BONNEVILLE POWER ADMINISTRATION

Development of a System-wide Predator Control Program

Northern Squawfish Management Program - Implementation

Annual Report 1997 October 1998 DOE/BP-24514-8

This Document should be cited as follows:

Young, Franklin, "Development of a System-wide Predator Control Program; Northern Squawfish Management Program - Implementation", 1997 Annual Report, Project No. 199007700, 100 electronic pages, (BPA Report DOE/BP-24514-8)

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This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

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

1997 ANNUAL REPORT

Prepared by:

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Columbia Basin Fish and Wildlife Authority

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

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P. O. Box 3621
Portland, OR 97208-3621

Project Number 90-077
Contract Number 94BI24514

October 1998

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1997 EXECUTIVE SUMMARY

by Franklin R. Young

We report our results from the sixth year of a basin-wide program to harvest northern pikeminnow[1] (*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 River 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 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 trapnet. We found this floating trapnet 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.

In 1995, 1996, and 1997, promotional activities and incentives were further improved

[1] The common name of the northern squawfish was recently changed by the American Fisheries Society to northern pikeminnow at the request of the Confederated Tribes and Bands of the Yakama Indian Reservation.

based on the favorable response in 1994. Results of these efforts are subjects of this annual report under 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 subcontracted various tasks and activities to ODFW, WDFW, CRITFC, and the four lower Columbia River treaty tribes based on the expertise each brought to the tasks involved in implementing 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 specific 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 can be found in Report A of our 1990 annual report (Vigg et al. 1990). Highlights of results of our work in 1997 by report are as follows.

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

1. Objectives for 1996 were to (1) implement a recreational fishery that rewards anglers who harvest northern pikeminnow ≥ 11 inches total length, (2) obtain catch data on all fish species caught by fishery participants while targeting northern pikeminnow, (3) collect length data on the above-mentioned species which are returned to registration stations, (4) collect, monitor, and report data on angler participation and catch-per-angler-day during the season, and (5) evaluate promotional, fish handling, and cost-analysis aspects of the Northern Pikeminnow Sport Reward Fishery (NPSRF) and (6) conduct research to determine if genetic differences exist between northern pikeminnow caught within the Program boundaries and those caught outside of the Program boundaries.

2. The NPSRF was conducted from May 19 through October 5, 1997. Thirteen registration stations were operated throughout the lower Snake and Columbia rivers.

3. A total of 119,488 northern pikeminnow ≥ 11 inches were harvested during the 1997 season with 27,338 angler days spent harvesting these fish. Both harvest and participation in 1997 were well below the six-year average of 156,136 fish and 54,958 angler days respectively. Catch-per-angler-day for all anglers during the season was 4.37 and exceeded the six-year average of 3.23 northern pikeminnow per angler day.

4. The NPSRF rendered 66 tons of northern pikeminnow in 1997 at a cost of $0.26 per fish. The total cost was $31,577.

Report B
Northern Pikeminnow Sport-Reward Fishery Payments

1. During 1997, vouchers totaling $470,175 were paid for 117,875 fish.

2. A total of 192 vouchers were paid for tagged fish at $50 per tag for a total of $9,600.

3. A total of 1,267 promotional coupons were redeemed at $3 each for a total of $3,801.

4. A total of $38,075 was paid out for promotional tournaments.

5. A total of 1,954 anglers received payments.

6. The total for all payments was $522,551.

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

1. Dam angling at eight dams on the lower Snake and Columbia rivers during 1997 resulted in a catch of 3,519 northern pikeminnow from June 2 through September 26 which was 13% less than the catch in 1996.

2. Overall catch per angler hour (CPAH) was 1.1 in 1997, compared to 1.7 the previous year. Total hook-and-line angling effort was 150 % of the 1996 effort for Bonneville, The Dalles, and John Day dams. Effort at McNary Dam was reduced to 54% of 1996 levels, a direct response to the decreased CPAH at that dam.

3. Incidental catch was 6.8% of the total hook-and-line catch, compared to 2.3% the previous year and 8.3% in 1995. White sturgeon and smallmouth bass, channel catfish, and shad constituted 83% of the incidental catch. Two salmonids were caught by hook-and-line in 1997, compared to none in 1996, and 5 in 1995.

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 2,831 predator-size northern pikeminnow during 1997 which was only 46% of the 1996 catch. Most of the fish were caught at locations in Bonneville Pool (90%). The mouth of the Klickitat River continued to be the most productive fishing location but this site's contribution to the total fell from 58% to 31% between 1996 and 1997.

2. The total incidental catch was 5,144 fish, with suckers (*Catostomus spp*.) being the most common (72%) incidentally caught species. Salmonid bycatch (110 adults; 44 juveniles) was minimal despite high concentrations of salmonids in the sampling areas.

3. Further developments and changes to the site-specific fishery are recommended to improve efficiency and productivity.

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

1997, (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 ≥ 250 mm fork length was 8.9% for sport-reward, 0.1% for dam-angling, and 0.6% for site-specific gill-net fisheries for a total systemwide exploitation of 9.6%. Reservoir exploitation ranged from zero in John Day, Lower Monumental, and Little Goose reservoirs to 16.5% in McNary Reservoir. The dam-angling fishery had the lowest percentage (6.9%) of incidental catch relative to the total number of fish caught. Incidental catch was 31.1% in the sport-reward fishery and 64.1% in the gill-net fishery.

3. If exploitation rates remain similar to mean 1991-97 levels, we estimate that potential predation by northern pikeminnow on juvenile salmonids in 1998 will be approximately 64% 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 1994-97 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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ACKNOWLEDGMENTS

This project was funded by the Bonneville Power Administration, William Maslen and John Skidmore, Project Managers (Contract DE-B179-90BP07084). We thank Frank Young and his staff, Columbia Basin Fish and Wildlife Authority; David Ward and his staff, Oregon Department of Fish and Wildlife; Keith Hatch and his staff, Columbia River Inter-Tribal Fish Commission; Russell Porter and his staff, Pacific States Marine Fisheries Commission, and Carlene Stenehjem, Bonneville Power Administration - Public Affairs, for their cooperation and coordination.

We are particularly grateful to the U. S. Army Corps of Engineers for the use of Hamilton Island Fort Rains northern pikeminnow outlook, Giles French, Hood Park, and Greenbelt Boat Ramps; the Washington State Parks and Recreation Commission for the use of Maryhill State Park and Lyon's Ferry State Park; the Washington Department of Transportation for the use of the Vernita Rest Area; Weyerhauser for allowing us to use the Weyerhauser Boat Ramp; the Skamania County Parks Department for the use of Home Valley Park; the Port of Klickitat County for the use of Bingen Marina; the Port of Camas/Washougal for the use of Camas/Washougal Boat Ramp; the Port of Cascade Locks for the use of Cascade Locks Marina; the Port of Cathlamet for the use of Cathlamet Marina; the Port of The Dalles for the use of The Dalles Boat Basin; the Port of Hood River for the use of Hood River Marina; the Portland Metro Regional Parks Department for the use of M.J. Gleason Boat Ramp and Chinook Landing; the City of Rainier for the use of the Rainier Boat Ramp; the City of Richland for the use of Columbia Point Park, and the City of Vancouver for the use of Marine Park; and Sheila Cannon and Ken Beer for the use of The Fishery at Covert's Landing.

We greatly appreciate Kerry Bennett, Marla Bennett, Kathleen Byrd, Matt Campbell, Shawn Collins, Christopher Davis, Ken Engelsen, Anne Godsil, Louis Hans, Craig Heiden, Maria Holmes, Kurt Hubbard, Sally Hyde, Seth Klein, Michelle Klies, Donna Laine, Tracy McGuire, Derrick Meaghers, Eric Meyers, Linda Moore, Kim Motyka, Kathleen Moyer, James Roban, Bill Rogers, Lawrence Rush, Tricia Shoblom, Michelle Sorensen, Joe J. Steele, Fella Tanaka, Mark Thompson, Robb Vezzetti, Nancy White, and Nick Yaksic for their work operating the sport-reward fishery registration stations. We also recognize Donna Hunt, Doug Koehn, and Cathy Moog for their excellent work in computer data entry and verification of volumes of documents; Bob Noyes for his work in fish handling, and Boo Fox for her numerous phone survey interviews.

We are particularly thankful to our administrative assistants, Janice Suarez-Pena and Wilbert Morrison for their 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 1997. 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) record length data on the above-mentioned species which are returned to registration stations, (4) collect, monitor and report data on angler participation and catch per angler day during the season, (5) report promotional, fish handling, and cost analysis aspects of the NPSRF and, (6) conduct research to determine if genetic differences exist between northern pikeminnow caught within the Program boundaries compared to those caught outside of the Program boundaries.

A total of 119,488 northern pikeminnow $\geq$ 279 mm were harvested during the 1997 season and 27,338 angler days were spent harvesting these fish. Harvest was below the six-year average of 156,136 while participation was well below the six-year average of 54,958. Catch per angler day for all anglers during the season was 4.37 and exceeded the six-year average of 3.23 northern pikeminnow per angler day.

Peamouth (*Mylocheilus caurinus*), and smallmouth bass (*Micropterus dolomieui)*, were other species most often harvested by returning NPSRF anglers targeting northern pikeminnow. Harvest of salmonids *(Onchorhynchus* 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 in the Lower Columbia and Snake River systems (Rieman et al. 1988). Rieman and Beamesderfer (1990) predicted 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 during the previous six years (Friesen et al. 1996).

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 cumulatively $3 each for their first 100 northern pikeminnow returned, $4 each from 101-400, and $5 each over 400. Anglers participating in the program registered at one of 21 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 (*Ptychocheilus oregonensis)* $\geq$ 279 mm total length, (2) collect catch data on selected fish species caught by fishery participants while targeting northern pikeminnow, (3) record length data on the above mentioned species which are returned to registration stations, (4) collect, monitor and report data on angler participation and catch-per-angler-day during the season, (5) report promotional, fish handling, and cost analysis aspects of the NPSRF and, (6) conduct research to determine if genetic differences exist between northern pikeminnow caught outside of the NPSRF boundaries compared to those caught within the boundries. Specific findings for objective 6 are reported in the Appendix.

METHODS OF OPERATION

Fishery 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. Angler rules for participation remained unchanged from 1996 (Winther et al. 1996). The 1997 NPSRF was fully implemented from May 19 (week 21) through October 5 (week 40), and was extended at limited stations through October 17 (week 42).

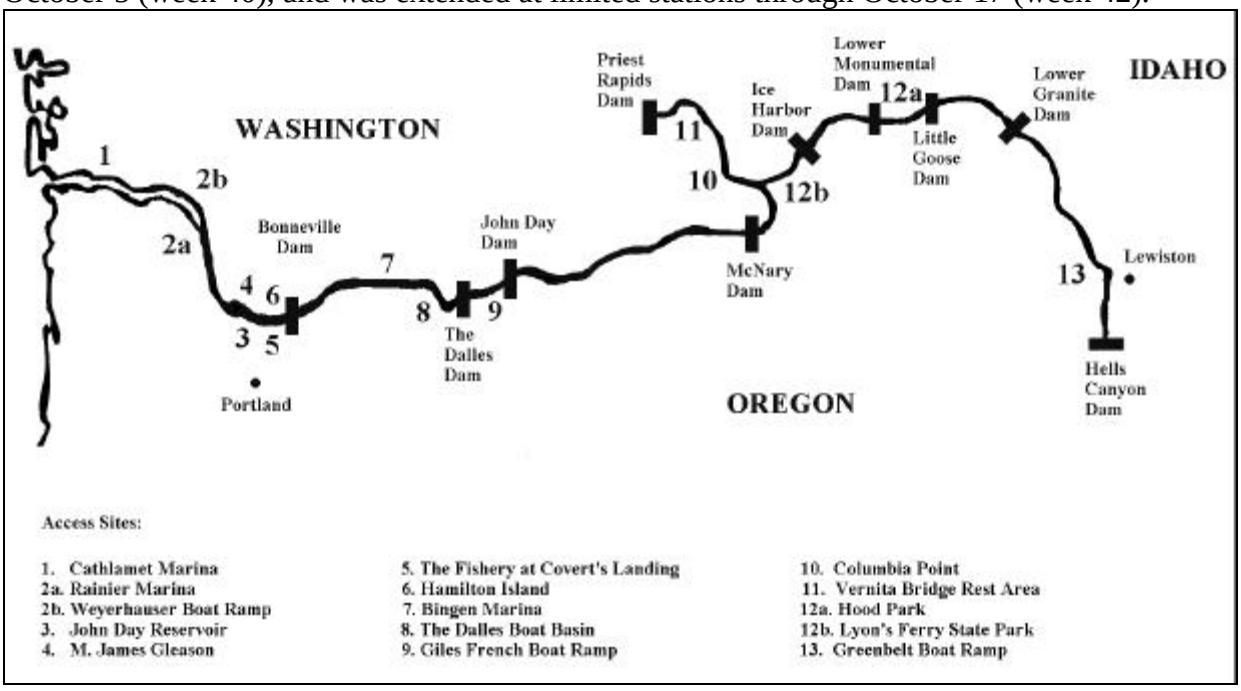

Figure 1. 1997 Northern Pikeminnow Sport-Reward Fishery Registration Stations.

Registration and Satellite Stations

Thirteen registration stations including two hybrid registration stations (Winther et al. 1996) 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 Hood Park/Lyons Ferry hybrid registration stations were full-time stations that split time each day at two locations. The Hood Park/Lyons Ferry registration station operated full-time during a short season from June 16 through August 24. 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 13 full-time registration stations used during the 1997 NPSRF, there were eight part-time satellite stations used (Figure 2), which performed the same functions as full-time stations. Satellite stations 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. Satellite stations 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.

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; with a "Yes" response

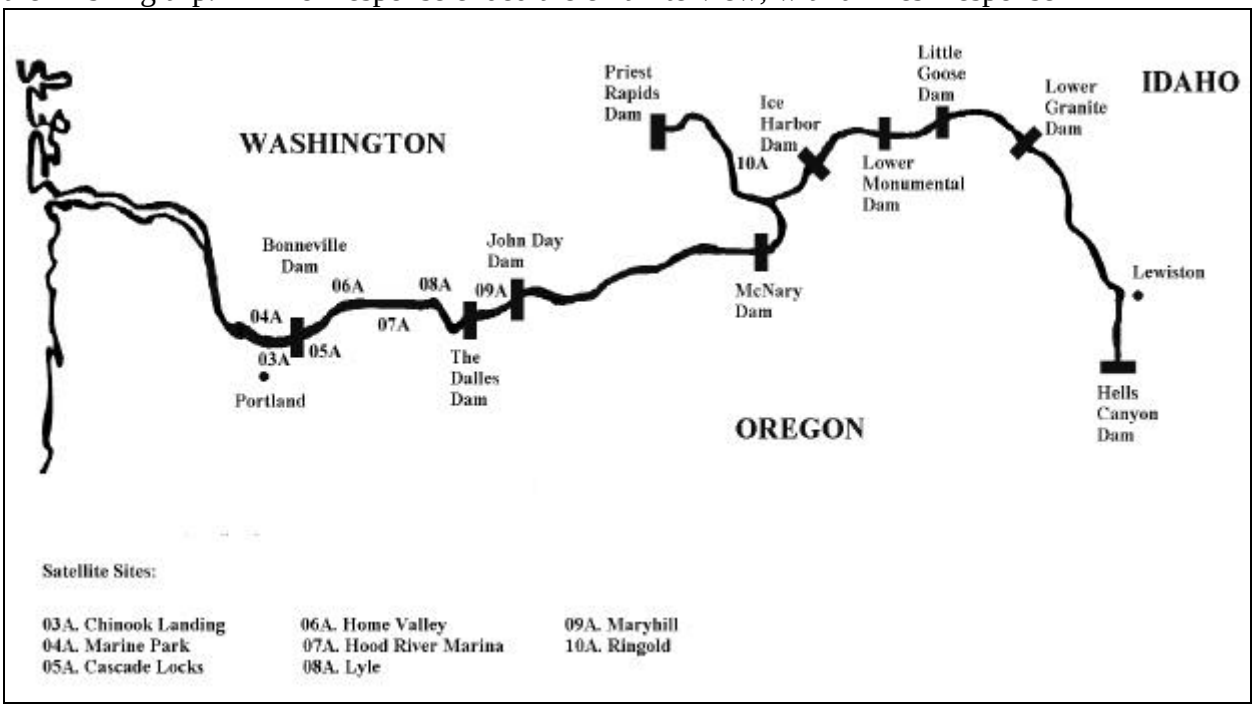

Figure 2. Northern Pikeminnow Sport-Reward Fishery Satellites for 1997.

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. We excluded fishing location 6 (Figure 3) salmonid catches from our Columbia River salmonid report per agreement with National Marine Fisheries Service (NMFS).

Non-Returning Angler Sampling

Technicians surveyed 20% of each week's non-returning anglers by telephone. To attain our 20% goal, a 50% systematic random sample (one in two) 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).

Non-Returning Angler Catch and Harvest Estimates

We sampled 20% of non-returning anglers targeting northern pikeminnow and estimated their catch, harvest and effort using a simple estimator (5.06). Salmonid catch and harvest estimates were reported by river. We reported Columbia River salmonid catch from the mouth to the confluence of the Snake and Columbia rivers to emphasize areas where the NPSRF may

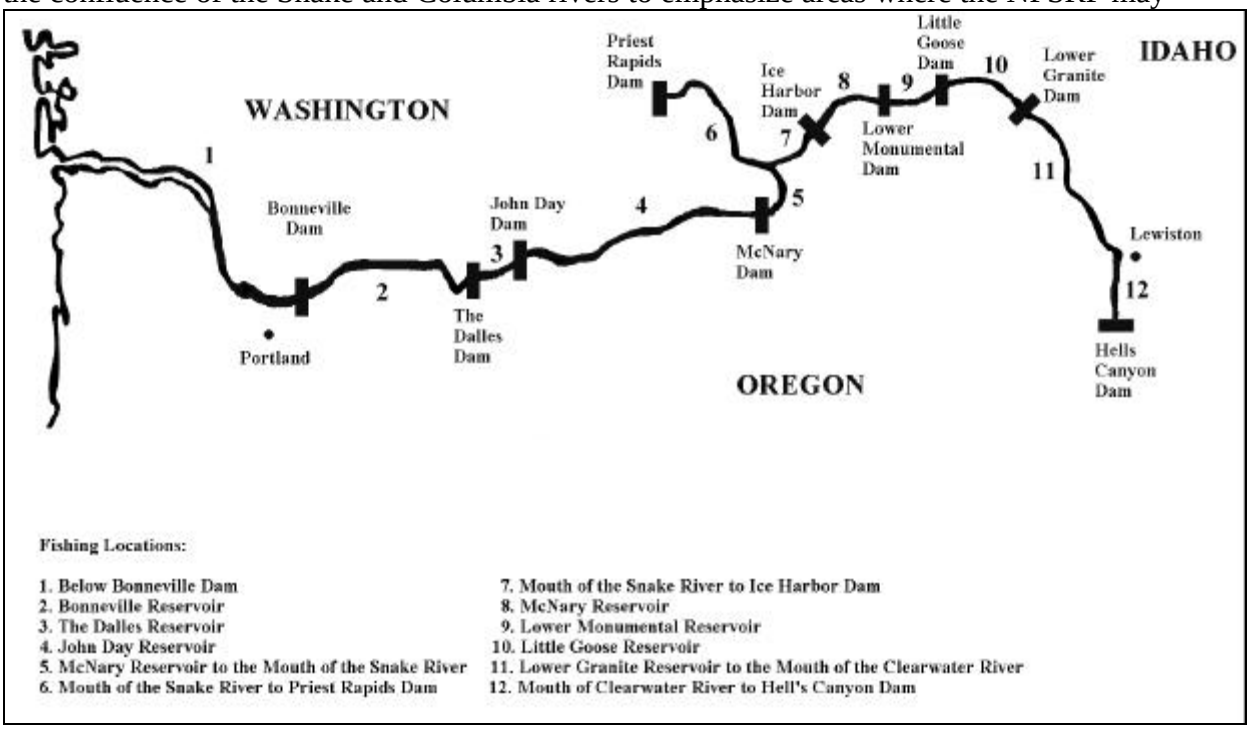

Figure 3. Fishing Locations for 1997.

affect Snake River stocks listed under the Endangered Species Act (ESA). Fishing location 6 (Figure 3) was excluded from our Columbia River salmonid catch estimates per agreement with NMFS.

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 coolers and delivered to storage facilities. Rendering companies picked up stored northern pikeminnow in Clarkston and Pasco, while all other northern pikeminnow were picked up by NPSRF technicians and transported to rendering facilities.

Cost Analysis

We monitored the cost effectiveness of the NPSRF to ensure the greater efficiency. Average operating cost per registration station and satellite station was estimated using the same methods developed by Winther et al. (1996). Overall cost per northern pikeminnow with and without satellite stations was determined by summing the associated operating costs and dividing by the total number of northern pikeminnow turned in to each station.

Northern Pikeminnow Tournaments

The NPSRF conducted five northern pikeminnow "BPA/Radio" tournaments in 1997 designed to increase participation with an emphasis on recruiting new anglers. Daily prizes were awarded to anglers catching the three longest northern pikeminnow for the day, and three grand prizes of $500, $250 and $100 were awarded for the three longest northern pikeminnow for the tournament. Four tournaments (Clarkston, Tri-Cities, Bingen/The Dalles/Giles French, and Cathlamet/Rainier) were associated with and sponsored in part by local radio stations. One tournament, Gleason/Washougal/The Fishery/Hamilton Island, was sponsored solely by BPA.

RESULTS AND DISCUSSION

Northern Pikeminnow Harvest

The 1997 NPSRF harvested 119,488 northern pikeminnow $\geq$ 279 mm total length. An additional 26,108 northern pikeminnow < 279 mm total length were caught of which 17,834 were released. Harvest in 1997 was 24% lower than 1996 (Winther et al. 1996), and 23.5% lower than the 6-year average of 156,135. Figure 4 shows the weekly harvest for 1997 compared to the means for each week from the 1991-96 seasons. Mean weekly harvest in 1997 was 5,431 with peak harvest occurring during week 27 (June 30 through July 6). Peak harvest occurred during the same week as 1996, one week later than the mean peak harvest for 1991-96. The lowest weekly harvest was during week 41 (October 6 through October 12, the first week of the extended fishery) when only selected stations were open.

Harvest by registration station ranged from 17,078 at Vernita to 1,087 at Hood Park/Lyons Ferry (Figure 5). Harvest by fishing location for 1997 ranged from 49,814 below Bonneville Dam (fishing location 1) to 15 northern pikeminnow for fishing location 10 (Figure 6). The greatest change in harvest between 1996 and 1997 was in fishing locations 1,2 and 3, where the combined harvest for 1997 was 25.8% less than 1996.

Over 16,000 northern pikeminnow were harvested at fishing locations 1, 2, 3, and 6. Totals from these locations comprised 90.5% of the harvest for all fishing locations.

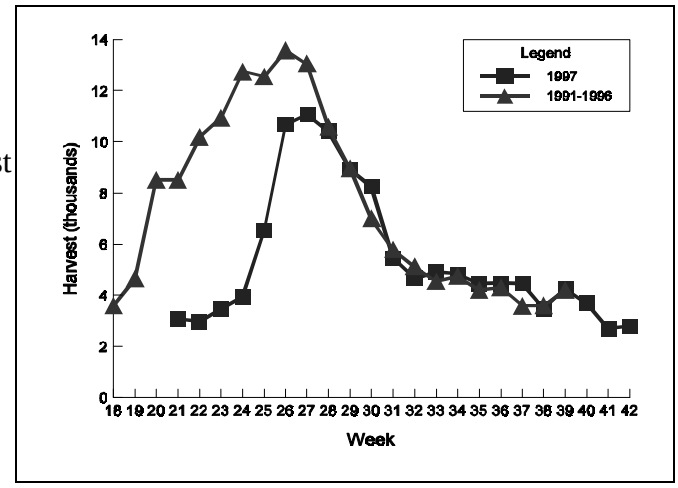

Figure 4-**Comparison of harvest by week for 1991-1996 (means) to 1997.**

Returning Angler Harvest

Northern pikeminnow ≥ 279 mm (117,391) were the most frequently caught species by returning anglers targeting northern pikeminnow, followed by northern pikeminnow < 279 mm, peamouth (*Mylocheilus caurinus*) and smallmouth bass (*Micropterus dolomieui*) (Table 1). The northern pikeminnow total is different from the overall total harvest of 119,488 because only fish caught while targeting northern pikeminnow were included. Fourteen adult chinook salmon (*Onchorhynchus tshawytscha*), including 6 chinook jacks, and 24 adult steelhead (*Onchorhynchus mykiss*) were caught incidentally from the Columbia River by anglers targeting northern pikeminnow (Table 2). Additionally, 1 adult chinook salmon and 15 adult steelhead were caught in the Snake River by anglers targeting northern pikeminnow. Forty-five percent of salmonids caught by anglers targeting northern pikeminnow were caught below Bonneville Dam. Incidental salmonid catches by anglers targeting northern pikeminnow were low when compared to the total number of northern pikeminnow ≥ 279 mm caught in the NPSRF, thus impact on salmonids by the NPSRF continues to be minimal.

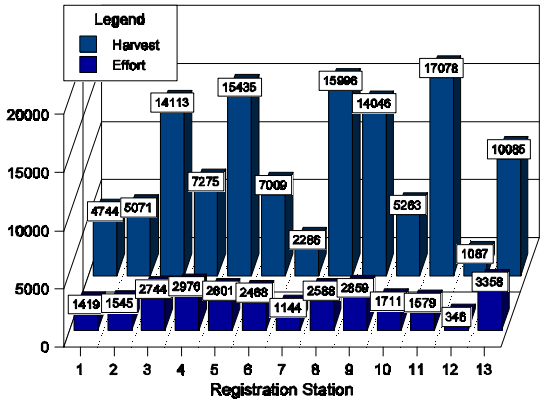

Figure 5- Harvest and effort by registration station in 1997. 1-Cathlamet, 2- Ranier /Weyerhauser, 3-Gleason, 4-Washougal, 5- The Fishery, 6- Hamilton Island, 7- Bingen, 8- The Dalles, 9- Giles French, 10-Columbia Point, 11- Vernita, 12- Hood Park/Lyon's Ferry, 13- Greenbelt.

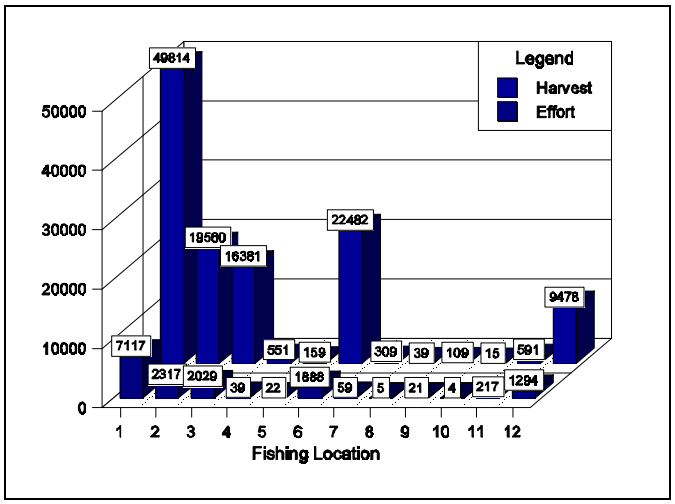

Figure 6- Harvest and effort by fishing location in 1997. 1- Below Bonneville Dam, 2- Bonneville Res., 3- The Dalles Res., 4- John Day Res., 5- McNary Dam to Mouth of Snake, 6- Mouth of Snake to Priest Rapids Dam, 7- Mouth of Snake to Ice Harbor Dam, 8- Ice Harbor Res., 9- Lower Monumental Res., 10- Little Goose Res., 11- Lower Granite Dam to Clarkston, 12- Clarkston to Hells Canyon Dam.

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

Species	Harvest	Percent Harvested
Northern Pikeminnow > 279 mm	116950	99.62%
Northern Pikeminnow < 280 mm	8274	31.69%
Peamouth	2946	24.01%
Smallmouth Bass	454	16.11%
White Sturgeon (*Acipenser transmontanus)*	47	1.86%
Walleye (*Stizostedion vitreum)*	520	50.53%
Channel Catfish (*Ictalurus punctatus)*	414	27.18%

Total Returning Angler-days Targeting Northern Pikeminnow = 12,526

Non-Returning Angler Harvest

We estimated that five adult chinook salmon were caught in the Columbia River and five juvenile chinook salmon were caught in the Snake River by anglers targeting northern pikeminnow. One hundred percent of the adult and juvenile chinook salmon caught in the Columbia and Snake River were released. Steelhead were the most frequently caught species,

while juvenile steelhead were the only salmonid species harvested by non-returning anglers targeting northern pikeminnow (Table 2).

Table2. Catch and harvest of adult and juvenile salmonids by returning anglers targeting northern pikeminnow and estimated catch and harvest of adult and juvenile salmonids by nonreturning anglers targeting northern pikeminnow.

Returning Anglers	**Columbia River**			**Snake River**		
Species	Catch	Harvest	Percent Harvested	Catch	Harvest	Percent Harvested
Chinook Salmon (Adult)	14	6	42.86%	1	0	0.00%
Chinook Salmon (Jack)	6	5	83.33%	0	0	0.00%
Chinook Salmon (Juvenile)	5	0	0.00%	0	0	0.00%
Steelhead Adult (Adipose Absent)	18	12	66.67%	13	7	53.85%
Steelhead Adult (Adipose Present)	6	0	0.00%	2	0	0.00%
Steelhead Juvenile(Adipose Absent)	8	0	0.00%	0	0	0.00%
Steelhead Juvenile(Adipose Present)	7	0	0.00%	0	0	0.00%

Columbia River N= 11,091
Snake River N= 1,435

Non-Returning Anglers	**Columbia River**					**Snake River**				
Species	Sample Catch (19.75%)	Estimated Catch	Confidence Interval (95%)	Estimated Harvest	Percent Harvested	Sample Catch (19.75%)	Estimated Catch	Confidence Interval (95%)	Estimated Harvest	Percent Harvested
Chinook Salmon (Adult)	1	5	9	0	0.00%	0	0	0	0	0.00%
Chinook Salmon (Juvenile)	2	10	13	0	0.00%	1	5	9	0	0.00%
Steelhead Adult (Adipose Absent)	1	5	9	0	0.00%	0	0	0	0	0.00%
Steelhead Juvenile (Adipose Absent)	6	30	29	5	16.67%	4	20	18	0	0.00%
Coho Salmon (Juvenile) *Oncorhynchus kisutch*	0	0	0	0	0.00%	1	5	9	0	0.00%

Columbia River N=6,947 n=1,373
Snake River N=1,503 n=297

Angler Effort

Total effort (number of registered-angler-days) for 1997 was 27,338 days. This was 8,147 days less than 1996 (Winther et. al. 1996), and 50% lower than the six year average of 54,958. Returning angler effort totaled 15,012 angler days, 54.9% of total angler effort. Peak angler effort occurred during week 26 (June 23 to June 29), which was the same as the peak in 1996 and much later than the mean peak effort for 1991-96 (Figure 7). Effort by fishing location for 1997 (returning anglers only) ranged from 7,117 below Bonneville Dam to only 4 in Little Goose Reservoir (Figure 6). The greatest change in effort between 1996 and 1997 was in fishing locations 1,2 and 3, where the combined returning angler effort for 1997 was 18.3% less than 1996. The decrease in total returning anglers days (3,338) in 1997 accounted for 70% of the difference in harvest from 1996. The Greenbelt registration station had the highest total effort (3,358) for the 1997 NPSRF and the next highest station (Washougal) had 89% of that total (Figure 5).

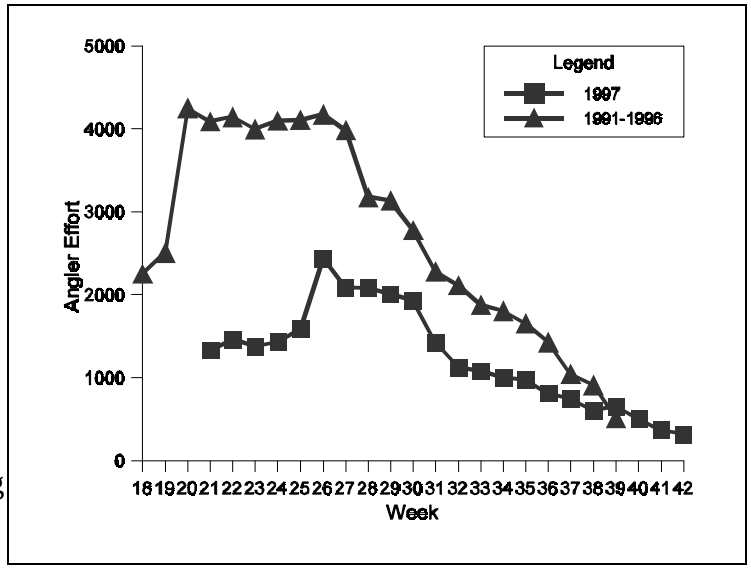

Figure 7- Comparison of angler effort by week for 1991-1996 (means) to 1997.

Catch Per Angler Day

Overall catch per unit effort (CPUE; returning + nonreturning anglers) in 1997 was 4.37 northern pikeminnow $\geq$ 279 mm/angler day, which exceeded the 1991-96 average of 3.23 northern pikeminnow/angler day. The tendency of the weekly CPUE to increase as the season progresses was consistent with 1996 (Winther et al. 1996), and the CPUE each week was much higher overall than the mean 1991-96 weekly CPUE (Figure 8). CPUE (returning anglers) ranged from 2.72 in Lower Granite Reservoir (fishing location 11), to 14.13 in fishing location 4 (Figure 9). Anglers utilizing the Vernita registration station had the highest CPUE with 10.82 and Bingen anglers had the lowest with 2.0 (Figure 10).

When we exclude nonreturning anglers, CPUE for returning anglers was 7.96 northern pikeminnow per angler day in 1997, which was down slightly from 8.6 in 1996. Factors that may contribute to annual variations in returning angler CPUE are: anglers effort, 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 1997 made little difference in the success rate for returning anglers in 1997, yet the overall effect of the decline in returning angler CPUE is important. If effort in 1997 would have equaled that of

1996, we would have needed an additional 1,403 returning angler days to equal the 1996 harvest of 157,230 northern pikeminnow.

Northern Pikeminnow Processing

The NPSRF disposed of 66 tons of northern pikeminnow in 1997 at a cost of $0.26 per northern pikeminnow. Total disposal costs for the 1997 NPSRF were $31,577.00, slightly less than the 1996 total disposal costs (Winther et al. 1996).

Cost Analysis

The estimated operating cost per registration station (including satellites) in 1997 was $46,812 and ranged from $40,871 at Rainier/Weyerhauser to $52,027 at Giles French. Average cost per northern pikeminnow (including satellites) was $5.09, while without

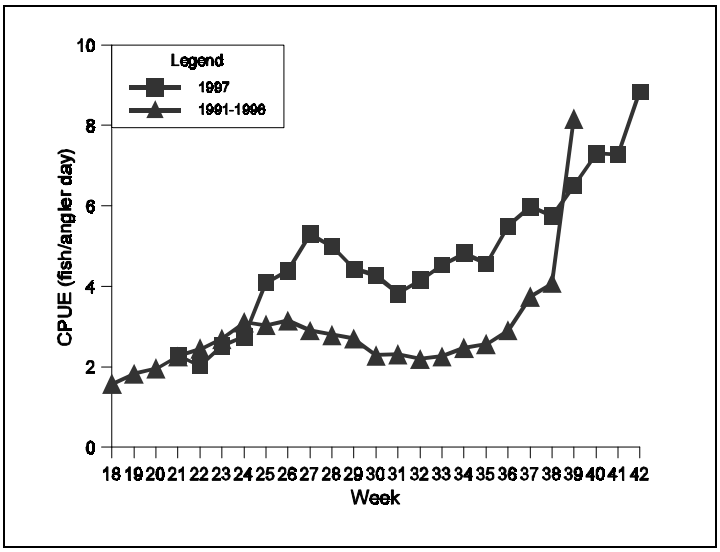

Figure 8- Comparison of CPUE (fish/angler day) by week for 1991-1996 (means) to 1997.

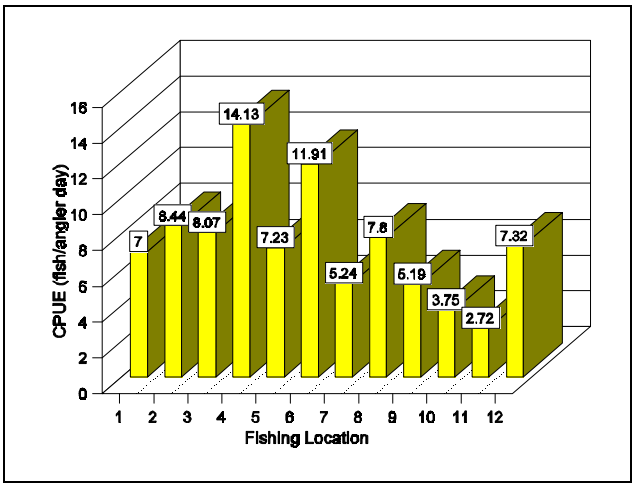

Figure 9- CPUE of returning anglers by fishing location in 1997. 1- Below Bonneville Dam, 2- Bonneville Res., 3- The Dalles Res., 4- John Day Res., 5- McNary Dam to Mouth of Snake, 6- Mouth of Snake to Priest Rapids Dam, 7- Mouth of Snake to Ice Harbor Dam, 8- Ice Harbor Res., 9- Lower Monumental Res., 10- Little Goose Res., 11- Lower Granite Dam to Clarkston, 12- Clarkston to Hells Canyon Dam

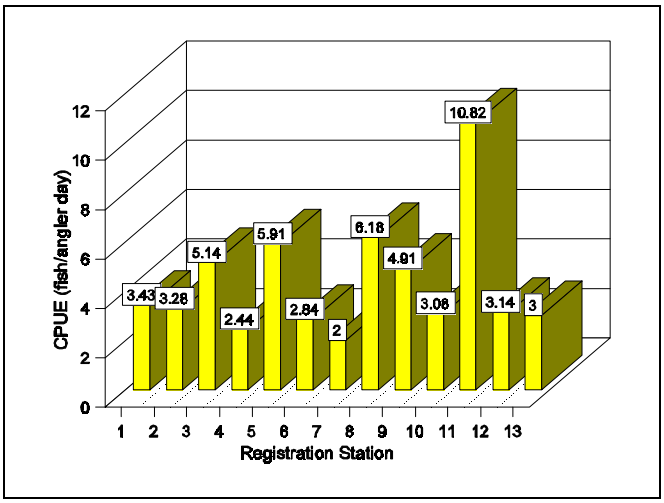

Figure 10-CPUE of returning anglers by registration station in 1997. 1-Cathlamet, 2- Ranier /Weyerhauser, 3- Gleason, 4-Washougal, 5- The Fishery, 6- Hamilton Island, 7- Bingen, 8- The Dalles, 9- Giles French, 10- Columbia Point, 11- Vernita, 12- Hood Park/Lyon's Ferry, 13- Greenbelt

satellites was $5.17. Operating costs per satellite in 1997 were estimated at $4,136 and ranged from $3,522 at Ringold to $4,823 at Hood River. Average cost per northern pikeminnow (satellites only) was $3.93. The average cost per northern pikeminnow rose $0.79 in 1997, most likely due to inflation costs and decline in harvest.

Northern Pikeminnow Tournaments

A combined 1,096 anglers fishing the NPSRF during "BPA/Radio" tournaments in 1997 were first time out/new anglers and accounted for 60% of all combined effort during the tournaments. Those anglers fished an additional 863 angler days and caught 3,455 northern pikeminnow after the tournament period. Total effort for first time out/new anglers for the tournament period was greater than any other time period during 1997 except week 1. These results show the "BPA/Radio" tournaments are extremely successful at recruiting anglers to the NPSRF and that many continue to participate after the tournaments are over. The success rate of these anglers is not as high as the more experienced anglers and suggests that we need to continue to improve our methods of educating these anglers.

SUMMARY

The reduction in harvest from 1996 to 1997 can be attributed to a drop in effort and success. 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 1997 NPSRF was well below mean 1991-96 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. Swift, high water hindered the use of small watercraft in some areas and limited shoreline access early in the NPSRF season . Participation levels throughout the 1997 NPSRF never came close to mean 1991-96 levels. Since returning anglers catch approximately eight northern pikeminnow per angler day, additional 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 localized "BPA/Radio" tournaments show excellent results for encouraging first time and/or first-time-out participants.

The trend in weekly CPUE for the 1997 NPSRF, as well as the mean CPUE for 1991-1996 shows an increase in CPUE throughout the season, especially toward the later 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 1998 SEASON:

1. Continue advertising and promotions to recruit additional anglers to the NPSRF.

2. Begin the 1998 NPSRF earlier than in 1997, from May 4 (week 19), through September 27. (week 38), 1998.

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.

6. Discontinue the use of Hood Park/Lyons Ferry hybrid registration station.

7. Begin reporting all steelhead caught in fishing location six by NPSRF anglers targeting northern pikeminnow.

REFERENCES

Friesen, T.A., M.P. Zimmerman, and D.L. Ward. 1996. Development of a system-wide predator control program: Indexing and fisheries evaluation. Oregon Department of Fish and Wildlife, Contract number DE-BI79-90BP07084. 1996 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Hisata, J.S., M.R. Petersen, D.R. Gilliland, E.C. Winther, S.S. Smith, and J. Suarez-Pena. 1995. Implementation of the northern squawfish sport-reward fishery in the Columbia and Snake Rivers. Report A *in* Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin (Northern Squawfish Management Program).1995 Annual Report, project number 90-077. Contract DE-B179-90BP07084, Bonneville Power Administration, Portland, Oregon.

Klaybor, D.C., C.C. Burley, S.S. Smith. E.N. Mattson, E.C. Winther, P.E. DuCommun, H.R. Bartlett, and S.L. Kelsey. 1993. Evaluation of the northern squawfish sport-reward fishery in the Columbia and Snake Rivers. Report B *in* C.F. Willis and D.L. Ward, editors. Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1993 Annual Report, Volume 1. Contract DE-B179-90BP07084, Bonneville Power Administration, Portland, Oregon.

Porter, R.G. 1995. Northern squawfish sport reward payments. *In* Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin (Northern Squawfish Management Program). 1995 Annual Report, project number 90-077. Bonneville Power Administration, Portland, Oregon.

Rieman, B.E., R.C. Beamesderfer, S. Vigg, and T.P. Poe. 1988. Predation by resident fish on juvenile salmonids in a mainstem Columbia reservoir: Part IV. Estimated total loss and mortality of juvenile salmonids to northern squawfish, walleye, and smallmouth bass. T. P. Poe and B. E. Rieman, editors. Resident fish predation on juvenile salmonids in John Day Reservoir, 1983-1986. Final Report (Contracts DE-AI79-82BP34796 and DE-AI79-82BP35097) to Bonneville Power Administration, Portland, Oregon.

Rieman, B.E., and R.C. Beamesderfer. 1990. Dynamics of a northern squawfish population and the potential to reduce predation on juvenile salmonids in a Columbia River reservoir. North American Journal of Fisheries Management 10:228-241.

Smith, S.E, D.R. Gilliland, E.C. Winther, M.R. Petersen, E.N. Mattson, S.L. Kelsey, J. Suarez-Pena, and J. Hisata. 1994. *In* Development of a system-wide predator control program: Evaluation of the northern squawfish sport-reward fishery in the Columbia and Snake Rivers. Washington Department of Fish and Wildlife, Contract Number DE-BI79-90BP07084. 1994 Annual Report to Bonneville Power Administration, Portland, Oregon.

Winther, E.C., J.S. Hisata, M.R. Petersen, M.A. Hagen and R.C. Welling. 1996. Implementation of the northern squawfish sport-reward fishery in the Columbia and Snake Rivers. *In* Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin (Northern Squawfish Management Program). 1996 Annual Report, project number 90-077. Contract DE-B179-90BP07084, Bonneville Power Administration, Portland, Oregon.

Zimmerman, M.P., D.L. Ward, T.A. Friesen, and C.J. Knutsen. 1995. Development of a system-wide predator control program: indexing and fisheries evaluation. *In* Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin (Northern Squawfish Management Program). 1995 Annual Report, project number 90-077. Bonneville Power Administration, Portland, Oregon.

APPENDIX

Genetic Research

Introduction

Northern pikeminnow (*Ptychocheilus oregonensis*) are native to many rivers and lakes in Washington and Oregon (Wydoski and Whitney 1979). As a result, enforcement of NPSRF by WDFW officials becomes problematic when northern pikeminnow caught outside program boundaries are illegally represented as fish caught within program boundaries. The consequences of this potential problem include payment for fish outside program boundaries, reduced effectiveness of northern pikeminnow fisheries within the program boundaries, and skewed population data about northern pikeminnow abundance.

Comparison of genetic differences among northern pikeminnow populations outside and within program boundaries is a plausible means of indicating northern pikeminnow illegally represented as eligible Sport-Reward Program fish. This study uses mitochondrial DNA restriction fragment length polymorphism (RFLP) analysis to describe genetic variation among northern pikeminnow populations of interest to the Sport-Reward Program. This comparison is part of a larger genetic study involving both nuclear and mitochondrial DNA to characterize genetic variation among several species of Cyprinidae endemic to Washington, Oregon, and Idaho.

Methods

Northern pikeminnow were collected from two locations within the NPSRF and from two sites outside the program's boundaries. "In bounds" locations sampled included Lower Granite (N=10) and the Columbia River below Bonneville Dam (N=10). Locations sampled outside the Northern Pikeminnow Sport-Reward Fishery boundaries included the Spokane River below Nine Mile Falls (N=10), and the East Fork Palouse River near Pullman, Washington (N=11). The samples from Lower Granite Reservoir were from a previous study (Smith 1996).

Tissue from the right pectoral fin was excised from each fish and total genomic DNA extracted using the procedure described by Smith (1996). Extracted DNA was amplified using the polymerase chain reaction (PCR) and primers specific for the amplification of the mitochondrial Cytochrome-b gene. Amplified products were digested separately using 15 restriction endonucleases (*Alu* I, *Bam*H I, *Bst*U I, *Dde* I, *Dpn* II, *Eco*R I, *Hae* III, *Hin*f I, *Hha* I, *Hpa* I, *Mse* I, *Nla* III, *Rsa* I, *Taq* I, and *Xba* I). Aliquots of digested DNA were electrophoresed on 1.8% agarose gels, along with a DNA size standard. Gels were stained with ethidium bromide and banding patterns visualized using ultraviolet light. Photographs were taken of each gel and scanned into a personal computer. The size (in base pairs) of each band was determined using the computer programs DNAsize (Raghava 1994) and SigmaScan Version 3.0 (1996). The variation in restriction fragment size was then compared for within and between group differences.

Preliminary Results and Discussion

Table 1 shows the simple haplotypes observed in each sample location and how they were combined into composite haplotypes. Of the 41 tissue samples examined, 3 composite haplotypes were observed, designated NS-01, NS-02 and NS-03. One of 4 sample locations examined, the Palouse River (PAL), was fixed for the composite haplotype NS-01 (N=11). More than one composite haplotype was observed in the remaining 3 sample locations. The composite haplotype NS-02 was not observed in the Columbia River (COR) samples (N=10). The samples from Lower Granite Reservoir (LGR), contained all 3 haplotypes (N=10). However, the frequencies of the composite haplotypes observed in the LGR samples were different from those observed at the other sample locations.

Table 2 shows the frequency of each composite haplotype among the four sample locations. The composite haplotype NS-01 was most frequently observed among samples from the Palouse River (fixed), Spokane River, and Columbia River. The composite haplotype NS-03 was most frequently observed among samples from Lower Granite Reservoir.

Significant differences were observed among composite haplotype frequencies from Lower Granite Reservoir when compared to the other sample location in this study. It should be noted that the sample sizes are small and composite haplotype frequencies could change dramatically when greater samples from each location are examined. Thus far, examination of mitochondrial haplotype frequencies should not be considered as an appropriate means of discriminating northern pikeminnow samples from "out of bounds" locations. Again, this may change with larger sample sizes or the examination of different mitochondrial gene regions. However, the discriminatory power required for this study is most likely near the limit of mitochondrial DNA to resolve such questions on this microgeographic scale.

Table 1. Simple and composite haplotype for each sample location. COR= Columbia River, LGR= Lower Granite Reservoir, PAL= Palouse River, SPO= Spokane River.

Pop.	*Alu* I	*Bam* H I	*Bst* U I	*Dde* I	*Dpn* II	*Eco* R I	*Hae* III	*Hin* f I	*Hpa* I	*Mse* I	*Nla* III	*Rsa* I	*Taq* I	*Xba* I	Composite Haplotype
COR	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NS-01
COR	A	A	A	A	A	A	A	A	A	A	B	A	A	A	NS-03
LGR	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NS-01
LGR	A	A	A	A	A	A	B	A	A	A	A	A	A	A	NS-02
LGR	A	A	A	A	A	A	A	A	A	A	B	A	A	A	NS-03
PAL	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NS-01
SPO	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NS-01
SPO	A	A	A	A	A	A	B	A	A	A	A	A	A	A	NS-02
SPO	A	A	A	A	A	A	A	A	A	A	B	A	A	A	NS-03

Table 2. Composite haplotype frequencies for each sample location.

Pop.	NS-01	NS-02	NS-03
COR	0.80	0.00	0.20
LGR	0.40	0.10	0.50
PAL	1.00	0.00	0.00
SPO	0.80	0.10	0.10

REFERENCES

Smith, S.S. 1996 Analysis of Hybridization Between Northern Squawfish and Chiselmouth in Lower Granite Reservoir, Washington. Thesis. Degree of Master of Science. University of Idaho, Moscow, Idaho.

Wydoski, R.S., and Whitney, R.R. 1979. Inland Fishes of Washington, p. 85. University of Washington Press, Seattle, Washington.

REPORT B

Northern Pikeminnow Sport Reward Payments - 1997

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Gladstone, OR 97202

February, 1998

INTRODUCTION

The Pacific States Marine Fisheries Commission 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 were 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 when the reward went to $5.00 per fish for all fish caught in excess of 400. 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 117,875 fish were paid on standard vouchers representing rewards of $470,175. 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 1,267 coupons were redeemed during the season.

TAGGED VOUCHERS

Tagged vouchers were sent to the Oregon Department of Fish and Wildlife 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. Once verified or rejected by Oregon Department of Fish and Wildlife, all tagged vouchers were delivered to PSMFC for payment. Verified 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 192 tag vouchers were received for total payments of $9,600 in 1997.

TOURNAMENTS

Biweekly tournaments were held at each of the 11 registration stations throughout the season. The three largest fish checked in at each station during each two week period received rewards of $125, $75 and $50 respectively. In addition, special 9 day tournaments were held in different parts of the river from July 14 - July 27, 1997 and in the lower river from June 21 - June 29, 1997. Prizes of $500, $250 and $100 were paid for the three biggest fish caught as well

as daily merchandise awards by the radio station sponsors. Tournament prizes paid by the sport-reward program totaled $38,975.

The attached table summarizes the payments, vouchers and tournament winnings during the 1997 season.

MISCELLANEOUS WORK

All IRS Form 1099-Misc. statements were sent to the qualifying anglers for tax purposes the third week in January, 1998. Appropriate reports and copies were provided to the IRS by the end of February, 1998.

1997 SPORT REWARD PAYMENTS SUMMARY

The following is a summary of the vouchers received and paid as of March 9, 1998.

	$Amount
TOTAL DOLLARS PAID OUT:	**$522,551**
Fish Paid at Tier 1: **40,789**	$122,367
Fish Paid at Tier 2: **37,622**	$150,488
Fish Paid at Tier 3: **39,464**	$197,320
Total: **117,875**	**$470,175**
Tags Returned: **192**	**$ 9,600**
Coupons Returned: **1,267**	**$ 3,801**
Total Bi-weekly Tournaments (all stations): **11**	$28,775
BPA Grand Tournament 6/21/97 – 6/29/97 (stations 1 & 2 [combined], with stations 10 through 13):	$ 4,250
BPA Grand Tournament 7/14/97 – 7/27/97 (stations 1 through 7):	$ 5,950
Total Tournament Payments:	**$ 38,975**

Anglers at Tier 3: **84**
Anglers at Tier 2: **125**
Anglers at Tier 1: **1,754**
Number of Separate Anglers: **1,963**

Anglers with 10 fish or less: **1,277**
Anglers with 1-2 fish: **578**

Number of Predacards ordered and/or issued: **833**

Top Anglers: *(Note: Does not include tournament winnings)*

1. Roy G. Kendall	Fish: **3,106**	Coupons: **1**	Tags: **1**	**$15,086**
2. Anthony S. Melius	Fish: **2,593**	Coupons: **0**	Tags: **0**	**$12,465**
3. Earl D. Miller	Fish: **2,137**	Coupons: **1**	Tags: **2**	**$10,290**
4. John G. Brown	Fish: **2,302**	Coupons: **1**	Tags: **2**	**$11,117**

REPORT C

Controlled Angling for Northern Pikeminnow at the Four Lower Dams of the Columbia River in 1997

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ACKNOWLEDGMENTS

We thank Gary James and Jed Volkman (Confederated Tribes of the Umatilla Indian Reservation); Lynn Hatcher and George Lee (Confederated Tribes and Bands of the Yakama Indian Nation); and Jim Griggs and Colleen Fagan (Confederated Tribes of the Warm Springs Reservation of Oregon) for implementing the work performed by tribal crews. Our deep appreciation goes to the tribal technicians who fulfilled their duties admirably. Volunteer anglers from the Northwest Steelheaders once again contributed to our efforts, for which we are grateful.

Personnel from the U.S. Army Corps of Engineers provided invaluable assistance in the completion of our work: Jim Kuskie and Dennis Schwartz (Bonneville Dam); Bob Cordie (The Dalles and John Day dams); and Peter Gibson and Brad Eby (McNary Dam).

We appreciate the review of an earlier draft of this report by Tom Friesen of ODFW.

ABSTRACT

Field crews and volunteers caught northern pikeminnow (*Ptychocheilus oregonensis*) by hook-and-line angling at four mainstem dams on the lower Columbia River from June 2 through September 26, 1997. A total of 3,519 predator-size ($250 mm fork length) northern pikeminnow were caught in 1997, down 13% from this project's 1996 catch. The preliminary estimate of the cost of delivering a unit of dam angling effort in 1997 was 24% less than it was in 1996. The highest catch rate was observed by technicians fishing at Bonneville Dam, they averaged 1.8 pikeminnow each hour (CPAH = 1.8). The overall catch per angler hour was 1.1 in 1997, compared to 1.7 the previous year. The total effort at three dams (Bonneville, The Dalles and John Day) increased to 150 percent that of 1996. Effort at McNary Dam was reduced to 54% of 1996 levels, a direct response to the decreased CPAH at that dam.

Volunteer angling at Bonneville Dam yielded 114 pikeminnow caught in 236 angler hours (CPAH: 0.5). A total of four sport-angling groups participated in the program this year. Their effort was similar to that of 1996's program which yielded 153 pikeminnow from 257 angler hours of effort (CPAH: 0.6).

Incidental catch was 6.8% of the total hook-and-line catch, compared to 2.3% the previous year, and 8.3% in 1995. White sturgeon (*Acipenser transmontanus*), smallmouth bass (*Micropterus dolomieu*), channel catfish *Ictalurus punctatus*, and American shad (*Alosa sapidissima*) constituted 83% of the incidental catch. Two salmonids were caught by hook-and-line in 1997 compared to none in 1996 and 5 in 1995.

INTRODUCTION

The eight hydroelectric dams on the lower Columbia and Snake rivers have converted a once free-flowing river into a series of reservoirs, prolonging the seaward migration of juvenile salmonids *Oncorhynchus* spp. Reservoirs provide predatory fish with conditions more suitable for feeding, especially near dams (Raymond 1979; Rieman et al. 1991). A principal predator on juvenile salmonids is the northern pikeminnow[1] *Ptychocheilus oregonensis*. This species has been targeted by the Columbia River Northern Pikeminnow Management Program (NPMP) for controlled removal from the lower Columbia and Snake rivers to reduce juvenile salmonid mortality due to predation.

Northern pikeminnow can be effectively removed from areas near dams using hook-and-line angling. Over the past seven years, dam based hook-and-line angling crews have caught nearly 115,000 predator-size ($ 250 mm fork length; Vigg et al. 1991) northern pikeminnow at eight dams on the lower Columbia and Snake rivers (Vigg et al. 1990; Beaty et al. 1993; Parker et al. 1993; CRITFC 1994, 1995; Collis et al. 1997). Our objectives in 1997 were to: 1) remove northern pikeminnow from areas near dams using hook-and-line angling; 2) minimize the incidental catch of salmonids, white sturgeon *Acipenser transmontanus*, and other fish; and 3) improve our effectiveness in carrying out these fisheries.

METHODS

Study Area

In 1997, dam angling was conducted at four U.S. Army Corps of Engineer dams on the lower Columbia River (Figure C-1). Removal activities were confined to the boat-restricted zones (BRZ) at these dams, with most of our effort focused in the tailraces.

Crew Scheduling

Hook-and-line angling by technicians started June 2nd and ended September 26th at Columbia River dams in 1997 (Tables C-1 and C-2). No dam-based angling was conducted at Snake River dams this year because catch rates at these dams were consistently lower than those observed at lower Columbia River dams. When feasible, crews working on the Columbia River rotated between dams to increase productivity (Table C-2). Still, each crew had its area(s) of primary responsibility. The Confederated Tribes of Warm Springs Reservation of Oregon crew fished Bonneville and McNary dams. The Yakama Indian Nation crew primarily fished John Day dam. The Confederated Tribes of the Umatilla Indian Reservation crew fished exclusively at McNary Dam, though fishing effort was reduced in response to low catch rates during 1997.

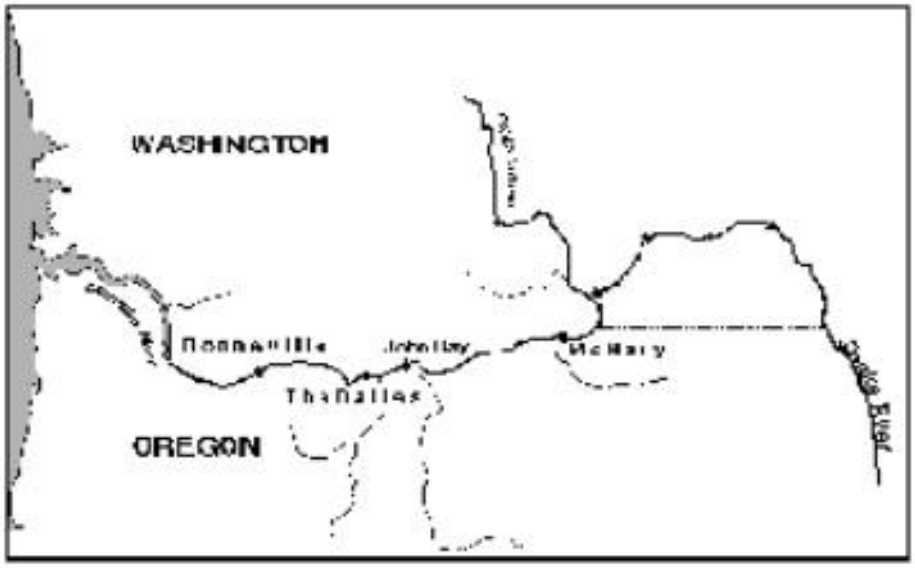

Figure C-1. Four lower Columbia River dams where controlled angling operations for northern pikeminnow took place in 1997.

Table C-1. Distribution of hook-and-line angling effort at Columbia River dams in 1997. A crew-day is defined as the expenditure of effort by a crew on a project during a 24 hr. period.

Dam	River km	Season	Number of crew-days worked
Bonneville	233	June 13 - Sept. 25	65
The Dalles	310	June 2 - Sept. 26	67
John Day	348	June 11 - Aug. 27	48
McNary	470	July 8 - Sept. 2	30

Volunteer anglers augmented the effort of technicians at Bonneville Dam (Table C-2). During the 1997 season, four sport-angling clubs (local chapters of the NW Steelheaders) volunteered to work two or more four-hour evening shifts and one morning shift on weekends from June 13th to August 2nd (Table C-2).

Field Procedures

Hook-and-line angling equipment and techniques, including measures to minimize incidental catch, were essentially the same as those used the previous five years (Parker et al. 1993). Size class determinations ($\leq$ or $\geq$ 250 mm fork length) were made by the crews who carried measuring tapes to verify the size category of questionable fish. Harvested northern pikeminnow were sacrificed, caudal fin clipped, and either returned to the river or delivered to NPMP check stations for biosampling and rendering. All tagged fish recovered were recorded and reported to the

appropriate agencies. All other incidentally caught fish were immediately released back into the river. Adult salmon and sturgeon were released by cutting the line as soon as the fish was identified. Species, adipose fin clips, and any injuries were noted if possible.

Boats were again used to access areas within the BRZ outside the reach of dam-based anglers, mostly at McNary Dam (Table C-3). Angling with downriggers was briefly tested at the Dalles Dam. Low speed, hand crank downriggers were used. One downrigger was mounted on each side of the boat gunnel near the transom. Fishing lures were attached (with downrigger clips) to 10 pound downrigger weights and fished within one foot of the bottom of the river using electronic depth-finders. Leader length behind the downrigger weights varied from 15 to 30 feet. A variety of lures were used. The lures were either fished by maneuvering the boat from side to side across the current or by anchoring and letting the downrigger fish the current.

Data Collection and Analysis

In 1997, data were collected as in previous years (Parker et al. 1993) using hand-held data loggers and transmitted daily via modem to the CRITFC Portland office. Anomalous data were identified using custom computer programs, then investigated and corrected if necessary. Weekly summary reports of catch and effort at each dam were provided to the Columbia Basin Fish and Wildlife Authority via e-mail.

Each crew was provided bi-weekly reports showing the relative productivity of different baits, sites, and time periods at each dam. Crews used this information to set their daily work schedules and to select the most effective baits and sites at each dam.

Table C-2. Methods applied by crew type and organization for removal of northern pikeminnow at Columbia River dams in 1997.

Crew type and organization	Dam(s)	Dates (days fished)
	Dam-based Angling	
Technicians[a]		
CTUIR	McNary	July 8 - Sept 2 (30)
CTWS	Bonneville, The Dalles	June 2 - Sept 26 (79)
YIN	John Day, The Dalles, Bonneville	June 11 - Aug 27 (51)
Volunteer Crews		
Beaverton Steelheaders	Bonneville	June 21 - July 19 (3)
Portland Steelheaders	Bonneville	June 19 - July 24 (4)
Sandy Steelheaders	Bonneville	June 13 - July 25 (3)
Tigard Steelheaders	Bonneville	June 27- Aug 2 (3)
	Boat Angling	
Technicians[a]		
CTUIR	McNary	July 8 - July 28 (15)
YIN	John Day	June 25 - Aug 20 (6)
	Downrigging	
Technicians[a]		
CTWS	The Dalles	Sept 12 (1)

[a] CTUIR = Confederated Tribes of the Umatilla Indian Reservation; CTWS = Confederated Tribes of Warm Springs Reservation of Oregon; YIN = Yakama Indian Nation

RESULTS AND DISCUSSION

Northern Pikeminnow Catch

In 1997, hook-and-line anglers caught 3,519 predator-size northern pikeminnow in 3,214 hours of fishing, for a seasonal CPAH of 1.1 (Table C-3). This catch declined by 13% from that of 1996; however, the preliminary estimate of the cost of delivering a unit of dam angling effort was 24% less in 1997 than it was in 1996. Among-year comparisons of catch and effort for hook-and-line angling are provided in Appendix B and discussed below (see *Temporal Effects*).

Spatial Effects

The 1997 angling effort was focused entirely at Columbia River dams, where recent-year catch rates have been consistently higher than at Snake River dams (Appendix Table B-1). Equal numbers of pikeminnow (1,086 each) were caught at Bonneville and John Day dams (Table C-3).

At all dams, angling effort was focused primarily in the tailrace areas, rather than in the forebay (Table C-4). This distribution of effort was consistent with that of previous years (Vigg et al. 1990; Beaty et al. 1993; Parker et al. 1993; CRITFC 1994, 1995; Collis et al. 1997).

Technicians at Bonneville dam reported the highest catch rate (CPAH = 1.8, Table C-5), followed by technician CPAH values of 1.3 at The Dalles and John Day dams, and a technician CPAH of 0.4 at McNary. The greatest angling effort (857 angler hours) was expended at John Day Dam (Table C-3).

Table C-3. Northern pikeminnow (NP) catch, effort, and catch per angler hour (CPAH) for dam-based angling, boat angling, and downrigging at Columbia River dams in 1997. Totals reflect actual values and not rounding errors.

River and dam	Dam-based angling			Boat angling			Downrigging			Totals		
	NP	Effort	CPAH	NPR	Effort	CPAH	NP	Effort	CPAH	NPR	Effort	CPAH
Columbia River												
Bonneville	1,086	784	1.4	--	--	--	--	--	--	1,086	784	1.4
The Dalles	1,084	824	1.3	--	--	--	0	2	0	1,084	826	1.3
John Day	1,063	816	1.3	23	41	0.6	--	--	--	1,086	857	1.3
McNary	124	319	0.4	139	426	0.3	--	--	--	263	746	0.4
Total	**3,357**	**2,743**	**1.2**	**162**	**468**	**0.3**	**0**	**2**	**0**	**3,519**	**3,214**	**1.1**

Table C-4. Northern pikeminnow (NP) catch, angler hours (effort), and catch per angler hour (CPAH) in tailrace and forebay fishing sites at Columbia River dams in 1997. No angling was conducted at Snake River dams in 1997.

River and dam	Tailrace			Forebay		
	NP	Effort	CPAH	NP	Effort	CPAH
Columbia River						
Bonneville	964	682	1.4	122	102	1.2
The Dalles	1,084	824	1.3	0	2	0
John Day	1,086	857	1.3	C	C	C
McNary	252	721	0.3	11	25	0.4
Total	**3,386**	**3,084**	**1.1**	**133**	**129**	**1.0**

Temporal Effects

The hook-and-line angling catch (over and under 250 mm fork length) totaled 3,525 in 1997, 13% less than that of 1996. Appendix Table B-1 reports the catches of large ($250 mm fork length) pikeminnow since 1991. The overall CPAH for hook-and-line angling declined from 1996 (CPAH = 1.7) to 1997's CPAH of 1.1. The total effort expended at Bonneville, The Dalles and John Day dams in 1997 was 150% greater than that in 1996. Because CPAH declined 75% at McNary Dam during 1997, effort was reduced to 54% that of 1996 (746 hours in 1997 vs 1372 hours in 1996). This scaling back was a direct response to the decreased CPAH at that dam.

Overall monthly northern pikeminnow catch was highest in July during 1997 (Appendix Table A-3). Weekly catch rates remained high from early July until September (Appendix Table A-1) this year. The 1997 weekly totals of catch, effort, and CPAH at Columbia River dams are listed in Appendix Table A-1. Comparisons among years (1991-1997) of weekly CPAH at Columbia River dams are provided in Appendix Table B-1.

Angling Gear and Techniques

A variety of gear and techniques were used in 1997. Downrigging was once again tested for removing northern pikeminnow from areas within the BRZ but outside the reach of dam-based anglers. Downriggers target northern pikeminnow that reside near the river bottom late in the season. Limited effort (2 angler hours) failed to catch a northern pikeminnow (Table C-3). Poor catches and stringent safety standards (a non-fishing rescue boat is required to stand by when a boat fishes in the BRZ) discouraged further use of this method.

As in past years, hook-and-line angling in 1997 was augmented with volunteers from local sport-angling groups. All volunteer angling was conducted at Bonneville Dam, the most convenient site for the Portland-area groups. This year's volunteers caught 114 northern pikeminnow in 236 hours, yielding a CPAH of 0.5. (Table C-5). It seems that a catch rate of one

pikeminnow every two hours is leading to reduced participation by volunteers in this aspect of the program. Four sport groups participated in the program in 1997, compared to twelve in 1995. Technicians will evaluate CPAH values early in 1998 to determine if this aspect of the program is likely to be feasible. If significantly improved CPAH values can be projected for volunteer groups, such angling may continue. Technician angling success at Bonneville (CPAH = 1.8 in 1997) remains viable.

Bait selection (Table C-6), and choice of fishing site (see *Spatial Effects*) varied by project. Overall, catch rates were highest using hard metal lures (CPAH = 2.2), followed by hard plastic lures (CPAH = 1.9). Soft plastic lures were used 77% of the time, even though their CPAH value was lower (1.0). This preference is probably a result of dependable performance of soft plastic lures under a greater diversity of fishing conditions.

Dam Operations and Smolt Passage

High discharge rates at hydroelectric dams, as in 1997, probably affects predator-prey interactions within the tailrace BRZ. Increased flow affects both the ability of northern pikeminnow to hold in areas preferred for feeding and the distribution and residence time of juvenile salmonids near dams (Faler et al. 1988; Mesa and Olson 1993; Hansel et al. 1994; Isaak and Bjornn 1994). For example, during periods of high discharge at McNary Dam, radio-tagged northern pikeminnow residing near the dam moved more than 2.5 km downstream, and moved back again when discharge decreased. Those fish that remained within the tailrace during high flow periods were found outside the main river channel, in backwaters and protected shoreline areas through which juvenile salmonids migrate (Faler et al. 1988).

We believe that high discharge rates and juvenile salmonid passage affected our catch rates of northern pikeminnow at Columbia River dams in 1997. Discharge rates at Bonneville Dam were very high this year, peaking at 557 kcfs on June 16th. Our CPAH values were their lowest this period, averaging 0.41 at Bonneville, The Dalles and John Day dams during statistical weeks 23-26 (Appendix Table A-1) CPAH values climbed to an average of 1.72 at these same dams during statistical weeks 27-30, as July's discharges fell to a daily average of 277 kcfs.

Catch rates increased from August to September at Bonneville and The Dalles dams. Members of the fishing crew felt that the pikeminnow were concentrated at the dams in order to feed on the shad outmigration, as many juvenile shad were observed in the guts of northern pikeminnow caught during this period.

Incidental Catch

The incidental catch was 6.8% of the total hook-and-line catch of northern pikeminnow in the Columbia River (Appendix Tables A-2 and A-3), compared to 2.2% in 1996, and 8.3% in 1995 (Collis et al. 1997). The proportion of sturgeon in the by-catch (3.2%) increased 3.2% from 1996 (0.8%). Bass *Micropterus* spp. and channel catfish *Ictalurus punctatus* were present in the by-catch at 1.1% and 1.0% of the total catch, respectively. Six walleye *Stizostedion vitreum* were observed. Two salmonids were caught by hook-and-line in 1997, compared to none in 1996 and five in 1995.

Table C-5. Northern pikeminnow (NP) catch, effort (angler hours), and catch per angler hour (CPAH) for technicians and volunteers at Bonneville Dam in 1997. Bonneville Dam was the only site for volunteer angling this year.

Dam	Technicians			Volunteers			Totals		
	NP	Effort	CPAH	NP	Effort	CPAH	NP	Effort	CPAH
Bonneville	972	548	1.83	114	236	0.5 6	1,086	784	1.4

Table C-6. Northern pikeminnow (NP) catch, effort (angler hours), and catch per angler hour (CPAH) for baits used at Columbia River dams in 1997. Totals reflect actual values and not rounding errors.

	Totals by dam				Totals			
Dam	Bait	NP	Effort	CPAH	Bait	NP	Effort	CPAH
Bonneville	HML	1	1.2	0.8	**Columbia River**			
	HPO	393	139.4	2.8	CLO	13	8.3	1.6
	SPO	686	608.1	1.3	HPO	808	422.0	1.9
	NBO	6	34.6	0.2	HML	8	3.7	2.2
					MIS	38	20.7	1.8
					SPO	2,541	2,476.0	1.0
The Dalles	HML	7	2.5	2.8	NBO	111	282.0	0.4
	HPO	328	130.8	2.5				
	SPO	699	516.2	1.4				
	NBO	50	176.9	0.3				
John Day	CLO	13	8.3	1.6				
	HPO	61	110.3	0.6				
	MIS*	38	20.7	1.8				
	NBO	55	70.4	0.8				
	SPO	919	647.1	1.4				
McNary	HPO	26	41.6	0.6				
	SPO	237	704.6	0.3				

Bait description:

HPO = Hard Plastic (such as Rat-L-Traps, Rapalas, and other plugs)

SPO = Soft Plastic (such as grubs, tubes, fish-like grubs)

MIS = Miscellaneous (bait unidentified or Items not in any other category)

NBO = Natural Bait (such as salmon smolts, Lamprey, worms)

CLO = Combination Lures (any combination Of the classes listed above)

HML = Hard Metal Lures (such as spoons, spinners, Zonars)

RECOMMENDATIONS FOR 1998

1. **Reduce dam angling effort overall and focus it at the most productive Columbia River dams, and at the most productive times (July through September).**

   Angling has been discontinued on the Snake River due to declines in catch and catch rate. Catch rates at McNary Dam have been low during two consecutive high flow years. A more average flow year should determine the value of continued angling on this dam under more average flows and present northern pikeminnow population levels. Angling effort should be expended at the most productive dams and times.

2. **Discontinue the volunteer angling program at Bonneville Dam unless conditions yield improved CPAH estimates for volunteers.**

   The level of participation in the volunteer angling program appears to depend on the in-season success in catching northern pikeminnow at this dam, and these rates have not supported the interest once exhibited in this aspect of the program. In 1997, volunteer angling success rates hit a new low (CPAH = 0.5) discouraging participation by the sport fishing clubs.

3. **Continue to recruit and hire experienced hook-and-line anglers and provide them with in-season information to help improve their effectiveness.**

   Angler ability and experience are important factors in catch success. We will attempt to hire experienced technicians and to provide them with in-season information (e.g., reports showing the relative productivity of different baits, sites, and time periods at each dam) that will help to maximize our productivity in catching northern pikeminnow. We will encourage information exchange among crews by scheduling different crews to work together and by organizing in-season meetings.

REFERENCES

Beaty, R. E., B. L. Parker, K. Collis, and K. McRae. 1993. The use of controlled angling to manage northern squawfish populations at selected dams on the Columbia and Snake rivers. Pages 111-185 *in* C. F. Willis and A. A. Nigro, editors. Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1991 Annual report. Contract DE-BI70-90BP07084, Bonneville Power Administration, Portland, Oregon.

Collis, K., K. McRae, J. McCormack, and R. E. Beaty. 1997. Controlled angling for northern squawfish at selected dams on the Columbia and Snake rivers in 1994. Pages 181-207 *in* F. R. Young, editor. Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1995 Annual Report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

CRITFC. 1995. Controlled angling for northern squawfish at selected dams on the Columbia and Snake rivers in 1994. Pages 103-152 *in* C. F. Willis and F. R. Young, editors. Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1994 Annual Report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

CRITFC. 1994. Controlled angling for northern squawfish at selected dams on the Columbia and Snake rivers in 1993. Pages 163-220 *in* C. F. Willis and D. L. Ward, editors. Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1993 Annual Report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

Faler, M. P., L. M. Miller, and K. I. Welke. 1988. Effects of variation in flow on distributions of northern squawfish in the Columbia River below McNary Dam. North American Journal of Fisheries Management 8:30-35.

Hansel, H. C., R. S. Shively, G. S. Holmberg, T. P King, T.L. Martinelli, and M. B. Sheer. 1994. Movements and distribution of radio-tagged northern squawfish near The Dalles and John Day dams. Pages 17-73 *in* T. P. Poe, editor. Significance of selective predation and development of prey protection measures for juvenile salmonids in the Columbia and Snake river reservoirs. 1993 Annual Report. Contract DE-AI79-88BP91964, Bonneville Power Administration, Portland, Oregon.

Issak, D. J., and T. C. Bjornn. 1994. Movements of northern squawfish in the lower Snake River during 1993. Pages 1-27 *in* T. P. Poe, editor. Significance of selective predation and development of prey protection measures for juvenile salmonids in the Columbia and Snake river reservoirs. 1993 Annual Report. Contract DE-AI79-88BP91964, Bonneville Power Administration, Portland, Oregon.

Mesa, M. G., and T. M. Olson. 1993. Prolonged swimming performance of northern squawfish. Transactions of the American Fisheries Society 122:1104-1110.

Parker, B. L., K. Collis, B. Ashe, R. E. Beaty, and K. McRae. 1993. Controlled angling for northern squawfish at selected dams on the Columbia and Snake rivers in 1992. Pages 129-182 *in* C. F. Willis and A. A. Nigro, editors. Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1992 Annual Report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

Raymond, H. L. 1979. Effects of dams and impoundments on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society 108:505-529.

Rieman, B. E., R. C. Beamesderfer, S. Vigg, and T. P. Poe. 1991. Estimated loss of juvenile salmonids to predation by northern squawfish, walleye, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:448-458.

Vigg, S., C. C. Burley, D. L. Ward, C. Mallette, S. Smith, and M. Zimmerman. 1990. Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. Pages 261-326 *in* A. A. Nigro, editor. Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1990 Annual Report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

Vigg, S., T. P. Poe, L. A. Prendergast, and H. C. Hansel. 1991. Rates of consumption of juvenile salmonids and alternative prey fish by northern squawfish, walleyes, smallmouth bass, and channel catfish in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:421-438.

APPENDIX A

1997 Tabular Data

Appendix Table A-1. Northern pikeminnow (NP) catch, angler hours (effort), and catch per angler hour (CPAH) for dam-based and boat angling (combined), by statistical week, at Columbia River dams in 1997. Totals are actual, and may not reflect rounding errors.

Statistical week: dates	Bonneville			The Dalles			John Day			McNary		
	NP	Effort	CPAH	NP	Effort	CPAH	NP	Effort	CPAH	NP	Effort	CPAH
23: 6/02/97 C 6/08/97	C	C	C	33	99.1	0.3	C	C	C	C	C	C
24: 6/09/97 C 6/15/97	13	17.7	0.7	25	83.6	0.3	2	38.9	0.1	C	C	C
25: 6/16/97 C 6/22/97	42	106.2	0.4	3	25.5	0.1	1	48.0	0.0	C	C	C
26: 6/23/97 C 6/29/97	57	78.0	0.7	52	57.8	0.9	14	59.6	0.2	C	C	C
27: 6/30/97 C 7/06/97	89	55.0	1.6	151	60.9	2.5	35	63.4	0.6	C	C	C
28: 7/07/97 C 7/13/97	95	55.3	1.7	133	62.0	2.1	246	110.3	2.2	26	103.5	0.3
29: 7/14/97 C 7/20/97	167	79.5	2.1	96	64.1	1.5	81	60.8	1.3	77	151.8	0.5
30: 7/21/97 C 7/27/97	106	72.3	1.5	136	59.9	2.3	118	96.2	1.2	38	149.7	0.3
31: 7/28/97 C 8/03/97	12	16.7	0.7	0	0.0	0	127	57.3	2.2	9	45.7	0.2
32: 8/04/97 C 8/10/97	116	46.4	2.5	39	26.6	1.5	170	83.0	2.0	33	50.6	0.7
33: 8/11/97 C 8/17/97	96	44.3	2.2	70	36.6	1.9	111	108.2	1.0	36	95.8	0.4
34: 8/18/97 C 8/24/97	60	48.2	1.2	82	55.6	1.5	126	96.3	1.3	23	102.7	0.2
35: 8/25/97 C 8/31/97	76	78.4	1.0	29	48.9	0.6	55	34.8	1.6	15	28.3	0.5
36: 9/01/97 C 9/07/97	51	22.9	2.2	64	52.2	1.2				6	18.3	0.3
37: 9/08/97 C 9/14/97	26	15.6	1.7	36	24.4	1.5						
38: 9/15/97 C 9/21/97	58	27.2	2.1	43	28.8	1.5						
39: 9/22/97 C 9/28/97	22	22.5	1.0	92	38.3	2.4						
Total	**1,086**	**784.3**	**1.4**	**1,084**	**824.0**	**1.3**	**1,086**	**857**	**1.3**	**263**	**746**	**0.4**

Appendix Table A-2. Species composition of the dam angling catch at Columbia River dams in 1997.

Dam	Percent NP in total catch	Percent of total catch						
		Salmonids	Sturgeon	Bass	Catfish	Walleye	Shad	Other
June-Sept.	93.20	0.05	3.23	1.08	1.00	0.16	0.85	.42

Appendix Table A-3. Monthly catch and by-catch for the combined dam- and boat-angling by condition at release at Columbia River dams in 1997. Condition codes: 1) minimal injury, certain to survive; 2) moderate injury, may or may not survive; 3) dead, nearly dead, or certain to die; L) line cut or broken, fish not removed from the water.

Dam and month	Total catch (all species)	Total by-catch	Salmonids				Sturgeon				Bass			Catfish			Walleye			Shad	Other
			1	2	3	L	1	2	3	L	1	2	3	1	2	3	1	2	3		
Columbia River																					
June	421	120	0	0	0	0	11	0	0	33	4	0	0	38	0	0	0	0	0	27	7
July	1,710	37	0	0	0	0	0	0	0	20	10	0	0	0	0	0	1	0	0	3	2
August	1,208	56	0	0	0	1	10	0	2	15	17	1	1	7	0	0	2	0	0	2	6
September	443	44	0	0	0	1	1	0	0	30	8	0	0	0	0	0	3	0	0	0	1
Total	**3,782**	**257**	**0**	**0**	**0**	**2**	**22**	**0**	**2**	**98**	**39**	**1**	**1**	**38**	**0**	**0**	**6**	**0**	**0**	**32**	**16**

APPENDIX B

Among-Year Comparisons

Appendix Table B-1. Northern pikeminnow (NP) catch, effort, and catch per angler hour (CPAH) for hook-and-line angling at Columbia and Snake river dams, 1991-1997.

		COLUMBIA RIVER DAMS					SNAKE RIVER DAMS					GRAND TOTALS
		Bonneville	The Dalles	John Day	McNary	Season	Ice Harbor	Lower Mon.	Little Goose	Lower Granite	Season	
1991	NP	8,131	3,674	5,004	8,348	25,157	1,486	3,313	4,915	4,480	14,194	39,351
	Effort (h)	2,621	1,333	2,816	3,416	10,186	2,052	2,471	2,140	2,448	9,112	19,298
	CPAH	3.1	2.8	1.8	2.4	2.5	0.7	1.3	2.3	1.8	1.6	2.0
1992	NP	4,814	7,561	3,427	7,297	23,099	278	475	1,664	2,352	4,769	27,868
	Effort (h)	1,781	2,496	2,775	2,523	9,575	298	943	3,062	2,880	7,183	16,758
	CPAH	2.7	3.0	1.2	2.9	2.4	0.9	0.5	0.5	0.8	0.7	1.7
1993	NP	5,836	2,712	2,509	5,148	16,205	122	105	100	678	1,005	17,210
	Effort (h)	1,991	1,992	1,561	2,780	8,324	404	396	378	734	1,911	10,235
	CPAH	2.9	1.4	1.6	1.9	1.9	0.3	0.3	0.3	0.9	0.5	1.7
1994	NP	5,238	4,393	3,083	2,556	15,270	23	27	92	685	827	16,097
	Effort (h)	2,232	2,064	1,649	2,966	8,910	141	55	203	692	1,092	10,002
	CPAH	2.3	2.1	1.9	0.9	1.7	0.2	0.5	0.5	1.0	0.8	1.6
1995	NP	2,422	409	950	1,002	4,783	9	1	186	320	516	5,299
	Effort (h)	2,823	920	777	1,670	6,190	80	38	183	798	1,099	7,289
	CPAH	0.9	0.4	1.2	0.6	0.8	0.1	0.0	1.0	0.4	0.5	0.7
1996	NP	1,135	623	1,278	2,184	5,220	0	27	96	112	235	5,455
	Effort (h)	693	338	618	1,372	3,022	56	75	206	307	645	3,666
	CPAH	1.6	1.8	2.1	1.6	1.7	0.0	0.4	0.5	0.4	0.4	1.5
1997	NP	1,086	1,084	1,086	263	3,519	0.0	0.0	0.0	0.0	0.0	3,519
	Effort (h)	784	826	857	746	3,214	0.0	0.0	0.0	0.0	0.0	3,214
	CPAH	1.4	1.3	1.3	.4	1.1	0.0	0.0	0.0	0.0	0.0	1.1
Total	NP	28,662	20,456	17,337	26,798	93,253	1,918	3,948	7,053	8,627	21,546	114,799
	Effort (h)	12,925	9,970	11,053	15,473	49,421	3,031	3,979	6,172	7,859	21,042	70,463
	CPAH	2.2	2.1	1.6	1.7	1.9	0.6	1.0	1.1	1.1	1.0	1.6

REPORT D

Site-Specific Gillnetting for Northern Pikeminnow Concentrated to Feed on Hatchery-Released Juvenile Salmonids in the Lower Columbia River in 1997

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1997 Annual Report

ACKNOWLEDGMENTS

We thank George Lee of the Confederated Tribes and Bands of the Yakama Indian Nation (YIN), Manuel Villalobos of the Nez Perce Tribe (NPT), and Colleen Fagan of the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS) for managing field activities of tribal crews. Invaluable assistance was provided in the field by tribal technicians and student volunteer Mike Nelson from Mt. Hood Community College. We thank Professor Jim Graybill for his help in coordinating the volunteer program at Mt. Hood Community College, he is retiring and will be missed.

Kathy Damtawe and Mike Wakeland were responsible for most of the data handling, entry, and proofing. Special thanks go to the numerous hatchery managers that provided their release schedules to us and to many other regional fisheries professionals for their cooperation and assistance. We appreciate the review of an earlier draft of this report by Mark Zimmerman of ODFW.

ABSTRACT

Field crews used small-meshed gillnets to catch northern pikeminnow *Ptychocheilus oregonensis* from areas where they concentrate to feed on hatchery-released juvenile salmonids *Oncorhynchus* spp. in the lower Columbia River from March 18 through June 19, 1997. The number of predator-sized (≥250 mm fork length) northern pikeminnow caught in 1997 totaled 2,831, which was 46% of the gill-net catch of the previous year. The catch per net hour (CPNH) for site-specific gillnetting was 1.8 in 1997, compared to 2.1 in 1996 and 3.9 in 1995. In 1997 most (90%) of these fish were caught at locations in Bonneville Pool, as in the previous two years. The mouth of the Klickitat River continued to be the most productive fishing location, but this site's contribution to the total fell from 58% to 31% between 1996 and 1997. CPNH at the Klickitat was 2.0 in 1997, compared to 2.4 in 1996, 5.7 in 1995, and 10.1 in 1994. This year the mouth of the Wind River had the highest CPNH value (2.4). Outside of Bonneville Pool the highest CPNH value (1.8) was observed at Horsethief Lake. Outside of Bonneville Pool the highest catch was at the mouth of Deschutes River where 118 predator-size northern pikeminnow were caught with a CPNH of 1.4. Once again, gill nets caught large fish (average fork length = 398 mm) relative to other fisheries.

The total incidental catch was 5,144 fish, with suckers *Catostomus* spp. being the most common (72%) of the incidentally caught species. Salmonid by-catch (110 adults; 44 juveniles) was minimal, despite high concentrations of salmonids in the sampling areas. Salmonids were assessed as to their condition and released. Incidental mortality to adult salmonids was estimated at 2.7%. Further developments and changes to the site-specific fishery are recommended to improve efficiency and productivity.

INTRODUCTION

The Columbia River Northern Pikeminnow Management Program (NPMP) was implemented in 1990 to increase survival of out-migrating juvenile salmonids *Oncorhynchus* spp. by reducing predation by northern pikeminnow[2] *Ptychocheilus oregonensis* in the lower Columbia and Snake rivers. The program goal is to sustain a 10-20% annual exploitation rate on predator-size (≥250 mm fork length; Vigg et al. 1991) northern pikeminnow, which over several years may result in a 50% or greater reduction in predation on juvenile salmonids (Rieman and Beamesderfer 1990). Various management fisheries were implemented as part of the NPMP, one of which was a tribal site-specific gill-net fishery in 1993.

Northern pikeminnow can be effectively removed from areas where hatchery-reared juvenile salmonids are released in the spring using small-meshed gillnets (Collis et al. 1995a; Collis et al. 1995b; Collis et al. 1997). Over the past three years, site-specific gill-net crews have caught over 29,000 predator-size northern pikeminnow at various locations in the lower Columbia and Snake rivers.

In 1997, the Columbia River Inter-Tribal Fish Commission (CRITFC) and three member tribes continued to investigate the step-wise implementation of a site-specific fishery using small-mesh gill nets to catch northern pikeminnow concentrated to feed on juvenile salmonids released from hatcheries. Our objectives in the current study were to 1) focus removal efforts at sampling locations that were productive in previous years, 2) investigate additional locations where northern pikeminnow might concentrate to feed on hatchery-released juvenile salmonids, and 3) continue to develop methods that increase our catch of predator-size northern pikeminnow while further reducing impacts to salmonids.

METHODS

Study Area

In 1997, the site-specific gillnet fishery was conducted at locations[3] between the mouth of the Washougal River on the Columbia River, and Lyons Ferry on the Snake River (Figure D-1). Sampling was conducted where northern pikeminnow were expected to concentrate to feed on juvenile salmonids, specifically below hatchery release points, near dams, and near the mouths of tributaries.[1]

[1] The Northern pikeminnow was known as the northern squawfish until 1998.

[2] A location is defined as a reach of one shoreline and adjacent mainstream waters that extend approximately 3 km upstream and downstream from a landmark.

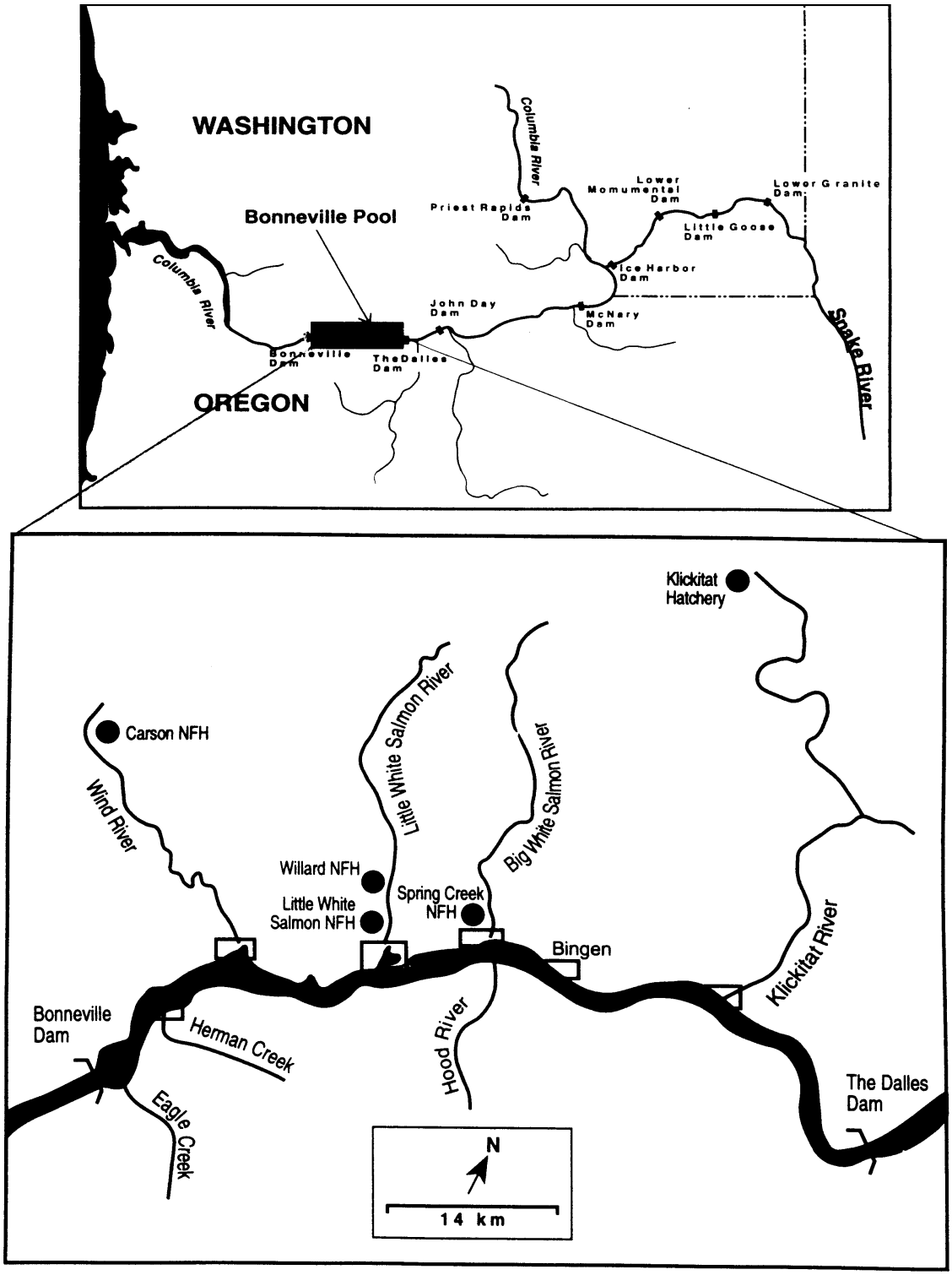

Figure D-1. Primary sampling locations (shown in boxes) in Bonneville Pool, 1997. Locations are (left to right) Herman Creek, Wind River, Drano Lake, Spring Creek, Bingen Marina, and Klickitat River.

Crew Scheduling

The Fish Passage Center and hatchery managers provided hatchery-release information used in determining crew schedules. Criteria used for crew scheduling were; 1) size and number of fish released, 2) date and location of hatchery release, 3) estimated time of arrival of the released fish at the sampling location, 4) previous success in catching northern pikeminnow, 5) incidental catch rate of salmonids at a sampling location, 6) site-specific hydrologic conditions, and 7) logistics. Schedules were set on a weekly basis, but often changed daily depending on catch success and last-minute changes in release schedules. Because of the large number of potential sampling locations and the limited number of crews, previous catch success at a location was, in most cases, given the highest priority in crew-scheduling decisions.

In 1997, four boat crews sampled from March 18 through June 19. Crews often moved to another location the same night when 1) fishing success was lower than in recent nights at a nearby location or 2) operational criteria (Collis et al. 1995b; see below) established to limit salmonid catch were reached. Technicians were assisted by a student volunteer enrolled in a cooperative education program at Mt. Hood Community College.

Field Procedures

Three or four small-mesh gill nets (2.4 m deep x 45.6 m long constructed from 7.6 m panels with the repeating mesh-size sequence of 4.4 cm and 5.1 cm bar measures) were fished concurrently by each crew. Most nets were placed perpendicular to shore on the river bottom for approximately 45 minutes. Initially, nets were placed in sites where northern pikeminnow were likely to concentrate based on river conditions such as back eddies or protected coves. Once we sampled a number of different sites, nets were placed in the most productive sites and moved whenever catch rates diminished or when two or more adult salmonids were caught at that site during the night (Collis et al. 1995b). All incidentally caught fish were identified if possible and immediately released back into the river. Operational criteria established to minimize potential impacts to salmonids were essentially the same as those used the previous two years (Collis et al. 1997, Collis et al. 1995b).

Data Collection and Analysis

We identified and enumerated the catch of each net set, and measured fork length (mm) from a random sample of up to three northern pikeminnow per net. Unless otherwise noted, subsequent data summaries and analyses include only predator-size (≥250 mm fork length) northern pikeminnow.

The beginning and ending time that each net was set was recorded. This allowed the calculation of the number of minutes each net was soaked. Northern pikeminnow catches divided by the summed time nets were fished yielded catch per net hour estimates (CPNH). Catch and CPNH for different areas and time periods were compared.

Incidentally caught salmonids were assigned one of three condition codes at the time of release: 1) minimal injury, certain to survive; 2) moderate injury, may or may not survive; or 3) dead, nearly dead, or certain to die. Additionally, all salmonids caught were identified as either

juvenile or adult and examined for external marks or fin clips. Adults were identified to species. Specific notes on condition were

recorded for each salmonid caught, including the presence of blood, whether the fish freed itself from the net, and where on the body the fish was caught in the net.

RESULTS & DISCUSSION

Northern Pikeminnow Catch

In 1997, we caught a total of 2,850 northern pikeminnow, the majority (99.3%) of which were predator-size (Table D-1). Overall, gill nets were fished for 1,608 net-hours and caught 2,831 predator-size northern pikeminnow, for a CPNH of 1.8 fish/net hr. The seasonal catch rate declined from 1996 (CPNH = 2.1, Collis et al. 1997), largely due to a decrease in harvest at the Klickitat River (see discussion below). Among-year comparisons of catch and effort for site-specific gillnetting are provided in Appendix A.

Gill-netting effort was distributed in pools or reaches (Figure D-2) and at locations according to the CPNH in that area. Bonneville pool had the highest catch (2,538) and CPNH (2.0) when compared to the other pools sampled. The pool with the second highest catch and CPNH was The Dalles, with a catch of 226 northern pikeminnow and a CPNH of 1.3. The high total catch in Bonneville pool relative to other pools was due to the sustained catches at the mouth of the Klickitat River, and five other productive fishing areas (Herman Creek, the mouth of the Wind River, Drano Lake, Spring Creek and Bingen Marina, Table
D-1).

As in previous years, the mouth of the Klickitat River was the most productive location in terms of total gillnet catch (866); however, catch rate has declined there for three consecutive years (1994: CPNH = 10.1; 1995: CPNH = 5.7; 1996: CPNH = 2.4; 1997: CPNH = 2.0). Over the past three years, about 18,000 northern pikeminnow have been removed from the mouth of the Klickitat River. These catches may, with harvests from other program fisheries in Bonneville Pool, help explain the decline in catch rate at that location. Dramatic improvements in salmon returns to the Klickitat River have also been noted in this time period. It is felt that this site will continue to yield good catches when fishing conditions improve. A low pool elevation in 1995 prevented us from fishing the most productive sites, and extremely high, turbid water conditions in 1996 and 1997 likely affected both the distribution of northern pikeminnow and our ability to fish nets effectively at that location.

Horsethief Lake, a new site this year, had the highest catch rate outside of the Bonneville Pool (CPNH = 1.8, northern pikeminnow catch = 94). The highest catch outside of the Bonneville Pool was at the mouth of Deschutes River, where 118 predator-size northern pikeminnow were caught at a CPNH of 1.4 (Table D-1). Several nights were spent test fishing in the Snake River at Lyons Ferry in 1997, but this proved relatively unproductive.

Table D-1. Northern pikeminnow catch, effort, and catch per net hour (CPNH) for the Site-specific Gillnet Fishery on the Columbia River in 1997. Totals are actual and do not reflect rounding errors.

Location	Effort (net hours)	Northern pikeminnow catch		CPNH[a]
		(<250 mm)	(≥250 mm)	
Washougal River	3.1	0	1	0.3
Tanner Creek	1.2	0	0	0
Herman Creek	167.5	2	279	1.8
Wind River	200.3	2	477	2.4
Drano Lake	324.5	0	663	2.0
Spring Creek	67.5	1	112	1.7
Bingen Marina	104.0	1	117	1.1
Klickitat River	423.3	9	866	2.0
Horsethief Lake	52.8	0	94	1.8
Brown Island	16.3	0	12	0.7
Rufus Area	19.4	0	2	0.1
Deschutes River	83.3	1	118	1.4
John Day River	18.7	0	5	0.3
Rock Creek	23.9	0	9	0.4
Umatilla River	40.9	2	21	0.5
Hat Rock	28.1	0	23	0.8
Lyons Ferry	25.2	1	8	0.3
Totals	**1,608.4**	**19**	**2,831**	**1.8**

This year the highest amount of effort was expended in April, as opposed to May in previous years. Catch rates increased throughout the season, averaging 1.0 CPNH in March, and ending at a high of 2.8 in June. This exceeded 1996's June high of 2.5 (Figure D-3).

In 1997, site-specific gillnetting caught larger northern pikeminnow (X = 397.7 mm, Figure D-4) than other management fisheries, as was the case in previous years (Zimmerman et al. 1997; Knutsen et al. 1995).

Incidental Catch

In 1997, 5,044 fish (64% of the total catch) were incidentally caught in gillnets (Table D-2). As in previous years, suckers (*Catostomus* spp.) were the most common incidentally caught species, constituting 72% of this catch in 1997. We caught 151 *Oncorhynchus* spp (2% of total catch) in 1997, down from the 235 in 1996 (Table D-2). Of the salmon and steelhead in the catch, most were adults (71%), and among those were 3 steelhead mortalities. Of the total adult salmonid catch, 52% were chinook salmon *O. tshawytscha* and 40% were steelhead *O. mykiss*. Five Dolly Varden or bull trout (*Salvelinus malma* or *S. confluentus*) were identified in the catch, it is unknown if they were anadromous or resident forms. Three of these were released in condition 1, one was released in condition 2, and one was released in condition 3.

Table D-2. Species composition for the Site-specific Gillnet Fishery catch in 1997.

Species	Total
Sucker *Catostomus* spp.	3,641
Northern pikeminnow *Ptychocheilus oregonensis*	2,850[a]
White sturgeon *Acipenser transmontanus*	286
Peamouth *Mylocheilus caurinus*	237
Common carp *Cyprinus carpio*	185
Channel catfish *Ictalurus punctatus*	171
Salmonids *Oncorhynchus* spp.	151
Walleye *Stizostedion vitreum*	144
Bass *Micropterus* spp.	74
American shad *Alosa sapidissima*	57
Mountain whitefish *Prosopium williamsoni*	52
Unidentified[b]	19
Chiselmouth *Acrocheilus alutaceus*	12
Brown trout *Salmo trutta*	5
Crappie *Pomoxis* spp.	2
Char *Salvelinus* spp.	5
Bullhead *Ictalurus* spp.	1
Bluegill *Lepomis macrochirus*	1
Pumpkinseed *Lepomis gibbosus*	1
Total	**7,894**

[a] Includes 19 northern pikeminnow <250 mm.
[b] Species information not available for these fish; however, none were salmonids.

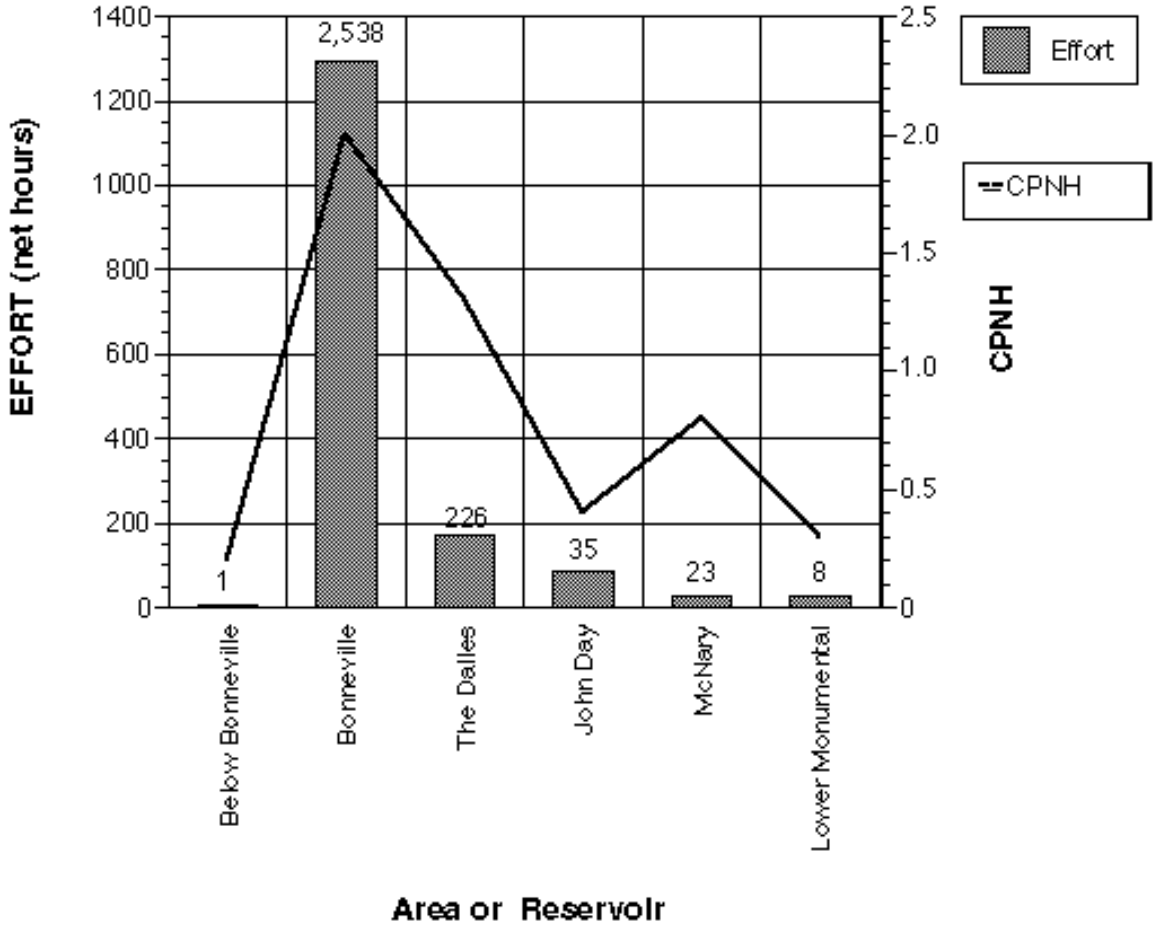

Figure D-2. Northern Pikeminnow catch (values above bars), effort, and catch per net hour (CPNH) on the Columbia River below Bonneville Dam and in lower Columbia and Snake River reservoirs, 1997.

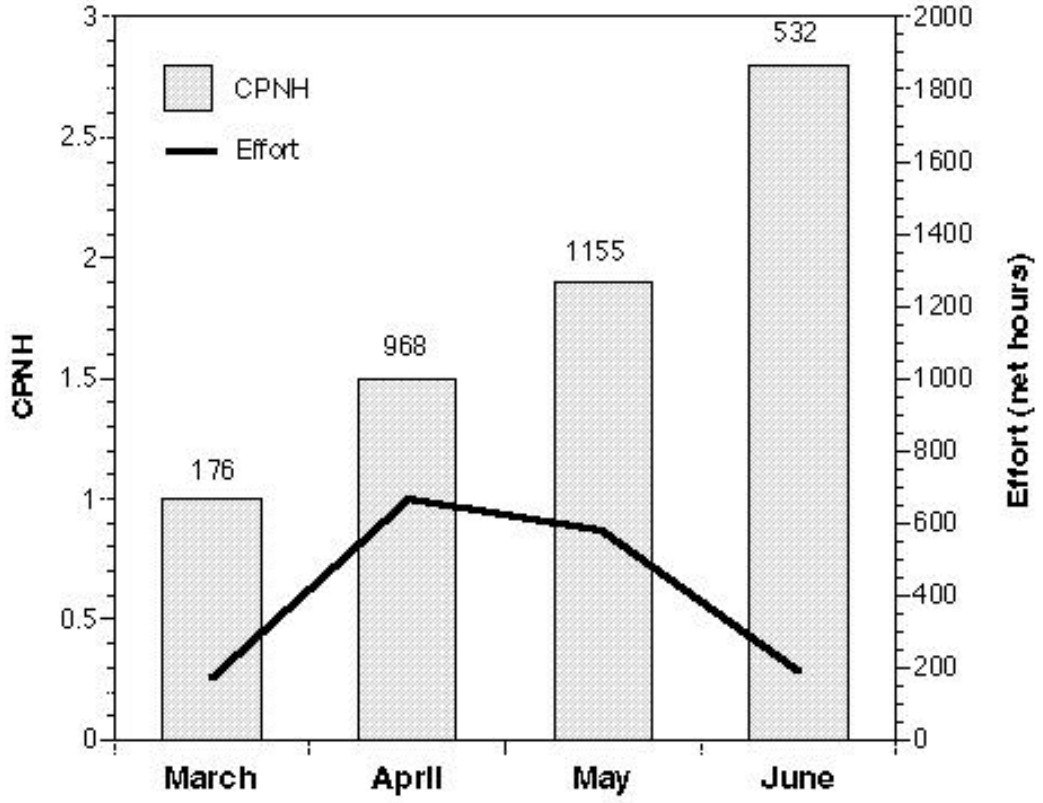

Figure D-3. Northern pikeminnow catch (values above bars), effort, and catch per net hour (CPNH) by month, 1997.

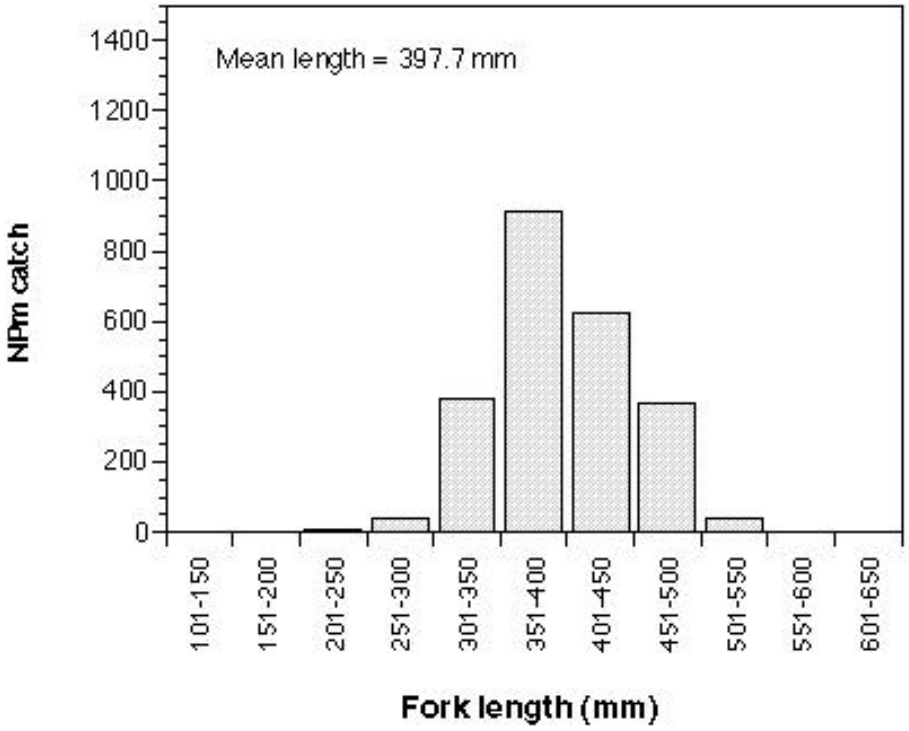

Figure D-4. Size distribution of northern pike minnow (NPm) caught in gill nets in the Columbia River in 1997. (Total sample size = 2,372)

RECOMMENDATIONS FOR 1997

1. **Continue to focus effort at the most productive times and locations as determined in-season and in previous years.**

   Based on three years of gillnetting, the lower Columbia River (particularly Bonneville Pool) is the most productive area to conduct site-specific gillnetting for northern pikeminnow. We will continue to focus our effort there and monitor in-season catch rates in order to schedule crews at the most productive times and locations.

2. **Investigate new locations where we have evidence of potentially high catch rates of northern pikeminnow.**

   Although most of our effort will be focused at locations previously sampled, we plan to investigate some new locations in 1998. These investigations will be based on in-season information on northern pikeminnow distribution and abundance available from Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and other sources.

3. **Continue to identify ways to reduce by-catch of salmonids and protect salmonids and other sensitive species from harm.**

   Incidental catch of salmonids will be closely monitored so that decisions can be made to reduce by-catch of salmonids, particularly listed stocks.

4. **Continue to recruit and hire experienced technicians and provide them with in-season information to help improve their effectiveness.**

   Technician ability and experience are important factors in catch success. We will attempt to hire experienced technicians and to provide them with in-season information to maximize productivity. We will encourage information exchange among crews by scheduling different crews to work together and by organizing in-season meetings.

REFERENCES

Collis, K., J. McCormack, K. McRae, and R. E. Beaty. 1997. Site-specific removal of northern squawfish aggregated to feed on juvenile salmonids in the spring in the lower Columbia and Snake rivers. Pages 181-207 *in* F. R. Young and, editors. Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1995 Annual report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

Collis, K., R. E. Beaty, and B. R. Crain. 1995a. Changes in catch rate and diet of northern squawfish associated with the release of hatchery-reared juvenile salmonids in a Columbia River reservoir. North American Journal of Fisheries Management 15:346-357.

Collis, K., R. E. Beaty, J. McCormack, and K. McRae. 1995b. Site-specific removal of northern squawfish aggregated to feed on juvenile salmonids in the spring in the lower Columbia and Snake rivers. Pages 153-186 *in* C. F. Willis and F. R. Young, editors. Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1994 Annual report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

Knutsen, C. J., D. L. Ward, T. A. Friesen, and M. P. Zimmerman. 1995. Development of a system-wide predator control program: indexing and fisheries evaluation. Pages 203-263 *in* C. F. Willis and F. R. Young, editors. Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1994 Annual report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

Rieman, B. E., and R. C. Beamesderfer. 1990. Dynamics of a northern squawfish population and the potential to reduce predation on juvenile salmonids in a Columbia River reservoir. North American Journal of Fisheries Management 10:228-241.

Vigg, S., T. P. Poe, L. A. Prendergast, and H. C. Hansel. 1991. Rates of consumption of juvenile salmonids and alternative prey fish by northern squawfish, walleyes, smallmouth bass, and channel catfish in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:421-438.

Zimmerman, M. P., D. L. Ward, T. A. Friesen, and C. J. Knutsen. 1997. Development of a system-wide predator control program: indexing and fisheries evaluation. Pages 227-302 *in* F. R. Young, editor. Development of a system-wide predator control program: stepwise implementation of a predator index, predator control fisheries, and evaluation plan in the Columbia River Basin. 1995 Annual report. Contract DE-BI79-90BP07084, Bonneville Power Administration, Portland, Oregon.

APPENDIX A

Among-Year Comparisons

Appendix Table A-1. Northern pikeminnow catch, effort, and catch per net hour (CPNH) for the Site-specific Gill-net Fishery, 1993-1997. Totals are actual and do not reflect rounding errors.

		COLUMBIA RIVER POOLS						SNAKE RIVER POOLS					GRAND TOTALS
		Below Bonneville	Bonneville	The Dalles	John Day	McNary	Season	Ice Harbor	Lower Monumental	Little Goose	Lower Granite	Season	
1993	Catch	--	1,772	--	--	--	**1,772**	--	--	--	--	--	**1,772**
	Effort (h)	--	394	--	--	--	**394**	--	--	--	--	--	**394**
	CPNH	--	4.5	--	--	--	**4.5**	--	--	--	--	--	**4.5**
1994	Catch	--	8,890	5	42	10	**8,947**	--	5	--	72	**77**	**9,024**
	Effort (h)	--	1,195	18	43	67	**1,323**	--	17	--	102	**120**	**1,442**
	CPNH	--	7.4	0.3	1.0	0.2	**6.8**	--	0.3	--	0.7	**0.6**	**6.3**
1995	Catch	263	8,668	25	136	57	**9,149**	231	22	22	60	**335**	**9,484**
	Effort (h)	166	1,844	19	139	45	**2,214**	112	26	13	66	**217**	**2,431**
	CPNH	1.6	4.7	1.3	1.0	1.3	**4.1**	2.1	0.8	1.7	0.9	**1.5**	**3.9**
1996	Catch	38	5,822	232	63	11	**6,166**	--	--	--	--	--	**6,166**
	Effort (h)	35	2,584	121	91	47	**2,878**	--	--	--	--	--	**2,878**
	CPNH	1.1	2.3	1.9	0.7	0.2	**2.1**	--	--	--	--	--	**2.1**
1997	Catch	1	2,538	226	35	23	**2,823**	--	8	--	--	**8**	**2,831**
	Effort (h)	4	1,296	172	84	28	**1,583**	--	25	--	--	**25**	**1,608**
	CPNH	0.2	2.0	1.3	0.4	0.8	**1.8**	--	0.3	--	--	**0.3**	**1.8**
Total	**Catch**	**302**	**27,690**	**488**	**276**	**101**	**28,857**	**231**	**35**	**22**	**132**	**420**	**29,277**
	Effort(h)	**205**	**7,314**	**330**	**358**	**186**	**8,392**	**112**	**68**	**13**	**168**	**362**	**8,754**
	CPNH	**1.5**	**3.8**	**1.5**	**0.8**	**0.5**	**3.4**	**2.1**	**0.5**	**1.7**	**0.8**	**1.6**	**3.3**

REPORT E

Development of a Systemwide Predator Control Program: Fisheries Evaluation

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ACKNOWLEDGMENTS

We are particularly grateful to project personnel that worked long hours in the field to collect the data presented in this report. Thanks to Tristan Uecker, Jennifer Harrington, Marianne Hathaway, Steve Intelmann, Anne Meckstroth, George Reed, and Vicki Royle.

This research was funded by the Bonneville Power Administration, John Skidmore, Project Manager (Contract DE-B1719-94BI24514). Kirk Beiningen of the Oregon Department of Fish and Wildlife, Frank Young of the Columbia Basin Fish and Wildlife Authority, and Russell Porter of the Pacific States Marine Fisheries Commission administered the contract and/or critically reviewed the manuscript.

We thank Keith Hatch and his staff (Columbia River Inter-Tribal Fish Commission) and John Hisata and his staff (Washington Department of Fish and Wildlife) for their cooperation and help with project coordination. The U.S. Army Corps of Engineers (Corps) was very cooperative in the use of project facilities. We especially thank the following Corps personnel for help with coordination: Jim Kuskie, Miro Zyndol, Brad Eby, Bill Spurgeon, Tim Wik, Rex Baxter, and Bob Cordie.

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. In this report, we (1) evaluate northern pikeminnow exploitation and compare catch rate of incidentally-harvested fishes among the three major management fisheries in 1997, (2) estimate reductions in predation on juvenile salmonids since implementation of the fisheries, and (3) update information on year-class strength of northern pikeminnow.

Systemwide exploitation of northern pikeminnow ≥250 mm fork length was 8.9% for sport-reward, 0.1% for dam-angling, and 0.6% for site-specific gill-net fisheries. Reservoir-specific exploitation ranged from zero in John Day, Lower Monumental, and Little Goose reservoirs to 16.5% in McNary Reservoir. The dam-angling fishery had the lowest percentage (6.9%) of incidental catch relative to the total number of fish caught. Incidental catch was 64.1% in the gill-net fishery and 31.1% for sport-reward anglers targeting northern pikeminnow.

If the exploitation rates remain similar to mean 1991-97 levels, we estimate that potential predation by northern pikeminnow on juvenile salmonids in 1998 will be approximately 64% 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 1994-97 levels.

We have found 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.

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* 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 1994-96, 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 (In press) provided a comprehensive summary of NPMP evaluation from 1990-96. In this report we describe our activities and findings for 1997, and wherever possible, evaluate changes from previous years.

Our objectives in 1997 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.

METHODS

Fishery Evaluation and Loss Estimates

Field Procedures

Three northern pikeminnow fisheries were conducted in 1997. The sport-reward fishery was implemented by the Washington Department of Fish and Wildlife (WDFW) from May 19 - October 17 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 (CTWSO), Confederated Tribes of the Umatilla Indian Reservation, and Confederated Tribes and Bands of the Yakama Indian Nation (YIN) from June 2 - September 26 at Bonneville, The Dalles, John Day, and McNary dams. A site-specific gill-net fishery was implemented by CRITFC, YIN, CTWSO , and the Nez Perce Tribe from March 18 - June 19 downstream from Bonneville Dam and in Bonneville, The Dalles, John Day, and Lower Monumental reservoirs.

We tagged and released northern pikeminnow to estimate exploitation rates for each fishery. We used electrofishing boats and gill nets to collect northern pikeminnow from March 25-June 20. 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 ≥250 mm fork length among fisheries and reservoirs in 1997. 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

$$m \forall 1.96 \% \overline{m/n} \quad (\text{if } mXn > 30),$$

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 1997 by determining the percent of the total catch composed of fish other than northern pikeminnow ≥250 mm fork length (incidental catch).

We used the ALoss 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 Aaverage≅ 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 northern pikeminnow scales from subsamples of fish harvested by the sport-reward and dam-angling fisheries downstream from Bonneville Dam and in Bonneville Reservoir. 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 (1985-93) 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 1,188 northern pikeminnow throughout the lower Columbia and Snake rivers in 1997. A total of 101 tagged fish were recaptured in the three fisheries: 97 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 1997 was 9.6%, and ranged from 0.0% in John Day, Lower Monumental, and Little Goose reservoirs to 16.5% in McNary Reservoir (Figure 1; **Appendix Table 1**). A sufficient number of tagged fish were captured in 1997 (mn > 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 8.9% in 1997 (Figure 1; **Appendix Table 2**). Sport-reward exploitation increased in Bonneville and Lower Granite reservoirs, and decreased downstream from Bonneville Dam and in The Dalles and McNary reservoirs relative to exploitation in 1995 and 1996. 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 1997, and systemwide exploitation was 0.1% (Figure 1; **Appendix Table 3**). Bonneville Reservoir was the only area in which tagged northern pikeminnow were recaptured in the site-specific gill-net fishery, and systemwide exploitation in 1997 was 0.6% (Figure 1; **Appendix Table 4**).

In 1997, the various fisheries reported 58,280 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, 6.9% in the dam-angling fishery, and 64.1% 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 0.5% of the incidental catch for all fisheries combined. The proportion of predator-sized (≥250 mm fork length) northern pikeminnow relative to the

total number of northern pikeminnow harvested was highest in the dam-angling fishery (99.8%) and lowest in the sport-reward fishery (81.8%). Incidental catch for the sport-reward fishery was underestimated because the data excludes catches from anglers who were not targeting northern pikeminnow, and nonsalmonid catches from non-returning anglers.

Results from the ALoss Estimate Spreadsheet Model≅ indicate that potential predation by northern pikeminnow on juvenile salmonids in 1998 may range from 46% to 76% of pre-program levels, with a median estimate of 64% (Figure 2). Continued exploitation at mean 1994-97 levels will result in minor reductions in predation. Predation will not decrease significantly unless exploitation is increased.

Biological Evaluation

Year-class strength of northern pikeminnow was highly variable; however, variations were generally similar between populations downstream from Bonneville Dam and in Bonneville Reservoir (Figure 3). Differences between areas were less than 25% except in 1987. To date we have found no evidence that year-class strengths of northern pikeminnow have been influenced by the NPMP; the strongest year class since NPMP implementation occurred in 1991.

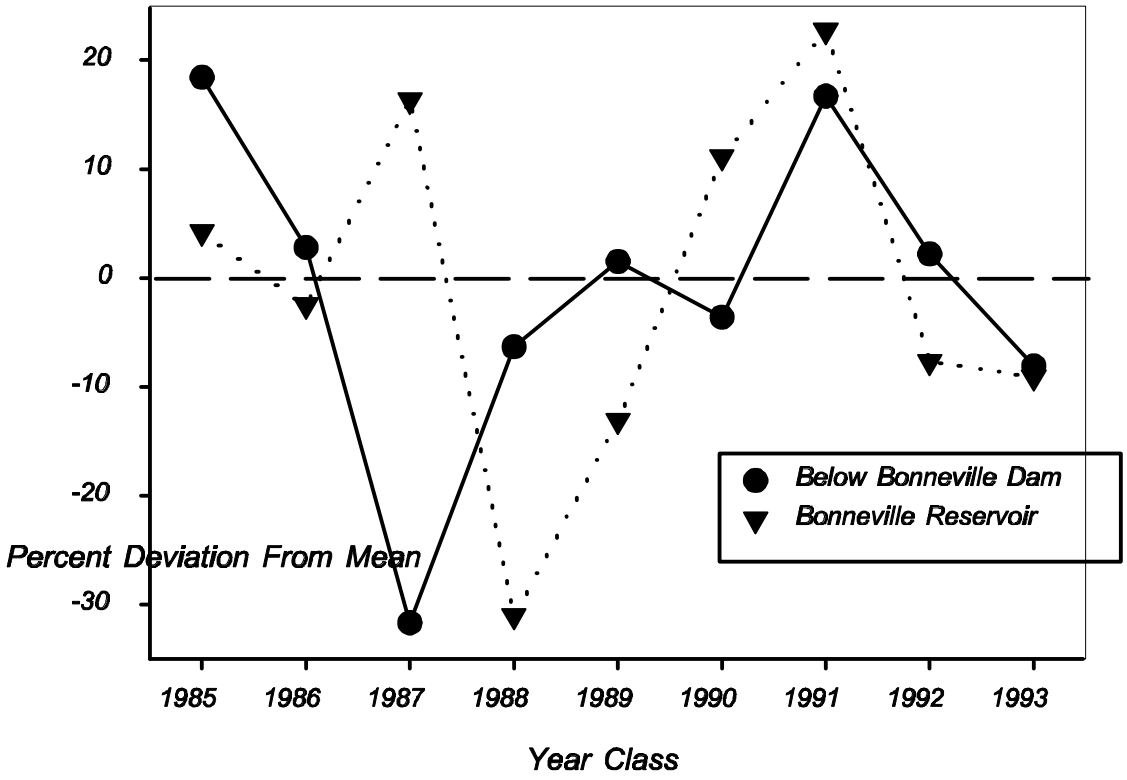

Figure 1. Exploitation of northern pikeminnow ≥250 mm fork length by area and fishery, 1991-97. Vertical bars for exploitation downstream from Bonneville Dam and systemwide are 95% confidence intervals.

Table 1. Number of northern pikeminnow and incidentally-caught fish by species or family in each fishery in 1997. Northern pikeminnow <250 mm fork length are considered incidental catch.

Species or family	Sport-reward[a]	Dam Angling	Gill Net
Northern pikeminnow			
≥250 mm fork length	117,391	3,519	2,831
<250 mm fork length	26,108	6	19
White sturgeon[b]	2,525	122	286
American shad[b]	237	32	57
Salmonidae[b]			
Chinook (adult)	19	0	57
Chinook (juvenile)	12	0	0
Sockeye (adult)	2	0	1
Sockeye (juvenile)	0	0	0
Steelhead (adult)	44	1	44
Unknown adult salmon	0	1	0
Unknown juvenile salmon	0	1	44
Other salmonidae	0	0	67
Cyprinidae (minnows)	13,264	5	434
Catostomidae (suckers)	2,553	4	3,641
Channel catfish[b]	1,523	38	171
Smallmouth bass[b]	2,819	41	23
Walleye[a]	1,029	6	144
Other/unidentified	2,589	7	75
Total (all species)	170,345	3,782	7,894
Percent incidental catch	31.1	6.9	64.1

[a] Based on catches from returning anglers targeting northern pikeminnow and catch estimates from non-returning anglers targeting northern pikeminnow.

[b] Salmonidae = *Oncorhynchus, Salmo, Salvelinus,* and *Prosopium* spp. White sturgeon = *Acipenser transmontanus*, American shad = *Alosa sapidissima*, channel catfish = *Ictalurus punctatus*, smallmouth bass = *Micropterus dolomieu*, walleye = *Stizostedion vitreum*.

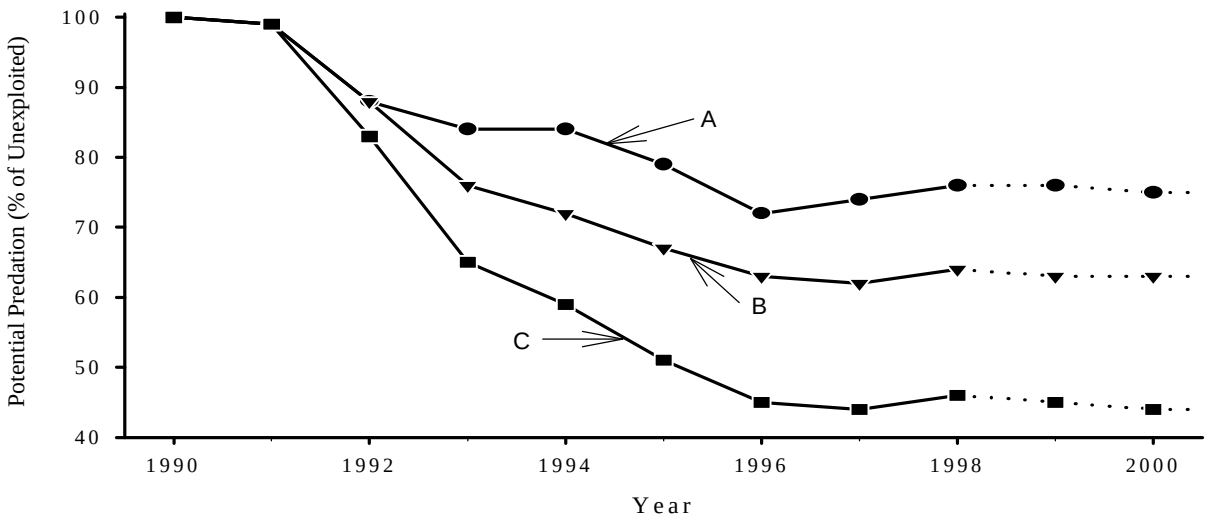

Figure 2. Maximum (A), median (B), and minimum (C) estimates of potential predation on juvenile salmonids by northern pikeminnow relative to predation prior to implementation of the northern pikeminnow management program. Dashed lines indicate predation in future years if exploitation is maintained at mean 1994-97 levels.

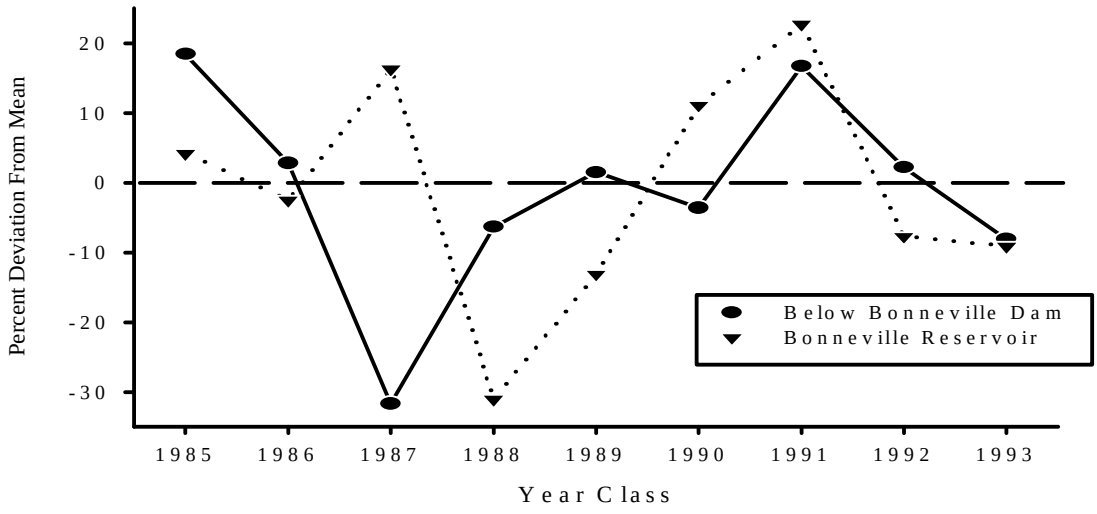

Figure 3. Index of relative year-class strength of northern pikeminnow in the Columbia River downstream from Bonneville Dam and in Bonneville Reservoir.

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 1997 was 9.6%, the second-lowest rate since the program was implemented. 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 probably harvested larger northern pikeminnow than the sport-reward fishery (Friesen and Ward, In press).

If exploitation rates remain similar to mean 1994-97 levels, it is likely that no further reductions in potential predation will be realized. Predation will remain at approximately 64% of pre-program levels. Exploitation rates lower than mean 1994-97 levels will result in increases in potential predation. Further reductions in predation will be small (1% to 4%) unless future exploitation exceeds 1994-97 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, particularly if the NPMP is sustained over a number of years. Periodic sampling (every 3-5 years) to evaluate response by northern pikeminnow and other predators to the NPMP would be prudent.

REFERENCES

Beamesderfer, R.C., B.E. Rieman, J.C. Elliott, A.A. Nigro, and D.L. Ward. 1987. Distribution, abundance, and population dynamics of northern squawfish, walleye, smallmouth bass, and channel catfish in John Day Reservoir, 1986. Oregon Department of Fish and Wildlife, Contract number DE-AI79-82BP35097. 1986 Annual Report to Bonneville Power Administration, Portland, Oregon.

Beamesderfer, R.C., and B.E. Rieman. 1991. Abundance and distribution of northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:439-447.

Collis, K., R.E. Beaty, and B.R. Crain. 1995. Changes in catch rate and diet of northern squawfish associated with the release of hatchery-reared juvenile salmonids in a Columbia River reservoir. North American Journal of Fisheries Management 15:346-357.

El-Zarka, S.E. 1959. Fluctuations in the population of yellow perch, *Perca flavescens* (Mitchill) in Saginaw Bay Lake Huron. U.S. Fish and Wildlife Service Fishery Bulletin 151:365-415.

Elliott, J. M. 1977. Some methods for the statistical analysis of samples of benthic invertebrates, 2nd edition. Freshwater Biological Association Scientific Publication 25.

Friesen, T.A., and D.L. Ward. In press. Management of northern squawfish and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. Pages 5-27 *in* D.L. Ward, editor. Evaluation of the northern squawfish management program. Oregon Department of Fish and Wildlife, Contract numbers DE-BI79-90BP07084 and 94BI24514. Final report of research, 1990-96, to the Bonneville Power Administration, Portland, Oregon.

Friesen, T. A., M.P. Zimmerman, D. L. Ward, and C.J. Knutsen. In press. Development of a system-wide predator control program: Indexing and fisheries evaluation. Oregon Department of Fish and Wildlife, Contract number DE-AI79-94BI24514. 1996 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Knutsen, C.J., D.L. Ward, T.A. Friesen, and M.P. Zimmerman. 1995. Development of a system-wide predator control program: Indexing and fisheries evaluation. Oregon Department of Fish and Wildlife, Contract number DE-AI79-94BI24514. 1994 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Parker, R.M., M.P. Zimmerman, and D.L. Ward. 1994. Development of a system-wide predator control program: Indexing and fisheries evaluation. Oregon Department of Fish and Wildlife, Contract number DE-AI79-90BP07096. 1992 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Parker, R.M., M.P. Zimmerman, and D.L. Ward. 1995. Variability in biological characteristics of northern squawfish in the lower Columbia and Snake rivers. Transactions of the American Fisheries Society 124:335-346.

Poe, T.P., H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in the John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405-420.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

Rieman, B.E., and R.C. Beamesderfer. 1990. Dynamics of a northern squawfish population and the potential to reduce predation on juvenile salmonids in a Columbia River reservoir. North American Journal of Fisheries Management 10:228-241.

Vigg, S., C.C. Burley, D.L. Ward, C. Mallette, S. Smith, and M. Zimmerman. 1990. Development of a system-wide predator control program: Stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River basin. Oregon Department of Fish and Wildlife, Contract number DE-BI79-90BP07084. 1990 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Ward, D.L. In press. Evaluation of the northern squawfish management program. Oregon Department of Fish and Wildlife, Contract numbers DE-BI79-90BP07084 and 94BI24514. Final report of research, 1990-96, to the Bonneville Power Administration, Portland, Oregon.

Ward, D.L., M.P. Zimmerman, R.M. Parker, and S.S. Smith. 1993. Development of a system-wide predator control program: Indexing, fisheries evaluation, and harvesting technology development. Oregon Department of Fish and Wildlife, Contract number DE-BI79-90BP07084. 1991 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Zimmerman, M.P., C. Knutsen, D.L. Ward, and K. Anderson. 1995. Development of a system-wide predator control program: Indexing and fisheries evaluation. Oregon Department of Fish and Wildlife, Contract number DE-AI79-90BP07084. 1993 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Zimmerman, M.P., D.L. Ward, T.A. Friesen, and C.J. Knutsen. 1997. Development of a system-wide predator control program: Indexing and fisheries evaluation. Oregon Department of Fish and Wildlife, Contract number DE-AI79-94BI24514. 1995 Annual Report to the Bonneville Power Administration, Portland, Oregon.

APPENDIX

Exploitation of Northern Pikeminnow, 1991-97

Appendix Table 1. Total exploitation rates of northern pikeminnow ≥250 mm fork length, 1991-97.

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

[a] No northern pikeminnow tagged.

Appendix Table 2. Exploitation rates (%) of northern pikeminnow ≥250 mm fork length for the sport-reward fishery, 1991-97.

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

[a] Northern pikeminnow harvested, but no tags recovered.
[b] No northern pikeminnow tagged.

Appendix Table 3. Exploitation rates (%) of northern pikeminnow ≥250 mm fork length for the dam-angling fishery, 1991-97.

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

[a] No fishing effort.
[b] Northern pikeminnow harvested, but no tags recovered.
[c] No northern pikeminnow tagged.

Appendix Table 4. Exploitation rates (%) of northern pikeminnow ≥250 mm fork length for the site-specific gill-net fishery, 1994-97.

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

[a] No fishing effort.
[b] Northern pikeminnow harvested, but no tags recovered.
[c] No northern pikeminnow tagged.

Appendix Table 5. Dates for each sampling period in 1997.

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

Appendix Table 6. Exploitation of northern pikeminnow downstream from Bonneville Dam in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam	Net
1	75	--	--	--	--	--	--	--
2	--	--	--	--	75	--	--	--
3	192	--	--	--	75	--	--	--
4	203	--	--	--	267	--	--	--
5	--	--	--	--	470	--	--	--
6	--	--	--	--	470	--	--	--
7	--	--	--	--	470	--	--	--
8	--	--	--	--	470	--	--	--
9	--	1	--	--	470	0.0021	--	--
10	--	3	--	--	469	0.0064	--	--
11	--	--	--	--	466	--	--	--
12	--	1	--	--	466	0.0021	--	--
13	--	3	--	--	465	0.0065	--	--
14	--	3	--	--	462	0.0065	--	--
15	--	8	--	--	459	0.0174	--	--
16	--	4	--	--	451	0.0089	--	--
17	--	3	1	--	447	0.0067	0.0022	--
18	--	3	--	--	443	0.0068	--	--
19	--	--	--	--	439[a]	--	--	--
20	--	--	--	--	439	--	--	--
21	--	2	--	--	439	0.0046	--	--
22	--	2	--	--	437	0.0046	--	--
23	--	--	--	--	435	--	--	--
24	--	--	--	--	435	--	--	--
25	--	--	--	--	435	--	--	--
26	--	--	--	--	435	--	--	--
27	--	--	--	--	435	--	--	--
28	--	--	--	--	435	--	--	--
29	--	1	--	--	435	0.0023	--	--
Total	470	34	1	0	--	0.0748	0.0022	0.0000
Adjusted for tag loss						0.0780	0.0023	0.0000

[a] A fish tagged downstream from Bonneville Reservoir was recaptured above Bonneville Dam.

Appendix Table 7. Exploitation of northern pikeminnow in Bonneville Reservoir in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam	Net
1	--	--	--	--	--	--	--	--
2	167	--	--	--	--	--	--	--
3	--	--	--	--	167	--	--	--
4	64	--	--	2	167	--	--	0.0120
5	--	--	--	--	229	--	--	--
6	--	--	--	--	229	--	--	--
7	--	--	--	1	229	--	--	0.0044
8	--	--	--	--	228	--	--	--
9	--	--	--	--	228	--	--	--
10	--	--	--	--	228	--	--	--
11	--	4	--	--	228	0.0175	--	--
12	--	1	--	--	223[a]	0.0045	--	--
13	--	2	--	--	222	0.0090	--	--
14	--	1	--	--	220	0.0045	--	--
15	--	6	--	--	219	0.0274	--	--
16	--	2	--	--	213	0.0094	--	--
17	--	1	--	--	211	0.0047	--	--
18	--	--	--	--	210	--	--	--
19	--	--	--	--	210	--	--	--
20	--	--	--	--	210	--	--	--
21	--	--	--	--	210	--	--	--
22	--	--	--	--	210	--	--	--
23	--	--	--	--	210	--	--	--
24	--	--	--	--	209[a]	--	--	--
25	--	--	--	--	209	--	--	--
26	--	--	--	--	209	--	--	--
27	--	--	--	--	209	--	--	--
28	--	--	--	--	209	--	--	--
29	--	--	--	--	209	--	--	--
Total	231	17	0	3	--	0.0771	0.0000	0.0163
Adjusted for tag loss						0.0803	0.0000	0.0170

[a] A fish tagged in Bonneville Reservoir was recaptured outside the reservoir.

Appendix Table 8. Exploitation of northern pikeminnow in The Dalles Reservoir in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam	Net
1	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--
6	167	--	--	--	--	--	--	--
7	--	--	--	--	167	--	--	--
8	--	--	--	--	167	--	--	--
9	--	1	--	--	167	0.0060	--	--
10	--	--	--	--	166	--	--	--
11	--	--	--	--	166	--	--	--
12	--	--	--	--	166	--	--	--
13	--	2	--	--	166	0.0120	--	--
14	--	--	--	--	164	--	--	--
15	--	1	--	--	163[a]	0.0061	--	--
16	--	3	--	--	162	0.0185	--	--
17	--	--	--	--	159	--	--	--
18	--	--	--	--	159	--	--	--
19	--	--	--	--	159	--	--	--
20	--	1	--	--	159	0.0063	--	--
21	--	1	--	--	158	0.0063	--	--
22	--	--	--	--	157	--	--	--
23	--	--	--	--	157	--	--	--
24	--	--	--	--	157	--	--	--
25	--	--	--	--	157	--	--	--
26	--	--	--	--	157	--	--	--
27	--	--	--	--	157	--	--	--
28	--	--	--	--	157	--	--	--
29	--	--	--	--	157	--	--	--
Total	167	9	0	--	--	0.0553	0.0000	0.0000
Adjusted for tag loss						0.0576	0.0000	0.0000

[a] A fish tagged in The Dalles Reservoir was recaptured outside the reservoir.

Appendix Table 9. Exploitation of northern pikeminnow in John Day Reservoir in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam	Net
1	13	--	--	--	--	--	--	--
2	21	--	--	--	13	--	--	--
3	--	--	--	--	34	--	--	--
4	--	--	--	--	34	--	--	--
5	--	--	--	--	34	--	--	--
6	--	--	--	--	34	--	--	--
7	--	--	--	--	34	--	--	--
8	--	--	--	--	34	--	--	--
9	--	--	--	--	34	--	--	--
10	--	--	--	--	34	--	--	--
11	20	--	--	--	34	--	--	--
12	11	--	--	--	54	--	--	--
13	--	--	--	--	65	--	--	--
14	--	--	--	--	65	--	--	--
15	--	--	--	--	65	--	--	--
16	--	--	--	--	65	--	--	--
17	--	--	--	--	65	--	--	--
18	--	--	--	--	65	--	--	--
19	--	--	--	--	65	--	--	--
20	--	--	--	--	65	--	--	--
21	--	--	--	--	64[a]	--	--	--
22	--	--	--	--	64	--	--	--
23	--	--	--	--	64	--	--	--
24	--	--	--	--	64	--	--	--
25	--	--	--	--	64	--	--	--
26	--	--	--	--	64	--	--	--
27	--	--	--	--	64	--	--	--
28	--	--	--	--	64	--	--	--
29	--	--	--	--	64	--	--	--
Total	65	0	0	--	--	0.0000	0.0000	0.0000
Adjusted for tag loss						0.0000	0.0000	0.0000

[a] A fish tagged in John Day Reservoir was recaptured outside the reservoir.

Appendix Table 10. Exploitation of northern pikeminnow in McNary Reservoir in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam	Net[a]
1	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--
6	--	--	--	--	--	--	--	--
7	68	--	--	--	--	--	--	--
8	--	--	--	--	68	--	--	--
9	29	--	--	--	68	--	--	--
10	32	--	--	--	97	--	--	--
11	--	--	--	--	129	--	--	--
12	--	1	--	--	129	0.0078	--	--
13	--	3	--	--	128	0.0234	--	--
14	--	2	--	--	125	0.0160	--	--
15	--	3	--	--	123	0.0244	--	--
16	--	2	--	--	120	0.0167	--	--
17	--	2	--	--	118	0.0169	--	--
18	--	1	--	--	116	0.0086	--	--
19	--	1	--	--	115	0.0087	--	--
20	--	--	--	--	114	--	--	--
21	--	1	--	--	114	0.0088	--	--
22	--	1	--	--	113	0.0088	--	--
23	--	--	--	--	112	--	--	--
24	--	--	--	--	112	--	--	--
25	--	--	--	--	112	--	--	--
26	--	1	--	--	112	0.0089	--	--
27	--	--	--	--	111	--	--	--
28	--	1	--	--	111	0.0090	--	--
29	--	--	--	--	110	--	--	--
Total	129	19	0	--	--	0.1581	0.0000	--
Adjusted for tag loss						0.1647	0.0000	--

[a] No fishing effort.

Appendix Table 11. Exploitation of northern pikeminnow in Lower Monumental Reservoir in 1997.

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

[a] No fishing effort.

Appendix Table 12. Exploitation of northern pikeminnow in Little Goose Reservoir in 1997.

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

[a] No fishing effort.

Appendix Table 13. Exploitation of northern pikeminnow in Lower Granite Reservoir in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam[a]	Net[a]
1	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--
5	86	--	--	--	--	--	--	--
6	--	--	--	--	86	--	--	--
7	--	--	--	--	86	--	--	--
8	--	--	--	--	86	--	--	--
9	--	1	--	--	86	0.0116	--	--
10	--	1	--	--	85	0.0118	--	--
11	--	1	--	--	84	0.0119	--	--
12	--	--	--	--	83	--	--	--
13	--	2	--	--	83	0.0241	--	--
14	--	2	--	--	81	0.0247	--	--
15	--	1	--	--	79	0.0127	--	--
16	--	2	--	--	78	0.0256	--	--
17	--	--	--	--	76	--	--	--
18	--	--	--	--	76	--	--	--
19	--	1	--	--	76	0.0132	--	--
20	--	--	--	--	75	--	--	--
21	--	--	--	--	75	--	--	--
22	--	--	--	--	75	--	--	--
23	--	--	--	--	75	--	--	--
24	--	--	--	--	75	--	--	--
25	--	1	--	--	75	0.0133	--	--
26	--	--	--	--	74	--	--	--
27	--	--	--	--	74	--	--	--
28	--	--	--	--	74	--	--	--
29	--	--	--	--	74	--	--	--
Total	86	12	0	--	--	0.1489	--	--
Adjusted for tag loss						0.1551	--	--

[a] No fishing effort.

Appendix Table 14. Exploitation of northern pikeminnow systemwide in 1997.

Time period	Tagged	Recaptures			At Large	Exploitation		
		Sport	Dam	Net		Sport	Dam	Net
1	88	--	--	--	--	--	--	--
2	188	--	--	--	88	--	--	--
3	192	--	--	--	276	--	--	--
4	267	--	--	2	468	--	--	0.0043
5	86	--	--	--	733	--	--	--
6	167	--	--	--	819	--	--	--
7	68	--	--	1	986	--	--	0.0010
8	35	--	--	--	1053	--	--	--
9	34	3	--	--	1088	0.0028	--	--
10	32	4	--	--	1119	0.0036	--	--
11	20	6	--	--	1147	0.0052	--	--
12	11	3	--	--	1161	0.0026	--	--
13	--	12	--	--	1169	0.0103	--	--
14	--	9	--	--	1157	0.0078	--	--
15	--	19	--	--	1148	0.0166	--	--
16	--	13	--	--	1129	0.0115	--	--
17	--	6	1	--	1116	0.0054	0.0009	--
18	--	5	--	--	1109	0.0045	--	--
19	--	2	--	--	1104	0.0018	--	--
20	--	2	--	--	1102	0.0018	--	--
21	--	4	--	--	1100	0.0036	--	--
22	--	3	--	--	1096	0.0027	--	--
23	--	1	--	--	1093	0.0009	--	--
24	--	--	--	--	1092	--	--	--
25	--	1	--	--	1092	0.0009	--	--
26	--	1	--	--	1091	0.0009	--	--
27	--	--	--	--	1090	--	--	--
28	--	1	--	--	1090	0.0009	--	--
29	--	2	--	--	1089	0.0018	--	--
Total	1188	97	1	3	--	0.0856	0.0009	0.0053
Adjusted for tag loss						0.0892	0.0009	0.0055

[1.] The northern pikeminnow was known as the northern squawfish until 1998.

[3.] A location is defined as a reach of one shoreline and adjacent mainstream waters that extend approximately 3 km upstream and downstream from a landmark.