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

2003 ANNUAL REPORT

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2003 EXECUTIVE SUMMARY

by Russell G. Porter

This report presents results for year thirteen in a basin-wide program to harvest northern pikeminnow[1] (Ptychocheilus oregonensis). This program was started in an effort to reduce predation by northern pikeminnow 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 system-wide 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.

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 system-wide fishery using floating trapnets, but found this fishery to be ineffective at harvesting large numbers of northern pikeminnow on a system-wide 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

[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.

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 based on the favorable response in 1994. Results of these efforts are subjects of this annual report.

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 Report C 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 in Report C.

Program cooperators include the Pacific States Marine Fisheries Commission (PSMFC), Oregon Department of Fish and Wildlife (ODFW), and Washington Department of Fish and Wildlife (WDFW). The PSMFC was responsible for coordination and administration of the program; PSMFC subcontracted various tasks and activities to ODFW and WDFW 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 system-wide (*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)**: Provide technical, contractual, fiscal and administrative oversight for the program. In addition, PSMFC processes and provides accounting for the reward payments to participants in the sport-reward fishery.

3. **ODFW (Report C)**: 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 2003 by report are as follows:

Report A

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

1. Objectives for 2003 were to: (1) implement a recreational fishery that rewards anglers who harvest northern pikeminnow ≥ 228 mm (9 inches) total length, (2) collect, compile, and report data on angler participation, catch and harvest of northern pikeminoow and other fish species, and success rtes of participating anglers during the season, (3) examine collected northern pikeminnow for the presence of external tags, PIT tags, and signs of tag loss, (4) collect biological data on northern pikeminnow and other fish species returned to registration stations, (5) scan northern pikeminnow for the presence of consumed salmonids containing PAIT tags, and (6) Survey non-returning fishery participants who were targeting northern pikeminnow to obtain catch and harvest data on all fish species caught.

2. The NPSRF was conducted from May 5 through October 5, 2003 from the Dalles dam downstream and from May 19 through October 20, 2003 from the Dalles dam upstream. Nineteen registration stations were operated throughout the lower Snake and Columbia rivers. Eleven more productive registration stations also continued to operate during a one-week extension from October 5 – October 12, 2003.

3. A total of 196,555 northern pikeminnow ≥ 9 inches in total length were harvested during the 2003 season with 28,676 angler days spent harvesting these fish. Catch-per-angler-day for all anglers during the season was 6.85fish.

4. Anglers submitted 177 northern pikeminnow with external tags, and an additional 20 with fin-clip marks, but no tag. A total of 194,748 northern pikeminnow were individually scanned for the presence of salmonid PIT tags in their gut. A total of 149 salmonid PIT tags were detected and the codes recorded for transmittal to the PITAGIS database.

Report B

Northern Pikeminnow Sport-Reward Fishery Payments

1. For 2003 the rewards paid to anglers returned to the traditional amounts for the three payment tiers. The Reward paid for the first 100 fish was $4 per fish. The reward for fish in the 101-400 fish range were $5 per fish and for all fish caught above 400 was $6 per fish. Rewards for tagged fish was $100 per fish.

2. During 2003, rewards excluding tagged fish totaled $997,731 were paid for 194,239 fish.

3. A total of 177 vouchers were paid for tagged fish at $100 per tag. The tagged rewards totaled $17,700.

4. Promotional coupons were discontinued in 2003.

5. A total of 1,736 separate successful anglers received payments during the season.

6. The total for all payments for non-tagged and tagged pikeminnows in 2003 was $1,015,431.

Report C

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

1. Objectives were to: (1) evaluate the efficiency of the northern pikeminnow fishery by analyzing exploitation rates and incidental catch, (2) estimate reductions in predation on juvenile salmonids since implementation of the NPMP, (3) estimate the tag loss rate for spaghetti tags, (4) validate aging methods for northern pikeminnow, and (5) investigate differential mortality between tagged and untagged northern pikeminnow. Objectives (3) and (4) were first implemented in 2000 based on the recommendations of an independent review of the NPMP (Hankin and Richards 2000). Objective (5) was added in 2003 to address concerns raised by a biometric review of our evaluation process (Styer 2003).

2. System-wide exploitation in 2003 of northern pikeminnow 200 mm or greater in fork length was 10.5%, and 13.0% for northern pikeminnow equal to or greater than 250 mm FL. Incidental catch was 40.4% in the sport-reward fishery.

3. Although some modest reductions in predation have been achieved since 1999, further reductions are likely to be minimal if exploitation continues at mean 1996-2003 levels. It is estimated potential predation is currently 79% of pre-program levels, indicating this level of reduction will remain relatively constant ($\pm$ 1%) through 2007.

4. A double-tagging experiment estimated tag loss at 7.4% for spaghetti tags. Exploitation rates for 2003 were adjusted using the new rate. The results of our mortality test suggest there is lilttle or no differenctial mortality between tagged and untagged northern pikeminnow (mortality was 5% for both groups).

5. Between-reader variation in the aging of northern pikeminnow scales and opercles was virtually unchanged from 2002. Ages assigned to opercles continued to be lower than for scales but showed improvement over previous years. Ages assigned to opercles exactly matched ages assigned to scales from the same fish 25.0% of the time, however, agreement within one year was 65.8%.

REPORT A

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

2003 ANNUAL REPORT

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ABSTRACT

We are reporting on the progress of the Northern Pikeminnow *Ptychocheilus oregonensis* Sport-Reward Fishery (NPSRF) operated on the Columbia and Snake Rivers from May 5 through October 12, 2003. The objectives of this project were to (1) implement a recreational fishery that rewards anglers who harvest northern pikeminnow ≥228mm (9 inches) total length, (2) collect, compile, and report data on angler participation, catch and harvest of northern pikeminnow and other fish species, and success rates of participating anglers during the season, (3) examine collected northern pikeminnow for the presence of external tags, fin-clips, and signs of tag loss, (4) collect biological data on northern pikeminnow and other fish species returned to registration stations, (5) scan northern pikeminnow for the presence of consumed salmonids containing Passive Integrated Transponder (PIT) tags, and (6) obtain catch and harvest data on fish species caught by non-returning fishery participants who were targeting northern pikeminnow

A total of 196,555 northern pikeminnow ≥228mm and 7,694 pikeminnow < 228 mm were harvested during the 2003 season. There were a total of 5,097 different anglers who spent 28,676 angler days participating in the fishery. Catch per unit of effort for combined returning and non-returning anglers was 6.85 fish/angler day. The Oregon Department of Fish and Wildlife reported that the overall exploitation rate for the 2003 NPSRF was 10.5%

Anglers submitted 177 northern pikeminnow with external spaghetti tags, 11 with fin-clip marks but no tag and 8 with possible tag wounds and no fin clip recorded. A total of 149 PIT tags from consumed juvenile salmonids were detected and interrogated from northern pikeminnow received (99.1% of all received northern pikeminnow) in the 2004 NPSRF.

Peamouth *Mylocheilus caurinus*, smallmouth bass *Micropterus dolomieui*, and channel catfish *Ictalurus punctatus* were once again the fish species most frequently harvested by NPSRF anglers targeting northern pikeminnow. The incidental catch of salmonids *Onchorhynchus spp*. by participating anglers targeting northern pikeminnow remained below established limits for the Northern Pikeminnow Management Program.

INTRODUCTION

Mortality of juvenile salmonids *Oncorhynchus spp.* migrating through the Columbia River system is a major concern of the Columbia Basin Fish and Wildlife Program, and predation is an important component of mortality (NPPC 1987a). Northern pikeminnow *Ptychocheilus oregonensis*, formerly known as northern squawfish (Nelson et al. 1998), are the primary piscine predator of juvenile salmonids in the Lower Columbia and Snake River systems (Rieman et al. 1991). 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 (FL). The Northern Pikeminnow Management Program (NPMP) was formed in 1990, with the goal of implementing fisheries which achieve the recommended 10-20% annual exploitation on northern pikeminnow >275 mm FL within the program area (Vigg and Burley 1989). The Washington Department of Fish and Wildlife (WDFW) was enlisted to conduct the Sport-Reward Fishery (Burley et al. 1992) which provides monetary rewards to recreational anglers who harvest reward sized (≥ 9" Total Length) northern pikeminnow from within program boundaries on the Columbia and Snake rivers. Since 1991, the Northern Pikeminnow Sport-Reward Fishery (NPSRF) has been responsible for harvesting more than 2.1 million reward size northern pikeminnow and generating more than 540,000 angler days of effort in becoming the NPMP's most successful component for achieving the annual 10-20% exploitation rate on northern pikeminnow within the program boundaries (Klaybor et al. 1993; Friesen and Ward 1999). In 2000, NPMP administrators reduced the minimum size for eligible (reward size) northern pikeminnow to 228 mm (9 inches) in response to recommendations contained in a review of NPMP justification, performance, and cost-effectiveness (Hankin and Richards 2000).

The 2003 NPSRF continued to provide a tiered reward system (Hisata et al. 1995) that paid anglers a higher amount per fish based on achieving designated harvest levels and a separate bonus reward for returning northern pikeminnow that were spaghetti tagged by the Oregon Department of Fish and Wildlife (ODFW) as a part of the NPSRF's biological evaluation. All returning anglers, and 20.7% of non-returning anglers were surveyed in order to collect catch and harvest data needed to monitor the effect of the NPSRF on other fish species.

The objectives of the 2003 NPSRF were to (1) implement a recreational fishery that rewards anglers who harvest northern pikeminnow ≥228mm (9 inches) total length, (2) collect, compile, and report data on angler participation, catch and harvest of northern pikeminnow and other fish species, and success rates of participating anglers during the season, (3) examine collected northern pikeminnow for the presence of external tags, PIT tags, and signs of tag loss, (4) collect biological data on northern pikeminnow and other fish species returned to registration stations, (5) scan northern pikeminnow for the presence of consumed salmonids containing PIT tags, and (6) Survey non-returning fishery participants who were targeting northern pikeminnow to obtain catch and harvest data on all fish species caught.

METHODS OF OPERATION

FISHERY OPERATION

Boundaries and Season

The NPSRF was 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, anglers were allowed to harvest (and submit for payment) northern pikeminnow from backwaters, sloughs, and up to 400 feet from the mouth of tributaries within this area. Angler rules for participating in the 2003 NPSRF were revised to clarify the participation requirements for the first time since 1995 (Hisata et al. 1995) (Appendix A).

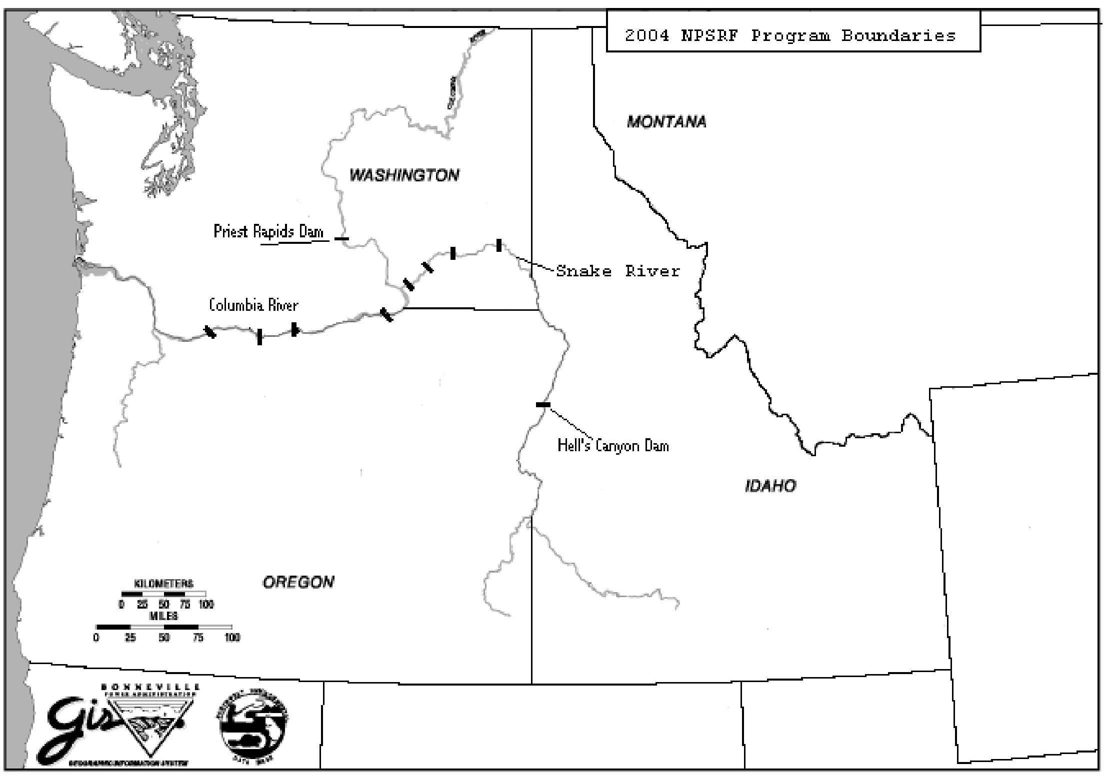
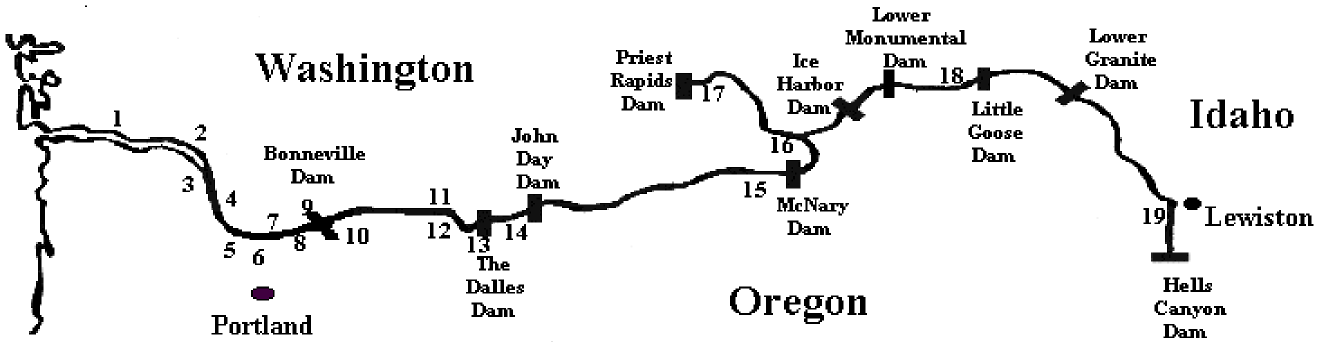


Figure 1. Northern Pikeminnow Sport-Reward Fishery Program Area

The NPSRF was fully implemented from May 19 through October 5, 2003. In addition, thirteen stations below The Dalles Dam conducted a two week long "pre-season" beginning on May 5, 2003 in order to take advantage of favorable river conditions that provided anglers with an earlier opportunity to begin harvesting northern pikeminnow. Eleven registration stations also continued to operate during a one-week season extension from October 5 – October 12, 2003 for the same reasons.



Registration Stations	Registration Stations	Registration Stations
1. Cathlamet Marina (11-3 pm)	9. Bonneville Trail Head (11:30-4:30 pm)	17. Vernita Bridge (12-8 pm)
2. Willow Grove Boat Ramp (4-7 pm)	10. Cascade Locks Boat Ramp (5-7:30 pm)	18. Lyon's Ferry (12:30-4 pm)
3. Rainier Marina (3-7 pm)	11. Bingen Marina (3-8 pm)	19. Greenbelt (12-8 pm)
4. Kalama Marina (10:30-2 pm)	12. Hood River Marina (11:30-2:30 pm)	
5. M. James Gleason Boat Ramp (12-8 pm)	13. The Dalles Boat Basin (12-8 pm)	
6. Chinook Landing (7-10 am)	14. Giles French (12-8 pm)	
7. Washougal Boat Ramp (12-8 pm)	15. Umatilla Boat Ramp (6-8 pm)	
8. The Fishery (12-8 pm)	16. Columbia Point Park (12-8 pm)	

Figure 2. 2003 Northern Pikeminnow Sport-Reward Fishery registration stations.

Registration Stations

Nineteen registration stations (Figure 2) were located on the Columbia and Snake rivers to provide anglers with access to the Sport-Reward Fishery. Washington Department of Fish and Wildlife technicians set up daily (seven days a week) registration stations at designated locations (normally public boat ramps or parks) which were available to anglers between two and eight hours per day during the season. Technicians registered anglers to participate in the NPSRF, collected creel information, issued pay vouchers to anglers returning with eligible northern pikeminnow, recorded biological data, scanned northern pikeminnow for the presence of PIT tags, and provided Sport-Reward Fishery information to the public. Self-registration boxes were located at each station so anglers could self-register when WDFW technicians were not present.

Reward System

The 2003 NPSRF rewarded anglers for harvesting northern pikeminnow $\geq$ 228mm (9 inches) total length (TL). The 2003 NPSRF continued to use a tiered reward system developed in 1995 (Hisata et al. 1995) that paid anglers a higher reward per fish once they had reached designated harvest levels over the course of the season. To receive payment, anglers returned their catch (daily) to the location where they had registered. Station technicians identified and measured the angler's fish and issued a payment voucher for the total number of eligible northern pikeminnow. Anglers mailed payment vouchers to the Pacific States Marine Fisheries Commission (PSMFC) for redemption. Anglers returning with northern pikeminnow that were spaghetti-tagged by

ODFW as part of the biological evaluation of the Fishery (Vigg et al. 1990), were issued a separate tag payment voucher that was mailed to ODFW for tag verification before payment was made by the PSMFC. The 2003 NPSRF retained the reward levels in place at the beginning of the 2001 NPSRF (Winther et. al, 2001) which paid anglers $4 each for their first 100 northern pikeminnow, $5 each for numbers 101 – 400, $6 each for all fish over 400. Anglers received $100 each for returning eligible spaghetti-tagged northern pikeminnow in 2003.

Angler Sampling

Angler data and creel data for the NPSRF were compiled from angler registration forms. One registration form represented one angler day. Angler data consisted of name, date, fishing license number, phone number, and city, state, zip code of participating angler. Creel data recorded by WDFW technicians included fishing location (Figure 3), and primary species targeted (Appendix B). Anglers were asked if they specifically fished for northern pikeminnow

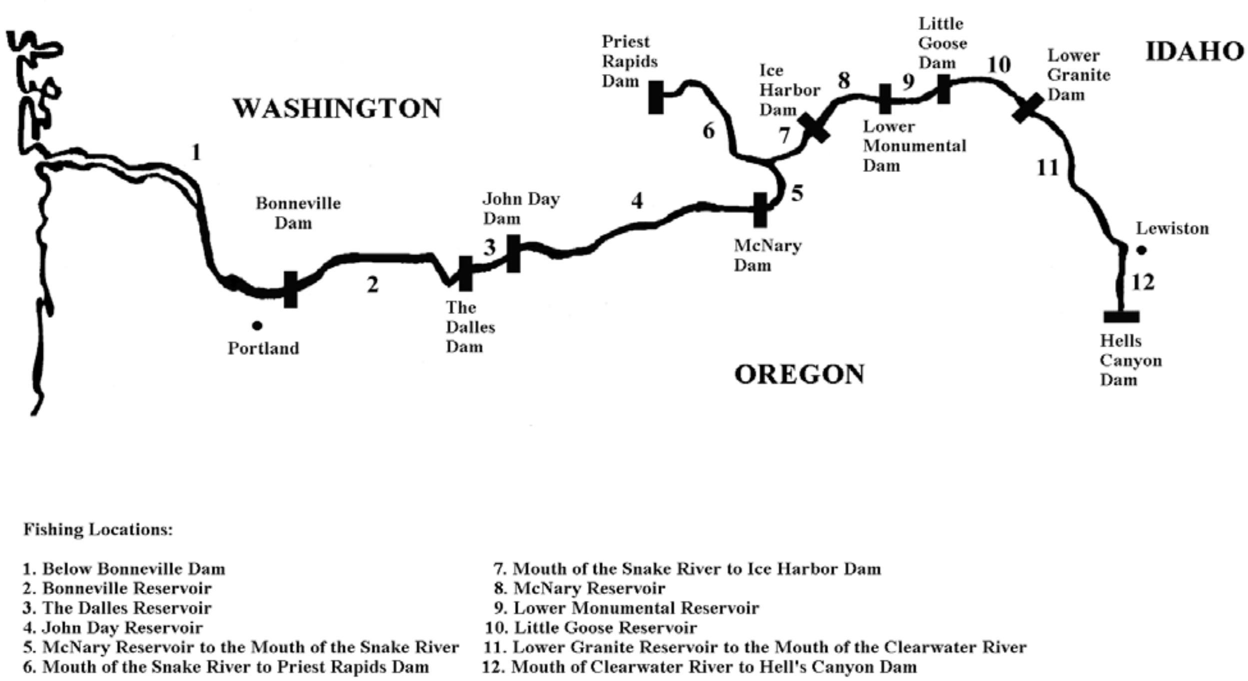


Figure 3. Fishing location codes used for the Northern Pikeminnow Sport-Reward Fishery

at any time during their fishing trip. A “No” response ended the exit interview. A “Yes” response prompted the technician to ask the angler, and record data on how many of each species of fish were caught, harvested or released while targeting northern pikeminnow. A fish was considered “caught” when the angler touched the fish, whether it was released or harvested. Fish returned to the water alive were defined as “released”. Fish that were retained by the angler or not returned to the water alive were considered “harvested”.

Returning Anglers

Technicians interviewed all returning anglers at each registration station to obtain any missing angler data, and to record creel data from each participants angling day. Creel data from caught and released fishes were recorded from angler recollection. Creel data from all harvested fish species were recorded from visual observation.

Non-Returning Anglers

Non-returning angler data was compiled from the pool of anglers who had registered for the NPSRF and targeted northern pikeminnow, but did not return to a registration station to participate in an exit interview. WDFW technicians were to survey 20% of the NPSRF's non-returning anglers by telephone in order to obtain creel data from that segment of the NPSRF's participants. To obtain the 20% sample, non-returning anglers were randomly selected from each registration station for each week. A technician called anglers from each random sample until the 20% sample was attained. Non-returning anglers were surveyed with the same exit interview questions used for returning anglers. For the 2003 season, non-returning angler catch and harvest data were only recorded for the number and species of adult and/or juvenile salmonids, the number of ≥ 9" total length pikeminnow and the number of < 9" total length northern pikeminnow. Non-returning angler catch and harvest data for all other fish species (last obtained during the 2000 NPSRF) were not collected in 2003 since their catch and harvest rates tend to be less than 25% of the catch and harvest rates of returning anglers (Hisata et al. 1995). We anticipate collecting full creel data for all other fish species (in order to reconfirm this trend) again in 2005 per NPSRF protocol (Fox et al 1999).

NORTHERN PIKEMINNOW HANDLING PROCEDURES

Biological Sampling

Technicians examined all fishes returned to registration stations and recorded species as well as number of fish per species. Technicians examined all northern pikeminnow for the presence of external tags (spaghetti or dart), fin-clip marks, and signs of tag loss. Fork lengths and sex (determined by evisceration) of northern pikeminnow as well as fork lengths for any other harvested fish species were recorded whenever possible. All spaghetti tagged northern pikeminnow were measured for fork length, eviscerated to determine sex, and scale and opercle samples were taken. Data from tags, fin-clip marks or signs of tag loss were recorded on data forms and on a tag envelope. The tag was placed in the envelope, stapled to the tag payment voucher and given to the angler to submit to ODFW for verification.

PIT Tag Detection

Northern pikeminnow harvested by anglers participating in the NPSRF have been found to ingest juvenile salmonids carrying passive integrated transponder (PIT) tags (Glaser et al. 2000). PIT tags were also used for the first time as a secondary mark in all northern pikeminnow that were fitted with spaghetti tags as part of the 2003 NPMP's biological evaluation activities. The use of PIT tags rather than fin clips as a secondary mark in northern pikeminnow was intended to remove uncertainties regarding tag loss, and will result in a more accurate estimate of exploitation for the NPSRF. WDFW technicians sought to scan 100% of all northern pikeminnow returned to registration stations for Pit Tags using two types of PIT tag "readers". Northern pikeminnow were scanned using primarily Destron Fearing portable transceiver systems (model # FS2001F), to record information from PIT tag detections for submission to the Columbia Basin PIT Tag Information System (PTAGIS). The NPSRF also used Allflex ISO Compatible RF/ID Portable Readers (model # RS601) to scan northern pikeminnow and assist in recovery of initial PIT tag data when the Destron's were not available. Scanning began on the first day of the NPSRF pre-season and continued throughout the rest of the year, including the season extension. Technicians individually scanned all northern pikeminnow for PIT tag presence and complete biological data were recorded from pikeminnow with positive readings. All PIT tagged northern pikeminnow were labeled and preserved for later dissection and tag recovery. All data were verified after recovery of PIT tags and readers were downloaded regularly to a central laptop computer from which detection information was forwarded to PTAGIS via electronic mail.

Northern Pikeminnow Processing

During biological sampling, all northern pikeminnow were eviscerated (to determine sex), or caudal clipped as an anti-fraud measure intended to eliminate the possibility of previously processed northern pikeminnow being resubmitted for payment. In 2003, most northern pikeminnow were caudal clipped rather than eviscerated in order to facilitate accurate scanning for PIT tags. Sampled northern pikeminnow were iced and transported to cold storage facilities from which they were ultimately delivered to rendering facilities for final disposal.

RESULTS AND DISCUSSION

Northern Pikeminnow Harvest

The NPSRF harvested a total of 196,555 reward size northern pikeminnow ($\geq$ 228 mm TL) during the 2003 season. Of this total, 9,768 northern pikeminnow (5%) were caught during the two week pre-season which operated below The Dalles Dam from May 5 through May 18th and 3,931 northern pikeminnow (2%) were caught during the one week extension from October 5 through October 12th. Total harvest for the 2003 NPSRF was 2% lower (4,841 fish) than for the 2002 NPSRF (Winther et al 2002), which harvested 201,396 northern pikeminnow (Figure 4). On the other hand, 2003 NPSRF total harvest was 21% higher than mean 1991-2002, harvest. It should also be noted that in addition to reward size northern pikeminnow, the 2003 NPSRF also harvested 7,694 northern pikeminnow < 228 mm TL during the 2003 season.

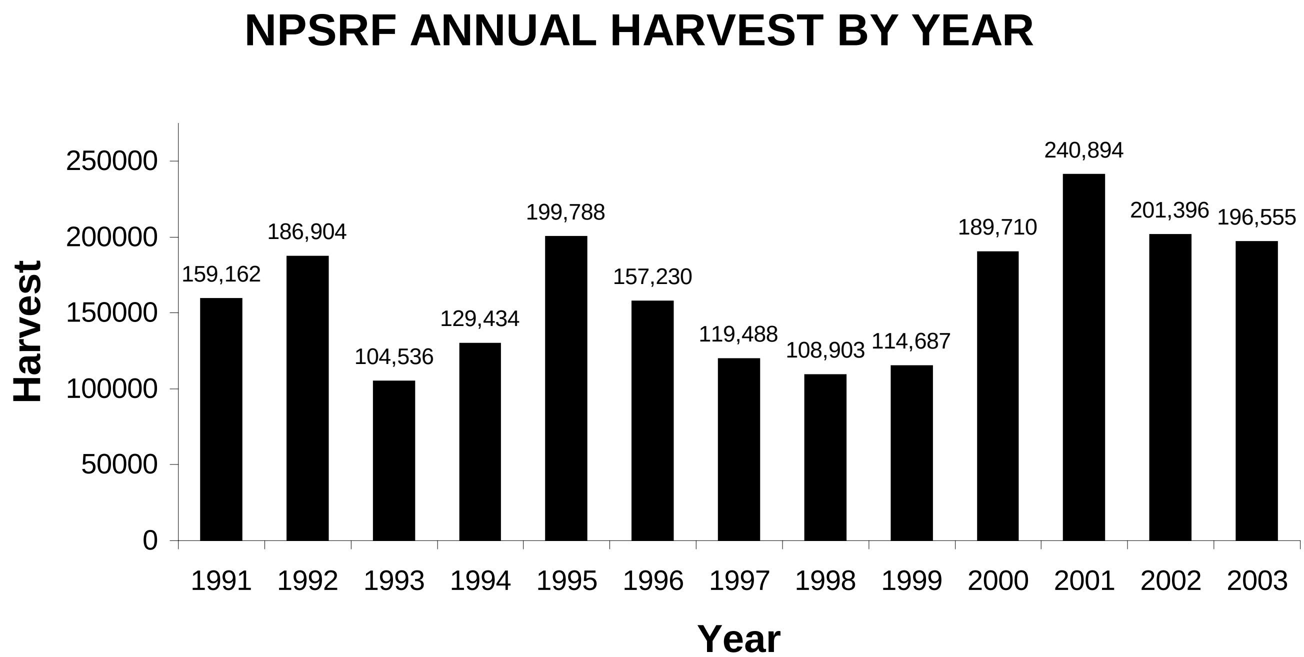


Figure 4. Annual Harvest totals for the Northern Pikeminnow Sport-Reward Fishery.

Mean weekly harvest for the 2003 NPSRF was 8,546 reward size northern pikeminnow and ranged from 3,931 in week 40 (October 6-12) to 14,365 in week 25 (June 23-29) (Figure 5). Mean weekly harvest for the pre-season and for the extension was 4,884 NPM and 3,931 NPM respectively. Peak weekly harvest for the 2003 NPSRF occurred during the traditional June peak harvest period (Figure 6) seen from 1991-2002 (Fox et al. 1999), and the weekly pattern nearly mimics the 2002 NPSRF (Figure 7) except for peaking one week earlier.

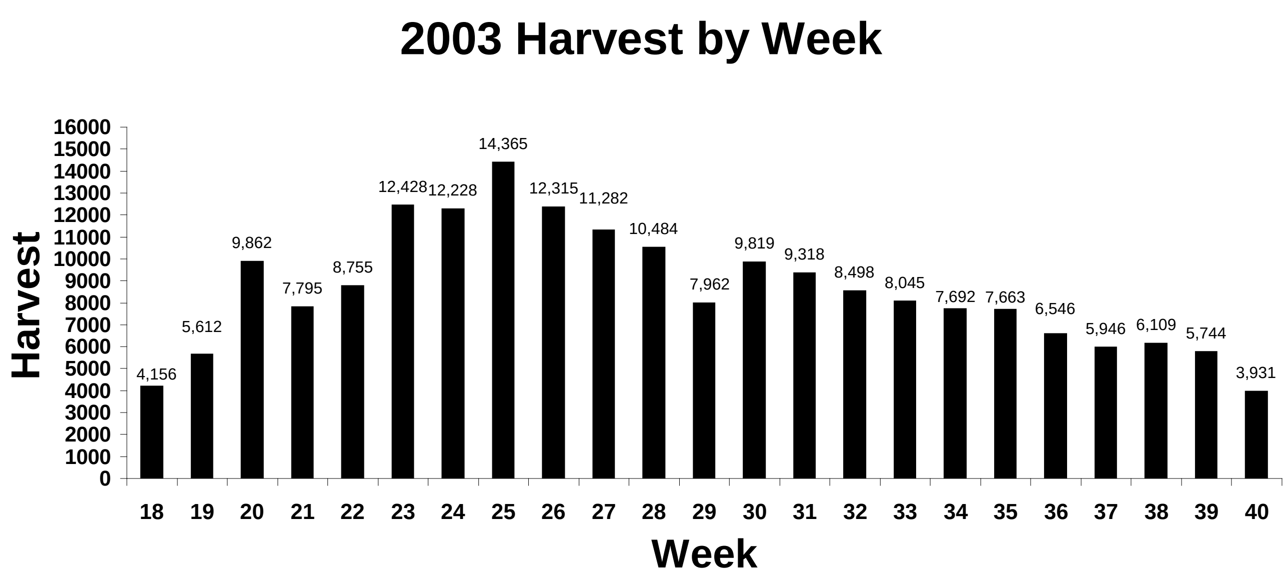


Figure 5. 2003 Northern Pikeminnow Sport-Reward Fishery Harvest by week.

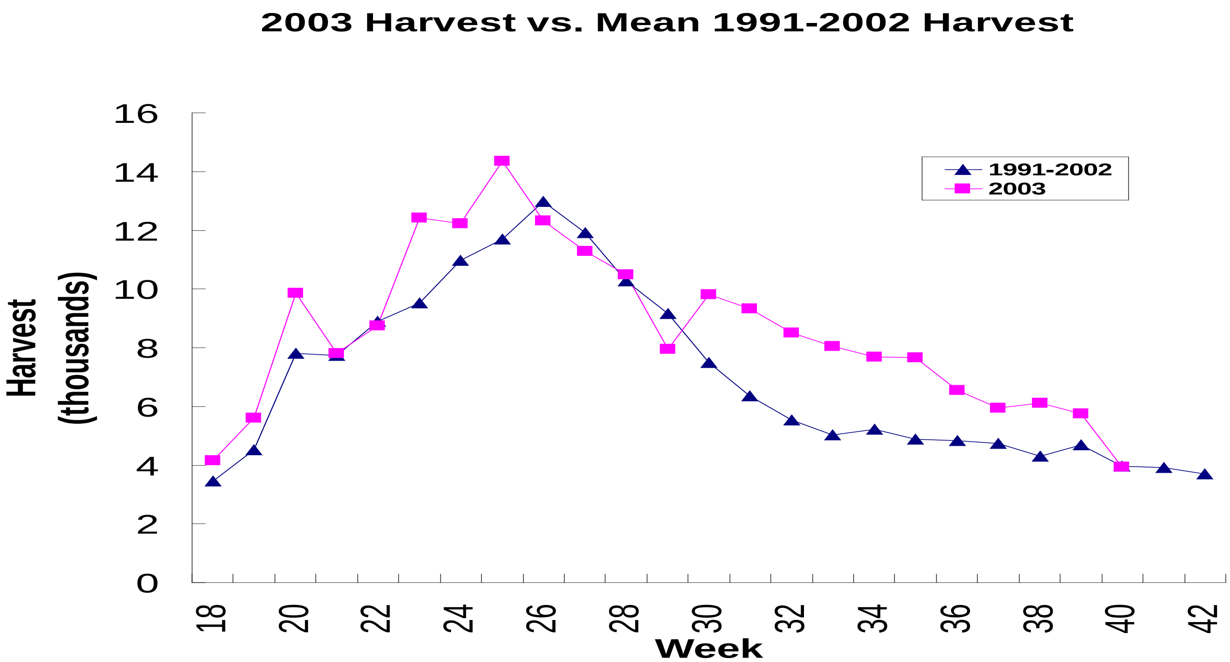


Figure 6. Comparison of 2003 NPSRF Weekly Mean Harvest to Mean 1991-2002 NPSRF Harvest.

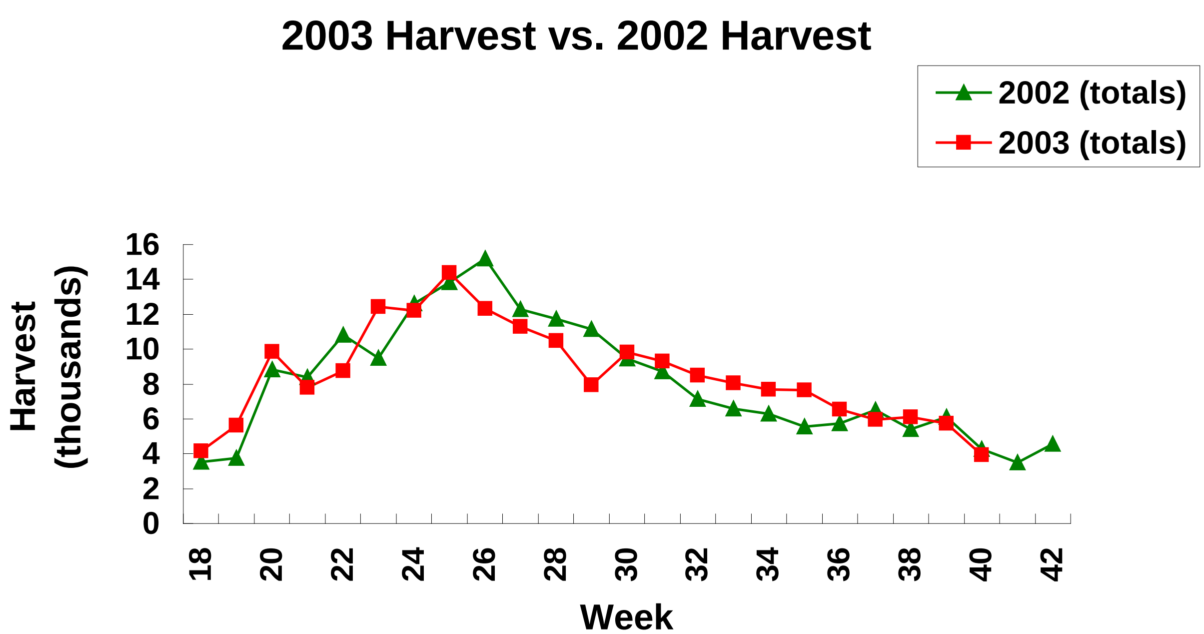


Figure 7. 2003 weekly Northern Pikeminnow Sport-Reward Fishery Harvest vs. 2002 weekly Harvest.

The mean harvest by fishing location was 16,380 northern pikeminnow and ranged from 80,257 reward size northern pikeminnow (42% of the total NPSRF season harvest) in fishing location 01, (downstream of Bonneville Dam) to 279 northern pikeminnow from fishing location 5 (McNary Dam to mouth of the Snake River) (Figure 8). Fishing location 01 was the NPSRF's top producing location for the thirteenth consecutive year. Harvest from fishing location 06 showed the greatest change from 2002, declining 44% (10,150 NPM) from 2002.

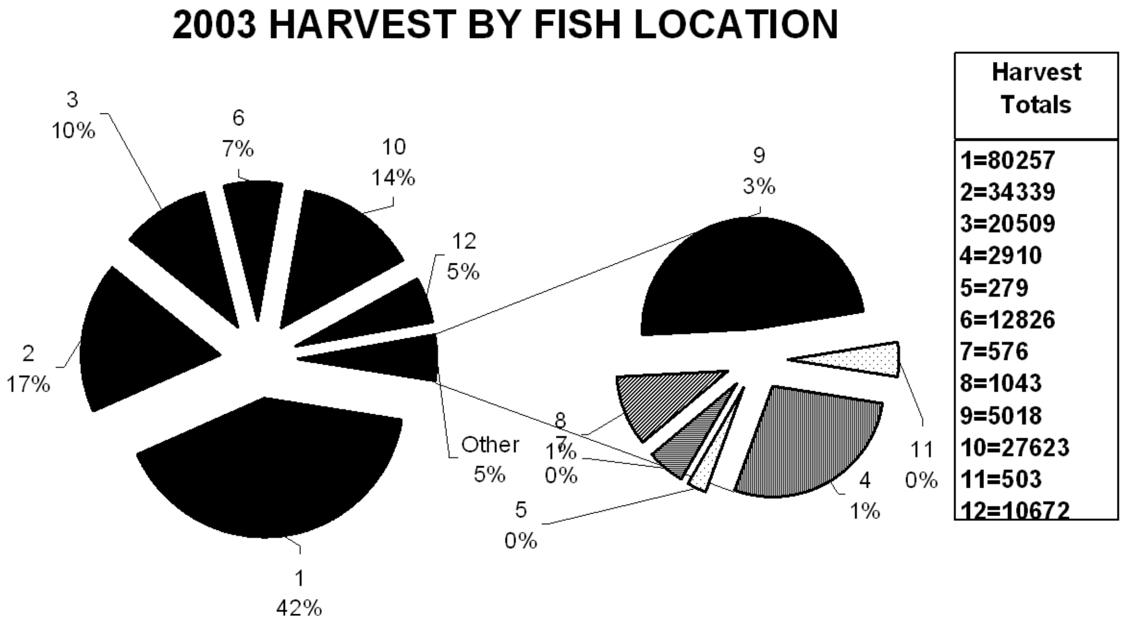


Figure 8. 2003 Northern Pikeminnow Sport-Reward Fishery Harvest by Fishing Location.

The mean harvest per registration station was 10,345 reward size northern pikeminnow and ranged from 36,325 northern pikeminnow at the Greenbelt station (19% of total 2003 NPSRF harvest) to 2,312 northern pikeminnow at the Umatilla station (Figure 9). Mean harvest per registration station was up slightly from 2002 (10,070). The Greenbelt registration station was the top producing registration station for the third year in a row. The Vernita station (which receives most of it's harvest total from fishing location 06) showed the greatest change in harvest from 2002, also declining to less than half (44%) (11,560 NPM) of it's total from 2002. The dramatic decreases in harvest from fishing location 06, and the Vernita station specifically, are primarily the result of several "high-catch" anglers (including the top angler from both the 2000 and 2002 NPSRF) being disqualified from the NPSRF for violation of program rules. With these anglers not participating in the 2003 NPSRF, harvest in this area returned to levels seen prior to the 2000 NPSRF when the activities of these anglers had increased dramatically.

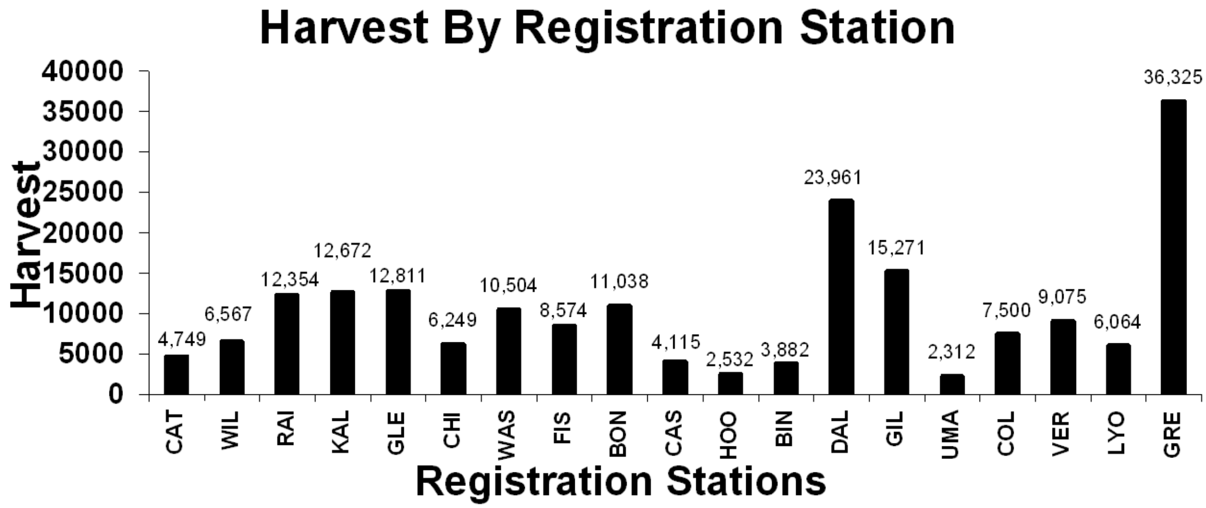


Figure 9. 2003 Northern Pikeminnow Sport-Reward Fishery Harvest by Registration station. CAT-Cathlamet, WIL-Willow Grove, RAI-Rainier, KAL-Kalama, GLE-Gleason, CHI-Chinook, WAS-Washougal, FIS-The Fishery, BON-Bonneville Trailhead, CAS-Cascade Locks, HOO-Hood River, BIN-Bingen, DAL-The Dalles, GIL-Giles French, UMA-Umatilla, COL-Columbia Point, VER-Vernita, LYO-Lyon's Ferry, GRE-Greenbelt.

Incidental Catch/Harvest by Species

Returning Anglers

Incidental salmonid catch by returning anglers targeting northern pikeminnow consisted mostly of juvenile and adult steelhead. Harvested salmonids are most often fish that are incidentally caught and kept by anglers during a legal fishery. Instances where anglers report harvesting juvenile salmonids are likely residualized hatchery steelhead smolts, and are sometimes listed as trout. Illegally harvested juvenile salmonids are reported to enforcement. Unknown caught and released salmonids are recorded based on angler recollection rather than identification by WDFW technicians. During the 2003 NPSRF, returning anglers reported that they caught or harvested the following salmonid species while targeting northern pikeminnow (Table 1).

Table 1. Catch and harvest totals by returning anglers targeting northern pikeminnow during the 2003 Northern Pikeminnow Sport-Reward Fishery.

Salmonid Species		**Caught**	**Harvest**	**Harvest Percent**
Chinook (Adult)	*Oncorhynchus tshawytscha*	19	3	15.79%
Chinook (Jack)	*Oncorhynchus tshawytscha*	29	5	17.24%
Chinook (Juvenile)	*Oncorhynchus tshawytscha*	50	0	0.00%
Steelhead Adult (Hatchery)	*Oncorhynchus mykiss*	36	14	38.89%
Steelhead Adult (Wild)	*Oncorhynchus mykiss*	30	0	0
Steelhead Juvenile (Hatchery)	*Oncorhynchus mykiss*	82	1	1.22%
Steelhead Juvenile (Wild)	*Oncorhynchus mykiss*	22	0	0
Coho (Adult)	*Oncorhynchus kisutch*	2	0	0
Coho (Juvenile)	*Oncorhynchus kisutch*	8	0	0
Salmon Pacific (unknown)	*Oncorhynchus spp.*	12	0	0
Searun Cutthroat	*Oncorhynchus clarki*	11	2	18.18%
Coastal Cutthroat	*Oncorhynchus clarki*	1	0	0
Cutthroat (unknown)	*Oncorhynchus clarki*	17	1	5.88%
Rainbow Trout	*Oncorhynchus mykiss*	5	2	40.00%
Trout (Unknown)		62	1	1.61%

As expected, returning anglers targeting northern pikeminnow most often caught and harvested northern pikeminnow. Other fish species incidentally caught by these anglers were mostly peamouth, smallmouth bass, and channel catfish. This has been the case in each year that the NPSRF has been implemented. In addition to these species, returning anglers targeting northern pikeminnow also reported that they incidentally caught or harvested the non-salmonid species listed in Table 2.

Non-Returning Anglers Catch and Harvest Estimates

We surveyed 2,301 non-returning anglers (23.07% of all non-returning anglers) to record their catch and/or harvest of northern pikeminnow and salmonid species. Catch and harvest data for all other fish species caught by non-returning anglers (last obtained during the 2000 NPSRF) were not recorded in 2003 since their levels have been historically very low. We anticipate collecting full creel data for other fish species in order to determine whether trends have changed in 2005 per NPSRF protocol (Fox et al. 1999). Surveyed non-returning anglers targeting northern pikeminnow reported that they caught and/or harvested the species listed in column one during the 2003 NPSRF (Table 3). We applied a simple estimator to the catch and harvest totals obtained from the surveyed anglers to obtain a total catch and harvest estimate for all non-returning anglers. Estimated total catch and harvest of northern pikeminnow and salmonids for <u>all</u> non-returning anglers participating in the 2003 NPSRF is listed in column two (Table 3).

Table 2. 2003 Catch and harvest totals of non-salmonids by returning anglers during the 2003 NPSRF.

Species	Catch	Harvest	Percent Harvested
Northern Pikeminnow ≥ 228 mm	196,573	196,555	99.99%
Northern Pikeminnow < 228 mm	49,597	7,694	15.51%
Peamouth *Mylocheilus cauriuus*	42,318	10,886	25.72%
Smallmouth Bass *Micropterus dolomieui*	13,525	1,314	9.72%
Channel Catfish *Ictalurus punctatus*	7,339	1,286	17.52%
White Sturgeon *Acipenser Transmountanus*	4,532	191	4.21%
Sculpin *Cottus spp.*	4,494	710	15.80%
Yellow Perch *Perea flauesceno*	3,863	333	8.62%
Sucker (Unknown) *Castostomus spp.*	2,647	308	11.64%
Walleye *Stizostedion vitreum*	947	629	66.42%
Chiselmouth *Acrochilus alutaceus*	798	88	11.03%
Redside Shiner *Richarsonius balteatus*	670	32	4.78%
Carp *Cyprinus carpio*	498	46	9.24%
American Shad *Alosa sapidissima*	441	246	55.78%
Bullhead *Ictalurus spp.*	345	24	6.96%
Yellow Bullhead *Ictalurus natlis*	340	37	10.88%
Starry Flounder *Platichthys stellatus*	243	7	2.88%
Crappie (Unknown) *Pomoxis spp.*	96	17	17.71%
Bluegill *lepomis macrochirus*	62	4	6.45%
Largemouth Bass *Micropterus salmonids*	60	15	25.00%
Brown Bullhead *Ictalurus nebulosus*	43	6	13.95%
Pumpkinseed *Leomis gibbosus*	41	4	9.76%
Mountain Whitefish *Prosopium williamsoni*	23	9	39.13%
Bridgelip Sucker *Catostomus columbianus*	19	0	0
Black Bullhead *Ictalurus melas*	13	0	0
Largescale Sucker *Catostomus macrocheilus*	10	0	0
Longnose Sucker *Catostomus catostomus*	4	0	0
White Crappie *Promoxis annularis*	3	1	33.33%
Black Crappie *Pomoxis nigromaculatus*	1	0	0
Blue Catfish *Ictalurus punctatus*	0	0	0
Flathead Catfish *Pilodictis olivaris*	0	0	0

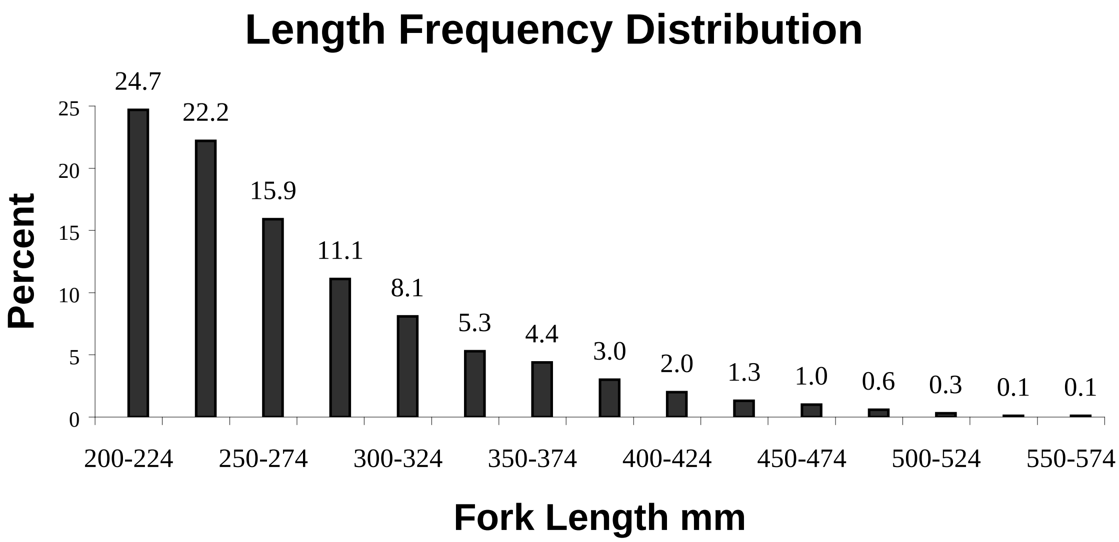
Table 3. Catch and harvest totals and estimates of catch and harvest for non-returning anglers.

Species	Caught	Harvested	%Harvested	Est. Catch	Est. Harvest
Northern Pikeminnow < 228 mm	179	172	96.09%	867	833
Chinook (Adult)	1	0	0	5	0
Chinook (Jack)	3	1	33.33%	15	5
Chinook (Juvenile)	70	0	0	339	0
Steelhead Adult (Adipose absent)	11	3	21.43%	53	15
Steelhead Adult (Adipose present)	6	0	0	29	0
Steelhead Juv. (Adipose absent)	28	0	0	136	0
Steelhead Juv.(Adipose present)	42	0	0	203	0
Rainbow Trout	12	0	0	58	0

N=9,972 n=2,301

Fork Length Data

A total of 119,747 northern pikeminnow $\geq$ 200 mm (60.9% of all returned to registration stations) were sampled for fork length in 2003. Of these, 112,047 had a fork length > 209 mm. The mean fork length for northern pikeminnow $\geq$ 200 mm was 272.4 mm with a standard deviation of 62.7 mm. The length frequency distribution of northern pikeminnow $\geq$ 200 mm is presented in Figure 10.



N = 119,747 **Mean = 272.4** **SD = 62.7**

FIGURE 10. LENGTH FREQUENCY DISTRIBUTION OF NORTHERN PIKEMINNOW $\geq$ 200 MM TOTAL LENGTH SAMPLED IN 2003.

Angler Effort

The NPSRF recorded total effort of 28,676 angler days spent during the 2003 season. Of this total, we noted that 2,259 angler days (8%) were spent during the pre-season and 402 angler days (1%) were spent during the season extension. This was a decline in total effort of 6% from the 2002 NPSRF (Figure 11). When total effort is divided into returning and non-returning angler days, 18,704 angler days (65%) were recorded by returning anglers. This is an increase from the 2002 NPSRF in which 61% of participating anglers returned for exit interviews. Of the 18,704 returning angler days spent during the 2003 NPSRF, 17,059 angler days (91%) were designated successful since they resulted in harvested NPM.

Mean weekly effort for the 2003 NPSRF increased slightly to 1,247 angler days and ranged from 402 in week 40 (October 6-12) to 1,858 during week 25 (June 23-29) (Figure 12). Mean weekly effort for the pre-season and the extension was 1,130 angler days, and 402 angler days respectively. Effort peaked during the first full week of implementation although a second similar peak occurred during the NPSRF's traditional peak harvest period in mid-June. The NPSRF peak effort period (which heavily influences total harvest) was substantially lower than the mean 1991-2002 peak, but continued to occur during the same week 21-25 time period seen from 1991-2002 (Figure 13).

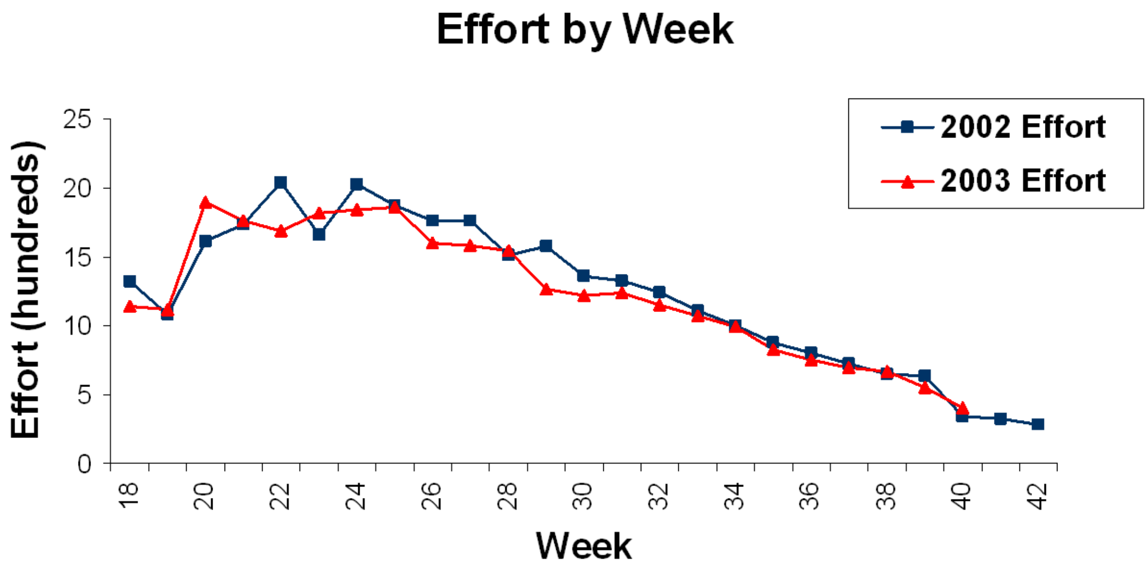


Figure 11. 2003 weekly Northern Pikeminnow Sport-Reward Fishery Effort vs. 2002 weekly Effort.

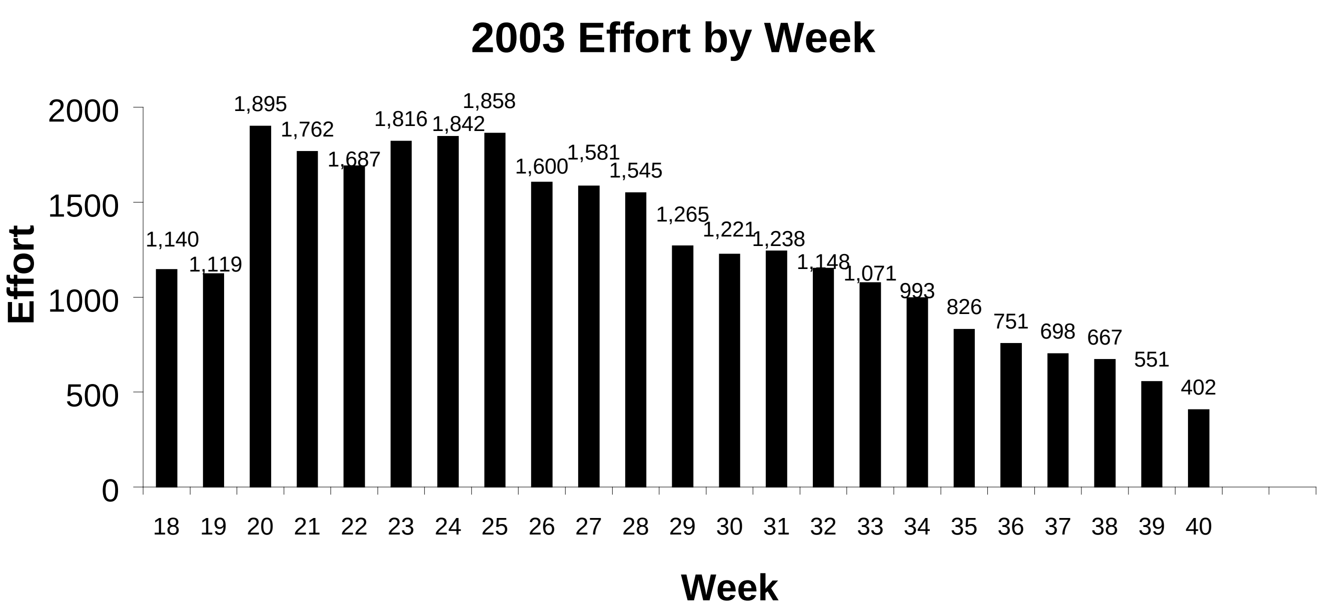


Figure 12. 2003 Northern Pikeminnow Sport-Reward Fishery Effort by week.

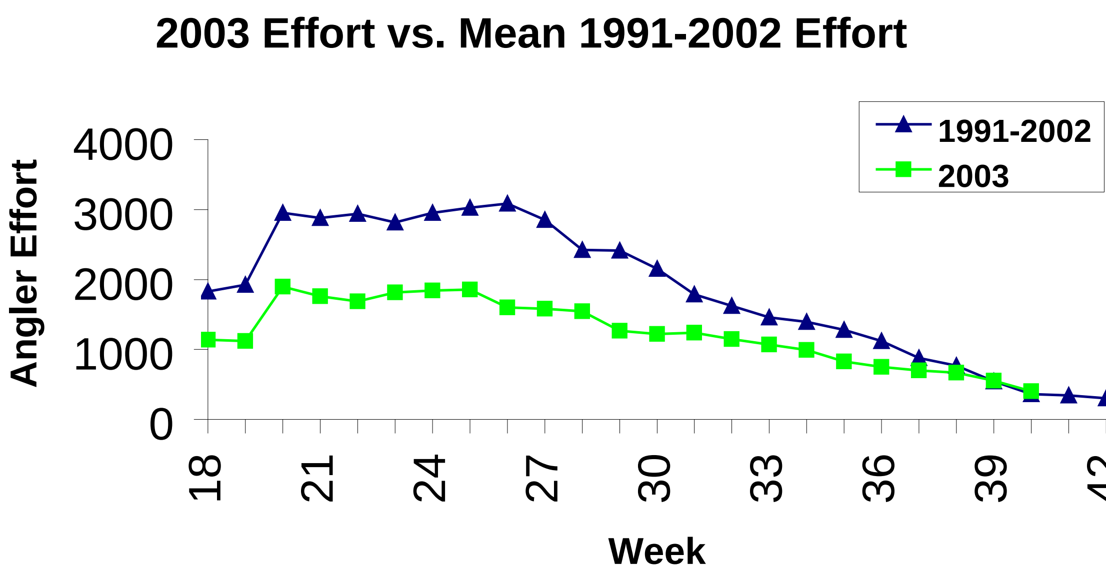


Figure 13. 2003 Northern Pikeminnow Sport-Reward Fishery weekly Effort vs. Mean 1991-2002 Effort.

Mean annual effort (returning anglers only) by fishing location was 2,390 angler days and ranged from 8,775 (48% of NPSRF total) in fishing location 01 (below Bonneville Dam) to 38 in fishing location 5 (McNary Dam to mouth of the Snake River) (Figure 14).

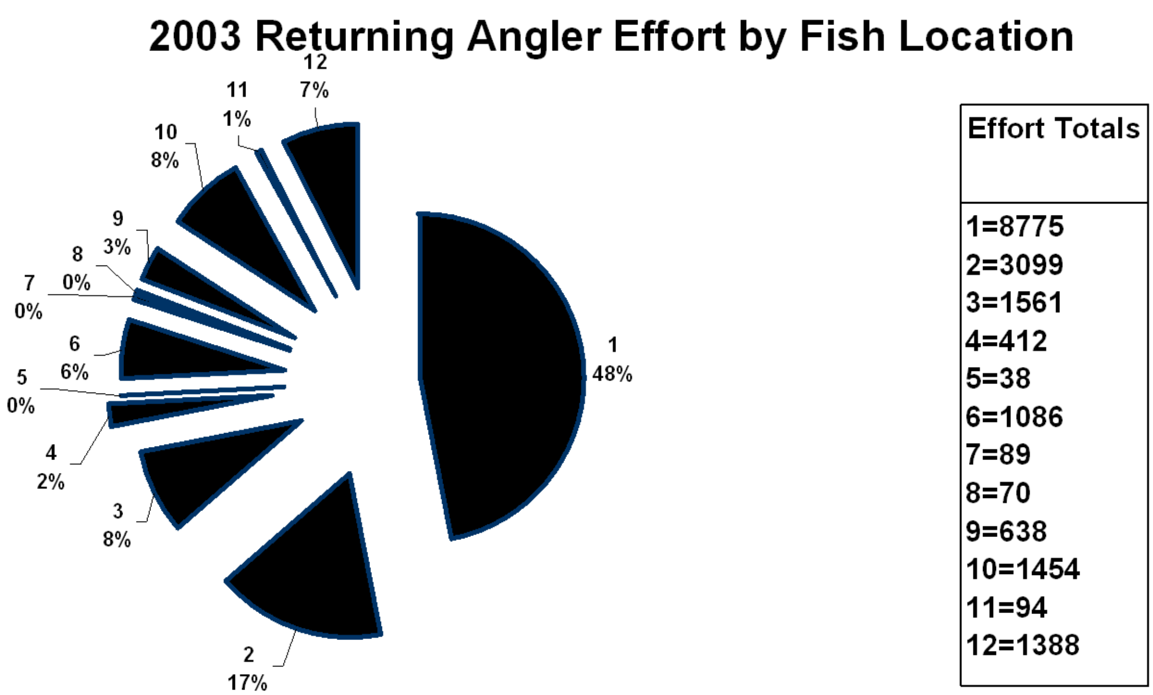


Figure 14. 2003 NPSRF Angler Effort by Fishing Location (returning anglers only).

Mean effort per registration station was 1,509 angler days and ranged from 3,994 angler days at Greenbelt to 318 angler days at Hood River (Figure 15). This continued a pattern that the NPSRF has seen for the past seven years in which the Greenbelt and Washougal stations had split time as the NPSRF's leader in effort. Effort at the Vernita station declined 15% from 1,222 angler days in 2002 to 1,037 angler days in 2003.

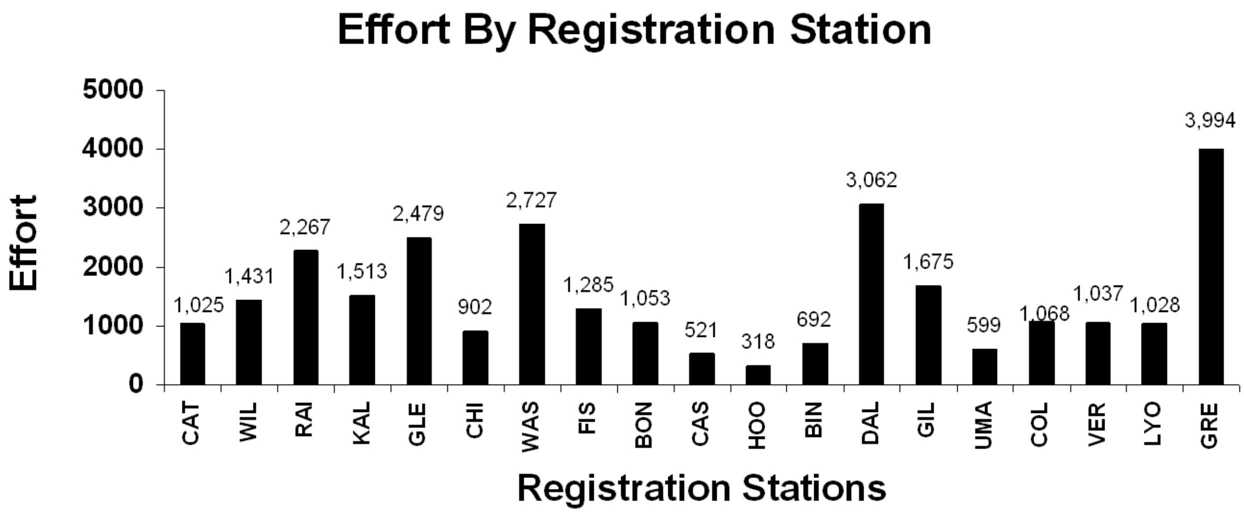


Figure 15. 2003 Northern Pikeminnow Sport-Reward Fishery Angler Effort by Registration Station. CAT-Cathlamet, WIL-Willow Grove, RAI-Rainier, KAL-Kalama, GLE-Gleason, CHI-Chinook, WAS-Washougal, FIS-The Fishery, BON-Bonneville Trailhead, CAS-Cascade Locks, HOO-Hood River, BIN-Bingen, DAL-TheDalles, GIL-Giles French, UMA-Umatilla, COL-Columbia Point, VER-Vernita, LYO-Lyon's Ferry, GRE-Greenbelt.

Catch Per Angler Day

The NPSRF recorded an overall catch per unit of effort (CPUE) of 6.85 northern pikeminnow harvested per angler day (returning + non-returning anglers) during the 2003 season. This catch rate was up from 6.57 in 2002 and once again set the standard for the highest CPUE in NPSRF history. The steady increase in CPUE from year to year is also consistent with the upward trend in CPUE seen in the NPSRF from 1991-2002 (Fox et al, 1999) (Figure 16). Returning angler CPUE was 10.50 northern pikeminnow per angler day and also set a NPSRF record as these anglers continued to develop their effectiveness at harvesting reward size northern pikeminnow. We also estimated CPUE for non-returning anglers to be .087 using our harvest estimates of northern pikeminnow by this group of anglers from Table 3. Clearly (as has been the case since 1991), returning anglers are considerably more skillful at harvesting reward size northern pikeminnow than are non-returning anglers.

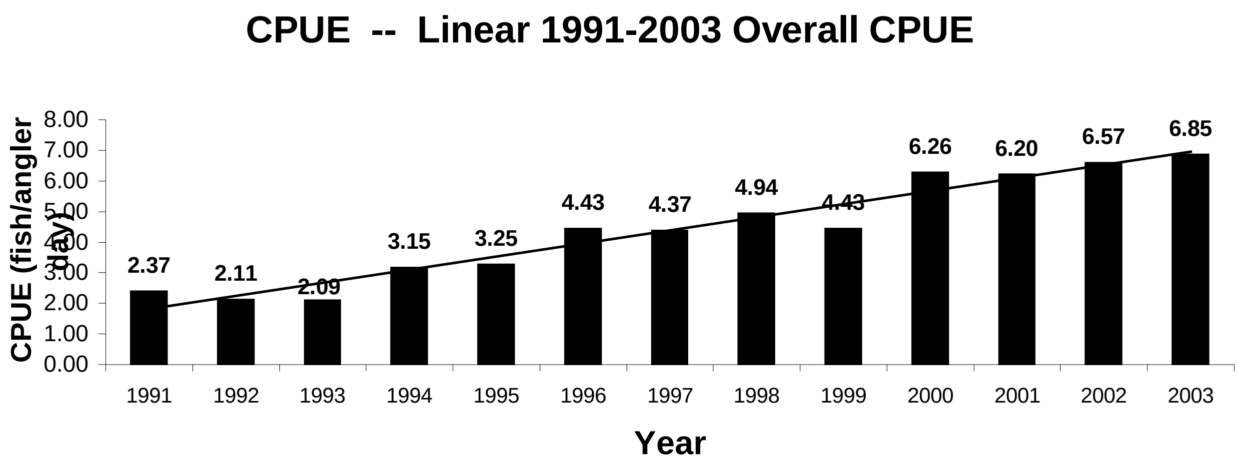


Figure 16. Annual CPUE totals for the Northern Pikeminnow Sport-Reward Fishery (return + non-return).

Mean weekly CPUE was 7.25 and ranged from 3.65 in week 18 (May 5-11) to a peak of 10.42 in week 39 (September 29-October 5) (Figure 17). The NPSRF also recorded mean CPUE of 4.34 fish/day during the pre-season, and 9.78 fish/day during the season extension.

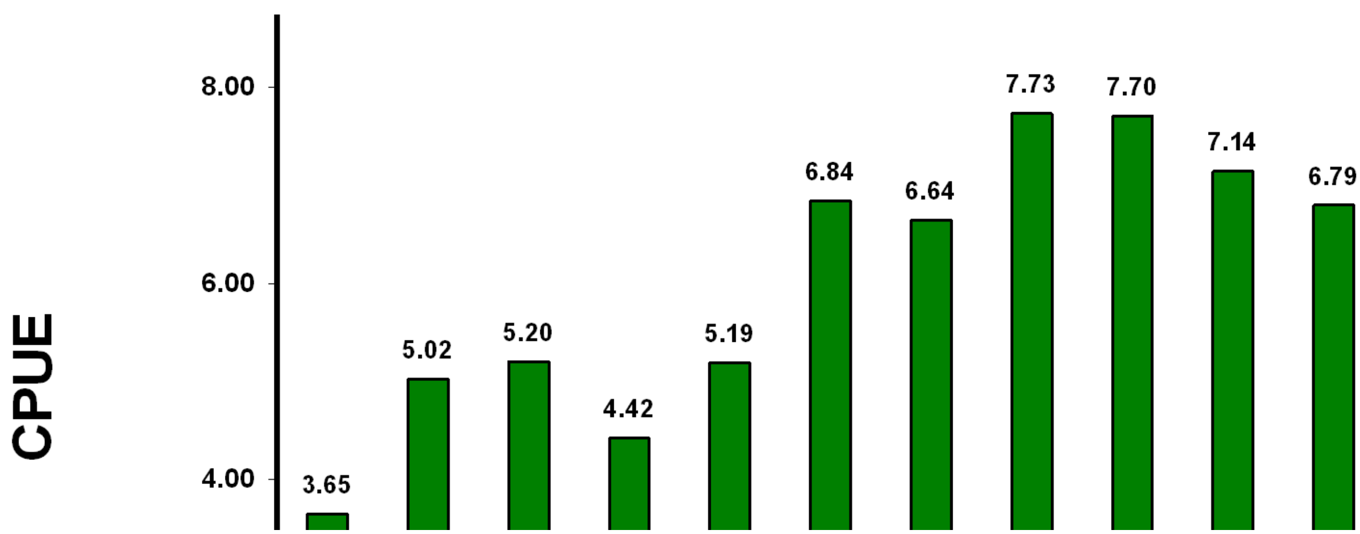


Figure 17. 2003 Northern Pikeminnow Sport-Reward Fishery Angler CPUE by Week.

The CPUE by fishing location during the 2003 NPSRF ranged from 19.00 northern pikeminnow per day in fishing location 10 (Little Goose Reservoir) to 5.35 in fishing location 11 (Lower Granite Reservoir) (Figure 18). When compared to 2002, all fishing locations below John DayDam (1-3) showed an increase in CPUE. On the other hand, all other fishing locations showed a decrease in CPUE, most notably in fishing location 06 which plummeted from 20.10 in 2002 to 11.81 in 2003 as a result of previously noted angler disqualifications.

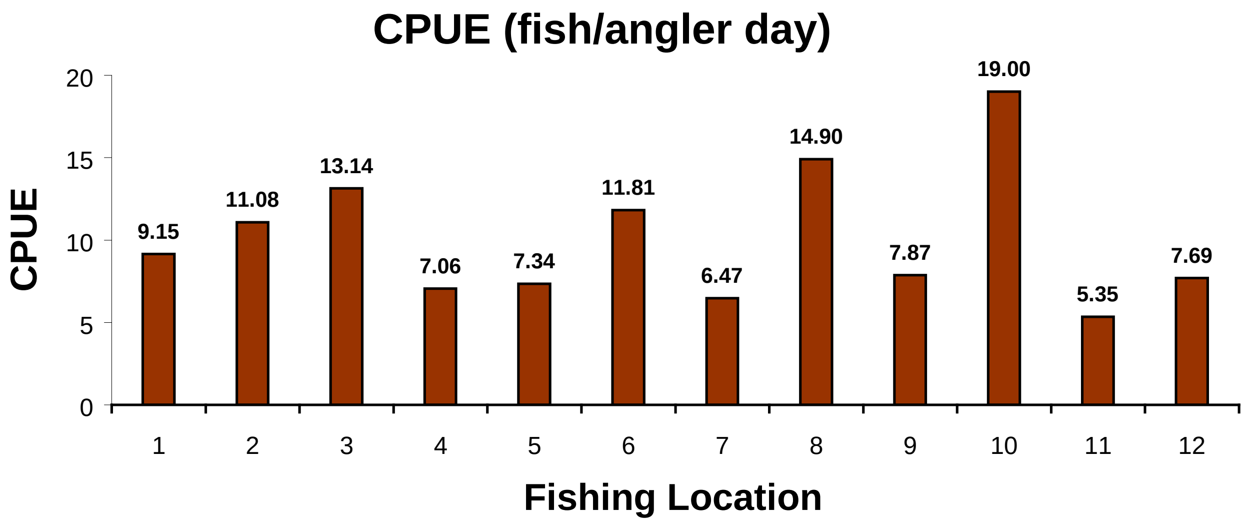


Figure 18. 2003 Northern Pikeminnow Sport-Reward Fishery Angler CPUE by Fishing Location.

The registration station that recorded the highest CPUE from the 2003 NPSRF was Bonneville Trailhead with 10.48 northern pikeminnow per angler day (Figure 19). The registration station with the lowest CPUE was Washougal with 3.85 northern pikeminnow per angler day. The largest change in CPUE was at the Vernita station which dropped from 16.89 in 2002 to 8.75 in 2003. Vernita was the station used by several "high-catch" anglers (including the top angler from 2002 whose CPUE was 68.8) who did not participate in the 2003 NPSRF after being disqualified for violating NPSRF rules.

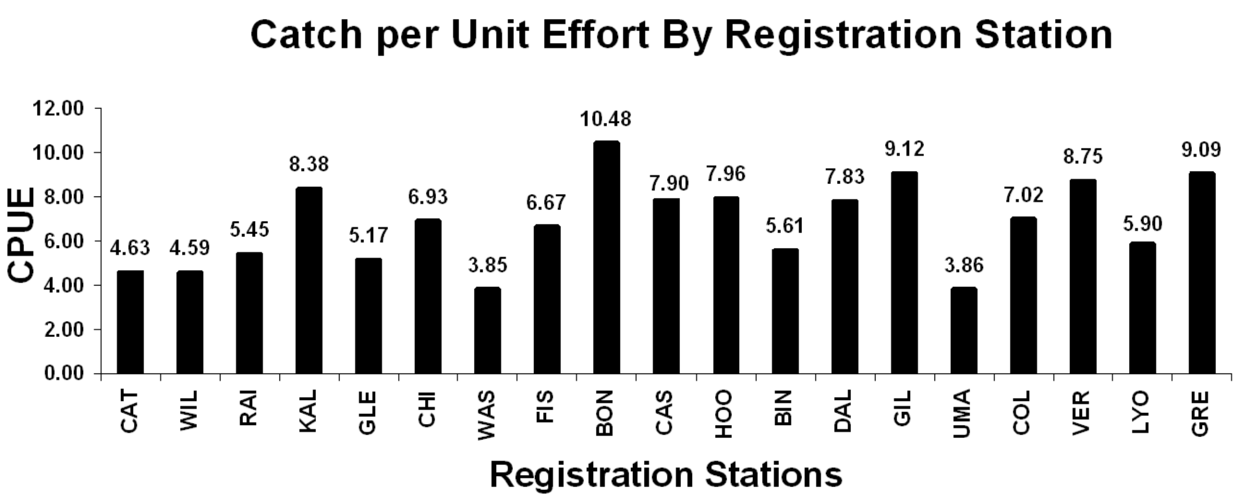


Figure 19. 2003 Northern Pikeminnow Sport-Reward Fishery Angler CPUE by Registration Station. CAT-Cathlamet, WIL-Willow Grove, RAI-Rainier, KAL-Kalama, GLE-Gleason, CHI-Chinook, WAS-Washougal, FIS-The Fishery, BON-Bonneville Trailhead, CAS-Cascade Locks, HOO-Hood River, BIN-Bingen, DAL-The Dalles, GIL-Giles French, UMA-Umatilla, COL-Columbia Point, VER-Vernita, LYO-Lyon's Ferry, GRE-Greenbelt.

Angler Totals

There were 5,097 separate anglers who participated in the 2003 NPSRF. Two thousand, two hundred and fifty of these anglers (44%) were classified as successful since they harvested at least one northern pikeminnow during the 2003 season. The average annual harvest of reward size northern pikeminnow per successful angler was 87 northern pikeminnow per season. When we break down the 2,250 successful anglers by tier, 85% (1,926 anglers) harvested less than 100 northern pikeminnow (Tier 1) during the 2003 season (Figure 20), with an average harvest of 13 northern pikeminnnow. Nine percent (197 anglers) harvested between 101 and 400 northern pikeminnow (Tier 2) during the 2003 season with an average harvest of 200 NPM. Six percent (127 anglers) caught more than 400 northern pikeminnow (Tier 3) during the 2003 season and averaged 1,048 NPM.

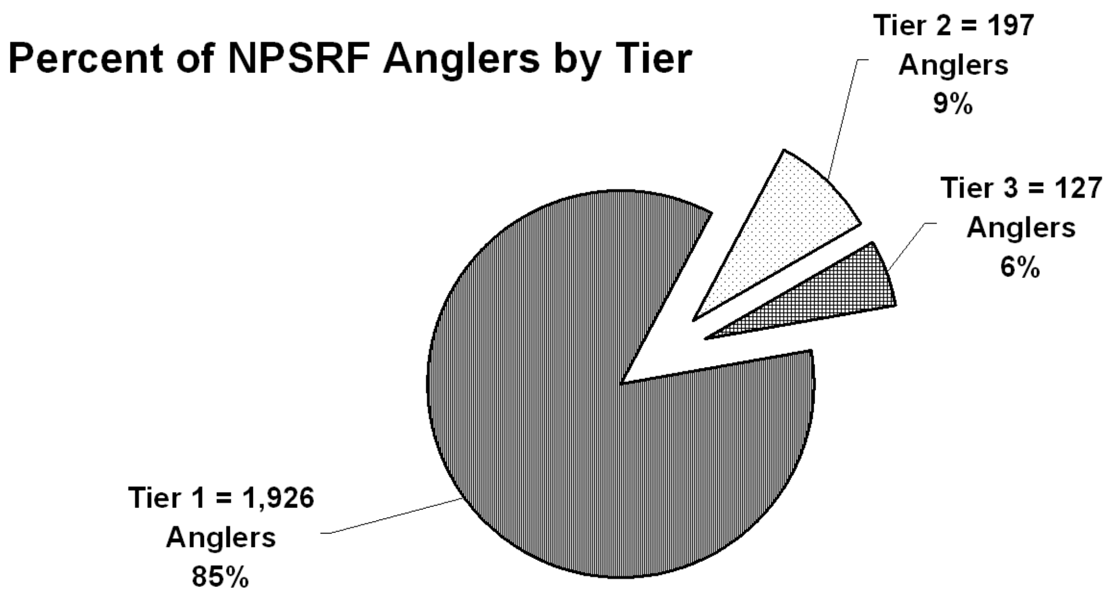


Figure 20. 2003 Northern Pikeminnow Sport-Reward Fishery Anglers based on number of fish harvested. Tier 1 anglers harvested ≤ 100 fish, Tier 2 anglers harvested 101-400 fish, and Tier 3 anglers harvested >400 fish during the 2003 Northern Pikeminnow Sport-Reward Fishery season.

Cumulative 2003 NPSRF harvest by angler tier was as follows. Tier 1 anglers caught 13% (24,634 northern pikeminnow) of the total 2003 NPSRF harvest (Figure 21). Tier 2 anglers caught 20% (39,402 northern pikeminnow) of the total 2003 NPSRF harvest. As in past seasons, Tier 3 anglers were the most proficient anglers catching 67% (132,519 northern pikeminnow) of the total 2003 NPSRF harvest. Harvest by Tier 1 anglers was virtually unchanged from 2002 (13.3%) while harvest by Tier 2 anglers was up from 18.2% in 2002, and Tier 3 anglers decreased from 68.5%

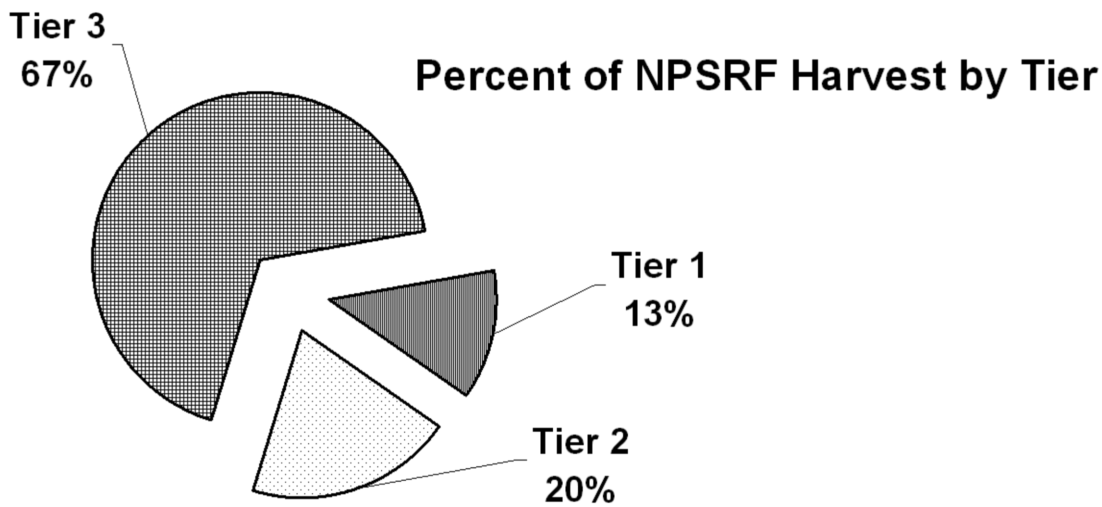


Figure 21. Percentage of 2003 Northern Pikeminnow Sport-Reward Fishery Harvest by Angler Tier. **Tier 1 anglers harvested ≤ 100 fish, Tier 2 anglers harvested 101-400 fish, and Tier 3 anglers harvested >400 fish during the 2003 Northern Pikeminnow Sport-Reward Fishery season.**

The average NPSRF angler spent five days fishing during the 2003 season, which was the same as the average number of days spent by Tier 1 anglers (Figure 22). Tier 2 anglers spent an average of 30 days fishing during the 2003 NPSRF, while Tier 3 anglers spent an average of 65 days fishing during the 2003 NPSRF. Angler effort by tier level has not varied much since first reported in the 2000 NPSRF Annual Report (Glaser et al 2000).

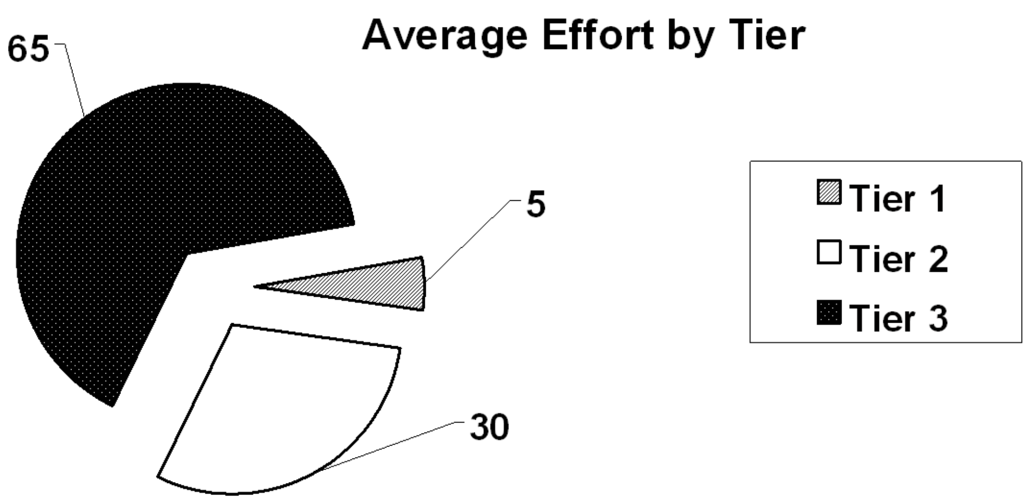


Figure 22. Average Effort of 2003 Northern Pikeminnow Sport-Reward Fishery Anglers by Tier. **Tier 1 anglers harvested ≤ 100 fish, Tier 2 anglers harvested 101-400 fish, and Tier 3 anglers harvested >400 fish during the 2003 Northern Pikeminnow Sport-Reward Fishery season.**

The CPUE for Tier 1 anglers was 2.38 northern pikeminnow per registered angling trip during the 2003 NPSRF (Figure 23). CPUE for Tier 2 anglers was 6.61 northern pikeminnow per trip, while Tier 3 angler CPUE was 16.09 northern pikeminnow per trip during the 2003 NPSRF. The 2003 NPSRF recorded a slight increase in CPUE for Tier 1 anglers and a decrease in CPUE for both Tier 2 and Tier 3 anglers from 2002.

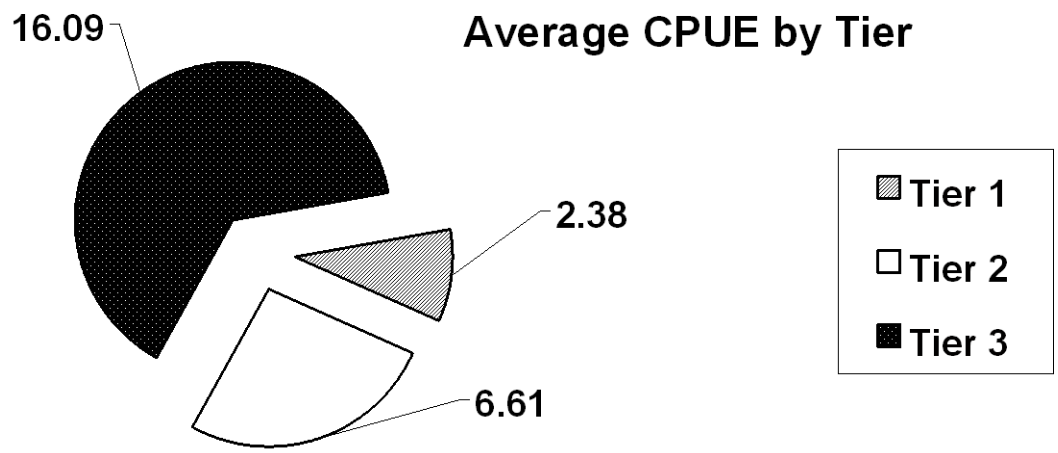


Figure 23. Average CPUE of 2003 Northern Pikeminnow Sport-Reward Fishery Anglers by Tier. Tier 1 anglers harvested < 100 fish, Tier 2 anglers harvested 101-400 fish, and Tier 3 anglers harvested >400 fish during the 2003 Northern Pikeminnow Sport-Reward Fishery season.

The top angler for the 2003 NPSRF harvested 4,009 NPM, which was 508 more fish than the number two angler harvested, but not even close to last year's top angler who harvested 6,811 northern pikeminnow (that angler has since been disqualified from the NPSRF for violation of NPSRF rules). The CPUE for this year's top angler was 43.6 northern pikeminnow (compared to the disqualified 2002 top angler's CPUE of 68.8), and she spent 92 angler days of effort during the 2003 season. By comparison, the top participating angler spent 151 days and harvested 2,036 northern pikeminnow.

Tag Recovery

Returning anglers recovered and turned in 177 northern pikeminnow tagged with external spaghetti tags during the 2003 NPSRF. This compares to the 2002 total of 157 tags turned in by NPSRF anglers (Winther et al., 2002). WDFW technicians identified 75 spaghetti tagged northern pikeminnow that had been PIT tagged by ODFW in 2003 as a secondary mark. Technicians recorded an additional 20 northern pikeminnow with a fin-clip mark and/or wounds consistent with having lost a tag. The recovered tags and potential tag loss data was estimated by ODFW to equal a 10.5% exploitation rate for the 2003 NPSRF (2003 ODFW, personal communication).

A total of 194,748 northern pikeminnow were individually scanned for the presence of PIT tags. This represents 99.1% of the total harvest handled by NPSRF technicians. A total of 149 PIT tags from consumed smolts were located and interrogated from the guts of these fish. This compares to the 2002 NPSRF which recovered 127 PIT tags from consumed smolts (Winther et al. 2002). We recorded PIT tag recoveries from May 5th through October 10th, with recoveries peaking on May 19th (14 recoveries) (Figure 24). PIT tag recoveries by fishing location showed that northern pikeminnow harvested from Bonneville Pool (fishing location 02), and The Dalles Pool (fishing location 03) yielded the majority of the NPSRF's PIT tag recoveries (Figure 25).

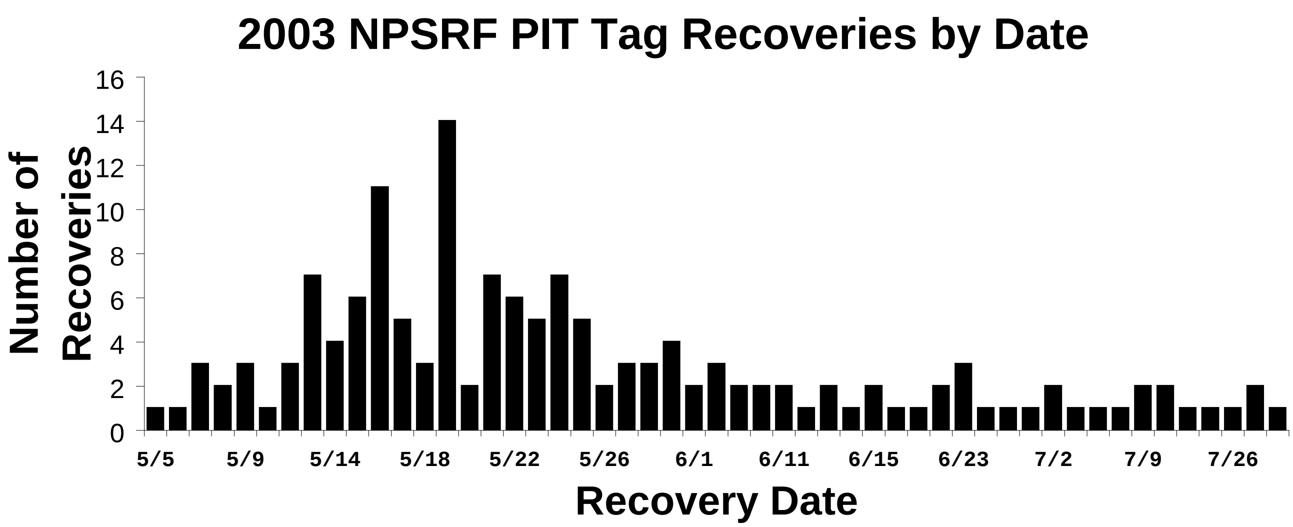


Figure 24. 2003 NPSRF PIT Tag Recoveries by Date.

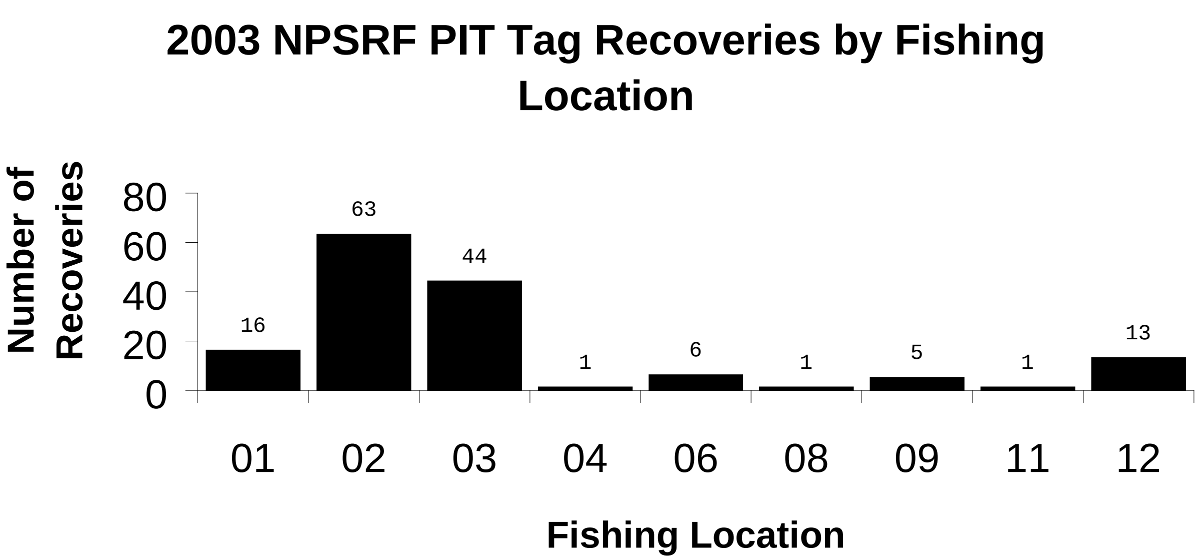


Figure 25. 2003 NPSRF PIT Tag Recoveries by Fishing Location.

All 149 PIT tag recoveries were queried through the PTAGIS database and those queries yielded the following information. Fork lengths of smolts at release from PTAGIS were compared to fork lengths of the northern pikeminnow from which the PIT tag was recovered (Figure 26). Mean fork length for consumed smolts was 122.58 mm, while mean fork length for the "consuming" northern pikeminnow was 370.6 mm. The mean fork length of northern pikeminnow found to have consumed PIT tagged smolts was much larger than the overall mean fork length (272.4 mm) for all reward-size northern pikeminnow from the 2003 NPSRF. Species composition of PIT tagged smolts recovered from northern pikeminnow harvested in the 2003 NPSRF indicated that 143 (95.9%) of the PIT tags were from chinook smolts, and 5 (3.4%) of the PIT tags were from steelhead smolts. We also recovered one PIT tagged Snake River sockeye smolt that accounted for the remaining 0.7%. PIT tags from chinook smolts indicated that there were 11 (7.7%) of wild origin, including 5 from the Snake River. Two of the 5 PIT tagged steelhead (40%), were of wild origin, both from the Snake River. The lone PIT tagged sockeye smolt came from the Redfish Lake Sockeye Salmon Broodstock Program (Frost et al. 2002) and was of hatchery origin.

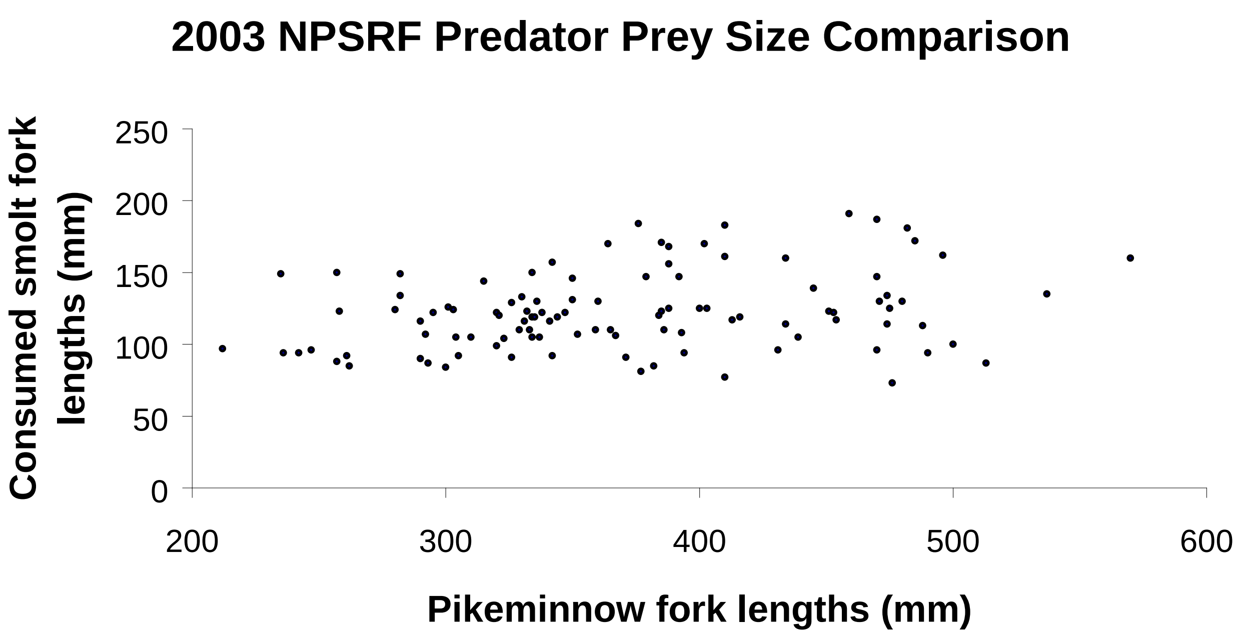


Figure 26. 2003 NPSRF Predator Prey Size Comparison (N=106).

Analysis of PIT tag recovery dates from the 2003 NPSRF continues to document northern pikeminnow predation on downstream migrating juvenile salmonids. Our PIT tag recovery data shows that northern pikeminnow with a mean average fork length of 370.6 consume chinook and steelhead smolts (including Snake River fish) most heavily during the peak migration month of May. It follows that it is important to implement the NPSRF for the full month of May in order to capture and document northern pikeminnow predation on these fish. Further data collection and analysis of PIT tag recoveries from juvenile salmonids consumed by northern pikeminnow harvested in the NPSRF may lead to a better understanding of northern pikeminnow predation on salmonids smolts migrating through the Columbia River system.

SUMMARY

The 2003 NPSRF succeeded in reaching the NPMP's 10-20% exploitation goal for the sixth consecutive year with a season that was slightly above average in terms of harvest. Although harvest for the 2003 NPSRF was down 4,811 fish from 2002, the angler catch rate (CPUE), mean weekly harvest and mean weekly harvest per station were up. This is mainly due to the fact that the 2003 NPSRF was implemented for two less weeks than in 2002. Fortunately, CPUE continued to climb (up from 6.57 in 2002 to 6.85 in 2003) as it has nearly every season since 1991, and this increase was able to overcome the shorter NPSRF season. Of concern was the fact that the NPSRF continued to show a decrease in participation. Total effort declined 1,961 angler days and there were 1,393 less individual anglers. While it is good to see the increased catch rate of our core anglers as they evolve to a more efficient level, the NPSRF must continue to find ways to stimulate interest and attract new anglers to the fishery. Inevitably, from year to year there will be some attrition from anglers at tiers 2 and 3 leaving the fishery. Continuing to recruit new anglers to the NPSRF, and educating participants on the most effective methods for catching northern pikeminnow has been the best way of developing tier 2 and tier 3 anglers for future NPSRF seasons.

Revising the angler rules for participation in the 2003 NPSRF proved to be an effective tool for the NPMP to use in addressing concerns about potential angler fraud. The effects of several angler disqualifications at the end of the 2002 NPSRF in addition to several additional disqualifications during the 2003 season were very apparent after analyzing the results of the 2003 NPSRF (most notably at the Vernita station). The elimination of participants who had artificially elevated harvest, effort, and CPUE totals in that area for the past several seasons resulted in the return to levels more typical of the first 10 years of the NPSRF.

Detection of PIT tags retained in the gut of northern pikeminnow has continued to show promise as a way to obtain additional data on northern pikeminnow predation on juvenile salmonids. Recovery of PIT tags from consumed juvenile salmonids peaked on May 19th in 2003 and species composition of recovered PIT tags was 95.9% chinook, 3.4% steelhead, and .7% sockeye salmon. Given that the peak in PIT tag recoveries coincided with the typical peak of the downstream smolt migration, the timing of the start date for full implementation of the NPSRF should be as early as possible in order to capture additional smolt predation data. PIT tags in northern pikeminnow were also successfully used as a secondary mark by ODFW in 2003 to eliminate uncertainties and document tag loss which will result in a more accurate estimate of pikeminnow exploitation by the NPSRF. PIT tags were also successfully used to identify and document angler fraud and subsequently disqualify several violators from participating in the NPSRF.

RECOMMENDATIONS FOR THE 2004 SEASON

1.) Begin full implementation of the 2004 NPSRF on May 3rd in order to take advantage of average to below average river flow which is conducive to harvesting northern pikeminnow.

2.) Review and revise WDFW technician procedures to ensure standardization between registration stations and consistency with NPMP mandates.

3.) Review NPSRF Rules of participation as needed to adjust to the dynamics of the fishery and fishery participants, and to maintain NPSRF integrity.

4.) Develop angler incentives designed to maintain the NPSRF's core group of participants and to encourage the harvest of northern pikeminnow needed to meet the NPMP's 10-20% exploitation goal.

5.) Provide additional information to the public about how to participate in the NPSRF and where and how to catch northern pikeminnow in order to recruit new anglers to the fishery and increase their effectiveness.

6.) Retain the option to extend the NPSRF season on a site-specific basis if harvest, angler effort and CPUE levels warrant.

7.) Continue to scan all northern pikeminnow for PIT tags from consumed juvenile salmonids, from the ODFW's biological evaluation, and as a means of identifying northern pikeminnow from outside NPSRF boundaries.

8.) Continue to develop additional measures to identify potential angler fraud and to deter anglers from fraudulently submitting northern pikeminnow to the NPMP for payment.

9.) Continue to survey 20% of non-returning anglers to calculate total non-returning angler catch and harvest estimates.

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APPENDICES

Appendix A

NORTHERN PIKEMINNOW SPORT-REWARD FISHERY RULES AND REGULATIONS

1. Present a valid fishing license and picture identification upon request by any authorized program representative.

2. Adhere to all applicable state fishing regulations for the area in which you fish. Contact your local state fishery agency for license requirements and current fishing regulations.

3. Register in person at one of the designated registration stations each day prior to fishing. Anglers may register during times when stations are unstaffed, by using the station's self-registration box. Anglers may not register at multiple stations on the same day.

4. Provide true and accurate information to authorized program representatives regarding the taking, possession, delivery, transportation, sale, transfer, or any other use of fish caught while participating in the northern pikeminnow sport-reward fishery program.

5. Comply with the directions of authorized program personnel related to the collection of sampling data and angler participation in the sport-reward fishery.

6. Mail in all reward vouchers within 30 days from the end of the season.

7. Fish must have been caught in the mainstem columbia river from the mouth up to the restricted zone below priest rapids dam, or in the snake river from the mouth up to the restricted zone below hell's canyon dam. The "mainstem" includes backwaters, sloughs, and up tributaries 400 feet from the tributary mouths. "tributary mouth" is as defined by state fishing regulations.

8. Fish must be returned to the same registration station where the angler registered. They must be returned on the same calendar day stamped on the angler's registration form, before that station closes for that day, and they must have been caught subsequent to that day's registration time.

9. Fish must have a total length greater than or equal to 9 inches. Fish less than 9 inches total length are not eligible for reward payment.

10. All fish to be redeemed for reward payment must have been personally caught solely by the angler submitting them for reward payment.

11. Fish must be alive or in fresh condition. Fish that are or were frozen, or that are in otherwise poor condition will not be accepted for payment. Technicians have the authority to determine whether northern pikeminnow submitted meet these standards.

12. Violation of any of the above rules may result in disqualification from the northern pikeminnow sport-reward fishery program.

[†]

[†] Rules were posted at all registration stations in 2003 and were printed on the back of all reward vouchers.

Appendix B

Species Codes

LMB	Bass, Largemouth
RKB	Bass, Rock
BG	Bluegill
BH	Bullhead (Unknown)
YBH	Bullhead, Yellow
BBH	Bullhead, Brown
BLB	Bullhead, Black
CP	Carp
BCF	Catfish, Blue
CC	Catfish, Channel
FCF	Catfish, Flathead
CMO	Chiselmouth
CRC**	Columbia River Chub
C	Crappie (Unknown)
BC	Crappie, Black
WC	Crappie, White
SF	Flounder, Starry
PMO	Peamouth
YP	Perch, Yellow
PS	Pumpkinseed
CK	Salmon, Chinook
CH	Salmon, Chum
CO	Salmon, Coho
K	Salmon, Kokanee
PK	Salmon, Pink
SO	Salmon, Sockeye
JAK	Salmon, Chinook (Jack)
JCK	Salmon, Chinook (Juvenile)
JCH	Salmon, Chum (Juvenile)
JCO	Salmon, Coho (Juvenile)
JPK	Salmon, Pink (Juvenile)
JSO	Salmon, Sockeye (Juvenile)
SAN	Sandroller
COT	Sculpin, (General)
AMS	Shad, American
RS	Shiner, Redside
NPM	Pikeminnow, Northern
SHP*	Steelhead (Adipose Present)
SHA*	Steelhead (Adipose Absent)
JSP	Steelhead, Juvenile (Adipose Present)
JSA	Steelhead, Juvenile (Adipose Absent)
GRS	Sturgeon, Green
WS	Sturgeon, White
SK	Sucker (Unknown)
BRS	Sucker, Bridgelip
LRS	Sucker, Largescale
S	Sunfish, (Unknown)
TNC	Tench
CT	Trout, Cutthroat (Unknown)
CCT	Trout, Cutthroat Coastal
SCT	Trout, Cutthroat Searun
LCT	Trout, Cutthroat Lahontan
DB	Trout, Dolly/Bull (Unknown)
BLC	Trout, Bull (Char)
DVC	Trout, Dolly Varden (Char)
RB	Trout, Rainbow (Resident)
RU	Trout, Rainbow (Unknown)
TR	Trout, (Unknown)
WAL	Walleye
WM	Warmouth
WF	Whitefish, Mountain

** Conventional naming for NPM Sport-Reward Program

REPORT B

NORTHERN PIKEMINNOW SPORT REWARD PAYMENTS 2003

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May, 2004

INTRODUCTION

The **Northern Pikeminnow Predator Control Program** was administered by PSMFC in 2003. The program is a joint effort between the fishery agencies of the states of Washington and Oregon, and the Pacific States Marine Fisheries Commission (PSMFC). Washington ran the sport-reward registration/creel check stations throughout the river and handled all fish checked in to the program. Oregon provided fish tagging services, population studies, food habit and reproductive studies, as well as exploitation rate estimates. PSMFC provided technical administration, and fiscal and contractual oversight for all segments of the Program and processed all reward vouchers for the sport-reward anglers. The former dam angling and site specific gillnetting conducted by the Columbia River tribes was terminated in 2002 and was not a part of the program this year.

CATCH AND PAYMENTS

In 2003 a total of 195,974 fish were harvested in the sport-reward fishery. Vouchers for 194,416 fish were submitted for payment totaling rewards of $1,015,431. Rewards were paid at $4 for the first 100 fish caught during the season, $5 for fish in the 101-400 range, and $6 for all fish caught by an angler above 400 fish. PSMFC maintained an accounting system during the season to determine the appropriate reward amount due each angler for particular fish. A total of 1,736 anglers who registered were successful in catching one or more fish in 2003. The 2003 season ran from May 15, 2000 through October 12, 2003.

TAGGED FISH PAYMENTS

A total of 177 tagged fish were caught. Anglers were issued a special tagged fish voucher for all tagged fish brought to the registration station. The tag voucher was then sent in with the tag for verification and payment of the special $100 tagged fish reward. This resulted in tag reward payments of $17,700.

ACCOUNTING

Total payments for the season of regular vouchers, and tagged fish totaled $1,015,431. All IRS Form 1099 MIS. Statements were sent to the qualifying anglers for tax purposes in the third week of January, 2004. Appropriate reports and copies were provided to the IRS by the end of February, 2004. A summary of the catch and rewards paid is provided in table 1. For further information contact Russell Porter, PSMFC, Senior Program Manager at (503) 650-5400 or email at: russell_porter@psmfc.org.

2003 SPORT REWARD PAYMENTS SUMMARY

The following is a summary of the vouchers received and paid as of Nov 7, 2003

	Fish	$ Amount
Fish paid @ tier 1 ($4.00):	55,032	$220,128
Fish paid @ tier 2 ($5.00):	57,639	$288,195
Fish paid @ tier 3 ($6.00):	81,568	$489,408
Tags paid ($100):	177	$17,700
Total:	**194,416**	**$1,015,431**

Anglers @ tier 1	1,412	Anglers with 10 fish or fewer:	846
Anglers @ tier 2	196	Anglers with 2 fish or less:	360
Anglers @ tier 3	128		
Number of separate anglers	1,736	Predacards ordered and/or issued:	108

	*Top Twenty Anglers **	TIER 1	TIER 2	TIER 3	TAGS	TOTAL FISH	BALANCE
1.	ESSEX,JANE A	98	300	3,611	7	4,016	$24,258
2.	PAPST,THOMAS H	100	300	3,101	5	3,506	$21,006
3.	SCHWARTZ, DWAYNE W	100	300	2,718	2	3,120	$18,408
4.	WHITE, JASON M	100	300	2,717	0	3,117	$18,202
5.	WILLIAMS, EDWARD R	100	300	2,627	0	3,027	$17,662
6.	ZAREMSKIY, NIKOLAY N	100	300	2,220	2	2,622	$15,420
7.	BROWN, JOHN G	100	299	2,192	6	2,597	$15,647
8.	VASILCHUK, DAVID R	99	300	2,147	1	2,547	$14,878
9.	SMITH, THOMAS M	100	300	2,013	0	2,413	$13,978
10.	HISTAND,TIMOTHY L	100	300	1,948	2	2,350	$13,788
11.	WEBER, STEVEN A	100	300	1,729	0	2,129	$12,274
12.	RARDIN, HANK J	100	300	1,702	0	2,102	$12,112
13.	JENSEN, TED A JR	100	300	1,691	0	2,091	$12,046
14.	GLASPIE, ROBERT R	100	300	1,688	0	2,088	$12,028
15.	MUCK,JAMES E	100	298	1,638	2	2,038	$11,918
16.	CAGLE, CARL D	99	299	1,588	3	1,989	$11,719
17.	OWRE, STEVEN H	98	300	1,528	6	1,932	$11,660
18.	WEARSTLER,ZACHARY A	100	299	1,460	1	1,860	$10,755
19.	MINGS, GLEN E	100	300	1,421	1	1,822	$10,526
20.	LEITCH, GARY L	100	300	1,378	0	1,778	$10,168
	* (by total fish caught)	1,994	5,995	41,117	38	49,144	$288,453

REPORT C

Development of a System-wide Predator Control Program: Fisheries Evaluation

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ABSTRACT

A predator control fishery aimed at reducing predation on juvenile salmonids by northern pikeminnow *Ptychocheilus oregonensis* was implemented for the thirteenth consecutive year in the mainstem Columbia and Snake rivers. We report on (1) exploitation rates of northern pikeminnow and catch rates of incidental fishes for the sport-reward fishery in 2003, (2) estimated reductions in predation on juvenile salmonids since implementation of the program, (3) estimated tag loss for spaghetti tags, (4) validation of aging methodology for northern pikeminnow based on scale and opercula readings, and (5) differential mortality between tagged and untagged northern pikeminnow.

For the sport-reward fishery, system-wide exploitation of all northern pikeminnow ≥ 200 mm fork length (FL) was 10.5%, and 13.0% for northern pikeminnow ≥ 250 mm FL (<4 recaptures of northern pikeminnow 200-249 mm FL prohibited calculation of exploitation rates). Among reservoirs/river areas, exploitation of northern pikeminnow ≥ 200 mm by the sport-reward fishery was highest in the area below Bonneville Dam (11.8%). Despite the continually low exploitation rate for smaller northern pikeminnow, the exploitation rate for larger fish (≥ 250 mm FL) was similar to the average rate for the past five years. River flow is likely a primary factor influencing the success of the fishery for fish ≥ 250 mm where exploitation increases as river levels decrease (r^2 = 0.75; P < 0.05). Recapture rates for smaller northern pikeminnow do not appear to be consistent with fishing catch rates, suggesting that they may be subject to higher post-tagging mortality than larger fish.

Incidental fish comprised 40.4% of the catch by sport-reward anglers targeting northern pikeminnow. The proportion of the northern pikeminnow catch consisting of predator-sized fish (≥ 200 mm FL) was 79.8% in the sport-reward fishery. Incidental catch of salmonids by all fisheries combined was 0.1% of the total catch.

Although modest reductions in potential predation have been achieved since 1999, further reductions are likely to be minimal if exploitation continues at mean 1996-2003 levels. We estimate potential predation is currently 79% of pre-program levels; extrapolation indicates this level of reduction will remain relatively constant (± 1%) through 2007.

A double-tagging experiment estimated tag losses of 7.4% for spaghetti tags. Exploitation rates for 2003 were adjusted using the new rate. However, estimates were somewhat higher than expected (up from 4.2% in 1999) due to some defective tags. The use of PIT tags as secondary markers proved to be cumbersome and time consuming. In 2004, PIT tags will be replaced with a secondary unmarked spaghetti tag to simplify marking and presumably increase detection at check stations.

The results of our mortality test suggest there is little or no differential mortality between tagged and untagged northern pikeminnow (mortality was 5% for both groups).

This validates the assumption of equal probabilities of mortality between marked and unmarked fish for exploitation and predation estimates of northern pikeminnow.

Between-reader agreement in aging of northern pikeminnow scales was virtually unchanged from 2002. Reader agreement for opercles continued to be lower than for scales but showed improvement over previous years. For age validation, moderate levels of agreement over four years were achieved on same-year recaptures, but that agreement was relatively low and continued to decrease over time when comparing data from different tagging and recapture years (43.6% for same-year, versus 25.9% for one year at-large, and 17.8% for two years at-large).

Ages assigned to opercles exactly matched ages assigned to scales from the same fish 25.0% of the time; however, agreement within ± one year was 65.8%. We have consistently found that ages for opercles tend to be greater than those for scales, suggesting scales probably underestimate ages of northern pikeminnow.

Opercles from fish injected in 2003 (same year recoveries) had a higher percentage of good quality marks (35% verses 14% in 2002). Examination of opercles from fish injected in 2002 and recaptured in 2003 showed that 84% of the OTC marks were on or immediately adjacent to an annulus. Results from 2003 indicated that three factors may play some role in the different quality of OTC marks: 1) OTC dosage was too low in 2002, 2) OTC was injected during the slow growth period of annulus formation, and 3) fish at-large for less than a year do not have sufficient time to grow and fully exhibit fluorescent marking on the opercle. We were able to use OTC marks to help us age some opercle samples from fish at-large for more than a year.

INTRODUCTION

The goal of the Northern Pikeminnow Management Program (NPMP) is to reduce mortality of juvenile salmonids attributed to predation by northern pikeminnow *Ptychocheilus oregonensis* in the lower Columbia and Snake rivers. Prior to the implementation of predator control fisheries, the Oregon Department of Fish and Wildlife (ODFW) established baseline levels of predation and described northern pikeminnow population characteristics. We estimated abundance, consumption, and predation in Columbia River reservoirs in 1990 and 1993, Snake River reservoirs in 1991, and the unimpounded lower Columbia River downstream from Bonneville Dam in 1992 (Ward et al. 1995). From 1994-1996 and 1999, we sampled in areas where sufficient numbers of northern pikeminnow could be collected to compare predation levels among years (Zimmerman and Ward 1999; Zimmerman et al. 2000). In this report, we describe our activities and findings for 2003, and wherever possible, evaluate changes from previous years.

Our objectives in 2003 were to (1) evaluate the efficiency of the northern pikeminnow fishery by analyzing exploitation rates and incidental catch, (2) estimate reductions in predation on juvenile salmonids since implementation of the NPMP, (3) estimate the tag loss rate for spaghetti tags, (4) validate aging methods for northern pikeminnow, and (5) investigate differential mortality between tagged and untagged northern pikeminnow. Objectives (3) and (4) were first implemented in 2000 based on the recommendations of an independent review of the NPMP (Hankin and Richards 2000). Objective (5) was added in 2003 to address concerns raised by a biometric review of our evaluation process (Styer 2003).

METHODS

Fishery Evaluation, Predation Estimates, Tag Loss, and Mortality

Field Procedures

Only one northern pikeminnow fishery operated in 2003. The Washington Department of Fish and Wildlife (WDFW) administered the sport-reward fishery from May 5 (May 19 for areas upstream of The Dalles Dam) to October 12 throughout the lower Columbia and Snake rivers. Participating anglers received payment for northern pikeminnow 9 inches (230 mm) total length (TL) (approximately equivalent to 200 mm fork length) and larger. The dam angling and site-specific gillnet fisheries were not implemented in 2003.

We tagged and released northern pikeminnow ≥ 200 mm fork length (FL) to estimate exploitation rates for the sport-reward fishery. Most tagging was completed prior to the start of the fishery to help reduce bias in exploitation estimates (Styer 2003). However, tagging operations occurred concurrently with the fishery in John Day and McNary reservoirs. We used electrofishing boats and bottom gillnets to collect northern pikeminnow from March 27 to June 20. Parker et al. (1995) provide a detailed description of sampling gears and methods. With some exceptions, we allocated equal effort in all sampled river kilometers (rkm). On the Columbia River, we sampled from rkm 78 (near Clatskanine, Oregon) upstream to rkm 634 (Priest Rapids Dam). We were unable to sample 67 kilometers in this section, mostly due to high winds. On the Snake River, we sampled above Lower Granite Dam from rkm 195 (approximately 27 kilometers downstream of Lewiston, Idaho) to rkm 246 (near the mouth of the Grande Ronde River). High winds prevented us from sampling 14 kilometers in this section. Sampling in Lower Monumental and Little Goose reservoirs was discontinued in 2001 due to historically low numbers of tagged and recaptured fish in those reservoirs.

We inserted uniquely numbered spaghetti tags in northern pikeminnow ≥ 200 mm FL. To evaluate retention of the spaghetti tags, we also injected a passive integrated transponder (PIT) tag into the dorsal sinus area of all spaghetti-tagged fish.

We also conducted a controlled experiment in 2003 to determine if there was differential mortality between tagged and untagged northern pikeminnow. From March 26 to April 23 we collected 39 fish by electrofishing and one fish by gillnet from the Columbia River below Bonneville Dam. Half of these fish were handled and processed as usual (measured, tagged, etc.) and the other half were left unprocessed. The fish were held in circular tanks for 1-2 days then transferred to two net pens tied to a dock in a large alcove of the Clackamas River. Field personnel periodically checked on the fish and any mortalities were removed from the pens. We did not provide supplemental food to the fish. We concluded the experiment on June 26.

Data Analysis

We used mark-and-recapture data to compare exploitation rates of northern pikeminnow ≥ 200 mm FL, 200-249 mm FL, and ≥ 250 mm FL among reservoirs. In 2003, we modified the way we calculated exploitation rates and confidence intervals. As recommended by Styer (2003) in her review of our estimation methods, in areas where tagging was completed prior to the start of the fishery, we used the simple Peterson method (Ricker 1975) to compute annual exploitation rates. This is given by the equation

$$u = R/M$$

where

M = the number of fish that are tagged in a season, and
R = the number of tagged fish that are recaptured in a season.

We calculated 95% confidence intervals for Peterson estimates using the formula

$$(R \pm z \cdot \sqrt{R})/M$$

where

z = the multiplier from the standard normal distribution,

M = the number of fish that are tagged in a season, and
R = the number of tagged fish that are recaptured in a season (Styer 2003).

For areas where tagging and fishing occurred concurrently, we continued to use a multiple sample approach to compute exploitation rates. Weekly estimates of exploitation were calculated by dividing the number of tagged northern pikeminnow recovered by the number of tagged fish at large. We then summed the weekly exploitation rates to yield total exploitation rates for the season (Beamesderfer et al. 1987).

We calculated 95% confidence intervals for exploitation estimates obtained by the multiple sample method by using the formula

$$u \pm t \cdot \sqrt{k} \cdot s$$

where

u = the annual exploitation estimate,
t = the multiplier from the Student's t-distribution,
k = the number of weeks in the fishing season, and
s = the standard deviation of the weekly exploitation estimates (Styer 2003).

All exploitation estimates and confidence intervals were adjusted for tag loss in 2003. We did not calculate exploitation rates for areas where the number of recaptures was less than four (Styer 2003). Also, in this report's tables and figures, we removed exploitation estimates from previous years where fewer than four tags were recovered.

To explore the effect of river flow on northern pikeminnow harvest, we plotted the annual system-wide sport-reward exploitation rate for fish ≥ 250 mm FL versus mean Columbia River stage during May-September below Bonneville Dam (USGS unpublished data). For this analysis, we used data from 1995-2003.

We evaluated the incidental catch for the sport-reward fishery by calculating the percent of the total catch comprised of fish other than northern pikeminnow ≥ 200 mm FL. We also estimated the proportion of predator-sized northern pikeminnow (≥ 200 mm FL) relative to the total northern pikeminnow catch, as well as the catch rate of salmonids in the fishery.

We used the model of Friesen and Ward (1999) to estimate predation on juvenile salmonids relative to predation prior to implementation of the NPMP. The model incorporates age-specific exploitation rates on northern pikeminnow and resulting changes in age structure to estimate changes in predation. We used a 10-year "average" age structure (based on catch curves) for a pre-exploitation base, and assumed constant recruitment. Age-specific consumption was incorporated; however, potential changes in consumption, growth, and fecundity due to removals were not considered likely (Knutsen and Ward 1998). The model therefore estimates changes in potential predation related directly to removals, allowing us to estimate the effects of removals if all variables except exploitation were held constant.

We estimated the potential relative predation in 2003 based on observed exploitation rates, and the eventual minimum potential predation assuming continuing exploitation at mean 1997-2003 levels. Because inputs to the model included three potential relationships between age of northern pikeminnow and consumption, as well as three estimates of exploitation (point estimate and confidence limits), we computed nine estimates of relative predation for each year (Friesen and Ward 1999). We report the maximum, median, and minimum estimates.

To estimate the tag loss rate for spaghetti tags, we used the formula

$$L = [m / (m + r)] * 100,$$

where

m = the number of northern pikeminnow recaptured with a secondary mark (PIT tag) and no spaghetti tag, and
r = the number of northern pikeminnow recaptured with year 2003 spaghetti tags intact.

Age Validation

Field and Laboratory Procedures

We collected scale samples from all northern pikeminnow we tagged in 2003. In addition, each fish was injected with a solution of oxytetracycline (OTC) at a dosage of 50 mg OTC per kg fish weight (McFarlane and Beamish 1987) to leave a fluorescent mark on aging structures. We increased the dosage from the 35 mg/kg used in 2002 to see if we could improve mark quality. The results of a small-scale preseason test utilizing 16 northern pikeminnow suggested that 50 mg/kg probably would not cause additional mortality. WDFW personnel collected scale and opercle samples from each tagged northern pikeminnow recaptured in the sport-reward fishery. Scales were cleaned, mounted on cards, and pressed onto acetate sheets for viewing on a microfiche reader. Parker et al. (1995) described methods of age determination in northern pikeminnow. Two experienced readers independently aged the scale samples. When the readers disagreed on an age, they reviewed the scale in question together until they agreed on a final age.

Opercula (still in their sample envelopes) were placed in a bowl of water and heated in a microwave oven at high temperature for approximately 10 minutes (per group of 10 samples) to soften the tissue and skin covering the opercular bone. We then removed the tissue using a knife, pair of tweezers, and a toothbrush. A thickened “ridge” radiating from the focus on the concave side of each opercle was ground down with a Dremel tool to enhance viewing of potential annuli near the focus (Scoppettone 1988). Readers examined each opercle under a digital video microscope at 10x magnification using light transmitted from either above or below the opercle (whichever gave the best view of the annuli on a particular sample). Opercular images from the microscope were viewed on a computer monitor using imaging software. The same two readers who had aged the scales also read the opercles. We resolved age differences in the same way that we had done for the scales. In addition, we checked opercles from fish tagged in 2002 and 2003 for fluorescent OTC marks. Each opercle was examined in a dark room under a dissecting microscope using a desk lamp fitted with a "black light".

Data Analysis

Continuing an age validation study initiated in 2000 (Takata and Ward 2001), we evaluated between-reader variation in ages assigned to both scales and opercles from northern pikeminnow. Aging discrepancies were calculated as

$$d = a_1 - a_2,$$

where

d = age discrepancy,
a_1 = age assigned to a scale or opercle by Reader 1, and
a_2 = age assigned to a scale or opercle by Reader 2.

This indicated both the magnitude and direction of the discrepancy (e.g. -2 years, - 1 year, 0 years, + 1 year, etc), so we could determine if differences were systematic. We then calculated the percentage of samples in each discrepancy category as a measure of between-reader agreement.

We also sought to validate our ability to detect annuli on scales. We compared ages (agreed upon by both readers) assigned to scales collected at recapture to those for scales collected from the same fish at tagging. We used the formula

$$D = (A_R - A_T) - (Y_R - Y_T),$$

where

D = age discrepancy,
A_R = age assigned to a scale at recapture,
A_T = age assigned to a scale at tagging,
Y_R = recapture year, and
Y_T = tagging year

to calculate aging discrepancies. We then calculated the percentage of samples in each discrepancy category as we had done for the between-reader comparison.

Finally, to evaluate the potential use of opercula for aging northern pikeminnow, we compared the age assigned to an opercle with the age assigned to a scale collected from the same fish at the same time. We calculated discrepancies using the formula

$$D = A_O - A_S,$$

where

D = age discrepancy,
A_O = age assigned to an opercle at recapture, and
A_S = age assigned to a scale at recapture.

We also directly compared opercle ages to corresponding scale ages from the same fish.

Opercles from northern pikeminnow tagged in 2002 and 2003 were checked for OTC marks and the marks were scored for quality. An easily observed, relatively wide fluorescent band along all or most of the opercle's edge was scored as a '3' (good mark). If the fluorescent band was thin or patchy but still went around ½ or more of the opercle's edge, it was scored as a '2' (fair mark). If there was fluorescent marking along less than half of the opercle's edge then it was considered a '1' (poor mark). In addition, for the 2002 opercles, we noted whether or not there was an annulus visible after the OTC mark since a year had elapsed between tagging and recapture.

RESULTS

Fishery Evaluation, Predation Estimates, Tag Loss, and Mortality

We tagged and released 959 northern pikeminnow throughout the lower Columbia and Snake rivers in 2003. Of these fish, 211 were 200-249 mm FL and 748 were ≥ 250 mm FL. A total of 87 northern pikeminnow tagged in 2003 were recaptured in the sport-reward fishery. Three of the recaptures were 200-249 mm and 84 were ≥ 250 mm (Appendix Table A-1).

The sport-reward fishery harvested 195,974 northern pikeminnow ≥ 200 mm fl. Based on sampled catch proportions, an estimated 103,866 of these fish were ≥ 250 mm fl and 92,108 were 200-249 mm fl. Mean fork length of northern pikeminnow harvested in the sport-reward fishery was 272 mm (j. Hone, wdfw, personal communication). The dam angling and site-specific gillnet fisheries were discontinued in 2003.

System-wide exploitation of northern pikeminnow ≥ 200 mm by the sport-reward fishery was 10.5% (95% confidence interval 8.1% - 14.4%). Reservoir/area-specific exploitation rates ranged from 6.6% in mcnary reservoir to 11.8% in the area downstream of bonneville dam. We did not calculate exploitation rates for the dalles or lower granite reservoirs due to an insufficient number of recaptures. In addition, no northern pikeminnow tagged in 2003 were recovered in john day reservoir (figure 1; appendix tables a-2, a-3).

For northern pikeminnow ≥ 250 mm, the system-wide exploitation rate was 13.0% (95% confidence interval 9.9% - 18.0%), ranging from 8.2% in mcnary reservoir to 16.7% in bonneville reservoir. We were unable to calculate exploitation rates for northern pikeminnow 200-249 mm due to the low number of recaptures (figure 1; appendix tables a-2, a-3). Weekly exploitation estimates for areas of concurrent tagging and fishing are given in appendix tables a-4 through a-7.

For larger northern pikeminnow (≥ 250 mm), we continued to find a significant inverse relationship (r^2 = 0.75; P < 0.05) between the system-wide sport-reward exploitation rate and mean Columbia River stage below Bonneville Dam during the sport-reward season (Figure 2).

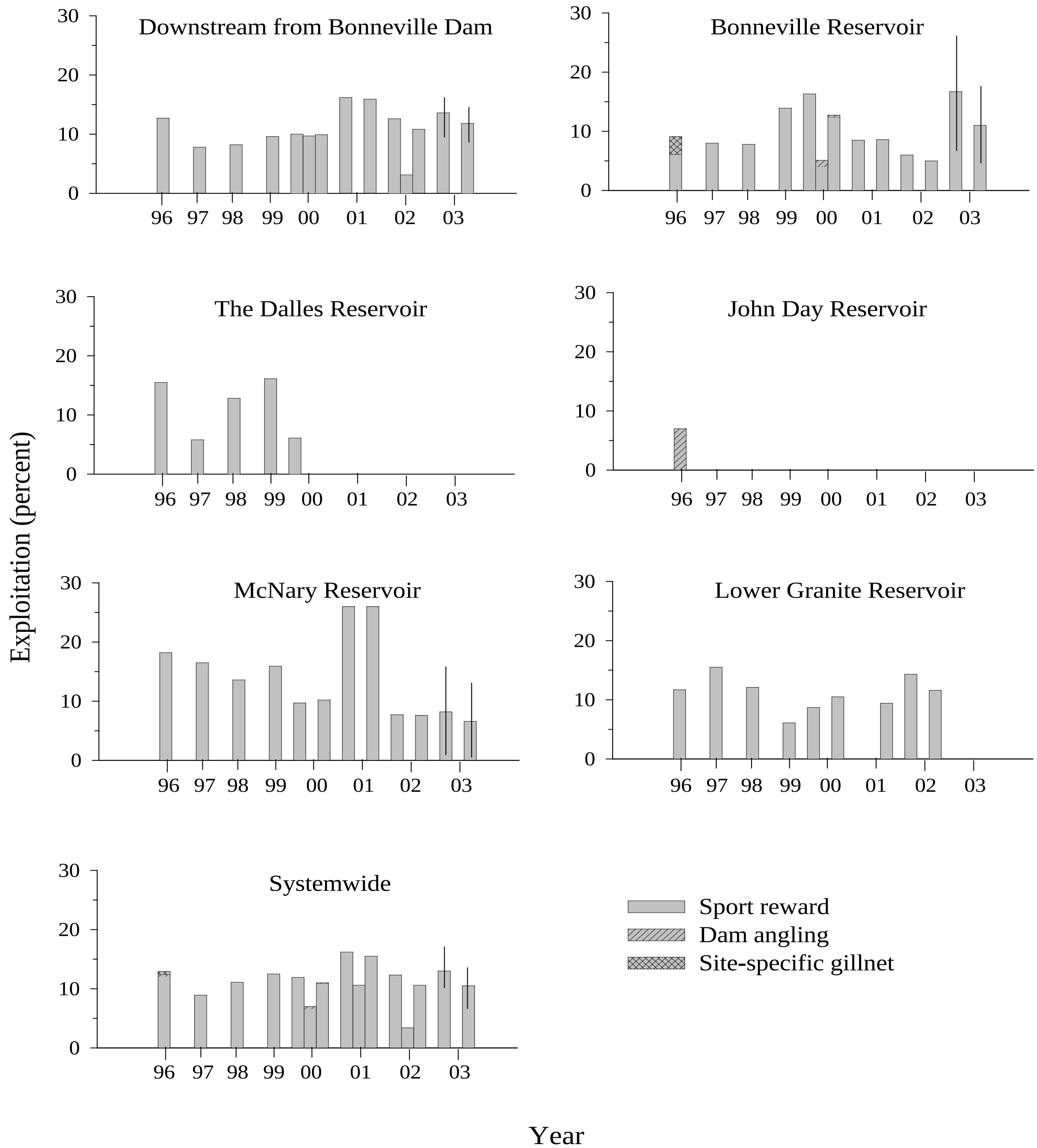

Figure 1. Exploitation of northern pikeminnow ≥ 250 mm fork length (FL) by reservoir/area and fishery, 1996-2003. Lower Monumental and Little Goose reservoirs are not shown due to insufficient data for this time period. For 2000-2003, vertical bars, from left to right, show exploitation for northern pikeminnow ≥ 250 mm FL, 200-249 mm FL, and ≥ 200 mm FL. Exploitation rates were not corrected for tag loss in 2000-2002. Confidence intervals (95%) are shown for 2003 exploitation estimates.

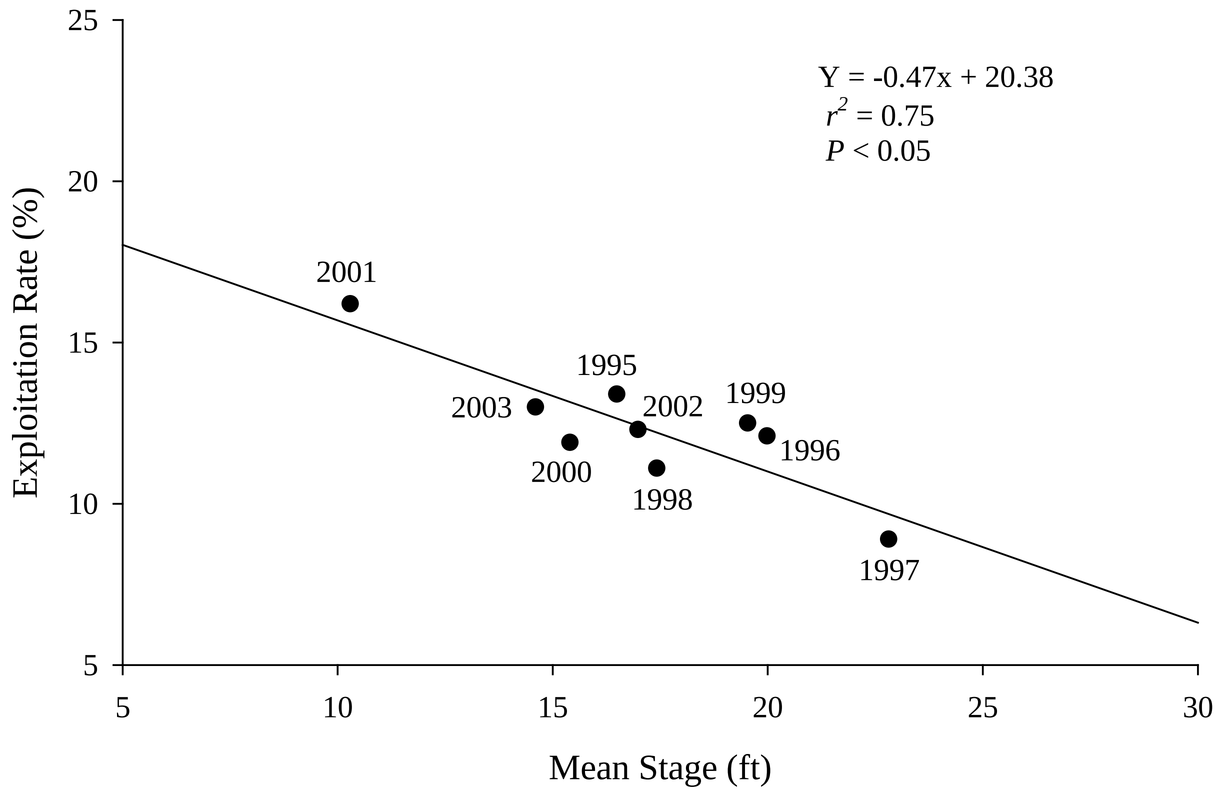

Figure 2. Relationship between sport-reward exploitation of northern pikeminnow ≥ 250 mm FL and mean Columbia River stage (gage height below Bonneville Dam) during the sport-reward season (May-September) for the period 1995-2003.

In 2003, the sport-reward fishery reported a total incidental catch of 133,380 fish, including northern pikeminnow < 200 mm FL (Table 1). The incidental catch rate was 40.4% for anglers who targeted northern pikeminnow. The most common incidental fishes were northern pikeminnow < 200 mm, other cyprinids, and smallmouth bass. The proportion of the northern pikeminnow catch consisting of fish ≥ 200 mm was 79.8%. Salmonids comprised 0.1% of the total catch.

Table 1. Catch of northern pikeminnow and incidental fishes in the sport-reward fishery in 2003. Northern pikeminnow < 200 mm fork length (FL) are considered incidental catch. Catches of incidental fishes are estimates based upon exit surveys of anglers who targeted northern pikeminnow.

Species or family	Sport-reward Catch
Northern pikeminnow	
≥ 200 mm FL	196,573
< 200 mm FL	49,597
Salmonidae	
Chinook salmon (adult/jack)	48
Coho salmon (adult/jack)	2
Sockeye salmon (adult)	0
Steelhead (adult)	66
Cutthroat trout	29
Juvenile salmon/steelhead	162
All other salmonids[b]	102
White sturgeon	4,532
Walleye	947
Smallmouth bass	13,525
Yellow perch	3,863
American shad	441
Cyprinidae[c]	44,284
Catostomidae	2,680
Ictaluridae	8,080
Centrarchidae[d]	262
Other/unidentified	4,760
Total (all species)	329,953
Percent incidental catch	40.4

[a] Catch unknown. Counts included in “Other/unidentified”.
[b] Includes juvenile and adult *Oncorhynchus* spp., and mountain whitefish *Prosopium williamsoni*.
[c] Excluding northern pikeminnow.
[d] Excluding smallmouth bass.

Modeling results indicated potential predation by northern pikeminnow on juvenile salmonids in 2003 ranged from 57% to 90% of pre-program levels, with a median estimate of 79% (Figure 3). Extrapolation through 2007 indicated continued harvest at mean 1996-2003 exploitation levels would result in minimal additional reductions in predation.

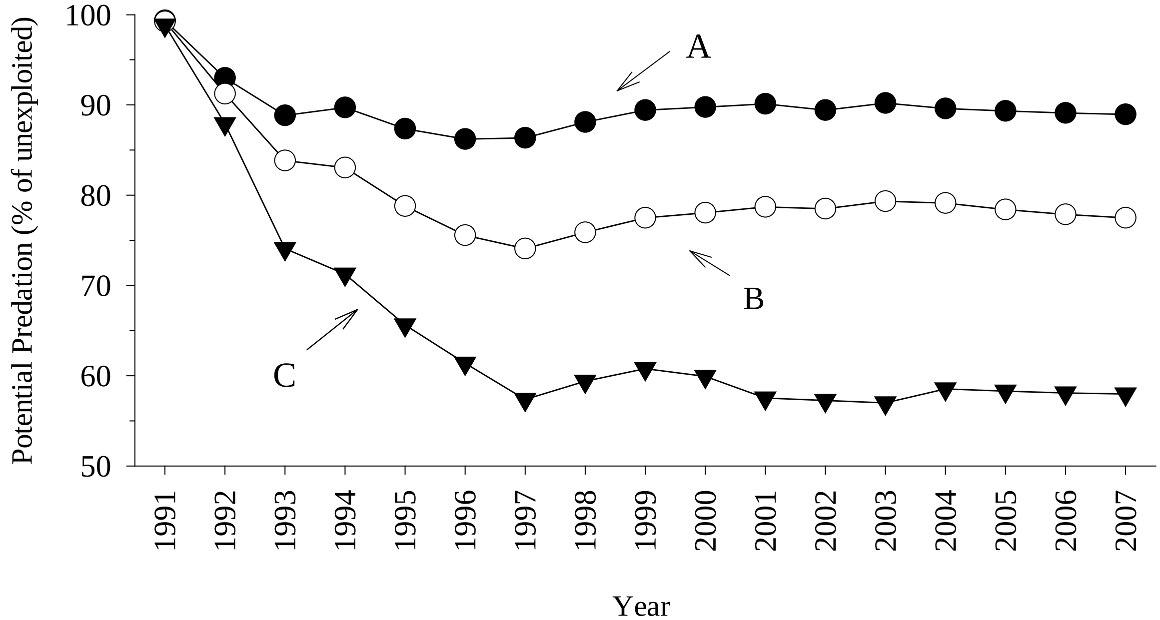

Figure 3. Maximum (A), median (B), and minimum (C) estimates of potential predation on juvenile salmonids by northern pikeminnow relative to predation prior to implementation of the Northern Pikeminnow Management Program. Trends after 2003 indicate predicted predation in future years if exploitation is maintained at mean 1996-2003 levels.

Seven northern pikeminnow with a PIT tag and a missing spaghetti tag were recovered in the sport-reward fishery, yielding a tag loss estimate of 7.4%. Fish tagged and recaptured in 2003 were at-large from 5 to 174 days. Additionally, three fish spaghetti-tagged in 2003 were recaptured with missing PIT tags. Therefore, tag loss for PIT tags was estimated at 3.2% (96.8% retention).

In the mortality experiment, one out of 20 tagged fish died and one out of 20 control fish also died. Therefore, mortality rates for tagged and untagged fish were both estimated to be 5%. The tagged fish died one day after capture/processing and the control fish was found dead about one month after capture.

AGE VALIDATION

We aged a total of 312 scale and 163 opercle samples from tagged and recaptured northern pikeminnow in 2003. For scales, complete agreement (i.e. zero discrepancy) on ages assigned by the two readers was 46.5%, with 85.6% agreement within ± one year (Figure 4). Complete agreement was lower for opercles at 39.3%. Agreement within ± one year was also a little lower at 81.0%. There may have been a slight tendency for Reader 1 to age older than Reader 2 on scales; however, for opercles there was no apparent trend (Figure 4). The largest age discrepancy between the two readers was 6 years on an opercle sample.

When final ages assigned to scales collected at both tagging and recapture in 2003 were compared, the ages accounted exactly for the time at-large 43.8% of the time (Figure 5, panel A). Agreement within ± one year was 78.1%.

Final ages assigned to scales collected at tagging in 2002 and recapture in 2003 accounted exactly for the time at-large 33.3% of the time (Figure 5, panel B). Agreement within ± one year occurred with 75.0% of the samples. Ages assigned to scales collected at recapture were usually not old enough to account for the one year that the fish were at-large.

Ages assigned to scales collected at tagging in 2001and recapture in 2003 accurately accounted for time at-large only 13.3% of the time (Figure 5, panel C).
Agreement within ± one year occurred in 53.3% of the samples. Ages assigned to scales collected at recapture were usually not old enough to account for the two years that the fish were at-large.

Finally, ages assigned to scales collected at tagging in 2000 and recapture in 2003 never accurately accounted for time at-large (Figure 5, panel D). Agreement within ± one year was 55.6%. The problem again appeared to be an underestimation of recapture age.

Ages assigned to scales matched exactly with ages assigned to opercles from the same fish 25.0% of the time (Figure 6, panel A). Agreement within ± one year was 65.8%. The largest discrepancy between scale and opercle ages was seven years, and differences were significant ($P < 0.0001$). The majority (52.0%) of the paired samples had an opercle age that was greater than the scale age. Scale ages ranged from 3 to 13 years while opercle ages ranged from 3 to 18 years. One opercle was aged at 21 years,

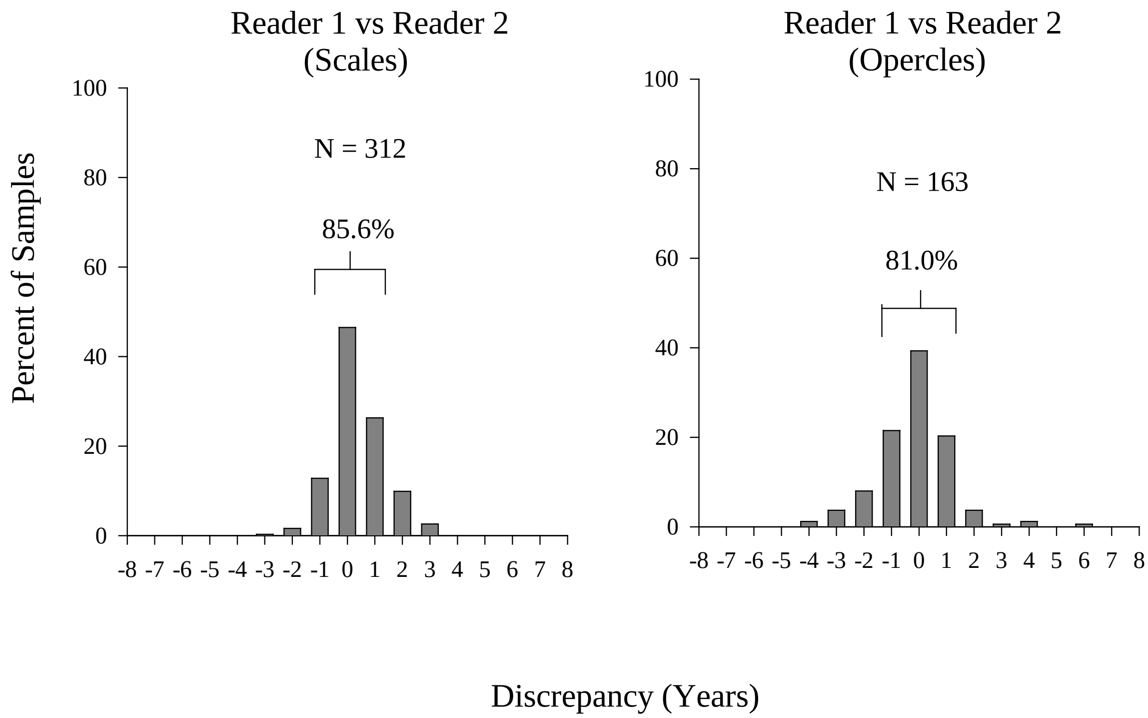

Figure 4. Distribution of reader aging discrepancies for northern pikeminnow scales and opercles collected in 2003. A potential aging discrepancy is defined as the Reader 2 age subtracted from the Reader 1 age.

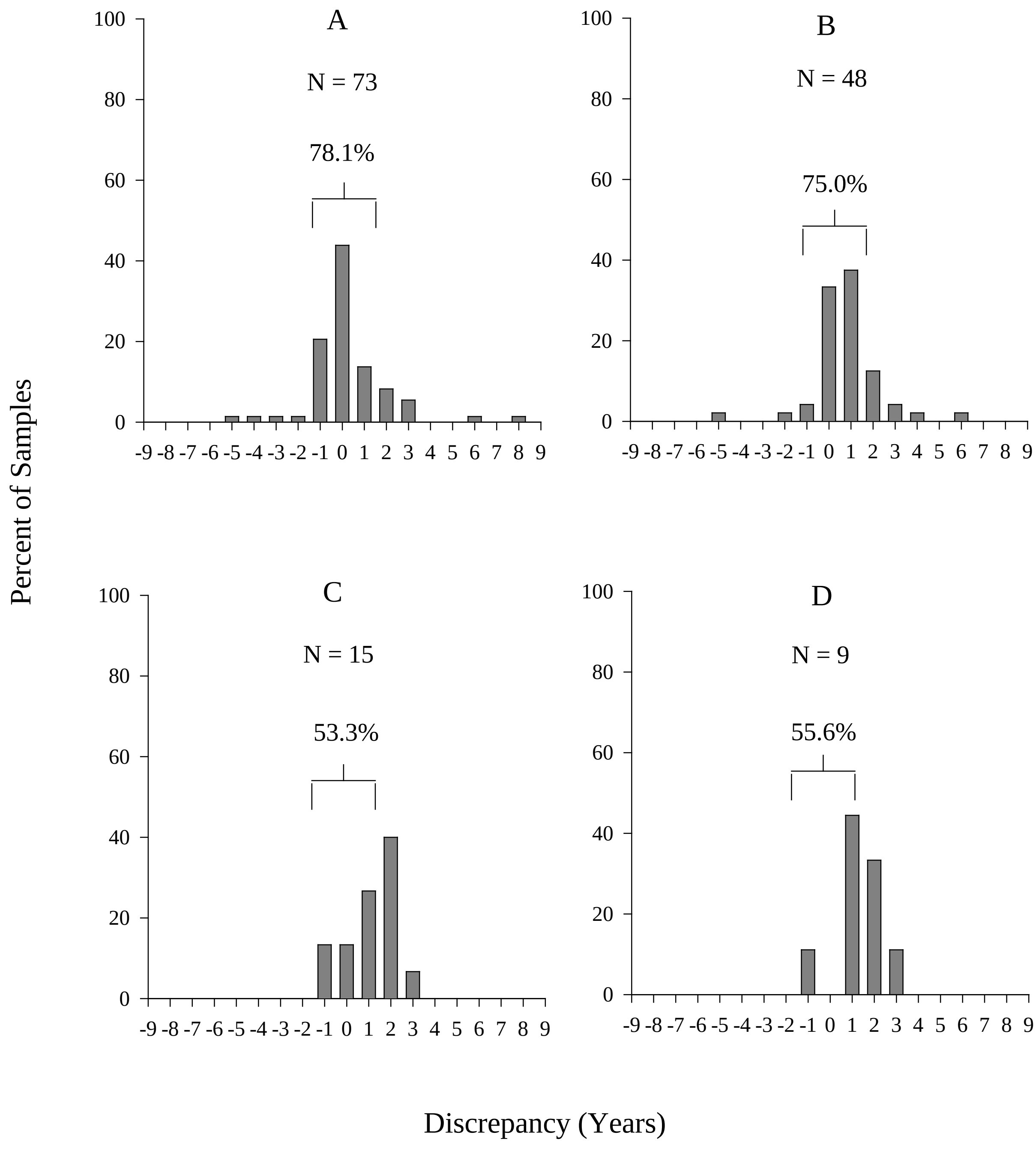

Figure 5. Panel A: aging discrepancies for scales collected from northern pikeminnow during tagging and recapture in 2003. Panel B: discrepancies for scales taken at tagging in 2002 and at recapture in 2003. Panel C: discrepancies for scales taken at tagging in 2001 and recapture in 2003. Panel D: discrepancies for scales taken at tagging in 2000 and recapture in 2003. A potential discrepancy is defined as the difference between recapture age minus tagging age and recapture year minus tagging year.

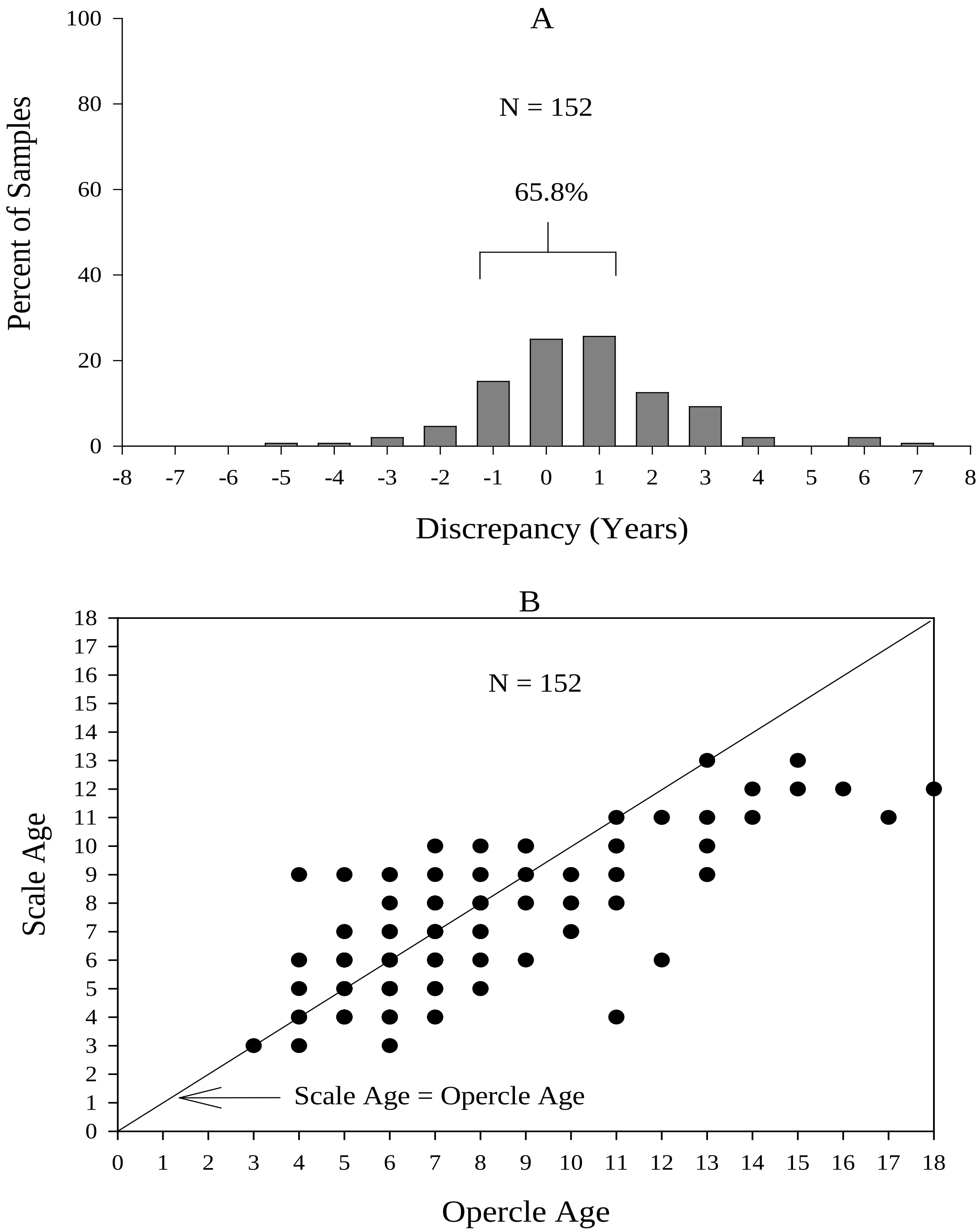

Figure 6. Comparison of ages assigned to scales and opercles from northern pikeminnow recaptured in 2003. Panel A: aging discrepancies between scales and opercles taken from the same fish. A potential discrepancy is defined as the scale age subtracted from the opercle age. Panel B: scale ages plotted against corresponding opercle ages.

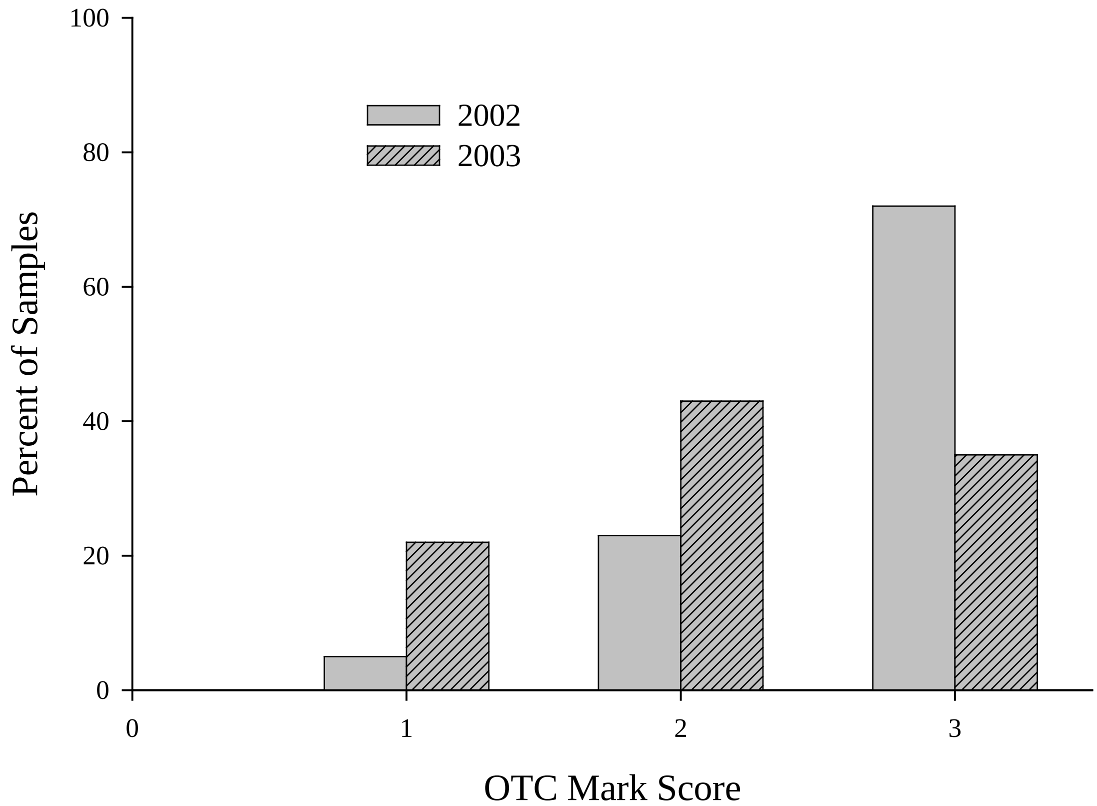

Figure 7. Comparison of OTC marks quality on opercles from northern pikeminnow tagged in 2002 and 2003. A score of ‘1’ is considered ‘poor’, ‘2’ is ‘fair’, and ‘3’ is ‘good’.

but the corresponding scale samples were unreadable, so this sample was not included in the analysis. Through age 8 or 9, scale and opercle ages were almost equally likely to be younger, older, or the same age. However, after these ages, opercles tended to be aged older than scales (Figure 6, panel B).

Opercle samples from 56 northern pikeminnow tagged in 2002 and 81 fish tagged in 2003 were examined for OTC mark quality. According to our criteria, most of the samples from the 2002 fish had OTC marks that were considered ‘good’, while the majority of samples from 2003 fish had only ‘fair’ marks (Figure 7). For the 2002 samples, 80% had an annulus visible after the OTC mark.

DISCUSSION

At 13.0%, system-wide exploitation of northern pikeminnow ≥ 250 mm by the sport-reward fishery in 2003 was nearly identical to the average exploitation rate of 12.9% for the 5-year period 1998-2002. The exploitation rates on these fish have remained relatively stable since the mid-1990s. On the other hand, the exploitation rates for northern pikeminnow 200-249 mm have been much more erratic in the four years that these smaller fish have been targeted, ranging from 3.4% in 2002 to 10.6% in 2001. It appears that tagged fish in this smaller size class may be less likely than their larger counterparts to be recovered in the fishery. Data for 2000-2003 shows that these smaller fish make up, on average, about 18% of the northern pikeminnow tagged and released each year. In the sport-reward fishery, 47% of the annual reward-size northern pikeminnow harvest consists of fish 200-249 mm. However, only about 8% of the tag recaptures are from fish in this size class. Higher mortality on these small fish after tagging and release may prevent them from being recaptured in the fishery at a rate more consistent with their share of the overall catch. In our mortality experiment, only two of the 20 treatment fish were in this size class (neither of which died), so it is difficult to say if tagging and other fish processing activities have higher direct mortality impacts on these fish compared to those ≥ 250 mm. It is possible the presence of a spaghetti tag on these smaller fish may make them more vulnerable to predators, leading to higher indirect mortality.

For northern pikeminnow ≥ 250 mm, exploitation rates exhibited a slight increasing trend since 1997 in the area below Bonneville Dam. On the other hand, exploitation rates since 1996 have declined somewhat in McNary Reservoir (with the exception of an unusually high exploitation rate in 2001). The Dalles and John Day reservoirs have either had no tag recoveries or too few to calculate exploitation rates since 2001 and 1997, respectively. Exploitation rates in Bonneville and Lower Granite reservoirs have fluctuated over time with no apparent trend.

Our new method of calculating confidence intervals reduced the variance around our exploitation estimates. For example, using our old method of summing weekly values, exploitation confidence intervals for northern pikeminnow ≥ 200 mm system-wide ranged from 5.7% to 17.2%. With our new method, confidence intervals ranged from 8.1% to 14.4%.

Sport-reward harvest of large (≥ 250 mm) northern pikeminnow appears to be driven by river flow, with exploitation increasing as river levels decrease. The strength of the relationship ($r^2 = 0.75$; $P < 0.05$) suggests that our index of river flow is a relatively good predictor of annual exploitation rates on northern pikeminnow ≥ 250 mm system-wide. Thus, river flow is likely a primary factor influencing the success of this fishery.

Incidental catch rates for 2003 were similar to 2002 (41.2%) in the sport-reward fishery. However, the incidental catch rate is 8.5% higher than the long-term average (31.9% from 1996 to 2002). The catch rate for salmonids decreased from 2002 to below historical average (0.37% from 1996 to 2002).

It appears most of the reduction in potential predation has been realized in the first seven years of the NPMP. After slight increases in 1998 and 1999, potential predation has stabilized at approximately 75- 80% of pre-program levels. If exploitation rates remain similar to mean 1996-2003 levels, further reductions in potential predation are likely to be minimal. Therefore, maintaining potential predation near the current levels of 79% may be a more realistic goal for the future rather than trying to gain additional large reductions in predation. In response to recommendations made in an audit of the NPMP (Hankin and Richards 2000), we are currently working on an updated predation model. We plan to use the new model once our aging and tag loss assessments are completed.

We calculated a tag loss estimate of 7.4% in 2003. This allowed us to adjust exploitation rates for tag loss for the first time since 1999. This year's tag loss is higher than the 4.2% used to adjust exploitation estimates prior to 2000. One likely reason for this is that during this year's tagging season, we found several defective spaghetti tags in our inventory. However, by the time we became aware of this problem, a few hundred fish had already been tagged and released. Almost all of the tag loss fish were released before we could remedy the situation. Therefore, the 7.4% estimate is probably a little higher than would be expected if all spaghetti tags had been working properly. The tag manufacturer has agreed to replace the entire tag series that contained the defective tags, and we will implement procedures to ensure that any more defective tags still on hand are "weeded out" and not used for tagging.

Although we were able to effectively use PIT tags as a secondary mark for our tag loss study in 2003, they required a lot of time for pre-season preparation, in-season implementation, and post-season data compilation. On the other hand, our experience with fin clips the previous three years indicates that fin marks are too difficult to properly identify during busy periods at sport-reward check stations when large numbers of fish are being processed. In 2004, we are planning on using electronic data recorders that may greatly simplify the data transfer process for PIT tags. If this is the case, we may again use PIT tags as our secondary mark.

The results of our mortality test suggest that there is little or no differential mortality between tagged and untagged northern pikeminnow. Therefore, this important assumption of mark-recapture studies is probably valid in our case. As mentioned earlier in this report, there is the possibility of some differential indirect mortality for smaller northern pikeminnow in the 200-249 mm size class. However, this would be difficult to assess in any kind of realistic experiment.

Since 2001, the readers in our aging study have been the same two individuals. After an initial improvement in reader agreement for scale ages from 2001 to 2002, both complete agreement and agreement within ± one year showed virtually no change between 2002 and 2003. Complete agreement appears to have leveled off at just below 50%, while agreement within ± one year has remained at about 85%.

Although reader agreement for opercles remains lower than that for scales, there has been continuous improvement over the three years we have been reading them. Currently, complete agreement is just below 40% and agreement within ± one year is about 80%. It's possible that aging precision may increase further as we continue to learn more about reading northern pikeminnow opercles and incorporate this knowledge into our aging protocols.

Over the course of four years, our attempts at age validation through comparison of tagging and recapture ages to time at-large indicate that we can achieve moderate levels of agreement on same-year recaptures, but that agreement is relatively low when comparing data from different tagging and recapture years, and that it continues to decrease as time passes. For same-year recaptures, complete agreement has averaged 43.6% during the four years of the study. For fish at-large for one year, agreement decreases to an average of 25.9%. When fish are at-large for two years, this drops even further to 17.8%. In 2003, nine fish at-large for three years were recaptured, and none of their assigned ages resulted in a complete agreement.

The distributions of discrepancies shown in Figure 5 indicate a strong tendency to underestimate ages at recapture when aging northern pikeminnow at-large for a year or more. This has been the case in every year of our age validation study. Panel C from Figure 5 shows a particularly telling case where fish at–large for two years were usually aged the same at recapture as they were at tagging. We do not know why this underestimation of recapture ages consistently occurs. It's possible that readers are unable to see recent annuli on scales, even though examination of opercles with OTC marks indicates that fish are growing after tagging and adding visible annuli to their opercles.

In the three years that we have been comparing scale ages to those from opercles, we have gotten almost identical results each year. It seems clear that beyond 8-9 years of age, opercles are consistently aged older than corresponding scales. Studies by Campbell and Babaluk (1979), Scoppettone (1988), Donald et al. (1992), and the Washington Department of Fish and Wildlife (J. Sneva, WDFW, personal communication) also found that ages derived from opercles tended to be older than those from scales. For this reason, some investigators have suggested that opercles may provide more accurate ages than scales, particularly for older fish (Donald et al. 1992). Although aging precision for opercles is currently lower than that for scales, continued improvement may eventually result in similar agreement rates. Given the lack of success that we have had in validating scale ages, we may begin to put more emphasis on the use of opercles for our aging data.

In 2002, the first year we injected northern pikeminnow with OTC, only 14% of the opercle samples had good quality fluorescent marks. We hypothesized several possible explanations for this: 1) OTC dosage was too low (McFarlane and Beamish

1987), 2) OTC was injected during the slow growth period of annulus formation (Conover and Sheehan 1999), and 3) fish at-large for less than a year did not have sufficient time to grow and fully exhibit fluorescent marking on the opercle. Our 2003 results indicate that all three factors may play a role in the quality of OTC marks. Opercles from fish injected in 2003 (same year recoveries) had a higher percentage of good quality marks (35%) than last year. This may be due to the higher dosage used this year (50 mg OTC/kg fish weight vs. 35 mg/kg). Furthermore, examination of opercles from fish injected in 2002 and recaptured in 2003 showed that 84% of the OTC marks were on or immediately adjacent to an annulus. Therefore, annulus formation does appear to occur in the late spring, during or close to our sampling period, and may make fluorescent marks more difficult to detect in the first year. Finally, opercles from fish injected in 2002 and recaptured in 2003 had 72% good quality marks compared to 35% for fish injected and recaptured in 2003. This suggests that the visibility of the OTC mark improves as the fish grows, at least within the first year or so at-large. We will see if fish injected in 2002 and recovered in 2004 maintain mark quality or if it decreases after two years at-large. This year, were able to derive some benefits from the OTC marking experiment because the fluorescent marks on opercles from fish at-large for a year or more helped us to identify annuli on the edge of some particularly difficult samples, and gave us some insight into the growth characteristics of northern pikeminnow.

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APPENDIX A

Exploitation of Northern Pikeminnow, 2000-2003

Appendix Table A-1. Number of northern pikeminnow tagged and recaptured in 2003.

Area or Reservoir	≥ 200 mm FL		200-249 mm FL		≥ 250 mm FL	
	Tagged	Recaptured	Tagged	Recaptured	Tagged	Recaptured
Below Bonneville	573	63	91	2	482	61
Bonneville	117	12	40	0	77	12
The Dalles	37	1	21	1	16	0
John Day	26	0	10	0	16	0
McNary	160	8	43	0	117	8
Lower Granite	46	3	6	0	40	3
System-wide	959	87	211	3	748	84

Appendix Table A-2. Exploitation rates (%) of northern pikeminnow ≥ 200 mm fork length (FL), 200-249 mm FL, and ≥ 250 mm FL for all fisheries combined, 2000-2003. Exploitation rates were not corrected for tag loss in 2000-2002.

Area or Reservoir	2000			2001			2002			2003[c]		
	≥200	200-249	≥250	≥200	200-249	≥250	≥200	200-249	≥250	≥200	200-249	≥250
Below Bonneville	9.9	9.7	10.0	15.9	[b]	16.2	10.8	3.1	12.6	11.8	[b]	13.6
Bonneville	12.7	5.2	16.3	8.6	[b]	8.5	5.0	0.0	6.0	11.0	0.0	16.7
The Dalles	[b]	0.0	[b]	0.0	0.0	0.0	[b]	0.0	[b]	[b]	[b]	0.0
John Day	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
McNary	10.2	[b]	9.7	26.0	[b]	26.0	7.6	[b]	7.7	6.6	0.0	8.2
Ice Harbor	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Lower Monumental	[b]	0.0	[b]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Little Goose	[b]	0.0	[b]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Lower Granite	10.5	[b]	8.7	9.4	[b]	[b]	11.6	[b]	14.3	[b]	0.0	[b]
System-wide	11.0	7.1	11.9	15.5	10.6	16.2	10.6	3.4	12.3	10.5	[b]	13.0

[a] No northern pikeminnow tagged.
[b] Not enough tagged fish recaptured for estimation.
[c] Sport-reward fishery only.

Appendix Table A-3. Exploitation rates (%) of northern pikeminnow ≥ 200 mm fork length (FL), 200-249 mm FL, and ≥ 250 mm FL for the sport-reward fishery, 2000-2003. Exploitation rates were not corrected for tag loss in 2000-2002.

Area or Reservoir	2000			2001			2002			2003		
	≥200	200-249	≥250	≥200	200-249	≥250	≥200	200-249	≥250	≥200	200-249	≥250
Below Bonneville	9.9	9.7	10.0	15.9	[b]	16.2	10.8	3.1	12.6	11.8	[b]	13.6
Bonneville	12.4	4.1	16.3	8.6	[b]	8.5	5.0	0.0	6.0	11.0	0.0	16.7
The Dalles	[b]	0.0	[b]	0.0	0.0	0.0	[b]	0.0	[b]	[b]	[b]	0.0
John Day	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
McNary	10.2	[b]	9.7	26.0	[b]	26.0	7.6	[b]	7.7	6.6	0.0	8.2
Ice Harbor	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Lower Monumental	[b]	0.0	[b]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Little Goose	[b]	0.0	[b]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Lower Granite	10.5	[b]	8.7	9.4	[b]	[b]	11.6	[b]	14.3	[b]	0.0	[b]
System-wide	10.9	6.6	11.9	15.5	10.6	16.2	10.6	3.4	12.3	10.5	[b]	13.0

[a] No northern pikeminnow tagged.

[b] Not enough tagged fish recaptured for estimation.

Appendix Table A-4. Weekly exploitation of northern pikeminnow ≥ 200 mm fork length system-wide in 2003.

Sampling Week	Tagged	Recaptured	At-Large	Exploitation (%)
13	18			
14	31		18	
15	59		49	
16	192		108	
17	203		300	
18	224		503	
19	89	2	727	0.3
20	46	5	814	0.7
21	70	6	855	0.8
22	18	10	919	1.2
23	7	3	927	0.3
24	1	9	931	1.0
25	1	6	923	0.7
26		2	918	0.2
27		7	916	0.8
28		2	909	0.2
29		6	907	0.7
30		7	901	0.8
31		3	894	0.4
32		2	891	0.2
33			889	0.0
34		5	889	0.6
35		2	884	0.2
36		1	882	0.1
37		2	881	0.2
38		3	879	0.4
39		2	876	0.2
40		1	874	0.1
41		1	873	0.1
42				
Total	959	87	872	10.5

Appendix Table A-5. Weekly exploitation of northern pikeminnow ≥ 250 mm fork length system-wide in 2003.

Sampling Week	Tagged	Recaptured	At-Large	Exploitation (%)
13	18			
14	29		18	
15	32		47	
16	123		79	
17	186		202	
18	187		388	
19	88	2	575	0.4
20	40	5	661	0.8
21	28	6	696	0.9
22	12	10	718	1.5
23	4	3	720	0.4
24		9	721	1.3
25	1	6	712	0.9
26		2	707	0.3
27		7	705	1.1
28		2	698	0.3
29		6	696	0.9
30		6	690	0.9
31		3	684	0.5
32		1	681	0.2
33			680	0.0
34		4	680	0.6
35		2	676	0.3
36		1	674	0.2
37		2	673	0.3
38		3	671	0.5
39		2	668	0.3
40		1	666	0.2
41		1	665	0.2
42				
Total	748	84	664	13.0

Appendix Table A-6. Weekly exploitation of northern pikeminnow ≥ 200 mm fork length in McNary Reservoir in 2003.

Sampling Week	Tagged	Recaptured	At-Large	Exploitation (%)
13				
14				
15				
16				
17				
18				
19	89			
20			89	
21	70	2	89	2.4
22		2	157	1.4
23			155	0.0
24		2	155	1.4
25	1	1	153	0.7
26			153	0.0
27			153	0.0
28			153	0.0
29			153	0.0
30			153	0.0
31			153	0.0
32			153	0.0
33			153	0.0
34			153	0.0
35			153	0.0
36			153	0.0
37		1	152	0.7
38			152	0.0
39			152	0.0
40			152	0.0
41			152	0.0
42				
Total	160	8	152	6.6

Appendix Table A-7. Weekly exploitation of northern pikeminnow ≥ 250 mm fork length in McNary Reservoir in 2003.

Sampling Week	Tagged	Recaptured	At-Large	Exploitation (%)
13				
14				
15				
16				
17				
18				
19	88			
20			88	
21	28	2	88	2.4
22		2	114	1.9
23			112	0.0
24		2	112	1.9
25	1	1	110	1.0
26			110	0.0
27			110	0.0
28			110	0.0
29			110	0.0
30			110	0.0
31			110	0.0
32			110	0.0
33			110	0.0
34			110	0.0
35			110	0.0
36			110	0.0
37		1	110	1.0
38			109	0.0
39			109	0.0
40			109	0.0
41			109	0.0
42				
Total	117	8	109	8.2

APPENDIX B

Dates of Sampling in 2003

Appendix Table B-1. Dates of each sampling week in 2003.

Sampling Week	Dates	Sampling Week	Dates
13	March 24 – March 30	28	July 7 – July 13
14	March 31 – April 6	29	July 14 – July 20
15	April 7 – April 13	30	July 21 – July 27
16	April 14 – April 20	31	July 28 – August 3
17	April 21 – April 27	32	August 4 – August 10
18	April 28 – May 4	33	August 11 – August 17
19	May 5 – May 11	34	August 18 – August 24
20	May 12 – May 18	35	August 25 – August 31
21	May 19 – May 25	36	September 1 – September 7
22	May 26 – June 1	37	September 8 – September 14
23	June 2 – June 8	38	September 15 – September 21
24	June 9 – June 15	39	September 22 – September 28
25	June 16 – June 22	40	September 29 – October 5
26	June 23 – June 29	41	October 6 – October 12
27	June 30 – July 6	42	October 13 – October 19