12/98   | 133                   | 47.6         | 2.8        | 221                    | 57.3         | 3.9        | 69                   | 104.9        | .7         | 169                | 187.0         | .9        |
| 29               | 7/13/98 – 7/19/98   | 296                   | 111.3        | 2.7        | 42                     | 20.3         | 2.1        | 36                   | 45.8         | .8         | 224                | 195.4         | 1.1       |
| 30               | 7/20/98 – 7/26/98   | 148                   | 69.3         | 2.1        | 102                    | 66.6         | 1.5        | 72                   | 54.6         | 1.3        | 163                | 151.6         | 1.1       |
| 31               | 7/27/98 – 8/02/98   | 88                    | 34.4         | 2.6        | 26                     | 17.4         | 1.5        | 101                  | 109.2        | .9         | 109                | 160.7         | .7        |
| 32               | 8/03/98 – 8/09/98   | 59                    | 52.0         | 1.1        | 26                     | 43.3         | .6         | 18                   | 69.4         | .3         | 107                | 141.2         | .8        |
| 33               | 8/10/98 – 8/16/98   | 49                    | 116.3        | .4         | 11                     | 32.9         | .3         | 90                   | 76.0         | 1.2        | 16                 | 57.6          | .3        |
| 34               | 8/17/98 – 8/23/98   | 16                    | 51.1         | .3         | 43                     | 74.8         | .6         | 52                   | 67.5         | .8         | 38                 | 112.6         | .3        |
| 35               | 8/24/98 – 8/30/98   | –                     | 0            | –          | 132                    | 115.2        | 1.1        | 60                   | 42.3         | 1.4        | –                  | 0             | –         |
| 36               | 8/31/98 – 9/06/98   | –                     | 0            | –          | 20                     | 115.4        | .2         | 1                    | 36.0         | .0         | –                  | 0             | –         |
| 37               | 9/07/98 – 9/13/98   | 2                     | 22.0         | .1         | 4                      | 9.6          | .4         | 10                   | 6.4          | 1.6        | –                  | 0             | –         |
| 38               | 9/14/98 – 9/20/98   | –                     | 0            | –          | 36                     | 36.3         | 1.0        | 107                  | 41.4         | 2.6        | –                  | 0             | –         |
| 39               | 9/21/98 – 9/27/98   | 14                    | 16.1         | .9         | 19                     | 48.3         | .4         | 106                  | 60.1         | 1.8        | –                  | 0             | –         |
| 40               | 9/28/98 – 10/04/98  | 24                    | 18.0         | 1.3        | 25                     | 22.3         | 1.1        | 34                   | 38.9         | .9         | –                  | 0             | –         |
| 41               | 10/05/98 – 10/11/98 | –                     | 0            | –          | 31                     | 53.3         | .6         | 64                   | 56.8         | 1.1        | –                  | 0             | –         |
| 42               | 10/12/98 – 10/18/98 | –                     | 0            | –          | 55                     | 38.4         | 1.4        | 125                  | 88.5         | 1.4        | –                  | 0             | –         |
| 43               | 10/19/98 – 10/25/98 | –                     | 0            | –          | 7                      | 6.4          | 1.1        | 0                    | 4.7          | .0         | –                  | 0             | –         |
| <b>Total:</b>    |                     | <b>829</b>            | <b>538.0</b> | <b>1.5</b> | <b>800</b>             | <b>757.6</b> | <b>1.1</b> | <b>945</b>           | <b>902.3</b> | <b>1.0</b> | <b>1106</b>        | <b>1355.2</b> | <b>.8</b> |

**Table C-2.** Northern pikeminnow (NPm) catch, effort, and catch per angler hour (CPAH) for hook-and-line angling at Columbia and Snake river dams, 1991-1998.

|              |             | COLUMBIA RIVER DAMS |            |            |            |            | SNAKE RIVER DAMS |            |              |               |            | GRAND<br>TOTALS |
|--------------|-------------|---------------------|------------|------------|------------|------------|------------------|------------|--------------|---------------|------------|-----------------|
|              |             | Bonneville          | The Dalles | John Day   | McNary     | Season     | Ice Harbor       | Lower Mon. | Little Goose | Lower Granite | Season     |                 |
| 1991         | NPm         | 8,131               | 3,674      | 5,004      | 8,348      | 25,157     | 1,486            | 3,313      | 4,915        | 4,480         | 14,194     | 39,351          |
|              | Effort      | 2,621               | 1,333      | 2,816      | 3,416      | 10,186     | 2,052            | 2,471      | 2,140        | 2,448         | 9,112      | 19,298          |
|              | <i>CPAH</i> | <i>3.1</i>          | <i>2.8</i> | <i>1.8</i> | <i>2.4</i> | <i>2.5</i> | <i>.7</i>        | <i>1.3</i> | <i>2.3</i>   | <i>1.8</i>    | <i>1.6</i> | <i>2.0</i>      |
| 1992         | NPm         | 4,814               | 7,561      | 3,427      | 7,297      | 23,099     | 278              | 475        | 1,664        | 2,352         | 4,769      | 27,868          |
|              | Effort      | 1,781               | 2,496      | 2,775      | 2,523      | 9,575      | 298              | 943        | 3,062        | 2,880         | 7,183      | 16,758          |
|              | <i>CPAH</i> | <i>2.7</i>          | <i>3.0</i> | <i>1.2</i> | <i>2.9</i> | <i>2.4</i> | <i>.9</i>        | <i>.5</i>  | <i>.5</i>    | <i>.8</i>     | <i>.7</i>  | <i>1.7</i>      |
| 1993         | NPm         | 5,836               | 2,712      | 2,509      | 5,148      | 16,205     | 122              | 105        | 100          | 678           | 1,005      | 17,210          |
|              | Effort      | 1,991               | 1,992      | 1,561      | 2,780      | 8,324      | 404              | 396        | 378          | 734           | 1,911      | 10,235          |
|              | <i>CPAH</i> | <i>2.9</i>          | <i>1.4</i> | <i>1.6</i> | <i>1.9</i> | <i>1.9</i> | <i>.3</i>        | <i>.3</i>  | <i>.3</i>    | <i>.9</i>     | <i>.5</i>  | <i>1.7</i>      |
| 1994         | NPm         | 5,238               | 4,393      | 3,083      | 2,556      | 15,270     | 23               | 27         | 92           | 685           | 827        | 16,097          |
|              | Effort      | 2,232               | 2,064      | 1,649      | 2,966      | 8,910      | 141              | 55         | 203          | 692           | 1,092      | 10,002          |
|              | <i>CPAH</i> | <i>2.3</i>          | <i>2.1</i> | <i>1.9</i> | <i>.9</i>  | <i>1.7</i> | <i>.2</i>        | <i>.5</i>  | <i>.5</i>    | <i>1.0</i>    | <i>.8</i>  | <i>1.6</i>      |
| 1995         | NPm         | 2,422               | 409        | 950        | 1,002      | 4,783      | 9                | 1          | 186          | 320           | 516        | 5,299           |
|              | Effort      | 2,823               | 920        | 777        | 1,670      | 6,190      | 80               | 38         | 183          | 798           | 1,099      | 7,289           |
|              | <i>CPAH</i> | <i>.9</i>           | <i>.4</i>  | <i>1.2</i> | <i>.6</i>  | <i>0.8</i> | <i>.1</i>        | <i>.0</i>  | <i>1.0</i>   | <i>.4</i>     | <i>.5</i>  | <i>.7</i>       |
| 1996         | NPm         | 1,135               | 623        | 1,278      | 2,184      | 5,220      | 0                | 27         | 96           | 112           | 235        | 5,455           |
|              | Effort      | 693                 | 338        | 618        | 1,372      | 3,022      | 56               | 75         | 206          | 307           | 645        | 3,666           |
|              | <i>CPAH</i> | <i>1.6</i>          | <i>1.8</i> | <i>2.1</i> | <i>1.6</i> | <i>1.7</i> | <i>0</i>         | <i>.4</i>  | <i>.5</i>    | <i>.4</i>     | <i>.4</i>  | <i>1.5</i>      |
| 1997         | NPm         | 1,086               | 1,084      | 1,086      | 263        | 3,519      | --               | --         | --           | --            | --         | 3,519           |
|              | Effort      | 784                 | 826        | 857        | 746        | 3,214      | 0                | 0          | 0            | 0             | 0          | 3,214           |
|              | <i>CPAH</i> | <i>1.4</i>          | <i>1.3</i> | <i>1.3</i> | <i>.4</i>  | <i>1.1</i> | <i>--</i>        | <i>--</i>  | <i>--</i>    | <i>--</i>     | <i>--</i>  | <i>1.1</i>      |
| 1998         | NPm         | 829                 | 800        | 945        | 1,106      | 3,680      | --               | --         | --           | --            | --         | 3,680           |
|              | Effort      | 538                 | 758        | 902        | 1,355      | 3,553      | 0                | 0          | 0            | 0             | 0          | 3,553           |
|              | <i>CPAH</i> | <i>1.5</i>          | <i>1.1</i> | <i>1.0</i> | <i>.8</i>  | <i>1.1</i> | <i>--</i>        | <i>--</i>  | <i>--</i>    | <i>--</i>     | <i>--</i>  | <i>1.1</i>      |
| <b>Total</b> | NPm         | 29,491              | 21,256     | 18,282     | 27,904     | 96,933     | 1,918            | 3,948      | 7,053        | 8,627         | 21,546     | 118,479         |
|              | Effort      | 13,463              | 10,727     | 11,955     | 16,828     | 52,975     | 3,031            | 3,979      | 6,172        | 7,859         | 21,041     | 74,016          |
|              | <i>CPAH</i> | <i>2.2</i>          | <i>2.0</i> | <i>1.5</i> | <i>1.7</i> | <i>1.8</i> | <i>.6</i>        | <i>1.0</i> | <i>1.1</i>   | <i>1.1</i>    | <i>1.0</i> | <i>1.6</i>      |

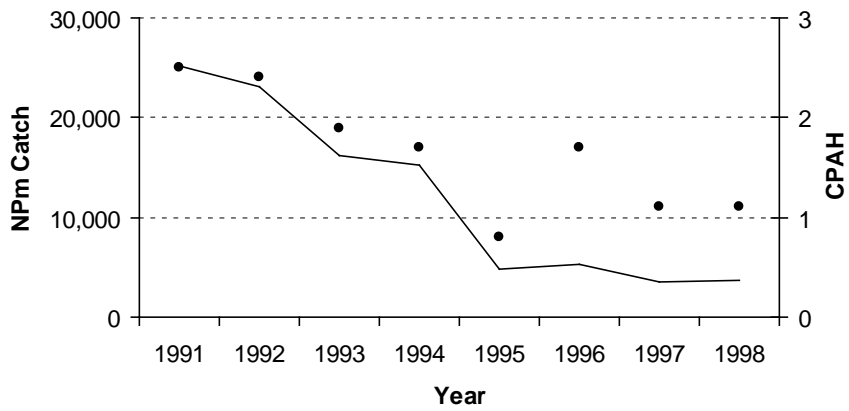
**Table C-3.** Distribution of 1998 dam angling catch of northern pikeminnow (NPM) by river reach or reservoir.

| Reach or Reservoir   | NPM Catch    |
|----------------------|--------------|
| Bonneville Tailrace  | 814          |
| Bonneville Reservoir | 796          |
| The Dalles Reservoir | 964          |
| John Day Reservoir   | 1,106        |
| McNary Reservoir     | 0            |
| <b>TOTAL</b>         | <b>3,680</b> |

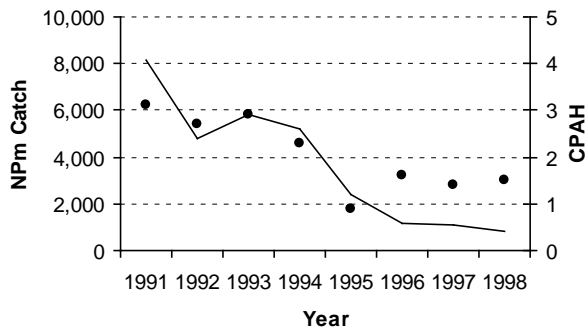
**Table C-4.** NPM catch and incidental catch for the dam angling fishery in 1998, by dam.

| Dam          | NPM Catch    | Incidental Catch |          |           |           |           |          |          |          | % of Total Catch |
|--------------|--------------|------------------|----------|-----------|-----------|-----------|----------|----------|----------|------------------|
|              |              | Salmonids        |          | Sturgeon  | Bass      | Catfish   | Walleye  | Shad     | Other    |                  |
| Juv.         | Adult        |                  |          |           |           |           |          |          |          |                  |
| Bonneville   | 829          | 0                | 0        | 11        | 1         | 1         | 0        | 2        | 0        | 1.8              |
| The Dalles   | 800          | 0                | 0        | 17        | 27        | 21        | 3        | 0        | 2        | 8.0              |
| John Day     | 945          | 0                | 0        | 0         | 0         | 4         | 0        | 0        | 3        | .7               |
| McNary       | 1,106        | 0                | 0        | 8         | 1         | 23        | 0        | 0        | 0        | 2.8              |
| <b>Total</b> | <b>3,680</b> | <b>0</b>         | <b>0</b> | <b>36</b> | <b>29</b> | <b>49</b> | <b>3</b> | <b>2</b> | <b>5</b> | <b>3.3</b>       |

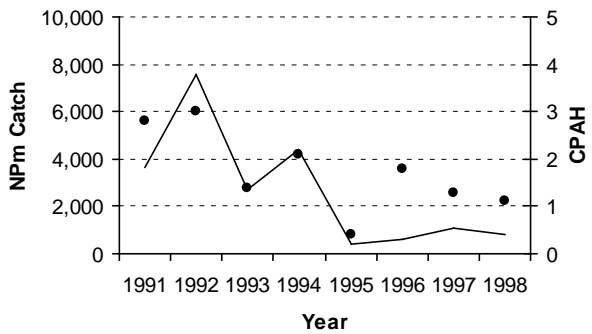
### All Columbia R. Dams



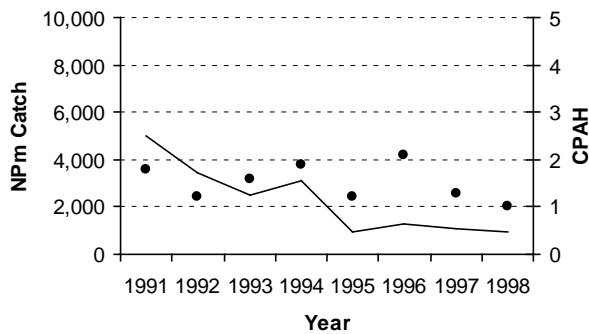
#### Bonneville



#### The Dalles



#### John Day



#### McNary

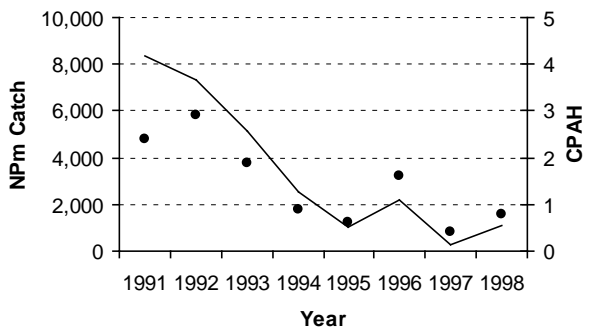


Figure C-2. Trends in annual NPM catch (lines) and CPAH (dots) for Columbia R. dams, 1991-98.

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# **REPORT D**

**Site-specific Gillnetting for Northern Pikeminnow  
in the Lower Columbia River in 1998**

**prepared by**

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**1998 Annual Report**

## ACKNOWLEDGEMENTS

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## ABSTRACT

Four crews fished small-meshed gillnets at 11 locations in Bonneville Reservoir and other areas of the lower Columbia River in 1998 as part of the on-going program to control the abundance of northern pikeminnow (NPM) and their predation on juvenile salmonids *Oncorhynchus* spp.. In the May-June season, a total of 3,035 NPM were caught in a total of 1,270 net-hr of effort, for a catch-per-net-hour (CPNH) of 2.4. Compared to 1997, catch increased 7% despite a 21% reduction in effort, for a 33% improvement in CPNH. Drano Lake and the mouth of the Klickitat River again produced most of the catch (> 1,100 NPM each). Incidental species composed 52.2% of the total catch, a reduction from 64% in 1997. Suckers *Catostomus* spp. accounted for most of the incidentals caught; 10 juvenile and 69 adult salmon and steelhead composed 1.2% of the catch. I recommend continuing to focus effort at Drano Lake and the Klickitat River in 1999, plus investing more effort at Tanner Creek (2.7 CPNH in 1998).

## INTRODUCTION

Implemented in 1990, the Northern Pikeminnow Management Program seeks to increase survival of juvenile salmonids by controlling the abundance of predaceous-sized (e.g., > 250 mm FL) northern pikeminnow *Ptychocheilus oregonensis* (NPM) in the lower Columbia and Snake rivers. One component of this program, the site-specific gillnet fishery, was first tested in 1993 and since then has been employed to target concentrations of predators in selected areas, particularly near hatchery-release points in Bonneville Reservoir (Collis et al. 1995a, 1995b, 1997). The objective of the fishery again in 1998 was to catch NPM as effectively and efficiently as possible while keeping incidental impacts to salmonids to a minimum. The NPT, CTWS, and YIN were contracted to conduct the fishing; the Columbia River Inter-Tribal Fish Commission supported their work through procurement, coordination, data management, and reporting.

## METHODS

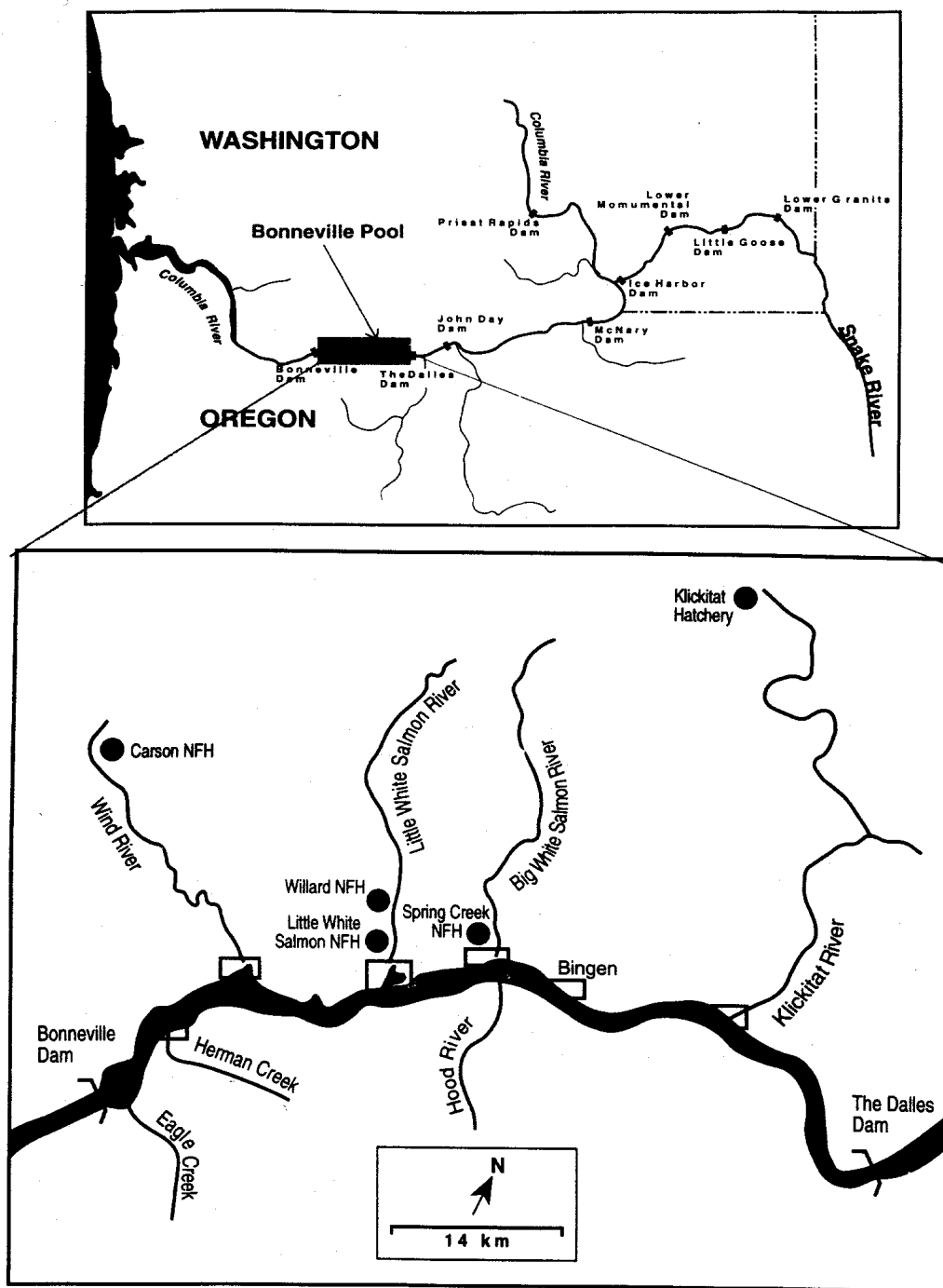
Four boats and crews fished small-meshed gillnets<sup>1</sup> at 11 locations in the lower Columbia River between the tailrace of Bonneville Dam and the mouth of the John Day R. (Fig. D-1). Effort was focussed in the most productive locations. The fishery commenced in early May, when contracts were in place and preparations were complete, and ended late in June as sockeye counts at Bonneville were increasing.

Operational criteria to reduce impacts to salmonids were essentially the same as in the previous two years (Collis et al. 1995b, 1997). For example, fishing was conducted only at night, and nets were fished only about 45 minutes to expedite the release of salmonids and to improve the survival of those that were incidentally caught. Each crew fished three to five nets simultaneously, pulling, checking, and resetting the nets in a regular rotation.

Fishing effort for each net was measured from the time the net was set until it was pulled. Fork lengths were recorded on up to three NPM taken from each net. Numbers of salmonids (by species) and white sturgeon *Acipenser transmontanus* were recorded for each net set based on their condition at release. Numbers (but not condition) of other gamefishes were recorded by species, and numbers and coarse identifications (e.g., “suckers” for *Catostomous* spp.) of nongame fishes were recorded as a note. Data were recorded on paper forms that were faxed to the CRITFC office in Portland. CRITFC then entered the data into spreadsheet (MS Excel) and database (MS Access) computer files and summarized them for weekly reports that were submitted to the Program Coordinator.

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<sup>1</sup> Gillnets were 2.4 m deep by 45.6 m long with mesh of 4.4 cm and/or 5.1 cm bar measures.



**Figure D-1.** General locations of site-specific gillnetting in 1998. Tanner Cr. is to the left (downstream) of Bonneville Dam. Drano Lake is at the mouth of the Little White Salmon R.. Horsethief Lake is 6 km to the right (upstream) of The Dalles Dam, and the Deschutes River is 22 km upstream of The Dalles Dam. The John Day site is 2 km upstream of John Day Dam.

## RESULTS & DISCUSSION

In 1998, 3,035 Npm > 250mm FL were caught in 1,270 net hr of fishing, for a catch-per-net-hour (CPNH) of 2.4 (Table D-1). Relative to 1997, catch increased 7% despite a 21% reduction in effort, and CPNH improved by 33% (Table D-2). Bonneville Reservoir accounted for 93.8% of the Npm caught; Drano Lake and the Klickitat River (two locations within Bonneville Reservoir) together produced over 87% of the catch. These areas produced large catches (Table D-1), despite the removal of over 30,000 from Bonneville Reservoir by this fishery alone over the past six years (Table D-2).

**Table D-1.** Npm (>250mm FL) catch, effort, and catch per net hour (CPNH) by location, 1998.

| Area/Location                      | Npm<br>Catch | Effort<br>(net<br>hr) | CPN<br>H   |
|------------------------------------|--------------|-----------------------|------------|
| <b><i>Below Bonneville</i></b>     |              |                       |            |
| Tanner Cr.                         | 76           | 28.1                  | 2.7        |
| <b><i>Bonneville Reservoir</i></b> |              |                       |            |
| Herman Cr.                         | 43           | 39.6                  | 1.1        |
| Wind R.                            | 102          | 100.9                 | 1.0        |
| Drano Lake                         | 1,163        | 389.3                 | 3.0        |
| Spring Cr.                         | 11           | 18.7                  | .6         |
| Hood R.                            | 16           | 12.0                  | 1.3        |
| Bingen<br>Marina                   | 17           | 20.6                  | .8         |
| Klickitat R.                       | 1,495        | 538.4                 | 2.8        |
| <b><i>The Dalles Reservoir</i></b> |              |                       |            |
| Horsethief<br>Lake                 | 26           | 42.6                  | .6         |
| Deschutes R.                       | 85           | 65.3                  | 1.3        |
| <b><i>John Day Reservoir</i></b>   |              |                       |            |
| John Day R.                        | 1            | 14.7                  | .1         |
| <b><i>TOTAL</i></b>                | <b>3,035</b> | <b>1,270.1</b>        | <b>2.4</b> |

Incidental species composed 52.2% (3,325/6,372) of the total catch in 1998, a reduction from 64% in 1997 (Table D-3). Suckers (*Catostomus* spp.) again were the most commonly caught incidental species, accounting for roughly half of all incidentals. The 69 adult and 10 juvenile salmon and steelhead were 1.2% of the catch; 2 juveniles (undetermined species) and two adult steelhead are known to have been killed.

Next year (1999) it is recommend to continuing to focus effort at Drano Lake and the Klickitat River. Also, additional effort could be productively invested at Tanner Creek., where few hours were fished this year despite respectable productivity (CPNH = 2.7).

**Table D-2.** Northern pikeminnow catch, effort (net hr), and catch per net hour (CPNH) for the site-specific gillnet fishery, 1993-97.  
Rounding may cause some apparent discrepancies.

|              |               | Columbia River     |               |               |            |            |               | Snake River |                     |                 |                  |            | GRAN<br>D<br>TOTAL<br>(mean) |            |
|--------------|---------------|--------------------|---------------|---------------|------------|------------|---------------|-------------|---------------------|-----------------|------------------|------------|------------------------------|------------|
|              |               | Reservoirs         |               |               |            |            |               | Reservoirs  |                     |                 |                  |            |                              |            |
|              |               | Below<br>Bon'ville | Bon'ville     | The<br>Dalles | John Day   | McNary     | Season        | Ice Harbor  | Lwr Mon-<br>umental | Little<br>Goose | Lower<br>Granite | Season     |                              |            |
| 1993         | Catch         | –                  | 1,772         | –             | –          | –          | 1,772         | –           | –                   | –               | –                | –          | –                            | 1,772      |
|              | Effort        | 0                  | 394           | 0             | 0          | 0          | 394           | 0           | 0                   | 0               | 0                | 0          | 0                            | 394        |
|              | <i>CPN</i>    | –                  | <b>4.5</b>    | –             | –          | –          | <b>4.5</b>    | –           | –                   | –               | –                | –          | –                            | <b>4.5</b> |
|              | <i>H</i>      |                    |               |               |            |            |               |             |                     |                 |                  |            |                              |            |
| 1994         | Catch         | –                  | 8,890         | 5             | 42         | 10         | 8,947         | –           | 5                   | –               | 72               | 77         | 9,024                        |            |
|              | Effort        | 0                  | 1,195         | 18            | 43         | 67         | 1,323         | 0           | 17                  | 0               | 102              | 120        | 1,442                        |            |
|              | <i>CPN</i>    | –                  | <b>7.4</b>    | <b>.3</b>     | <b>1.0</b> | <b>.2</b>  | <b>6.8</b>    | –           | <b>.3</b>           | –               | <b>.7</b>        | <b>.6</b>  | <b>6.3</b>                   |            |
|              | <i>H</i>      |                    |               |               |            |            |               |             |                     |                 |                  |            |                              |            |
| 1995         | Catch         | 263                | 8,668         | 25            | 136        | 57         | 9,149         | 231         | 22                  | 22              | 60               | 335        | 9,484                        |            |
|              | Effort        | 166                | 1,844         | 19            | 139        | 45         | 2,214         | 112         | 26                  | 13              | 66               | 217        | 2,431                        |            |
|              | <i>CPN</i>    | <b>1.6</b>         | <b>4.7</b>    | <b>1.3</b>    | <b>1.0</b> | <b>1.3</b> | <b>4.1</b>    | <b>2.1</b>  | <b>.8</b>           | <b>1.7</b>      | <b>.9</b>        | <b>1.5</b> | <b>3.9</b>                   |            |
|              | <i>H</i>      |                    |               |               |            |            |               |             |                     |                 |                  |            |                              |            |
| 1996         | Catch         | 38                 | 5,822         | 232           | 63         | 11         | 6,166         | –           | –                   | –               | –                | –          | 6,166                        |            |
|              | Effort        | 35                 | 2,584         | 121           | 91         | 47         | 2,878         | 0           | 0                   | 0               | 0                | 0          | 2,878                        |            |
|              | <i>CPN</i>    | <b>1.1</b>         | <b>2.3</b>    | <b>1.9</b>    | <b>.7</b>  | <b>.2</b>  | <b>2.1</b>    | –           | –                   | –               | –                | –          | <b>2.1</b>                   |            |
|              | <i>H</i>      |                    |               |               |            |            |               |             |                     |                 |                  |            |                              |            |
| 1997         | Catch         | 1                  | 2,538         | 226           | 35         | 23         | 2,823         | –           | 8                   | –               | –                | 8          | 2,831                        |            |
|              | Effort        | 4                  | 1,296         | 172           | 84         | 28         | 1,583         | 0           | 25                  | 0               | 0                | 25         | 1,608                        |            |
|              | <i>CPN</i>    | <b>.2</b>          | <b>2.0</b>    | <b>1.3</b>    | <b>.4</b>  | <b>.8</b>  | <b>1.8</b>    | –           | <b>.3</b>           | –               | –                | <b>.3</b>  | <b>1.8</b>                   |            |
|              | <i>H</i>      |                    |               |               |            |            |               |             |                     |                 |                  |            |                              |            |
| 1998         | Catch         | 76                 | 2,847         | 111           | 1          | –          | 3,035         | –           | –                   | –               | –                | –          | 3,035                        |            |
|              | Effort        | 28                 | 1,119         | 108           | 15         | 0          | 1,271         | 0           | 0                   | 0               | 0                | 0          | 1,271                        |            |
|              | <i>CPN</i>    | <b>2.7</b>         | <b>2.5</b>    | <b>1.0</b>    | <b>.1</b>  | –          | <b>2.4</b>    | –           | –                   | –               | –                | –          | <b>2.4</b>                   |            |
|              | <i>H</i>      |                    |               |               |            |            |               |             |                     |                 |                  |            |                              |            |
| <b>Total</b> | <b>Catch</b>  | <b>378</b>         | <b>30,537</b> | <b>599</b>    | <b>277</b> | <b>101</b> | <b>31,892</b> | <b>231</b>  | <b>35</b>           | <b>22</b>       | <b>132</b>       | <b>420</b> | <b>32,312</b>                |            |
|              | <b>Effort</b> | <b>233</b>         | <b>8,433</b>  | <b>438</b>    | <b>373</b> | <b>186</b> | <b>9,663</b>  | <b>112</b>  | <b>68</b>           | <b>13</b>       | <b>168</b>       | <b>362</b> | <b>10,025</b>                |            |
|              | <b>CPNH</b>   | <b>1.6</b>         | <b>3.6</b>    | <b>1.4</b>    | <b>.7</b>  | <b>.5</b>  | <b>3.3</b>    | <b>2.1</b>  | <b>.5</b>           | <b>1.7</b>      | <b>.8</b>        | <b>1.6</b> | <b>3.2</b>                   |            |

**Table D-3.** Species composition of the site-specific gillnet fishery catch in 1998. Condition codes for salmonids: 1 = minimal injury, certain to survive; 2 = moderate injury, may or may not survive; 3 = dead, nearly dead, or certain to die.

| Species                                                       |                               | No.       | Species                                 | No.          |                                                   |     |
|---------------------------------------------------------------|-------------------------------|-----------|-----------------------------------------|--------------|---------------------------------------------------|-----|
| <b><i>Ptychocheilus oregonensis</i> (northern pikeminnow)</b> | ≥ 250mm                       | 3,035     | <b>Game fishes</b>                      |              |                                                   |     |
|                                                               | < 250 mm                      | 12        |                                         |              |                                                   |     |
| <b><i>Oncorhynchus</i> spp. (salmon and steelhead)</b>        | <u>Condition</u>              |           |                                         |              | <i>Acipenser transmontanus</i> (white sturgeon)   | 926 |
|                                                               | Juveniles (undetermined spp.) |           |                                         |              | <i>Alosa sapidissima</i> (American shad)          | 235 |
|                                                               | 1                             | 8         |                                         |              | <i>Stizostedion vitreum</i> (walleye)             | 76  |
|                                                               | 2                             | 0         |                                         |              | <i>Micropterus</i> spp. (bass)                    | 53  |
|                                                               | 3                             | 2         |                                         |              | <i>Ictalurus</i> spp. (catfish/bullhead)          | 22  |
| Adults                                                        |                               |           |                                         |              | <i>Prosopium williamsoni</i> (mountain whitefish) | 19  |
| <i>O. tshawytscha</i> (chinook)                               | 1                             | 38        |                                         |              | <i>Salvelinus</i> spp. (char)                     | 9   |
|                                                               | 2                             | 4         |                                         |              | <i>O. mykiss</i> (rainbow trout)                  | 4   |
|                                                               | 3                             | 0         | <i>Pomoxis</i> spp. (crappie)           | 4            |                                                   |     |
| <i>O. mykiss</i> (steelhead)                                  | 1                             | 18        | <b>Non-game fishes</b>                  |              |                                                   |     |
|                                                               | 2                             | 7         | <i>Catostomus</i> spp. (suckers)        | 1,745        |                                                   |     |
|                                                               | 3                             | 2         | Cyprinids (carp, peamouth, chiselmouth) | 143          |                                                   |     |
| <i>O. nerka</i> (sockeye)                                     |                               | 0         | <b>Unidentified non-salmonid</b>        | 10           |                                                   |     |
| <b>Total Salmon and Steelhead</b>                             |                               | <b>79</b> | <b>Total Game and Non-game</b>          | <b>3,246</b> |                                                   |     |
|                                                               |                               |           | <b>Total Catch</b>                      | <b>6,372</b> |                                                   |     |



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# **REPORT E**

Development of a Systemwide Predator Control Program: Fisheries Evaluation

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## ABSTRACT

Predator control fisheries aimed at reducing predation on juvenile salmonids by northern pikeminnow *Ptychocheilus oregonensis* were implemented for the eighth consecutive year in the mainstem Columbia and Snake rivers. We report on (1) northern pikeminnow exploitation rate and catch rate of incidentally-harvested fishes among the three major management fisheries in 1998, (2) estimated reductions in predation on juvenile salmonids since implementation of the fisheries, and (3) variation in relative year-class strength of northern pikeminnow.

Systemwide exploitation of northern pikeminnow  $\geq 250$  mm fork length was 11.1% for sport-reward, 0.1% for dam-angling, and 0.3% for site-specific gill-net fisheries. Reservoir-specific exploitation ranged from zero in John Day, Lower Monumental, and Little Goose reservoirs to 13.6% in McNary Reservoir. Incidental catch was 31.1% for sport-reward anglers targeting northern pikeminnow, 3.1% in the dam-angling fishery, and 52.4% in the gill-net fishery. Northern pikeminnow  $<250$  mm, other cyprinids, smallmouth bass, catostomids, and white sturgeon were the most common incidentally-caught fish, whereas salmonids made up 1.1% of the incidental catch for all fisheries combined. The proportion of predator-sized ( $\geq 250$  mm fork length) northern pikeminnow relative to the total number of northern pikeminnow harvested was highest in the dam-angling (100.0%) and gillnet (99.6%) fisheries and lowest in the sport-reward fishery (80.0%).

If exploitation rates remain similar to mean 1991-1998 levels, we estimate that potential predation by northern pikeminnow on juvenile salmonids in 1999 will be approximately 70% of predation levels prior to the implementation of removal fisheries. Further reductions in predation will be minimal unless exploitation in future years exceeds levels from 1994-1998.

## INTRODUCTION

The goal of the Northern Pikeminnow Management Program (NPMP) is to reduce mainstem mortality of juvenile salmonids attributed to predation by northern pikeminnow *Ptychocheilus oregonensis*, known as northern squawfish prior to 1998 (Nelson et al. 1998), in the lower Columbia Basin. We established baseline levels of predation and described northern pikeminnow population characteristics prior to the implementation of sustained predator control fisheries by estimating northern pikeminnow abundance, consumption, and predation in Columbia River reservoirs in 1990 (Vigg et al. 1990), Snake River reservoirs in 1991 (Ward et al. 1993), and the unimpounded lower Columbia River downstream from Bonneville Dam in 1992 (Parker et al. 1994). We sampled Columbia River impoundments again in 1993 to evaluate changes from 1990 (Zimmerman et al. 1995). From 1994-1996, we sampled in areas where sufficient numbers of northern pikeminnow could be collected to compare changes in predation among years (Friesen et al. In press; Knutsen et al. 1995; Zimmerman et al. 1997). Ward (1998) provided a comprehensive summary of NPMP evaluation from 1990-96. In this report we describe our activities and findings for 1998, and wherever possible, evaluate changes from previous years.

Our objectives in 1998 were to (1) evaluate the relative efficiency of each northern pikeminnow fishery by comparing exploitation rate and incidental catch, (2) estimate reductions in predation on juvenile salmonids since the implementation of the NPMP, and (3) update information on relative year-class strength of northern pikeminnow based upon scale samples collected in 1998.

## METHODS

### Fishery Evaluation and Loss Estimates

#### Field Procedures

Three northern pikeminnow fisheries were conducted in 1998. The sport-reward fishery was implemented by the Washington Department of Fish and Wildlife (WDFW) from May 4 - October 11 throughout the lower Columbia and Snake rivers. The dam-angling fishery was implemented by the Columbia River Inter-Tribal Fish Commission (CRITFC), Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS), Confederated Tribes of the Umatilla Indian Reservation, and Confederated Tribes and Bands of the Yakama Indian Nation (YIN) from June 10 - October 21 at Bonneville, The Dalles, John Day, and McNary dams. A site-specific gill-net fishery was implemented by CRITFC, YIN, CTWS, and the Nez Perce Tribe from May 3 - June 30 downstream from Bonneville Dam and in Bonneville and The Dalles reservoirs.

We tagged and released northern pikeminnow to estimate exploitation rates for each fishery. We used electrofishing boats and bottom gillnets to collect northern pikeminnow from April 2 - June 18. We allocated equal sampling effort in all river kilometers (Rkm) from Rkm 71 through Priest Rapids Dam tailrace (Rkm 639) on the lower Columbia River, and on the Snake River from the mouth

through Rkm 248, excluding Ice Harbor Reservoir. Northern pikeminnow greater than 240 mm fork length were tagged with a serially-numbered spaghetti tag.

## Data Analysis

We used mark-and-recapture data to compare exploitation rates of northern pikeminnow  $\geq 250$  mm fork length among fisheries and reservoirs in 1998. Weekly estimates of exploitation for each fishery were calculated by dividing the number of tagged northern pikeminnow recovered by the number of tagged fish at large and summed to yield total exploitation rates (Beamesderfer et al. 1987). We adjusted exploitation estimates for a tag loss rate of 4.2% (Friesen et al. In press).

We calculated 95% confidence intervals for the number of tagged fish recovered each week. We calculated confidence intervals for variables distributed in a Poisson distribution from Ricker (1975) for weeks when tagging and fishing occurred simultaneously. After tagging was complete, we calculated weekly confidence intervals using the formula

$$m \pm 1.96 \sqrt{m/n} \quad (\text{if } mn > 30),$$

where

$n$  = the number of sampling periods (weeks) remaining, and

$m$  = the mean number of tagged fish recovered per week (Elliott 1977).

We summed estimates for each week to give overall confidence limits.

We compared incidental catch among fisheries for 1998 by calculating the percent of the total catch composed of fish other than northern pikeminnow  $\geq 250$  mm fork length.

We used the “Loss Estimate Spreadsheet Model” (Zimmerman et al. 1995) to estimate predation on juvenile salmonids relative to predation prior to implementation of the NPMP. The model incorporates age-specific exploitation rates on northern pikeminnow and resulting changes in age structure to estimate changes in predation. We used a 10-year “average” age structure (based on catch curves) for a pre-exploitation base, and assumed constant recruitment. Age-specific consumption was incorporated; however, potential changes in consumption, growth, and fecundity due to removals were not considered likely. The model therefore estimates changes in potential predation related directly to removals. This in effect allows us to estimate the effects of removals if all variables except exploitation were held constant.

We estimated the potential relative predation in 1998 based on observed exploitation rates, and the eventual minimum potential predation assuming continuing exploitation at mean 1994-97 levels. Because inputs to the model included three potential relationships between age of northern pikeminnow and consumption, and three estimates of exploitation (point estimate plus confidence limits), we computed nine estimates of relative predation for each year. We report the maximum, median, and minimum estimates.

## Biological Evaluation

### Field and Laboratory Procedures

We collected scale samples from northern pikeminnow downstream from Bonneville Dam, and in Bonneville and John Day reservoirs. Methods of age determination were described by Parker et al. (1995).

### Data Analysis

We used the method of El-Zarka (1959) to index year-class strengths of northern pikeminnow cohorts (1985-1994) based on their relative abundance in standardized electrofishing catches downstream from Bonneville Dam and in Bonneville Reservoir. Because the relative abundance of year classes in electrofishing catches were biased by annual variation in exploitation (Friesen et al. In press), we limited our comparisons to northern pikeminnow ages 3-5 which are not vulnerable to NPMP exploitation.

## RESULTS

### Fishery Evaluation and Loss Estimates

We tagged and released 1,265 northern pikeminnow throughout the lower Columbia and Snake rivers in 1998. A total of 124 tagged fish were recaptured in the three fisheries: 120 in the sport-reward fishery, one in the dam-angling fishery, and three in the site-specific gill-net fishery.

Total exploitation of northern pikeminnow in 1998 was 11.5%, and ranged from 0.0% in John Day, Lower Monumental, and Little Goose reservoirs to 13.6% in McNary Reservoir (Figure 1; **Appendix Table 1**). A sufficient number of tagged fish were captured in 1998 ( $n > 30$ ) to calculate 95% confidence intervals for total exploitation downstream from Bonneville Dam (5.5 to 10.8%) and systemwide (6.5 to 16.7%).

Systemwide exploitation of northern pikeminnow by the sport-reward fishery was 11.1% in 1998 (Figure 1; **Appendix Table 2**). Sport-reward exploitation increased downstream from Bonneville Dam and in The Dalles Reservoir and decreased in Bonneville, McNary, and Lower Granite reservoirs relative to exploitation in 1997. No tagged northern pikeminnow were returned by sport anglers in John Day, Lower Monumental, and Little Goose reservoirs. Only one tagged northern pikeminnow was recaptured in the dam angling fishery in 1998, and systemwide exploitation was 0.1% (Figure 1; **Appendix Table 3**). Exploitation in the site-specific gill-net fishery was 0.3% downstream from Bonneville Dam and 0.9% in Bonneville Reservoir (Figure 1; **Appendix Table 4**), the only areas where tagged northern pikeminnow were recaptured in gillnets in 1998.

In 1998, the various fisheries reported 52,065 incidentally-caught fish including northern pikeminnow <250 mm fork length (Table 1). The incidental catch rate was 31.1% for anglers targeting northern pikeminnow in the sport-reward fishery, 3.1% in the dam-angling fishery, and 52.4% in the

gill-net fishery. Northern pikeminnow <250 mm, other cyprinids, smallmouth bass, catostomids, and white sturgeon were the most common incidentally-caught fish. Salmonids made up only 0.2% of the total catch and 0.8% of the incidental catch for all fisheries combined. The proportion of predator-sized ( $\geq 250$  mm fork length) northern pikeminnow relative to the total number of northern pikeminnow harvested was highest in the dam-angling fishery (100.0%) and lowest in the sport-reward fishery (80.0%). Incidental catch of all taxa other than salmonids and northern pikeminnow  $\geq 250$  mm by sport anglers was underestimated because catches were not adjusted for non-returning anglers.

Results from the “Loss Estimate Spreadsheet Model” indicate that potential predation by northern pikeminnow on juvenile salmonids in 1998 ranged from 47% to 82% of pre-program levels, with a median estimate of 70% (Figure 2). Continued harvest at mean 1994-1998 exploitation levels will result in minimal additional reductions in predation unless exploitation exceeds 1994-1998 levels.

Year-class strength of northern pikeminnow was above average in 1991 downstream from Bonneville Dam and in Bonneville Reservoir (Figure 3).

## **DISCUSSION**

Rieman and Beamesderfer (1990) predicted that sustained exploitation of northern pikeminnow > 275 mm fork length at an annual rate of 10-20% would reduce losses of juvenile salmonids to predation by 50%. Total systemwide exploitation by the three fisheries in 1998 was similar to the 11.7% mean rate from 1991-97, but exploitation



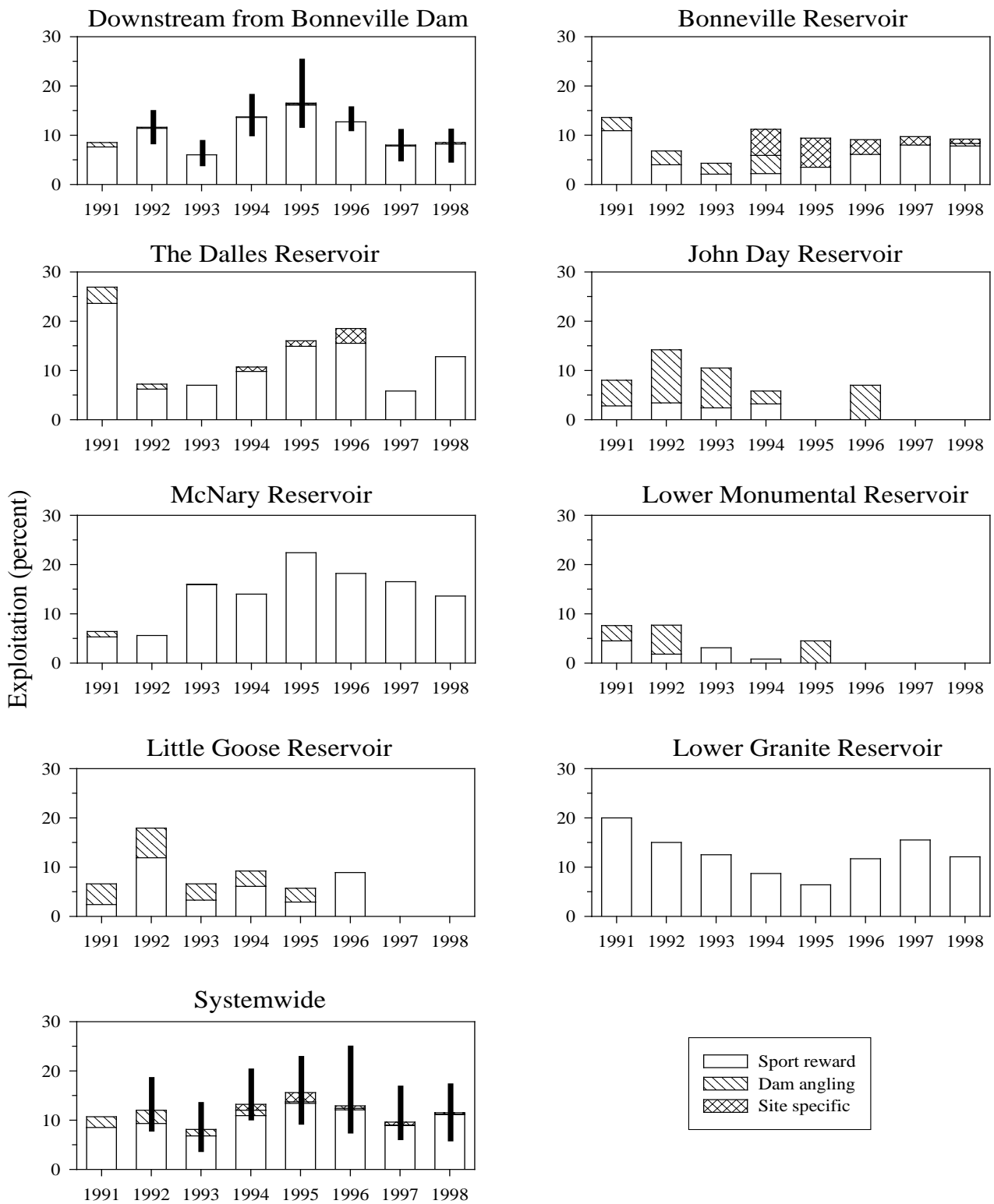


Figure 1. Exploitation of northern pikeminnow  $\geq 250$  mm fork length by area and fishery, 1991-97. Vertical bars for exploitation downstream from Bonneville Dam and systemwide are 95% confidence intervals.

Table 1. Number of northern pikeminnow and incidentally-caught fish by species or family in each fishery in 1998. Northern pikeminnow <250 mm fork length are considered incidental catch. Sport reward catches of salmonids and northern pikeminnow ≥250 mm are estimates based upon returning anglers and non-returning anglers targeting northern pikeminnow. Sport reward catches of all other taxa are by returning anglers only.

| Species or family            | Sport Reward | Dam Angling     | Gill Net        |
|------------------------------|--------------|-----------------|-----------------|
| Northern pikeminnow          |              |                 |                 |
| ≥250 mm fork length          | 107,652      | 3,216           | 3,035           |
| <250 mm fork length          | 26,861       | 0               | 12              |
| White sturgeon <sup>a</sup>  | 2,455        | 30              | 926             |
| American shad <sup>a</sup>   | 376          | 1               | 222             |
| Salmonidae <sup>a</sup>      |              |                 |                 |
| Chinook (adult)              | 12           | 0               | 33              |
| Chinook (juvenile)           | 105          | 0               | -- <sup>b</sup> |
| Sockeye (adult)              | 0            | 0               | 0               |
| Sockeye (juvenile)           | 0            | 0               | -- <sup>b</sup> |
| Steelhead (adult)            | 26           | 0               | 27              |
| Other adult salmon           | 1            | 0               | 22              |
| Other juvenile salmon        | 60           | 0               | -- <sup>b</sup> |
| All other salmonidae         | 240          | 0               | 41              |
| Cyprinidae                   | 10,802       | 2               | 146             |
| Catostomidae                 | 1,741        | 0               | 1,742           |
| Channel catfish <sup>a</sup> | 758          | 38 <sup>c</sup> | 22 <sup>c</sup> |
| Smallmouth bass <sup>a</sup> | 2,384        | 31 <sup>d</sup> | 52 <sup>d</sup> |
| Walleye <sup>a</sup>         | 481          | 2               | 76              |
| Other/unidentified           | 2,318        | 1               | 19              |
| Total (all species)          | 156,267      | 3,321           | 6,375           |
| Percent incidental catch     | 31.1         | 3.2             | 52.4            |

<sup>a</sup> Salmonidae = *Oncorhynchus* and *Prosopium* spp. White sturgeon = *Acipenser transmontanus*, American shad = *Alosa sapidissima*, channel catfish = *Ictalurus punctatus*, smallmouth bass = *Micropterus dolomieu*, walleye = *Stizostedion vitreum*.

<sup>b</sup> Juvenile salmonids were not identified to species and are totaled under “All other salmonidae”.

<sup>c</sup> Includes all ictalurid spp.

<sup>d</sup> Includes all *Micropterus* spp.

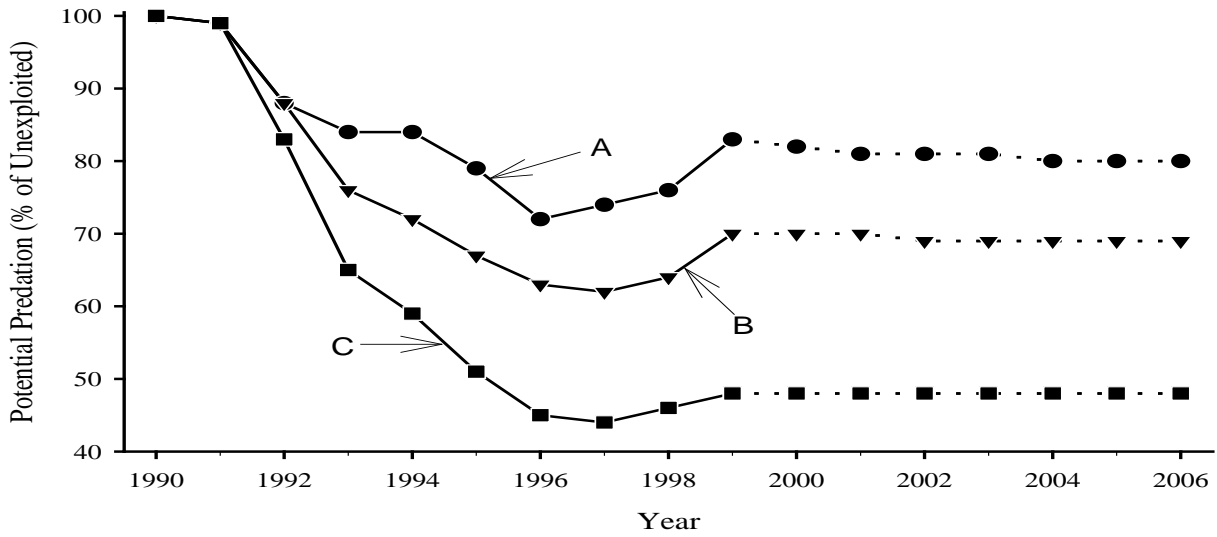
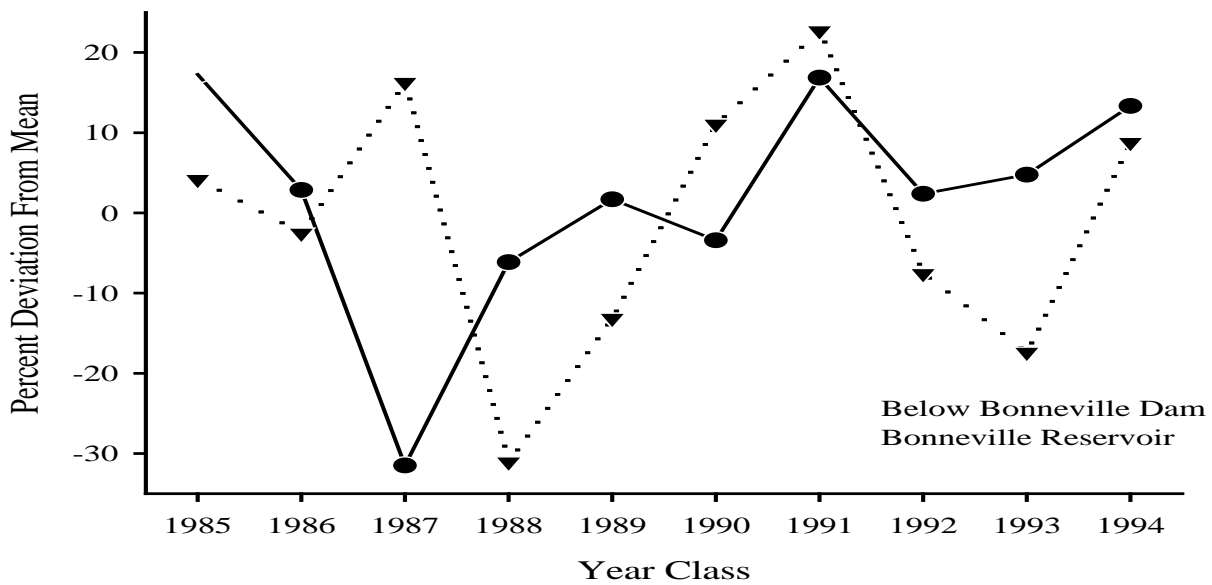


Figure 2. Maximum (A), median (B), and minimum (C) estimates of potential predation on juvenile salmonids by northern pikeminnow relative to predation prior to implementation of the northern pikeminnow management program. Dashed lines indicate predation in future years if exploitation is maintained at mean 1994-98 levels.

Figure 3. Index of relative year-class strength of northern pikeminnow downstream from Bonneville Dam and in Bonneville Reservoir.



in 1997 and 1998 was considerably lower than 1994-96. As in previous years, sport-reward exploitation greatly exceeded exploitation by other fisheries. The dam-angling and site-specific gill-net fisheries, while contributing less to exploitation, harvested localized concentrations of northern pikeminnow which may have aggregated to feed on juvenile salmonids (Beamesderfer and Rieman 1991; Poe et al. 1991; Collis et al. 1995). These fisheries captured a smaller number of other species, and harvested larger northern pikeminnow on average than the sport-reward fishery (Friesen and Ward, In press).

If exploitation rates remain similar to mean 1994-98 levels, it is likely that no further reductions in potential predation will be realized. Predation will remain at approximately 70% of pre-program levels. Exploitation rates lower than mean 1994-98 levels will result in increases in potential predation. Further reductions in predation will be small (1% to 4%) unless future exploitation exceeds 1997-98 levels.

We have found no evidence that year-class strengths of northern pikeminnow have been influenced by the NPMP, although interpretation of recent variation in year-class strength will be enhanced by continuing to collect scale samples in the coming years. Although compensation is unlikely, it remains possible as the NPMP is continued in future years. We recommend standardized sampling, as conducted in 1996, be repeated in 1999 and every three years thereafter to monitor and evaluate responses by northern pikeminnow and other predators to the NPMP.

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## **APPENDIX**

Exploitation of Northern Pikeminnow, 1991-1998

**Appendix Table 1.** Total exploitation rates of northern pikeminnow  $\geq 250$  mm fork length, 1991-1998.

| Area or reservoir | 1991 | 1992            | 1993            | 1994            | 1995            | 1996            | 1997            | 1998            |
|-------------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Downstream from   |      |                 |                 |                 |                 |                 |                 |                 |
| Bonneville Dam    | 8.6  | 11.7            | 6.0             | 13.8            | 16.5            | 12.7            | 8.0             | 8.4             |
| Bonneville        | 13.6 | 6.8             | 4.3             | 11.2            | 9.4             | 9.1             | 9.7             | 9.2             |
| The Dalles        | 26.9 | 7.2             | 7.0             | 10.7            | 16.0            | 15.5            | 5.8             | 12.8            |
| John Day          | 8.0  | 14.2            | 10.5            | 5.8             | 0.0             | 7.0             | 0.0             | 0.0             |
| McNary            | 6.5  | 5.6             | 16.0            | 14.0            | 22.4            | 18.2            | 16.5            | 13.6            |
| Ice Harbor        | 4.4  | -- <sup>a</sup> | -- <sup>a</sup> | -- <sup>a</sup> | -- <sup>a</sup> | -- <sup>a</sup> | -- <sup>a</sup> | -- <sup>a</sup> |
| Lower Monumental  | 7.6  | 7.7             | 3.1             | 0.8             | 4.5             | 0.0             | 0.0             | 0.0             |
| Little Goose      | 6.6  | 17.9            | 6.6             | 9.2             | 5.7             | 8.9             | 0.0             | 0.0             |
| Lower Granite     | 20.0 | 15.0            | 12.5            | 8.7             | 6.4             | 11.7            | 15.5            | 12.1            |
| Systemwide        | 10.7 | 12.0            | 8.1             | 13.2            | 15.5            | 12.9            | 9.6             | 11.5            |

<sup>a</sup> No northern pikeminnow tagged.

**Appendix Table 2.** Exploitation rates (%) of northern pikeminnow  $\geq 250$  mm fork length for the sport-reward fishery, 1991-1998.

| Area or Reservoir | 1991 | 1992            | 1993            | 1994            | 1995             | 1996             | 1997             | 1998             |
|-------------------|------|-----------------|-----------------|-----------------|------------------|------------------|------------------|------------------|
| Downstream from   |      |                 |                 |                 |                  |                  |                  |                  |
| Bonneville Dam    | 7.6  | 11.4            | 6.0             | 13.6            | 16.1             | 12.7             | 7.8              | 8.2              |
| Bonneville        | 10.9 | 4.0             | 2.1             | 2.2             | 3.5              | 6.1              | 8.0              | 7.8              |
| The Dalles        | 23.6 | 6.2             | 7.0             | 9.8             | 14.9             | 15.5             | 5.8              | 12.8             |
| John Day          | 2.8  | 3.4             | 2.4             | 3.2             | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> |
| McNary            | 5.3  | 5.6             | 15.9            | 14.0            | 22.4             | 18.2             | 16.5             | 13.6             |
| Ice Harbor        | 1.0  | -- <sup>b</sup> | -- <sup>b</sup> | -- <sup>b</sup> | -- <sup>b</sup>  | -- <sup>b</sup>  | -- <sup>b</sup>  | -- <sup>b</sup>  |
| Lower Monumental  | 4.5  | 1.8             | 3.1             | 0.8             | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> |
| Little Goose      | 2.4  | 11.9            | 3.3             | 6.1             | 2.9              | 8.9              | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> |
| Lower Granite     | 20.0 | 15.0            | 12.5            | 8.7             | 6.4              | 11.7             | 15.5             | 12.1             |
| Systemwide        | 8.5  | 9.3             | 6.8             | 10.9            | 13.4             | 12.1             | 8.9              | 11.1             |

<sup>a</sup> Northern pikeminnow harvested, but no tags recovered.

<sup>b</sup> No northern pikeminnow tagged.



**Appendix Table 3.** Exploitation rates (%) of northern pikeminnow  $\geq 250$  mm fork length for the dam-angling fishery, 1991-1998.

| Area or Reservoir              | 1991 | 1992             | 1993             | 1994             | 1995             | 1996             | 1997             | 1998             |
|--------------------------------|------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Downstream from Bonneville Dam | 0.9  | 0.2              | 0.0 <sup>b</sup> | 0.1              | 0.2              | 0.0 <sup>b</sup> | 0.2              | 0.0              |
| Bonneville                     | 2.7  | 2.8              | 2.2              | 3.7              | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.5              |
| The Dalles                     | 3.3  | 1.0              | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> |
| John Day                       | 5.2  | 10.8             | 8.1              | 2.6              | 0.0 <sup>b</sup> | 7.0              | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> |
| McNary                         | 1.1  | 0.0 <sup>b</sup> | 0.1              | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> |
| Ice Harbor                     | 3.4  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  |
| Lower Monumental               | 3.1  | 5.9              | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 4.5              | 0.0 <sup>b</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> |
| Little Goose                   | 4.2  | 6.0              | 3.3              | 3.1              | 2.8              | 0.0 <sup>b</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> |
| Lower Granite                  | <0.1 | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>a</sup> | 0.0 <sup>a</sup> |
| Systemwide                     | 2.2  | 2.7              | 1.3              | 1.1              | 0.3              | 0.3              | 0.1              | 0.1              |

<sup>a</sup> No fishing effort.

<sup>b</sup> Northern pikeminnow harvested, but no tags recovered.

<sup>c</sup> No northern pikeminnow tagged.

**Appendix Table 4.** Exploitation rates (%) of northern pikeminnow  $\geq 250$  mm fork length for the site-specific gill-net fishery, 1994-1998.

| Area or Reservoir              | 1994             | 1995             | 1996             | 1997             | 1998            |
|--------------------------------|------------------|------------------|------------------|------------------|-----------------|
| Downstream from Bonneville Dam | --               | 0.2              | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.3             |
| Bonneville                     | 5.3              | 5.9              | 3.0              | 1.7              | 0.9             |
| The Dalles                     | 0.9              | 1.1              | 0.0 <sup>b</sup> | -- <sup>b</sup>  | -- <sup>b</sup> |
| John Day                       | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | -- <sup>b</sup>  | -- <sup>b</sup> |
| McNary                         | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | -- <sup>a</sup>  | -- <sup>a</sup> |
| Ice Harbor                     | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup>  | -- <sup>c</sup> |
| Lower Monumental               | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | -- <sup>a</sup>  | -- <sup>b</sup>  | -- <sup>a</sup> |
| Little Goose                   | -- <sup>a</sup>  | 0.0 <sup>b</sup> | -- <sup>a</sup>  | -- <sup>a</sup>  | -- <sup>a</sup> |
| Lower Granite                  | 0.0 <sup>b</sup> | 0.0 <sup>b</sup> | -- <sup>a</sup>  | -- <sup>a</sup>  | -- <sup>a</sup> |
| Systemwide                     | 1.2              | 1.9              | 0.5              | 0.6              | 0.3             |

<sup>a</sup> No fishing effort.

<sup>b</sup> Northern pikeminnow harvested, but no tags recovered.

<sup>c</sup> No northern pikeminnow tagged.

**Appendix Table 5.** Dates for each sampling period in 1998.

| Period | Dates               | Period | Dates                       |
|--------|---------------------|--------|-----------------------------|
| 1      | March 30 - April 5  | 16     | July 13 - July 19           |
| 2      | April 6 - April 12  | 17     | July 20 - July 26           |
| 3      | April 13 - April 19 | 18     | July 27 - August 2          |
| 4      | April 20 - April 26 | 19     | August 3 - August 9         |
| 5      | April 27 - May 3    | 20     | August 10 - August 16       |
| 6      | May 4 - May 10      | 21     | August 17 - August 23       |
| 7      | May 11 - May 17     | 22     | August 24 - August 30       |
| 8      | May 18 - May 24     | 23     | August 31 - September 6     |
| 9      | May 25 - May 31     | 24     | September 7 - September 13  |
| 10     | June 1 - June 7     | 25     | September 14 - September 20 |
| 11     | June 8 - June 14    | 26     | September 21 - September 27 |
| 12     | June 15 - June 21   | 27     | September 28 - October 4    |
| 13     | June 22 - June 28   | 28     | October 5 - October 11      |
| 14     | June 29 - July 5    | 29     | October 12 - October 18     |
| 15     | July 6 - July 12    |        |                             |

**Appendix Table 6.** Exploitation of northern pikeminnow downstream from Bonneville Dam in 1998.

| Time period           | Tagged | Recaptures |     |     |                  | Exploitation |        |        |
|-----------------------|--------|------------|-----|-----|------------------|--------------|--------|--------|
|                       |        | Sport      | Dam | Net | At Large         | Sport        | Dam    | Net    |
| 1                     | 30     | --         | --  | --  | --               | --           | --     | --     |
| 2                     | 110    | --         | --  | --  | 30               | --           | --     | --     |
| 3                     | 168    | --         | --  | --  | 140              | --           | --     | --     |
| 4                     | 119    | --         | --  | --  | 308              | --           | --     | --     |
| 5                     | --     | --         | --  | --  | 426              | --           | --     | --     |
| 6                     | --     | 3          | --  | --  | 426 <sup>b</sup> | 0.0070       | --     | --     |
| 7                     | --     | --         | --  | --  | 422              | --           | --     | --     |
| 8                     | --     | 1          | --  | --  | 422              | 0.0024       | --     | --     |
| 9                     | --     | 1          | --  | --  | 421              | 0.0024       | --     | --     |
| 10                    | --     | 1          | --  | --  | 420              | 0.0024       | --     | --     |
| 11                    | --     | 2          | --  | 1   | 419              | 0.0048       | --     | 0.0024 |
| 12                    | --     | 4          | --  | --  | 416              | 0.0096       | --     | --     |
| 13                    | --     | 3          | --  | --  | 412              | 0.0073       | --     | --     |
| 14                    | --     | 4          | --  | --  | 409              | 0.0098       | --     | --     |
| 15                    | --     | 3          | --  | --  | 405              | 0.0074       | --     | --     |
| 16                    | --     | 3          | --  | --  | 402              | 0.0075       | --     | --     |
| 17                    | --     | --         | --  | --  | 399              | --           | --     | --     |
| 18                    | --     | 2          | --  | --  | 399              | 0.0050       | --     | --     |
| 19                    | --     | --         | --  | --  | 397 <sup>a</sup> | --           | --     | --     |
| 20                    | --     | --         | --  | --  | 396              | --           | --     | --     |
| 21                    | --     | 2          | --  | --  | 396              | 0.0051       | --     | --     |
| 22                    | --     | --         | --  | --  | 394              | --           | --     | --     |
| 23                    | --     | --         | --  | --  | 394              | --           | --     | --     |
| 24                    | --     | 2          | --  | --  | 394              | 0.0051       | --     | --     |
| 25                    | --     | --         | --  | --  | 392              | --           | --     | --     |
| 26                    | --     | 1          | --  | --  | 392              | 0.0026       | --     | --     |
| 27                    | --     | --         | --  | --  | 391              | --           | --     | --     |
| 28                    | --     | --         | --  | --  | 391              | --           | --     | --     |
| 29                    | --     | --         | --  | --  | 391              | --           | --     | --     |
| Total                 | 427    | 32         | 0   | 1   | --               | 0.0782       | 0.0000 | 0.0024 |
| Adjusted for tag loss |        |            |     |     | 0.0815           | 0.0000       | 0.0025 |        |

<sup>a</sup> A fish tagged downstream from Bonneville Reservoir was recaptured above Bonneville Dam.

<sup>b</sup> A tagged fish was caught by an angler not participating in the NPMP.

**Appendix Table 7.** Exploitation of northern pikeminnow in Bonneville Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |                  | Exploitation |        |        |
|-----------------------|--------|------------|-----|-----|------------------|--------------|--------|--------|
|                       |        | Sport      | Dam | Net | At Large         | Sport        | Dam    | Net    |
| 1                     | --     | --         | --  | --  | --               | --           | --     | --     |
| 2                     | --     | --         | --  | --  | --               | --           | --     | --     |
| 3                     | --     | --         | --  | --  | --               | --           | --     | --     |
| 4                     | 176    | --         | --  | --  | --               | --           | --     | --     |
| 5                     | --     | --         | --  | --  | 176              | --           | --     | --     |
| 6                     | 66     | 1          | --  | --  | 176 <sup>a</sup> | 0.0057       | --     | --     |
| 7                     | --     | 3          | --  | 1   | 240              | 0.0125       | --     | 0.0042 |
| 8                     | --     | 1          | --  | 1   | 236              | 0.0042       | --     | 0.0042 |
| 9                     | --     | 3          | --  | --  | 234              | 0.0128       | --     | --     |
| 10                    | --     | --         | --  | --  | 231              | --           | --     | --     |
| 11                    | --     | 1          | --  | --  | 231              | 0.0043       | --     | --     |
| 12                    | --     | 3          | --  | --  | 230              | 0.0130       | --     | --     |
| 13                    | --     | 2          | --  | --  | 227              | 0.0088       | --     | --     |
| 14                    | --     | 1          | --  | --  | 225 <sup>a</sup> | 0.0044       | --     | --     |
| 15                    | --     | 2          | 1   | --  | 221 <sup>a</sup> | 0.0090       | 0.0045 | --     |
| 16                    | --     | --         | --  | --  | 217 <sup>a</sup> | --           | --     | --     |
| 17                    | --     | --         | --  | --  | 216              | --           | --     | --     |
| 18                    | --     | --         | --  | --  | 216 <sup>a</sup> | --           | --     | --     |
| 19                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 20                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 21                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 22                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 23                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 24                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 25                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 26                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 27                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 28                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| 29                    | --     | --         | --  | --  | 215              | --           | --     | --     |
| Total                 | 242    | 17         | 1   | 2   | --               | 0.0749       | 0.0045 | 0.0084 |
| Adjusted for tag loss |        |            |     |     | 0.0781           | 0.0047       | 0.0088 |        |

<sup>a</sup> A fish tagged in Bonneville Reservoir was recaptured outside the reservoir.

**Appendix Table 8.** Exploitation of northern pikeminnow in The Dalles Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |                 | Exploitation |        |        |
|-----------------------|--------|------------|-----|-----|-----------------|--------------|--------|--------|
|                       |        | Sport      | Dam | Net | At Large        | Sport        | Dam    | Net    |
| 1                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 2                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 3                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 4                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 5                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 6                     | 61     | 1          | --  | --  | --              | --           | --     | --     |
| 7                     | --     | --         | --  | --  | 60              | --           | --     | --     |
| 8                     | --     | --         | --  | --  | 60              | --           | --     | --     |
| 9                     | --     | --         | --  | --  | 60              | --           | --     | --     |
| 10                    | --     | --         | --  | --  | 60              | --           | --     | --     |
| 11                    | --     | --         | --  | --  | 60              | --           | --     | --     |
| 12                    | --     | 3          | --  | --  | 60 <sup>a</sup> | 0.0500       | --     | --     |
| 13                    | --     | --         | --  | --  | 56              | --           | --     | --     |
| 14                    | --     | 1          | --  | --  | 56              | 0.0179       | --     | --     |
| 15                    | --     | 3          | --  | --  | 55              | 0.0545       | --     | --     |
| 16                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 17                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 18                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 19                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 20                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 21                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 22                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 23                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 24                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 25                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 26                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 27                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 28                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| 29                    | --     | --         | --  | --  | 52              | --           | --     | --     |
| Total                 | 61     | 8          | 0   | --  | --              | 0.1224       | 0.0000 | 0.0000 |
| Adjusted for tag loss |        |            |     |     | 0.1275          | 0.0000       | 0.0000 |        |

<sup>a</sup> A fish tagged in The Dalles Reservoir was recaptured outside the reservoir.

**Appendix Table 9.** Exploitation of northern pikeminnow in John Day Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |                 | Exploitation |        |        |
|-----------------------|--------|------------|-----|-----|-----------------|--------------|--------|--------|
|                       |        | Sport      | Dam | Net | At Large        | Sport        | Dam    | Net    |
| 1                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 2                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 3                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 4                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 5                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 6                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 7                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 8                     | --     | --         | --  | --  | --              | --           | --     | --     |
| 9                     | 8      | --         | --  | --  | --              | --           | --     | --     |
| 10                    | --     | --         | --  | --  | 8               | --           | --     | --     |
| 11                    | 9      | --         | --  | --  | 8               | --           | --     | --     |
| 12                    | 1      | --         | --  | --  | 17              | --           | --     | --     |
| 13                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 14                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 15                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 16                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 17                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 18                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 19                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 20                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 21                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 22                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 23                    | --     | --         | --  | --  | 18              | --           | --     | --     |
| 24                    | --     | --         | --  | --  | 18 <sup>a</sup> | --           | --     | --     |
| 25                    | --     | --         | --  | --  | 17              | --           | --     | --     |
| 26                    | --     | --         | --  | --  | 17              | --           | --     | --     |
| 27                    | --     | --         | --  | --  | 17              | --           | --     | --     |
| 28                    | --     | --         | --  | --  | 17              | --           | --     | --     |
| 29                    | --     | --         | --  | --  | 17              | --           | --     | --     |
| Total                 | 18     | 0          | 0   | --  | --              | 0.0000       | 0.0000 | 0.0000 |
| Adjusted for tag loss |        |            |     |     | 0.0000          | 0.0000       | 0.0000 |        |

<sup>a</sup> A tagged fish was caught by an angler not participating in the NPMP.

**Appendix Table 10.** Exploitation of northern pikeminnow in McNary Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |                  | Exploitation |        |                  |
|-----------------------|--------|------------|-----|-----|------------------|--------------|--------|------------------|
|                       |        | Sport      | Dam | Net | At Large         | Sport        | Dam    | Net <sup>a</sup> |
| 1                     | --     | --         | --  | --  | --               | --           | --     | --               |
| 2                     | --     | --         | --  | --  | --               | --           | --     | --               |
| 3                     | --     | --         | --  | --  | --               | --           | --     | --               |
| 4                     | --     | --         | --  | --  | --               | --           | --     | --               |
| 5                     | --     | --         | --  | --  | --               | --           | --     | --               |
| 6                     | --     | --         | --  | --  | --               | --           | --     | --               |
| 7                     | 233    | --         | --  | --  | --               | --           | --     | --               |
| 8                     | 76     | 1          | --  | --  | 233              | 0.0043       | --     | --               |
| 9                     | 12     | 7          | --  | --  | 308              | 0.0227       | --     | --               |
| 10                    | --     | 2          | --  | --  | 313              | 0.0064       | --     | --               |
| 11                    | --     | 6          | --  | --  | 311              | 0.0193       | --     | --               |
| 12                    | --     | 4          | --  | --  | 305              | 0.0131       | --     | --               |
| 13                    | --     | 3          | --  | --  | 301              | 0.0100       | --     | --               |
| 14                    | --     | 6          | --  | --  | 298 <sup>b</sup> | 0.0201       | --     | --               |
| 15                    | --     | 2          | --  | --  | 291              | 0.0069       | --     | --               |
| 16                    | --     | 4          | --  | --  | 289              | 0.0138       | --     | --               |
| 17                    | --     | --         | --  | --  | 285              | --           | --     | --               |
| 18                    | --     | 1          | --  | --  | 285              | 0.0035       | --     | --               |
| 19                    | --     | --         | --  | --  | 284              | --           | --     | --               |
| 20                    | --     | --         | --  | --  | 284              | --           | --     | --               |
| 21                    | --     | --         | --  | --  | 284              | --           | --     | --               |
| 22                    | --     | --         | --  | --  | 284              | --           | --     | --               |
| 23                    | --     | --         | --  | --  | 284              | --           | --     | --               |
| 24                    | --     | --         | --  | --  | 284              | --           | --     | --               |
| 25                    | --     | 1          | --  | --  | 284 <sup>b</sup> | 0.0035       | --     | --               |
| 26                    | --     | --         | --  | --  | 281              | --           | --     | --               |
| 27                    | --     | 1          | --  | --  | 281              | 0.0036       | --     | --               |
| 28                    | --     | 1          | --  | --  | 280              | 0.0036       | --     | --               |
| 29                    | --     | --         | --  | --  | 279              | --           | --     | --               |
| Total                 | 321    | 39         | 0   | --  | --               | 0.1308       | 0.0000 | --               |
| Adjusted for tag loss |        |            |     |     | 0.1363           | 0.0000       | --     | --               |

<sup>a</sup> No fishing effort.

<sup>b</sup> A tagged fish was caught by an angler not participating in the NPMP.

**Appendix Table 11.** Exploitation of northern pikeminnow in Lower Monumental Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |          | Exploitation |                  |                  |
|-----------------------|--------|------------|-----|-----|----------|--------------|------------------|------------------|
|                       |        | Sport      | Dam | Net | At Large | Sport        | Dam <sup>a</sup> | Net <sup>a</sup> |
| 1                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 2                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 3                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 4                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 5                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 6                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 7                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 8                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 9                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 10                    | 20     | --         | --  | --  | --       | --           | --               | --               |
| 11                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 12                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 13                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 14                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 15                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 16                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 17                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 18                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 19                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 20                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 21                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 22                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 23                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 24                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 25                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 26                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 27                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 28                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| 29                    | --     | --         | --  | --  | 20       | --           | --               | --               |
| Total                 | 20     | 0          | 0   | --  | --       | 0.0000       | --               | --               |
| Adjusted for tag loss |        |            |     |     | 0.0000   | --           | --               |                  |

<sup>a</sup> No fishing effort.



**Appendix Table 12.** Exploitation of northern pikeminnow in Little Goose Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |                 | Exploitation |                  |                  |
|-----------------------|--------|------------|-----|-----|-----------------|--------------|------------------|------------------|
|                       |        | Sport      | Dam | Net | At Large        | Sport        | Dam <sup>a</sup> | Net <sup>a</sup> |
| 1                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 2                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 3                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 4                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 5                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 6                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 7                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 8                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 9                     | --     | --         | --  | --  | --              | --           | --               | --               |
| 10                    | 49     | --         | --  | --  | --              | --           | --               | --               |
| 11                    | --     | --         | --  | --  | 49              | --           | --               | --               |
| 12                    | --     | --         | --  | --  | 49              | --           | --               | --               |
| 13                    | --     | --         | --  | --  | 49              | --           | --               | --               |
| 14                    | --     | --         | --  | --  | 49 <sup>b</sup> | --           | --               | --               |
| 15                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 16                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 17                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 18                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 19                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 20                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 21                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 22                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 23                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 24                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 25                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 26                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 27                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 28                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| 29                    | --     | --         | --  | --  | 48              | --           | --               | --               |
| Total                 | 49     | 0          | 0   | --  | --              | 0.0000       | --               | --               |
| Adjusted for tag loss |        |            |     |     | 0.0000          | --           | --               |                  |

<sup>a</sup> No fishing effort.

<sup>b</sup> A tagged fish was caught by an angler not participating in the NPMP.

**Appendix Table 13.** Exploitation of northern pikeminnow in Lower Granite Reservoir in 1998.

| Time period           | Tagged | Recaptures |     |     |          | Exploitation |                  |                  |
|-----------------------|--------|------------|-----|-----|----------|--------------|------------------|------------------|
|                       |        | Sport      | Dam | Net | At Large | Sport        | Dam <sup>a</sup> | Net <sup>a</sup> |
| 1                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 2                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 3                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 4                     | --     | --         | --  | --  | --       | --           | --               | --               |
| 5                     | 127    | --         | --  | --  | --       | --           | --               | --               |
| 6                     | --     | --         | --  | --  | 127      | --           | --               | --               |
| 7                     | --     | 1          | --  | --  | 127      | 0.0079       | --               | --               |
| 8                     | --     | --         | --  | --  | 126      | --           | --               | --               |
| 9                     | --     | --         | --  | --  | 126      | --           | --               | --               |
| 10                    | --     | --         | --  | --  | 126      | --           | --               | --               |
| 11                    | --     | --         | --  | --  | 126      | --           | --               | --               |
| 12                    | --     | --         | --  | --  | 126      | --           | --               | --               |
| 13                    | --     | 1          | --  | --  | 126      | 0.0079       | --               | --               |
| 14                    | --     | --         | --  | --  | 125      | --           | --               | --               |
| 15                    | --     | --         | --  | --  | 125      | --           | --               | --               |
| 16                    | --     | 2          | --  | --  | 125      | 0.0160       | --               | --               |
| 17                    | --     | 1          | --  | --  | 123      | 0.0081       | --               | --               |
| 18                    | --     | --         | --  | --  | 122      | --           | --               | --               |
| 19                    | --     | 1          | --  | --  | 122      | 0.0082       | --               | --               |
| 20                    | --     | 2          | --  | --  | 121      | 0.0165       | --               | --               |
| 21                    | --     | --         | --  | --  | 119      | --           | --               | --               |
| 22                    | --     | 2          | --  | --  | 119      | 0.0168       | --               | --               |
| 23                    | --     | 1          | --  | --  | 117      | 0.0085       | --               | --               |
| 24                    | --     | --         | --  | --  | 116      | --           | --               | --               |
| 25                    | --     | 1          | --  | --  | 116      | 0.0086       | --               | --               |
| 26                    | --     | 1          | --  | --  | 115      | 0.0087       | --               | --               |
| 27                    | --     | 1          | --  | --  | 114      | 0.0088       | --               | --               |
| 28                    | --     | --         | --  | --  | 113      | --           | --               | --               |
| 29                    | --     | --         | --  | --  | 113      | --           | --               | --               |
| Total                 | 127    | 14         | --  | --  | --       | 0.1161       | --               | --               |
| Adjusted for tag loss |        |            |     |     | 0.1210   | --           | --               |                  |

<sup>a</sup> No fishing effort.

**Appendix Table 14.** Exploitation of northern pikeminnow systemwide in 1998.

| Time period           | Tagged | Recaptures |     |     |          | Exploitation |        |        |
|-----------------------|--------|------------|-----|-----|----------|--------------|--------|--------|
|                       |        | Sport      | Dam | Net | At Large | Sport        | Dam    | Net    |
| 1                     | 30     | --         | --  | --  | --       | --           | --     | --     |
| 2                     | 110    | --         | --  | --  | 30       | --           | --     | --     |
| 3                     | 168    | --         | --  | --  | 140      | --           | --     | --     |
| 4                     | 295    | --         | --  | --  | 308      | --           | --     | --     |
| 5                     | 127    | --         | --  | --  | 602      | --           | --     | --     |
| 6                     | 127    | 6          | --  | --  | 729      | 0.0082       | --     | --     |
| 7                     | 233    | 5          | --  | 1   | 849      | 0.0059       | --     | 0.0012 |
| 8                     | 76     | 3          | --  | 1   | 1076     | 0.0028       | --     | 0.0009 |
| 9                     | 20     | 11         | --  | --  | 1148     | 0.0096       | --     | --     |
| 10                    | 69     | 3          | --  | --  | 1157     | 0.0026       | --     | --     |
| 11                    | 9      | 9          | --  | 1   | 1223     | 0.0074       | --     | 0.0008 |
| 12                    | 1      | 15         | --  | --  | 1222     | 0.0123       | --     | --     |
| 13                    | --     | 9          | --  | --  | 1208     | 0.0075       | --     | --     |
| 14                    | --     | 15         | --  | --  | 1199     | 0.0125       | --     | --     |
| 15                    | --     | 11         | 1   | --  | 1182     | 0.0093       | 0.0008 | --     |
| 16                    | --     | 10         | --  | --  | 1170     | 0.0085       | --     | --     |
| 17                    | --     | 1          | --  | --  | 1160     | 0.0009       | --     | --     |
| 18                    | --     | 4          | --  | --  | 1159     | 0.0035       | --     | --     |
| 19                    | --     | 2          | --  | --  | 1155     | 0.0017       | --     | --     |
| 20                    | --     | 2          | --  | --  | 1153     | 0.0017       | --     | --     |
| 21                    | --     | 2          | --  | --  | 1151     | 0.0017       | --     | --     |
| 22                    | --     | 2          | --  | --  | 1149     | 0.0017       | --     | --     |
| 23                    | --     | 1          | --  | --  | 1147     | 0.0009       | --     | --     |
| 24                    | --     | 2          | --  | --  | 1146     | 0.0017       | --     | --     |
| 25                    | --     | 2          | --  | --  | 1143     | 0.0017       | --     | --     |
| 26                    | --     | 2          | --  | --  | 1139     | 0.0018       | --     | --     |
| 27                    | --     | 2          | --  | --  | 1137     | 0.0018       | --     | --     |
| 28                    | --     | 1          | --  | --  | 1135     | 0.0009       | --     | --     |
| 29                    | --     | --         | --  | --  | 1134     | --           | --     | --     |
| Total                 | 1265   | 120        | 1   | 3   | --       | 0.1066       | 0.0008 | 0.0029 |
| Adjusted for tag loss |        |            |     |     | 0.1110   | 0.0009       | 0.0030 |        |