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REPORT ON THE PREDATION INDEX, PREDATOR CONTROL FISHERIES, AND PROGRAM EVALUATION FOR THE COLUMBIA RIVER BASIN EXPERIMENTAL NORTHERN PIKEMINNOW MANAGEMENT PROGRAM

2011 ANNUAL REPORT

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In Cooperation with:

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2011 Executive Summary
by

Russell G. Porter

This report presents results for year twenty-one in the basin-wide Experimental Northern Pikeminnow Management Program to harvest northern pikeminnow[1] (Ptychocheilus oregonensis) in the Columbia and Snake Rivers. 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 long-line 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 long-line 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 long-line 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 long-line 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 to increase public participation in the sport-reward fishery through a series of promotional and incentive activities. In 1995, 1996, and 1997, promotional activities and incentives were further improved

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

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

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.

4. **WDFW (Report D)**: Dam angling at The Dalles and John Day dams.

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 2011 by report are as follows:

Report A

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

1. The objectives of the 2011 NPSRF were to (1) implement a public fishery that rewards recreational anglers for harvesting northern pikeminnow $\geq$ 228 mm (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 Passive Integrated Transponder (PIT) tags implanted into northern pikeminnow by ODFW as secondary tags, and/or from northern pikeminnow containing consumed salmonids with PIT tags, and (6) survey non-returning fishery participants targeting northern pikeminnow in order to obtain catch and harvest data on fish species caught.

2. A total of 155,312 northern pikeminnow $\geq$ 228 mm were harvested during the 2011 NPSRF season. There were a total of 3,624 different anglers who spent 24,406 angler days participating in the fishery during the 2011 season.

3. Anglers submitted 155 northern pikeminnow with external spaghetti tags, 153 of which also had ODFW PIT tags. There were also 68 northern pikeminnow with ODFW PIT tags only, but missing spaghetti tags. An additional 62 PIT tags were recovered from juvenile salmonids ingested by northern pikeminnow received during the 2011 NPSRF.

Report B

Northern Pikeminnow Sport-Reward Fishery Payments

1. For 2011 the rewards paid to anglers were the same as in the 2010 season. Anglers were paid \$4, \$5, and \$8 per fish for the three payment tiers (up to 100 fish, 101-400 fish and 401 and up) during the season. The rewards for a tagged fish were \$500 per fish.

2. During 2011, excluding tagged fish, rewards paid totaled \$978,678 for 153,999 fish.

3. A total of 155 tagged fish vouchers were paid. The total season tag rewards paid totaled \$77,500.

4. A total of 1,108 separate successful anglers caught one or more fish and received payments during the season. A total of 3,624 separate anglers registered to fish, of which two thirds were unsuccessful.

5. The total for all payments for non-tagged and tagged pikeminnows in 2011 was \$1,062,188.

Report C

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

1. The objectives in 2011 were to 1) evaluate northern pikeminnow exploitation, potential predation, and tag loss, 2) define population parameters of northern pikeminnow, smallmouth bass *Micropterus dolomieu*, and walleye *Sander vitreus* downstream of Bonneville dam and in Bonneville reservoir, and 3) look for possible compensatory responses by smallmouth bass and walleye.

2. System-wide exploitation in 2011 of northern pikeminnow 250 mm or greater in fork length was 15.6% which incorporated a tag loss of 2.7%.

2. The 2011 estimated reduction in potential predation was estimated at 36% of pre-program levels.

3. Biological indexing was conducted downstream of Bonneville and in Bonneville reservoir in 2011 as part of our predator community evaluation. Northern pikeminnow abundance indices in these reservoirs remained at low levels. Occurrence of salmonids in northern pikeminnow digestive tracts was highest downstream of Bonneville Dam. They comprised 64% of the prey fish found in digestive tracts collected from pikeminnow downstream of Bonneville Dam. The relative weight of female northern pikeminnow was also highest downstream of Bonneville Dam. Predation indices, in 2011 are among the lowest observed across all reaches and seasons – since predation monitoring first began in 1990.

4. During both seasons sampled in 2011, smallmouth bass abundance was greatest in the middle reach of Bonneville Reservoir. Consumption index values in Bonneville Reservoir were similar in each indexed area during spring and summer. Among smallmouth bass containing fish, cottids were the most frequently occurring fish species; appearing in 43% and 59% of the diets containing fish for the area below Bonneville Dam and Bonneville Reservoir, respectively. Smallmouth bass stomach samples containing salmonids occurred between 4 and 10% of the time. Proportional stock density values for smallmouth bass were within the range of previous years. Relative weights in both areas have been between 94 and 99 since 2005.

5. In Bonneville Reservoir more walleye (n=22) were caught during 2011 than in previous years, but abundance continues to be far lower than that of northern pikeminnow and smallmouth bass. Salmonids continued to be the most prevalent prey fish observed in walleye stomachs. Cyprinids were the second most prevalent prey item observed in walleye samples.

6. Northern pikeminnow diet samples collected during angling at John Day and The Dalles in 2011 were evaluated. Fish were found to be the primary prey type consumed at The Dalles dam; however, other invertebrates were the primary prey type consumed at John

Day Dam. Salmon and lamprey made up the highest percentage of prey fish species consumed by northern pikeminnow.

7. At this time, a predator response to the NPMP in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir does not seem apparent. However, because responses to fisheries management programs may not be detected for several years, continued monitoring of predator populations in the Columbia River is recommended.

Report D

Dam angling at The Dalles and John Day dams

1. The 18 week fishery took place at The Dalles and John Day dams from May 2nd to October 6th, 2011. High flows and spill prevented fishing during some weeks this season.

2. The project objectives were to: a) implement a recreational-type hook and line fishery that harvests northern pikeminnow from the dam tailraces unavailable to the public fishing effort; b) allocate equal angler effort between The Dalles and John Day dams, based on angler CPUE in order to maximize harvest of northern pikeminnow, while collecting, compiling and reporting data on harvest, CPUE, gear/techniques and incidental catch of other species; c) scan record and report Passive Integrated Transponder (PIT) tag data from all northern pikeminnow, smallmouth bass, walleye, and channel catfish caught by the angling crew; d) record the presence of any external spaghetti tags, fin-clips, or signs of tag loss; and e) collect biological data on all northern pikeminnow and other fishes caught.

3. Harvests for the 18 week fishery at the two dams were 1,204 northern pikeminnow at The Dalles dam and 3,322 northern pikeminnow at John Day dam. The total fishing time at the two dams was 2,050.4 hours for a combined overall average catch per angler hour of 2.21 fish. The catch at The Dalles dam was 1.60 fish per angler hour and at John Day dam, 2.56 fish per angler hour.

4. Back bouncing soft plastic lures were found to be the most effective method for harvesting northern pikeminnow from both dams.

5. Incidental species most frequently caught and released at both dams were smallmouth bass *Micropterus dolomieue,* walleye *Sander vitreus,* white sturgeon *Acipenser transmontanus* and peamouth *Mylocheilus caurinus.*

6. The mean fork length of northern pikeminnow caught from The Dalles Dam was 361.0 mm and 380.0 mm at John Day dam.

REPORT A

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

2011 Annual Report

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ABSTRACT

We are reporting on the progress of the Northern Pikeminnow Sport-Reward Fishery (NPSRF) implemented by the Washington Department of Fish and Wildlife (WDFW) on the Columbia and Snake Rivers from May 1 through October 16, 2011. The objectives of this project were to (1) implement a recreational fishery that rewards recreational anglers for harvesting northern pikeminnow $\geq$ 228mm (9 inches) total length (TL), (2) collect, compile, and report data on angler participation, catch and harvest of northern pikeminnow and other fish species, as well as success rates of participants 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 Passive Integrated Transponder (PIT) tags implanted into northern pikeminnow by ODFW as secondary tags, and/or from northern pikeminnow containing consumed salmonids with PIT tags, and (6) survey non-returning NPSRF participants targeting northern pikeminnow in order to obtain catch and harvest data on specified fish species.

A total of 155,312 northern pikeminnow $\geq$ 228 mm and 6,883 pikeminnow < 228 mm were harvested during the 2011 NPSRF season. There were a total of 3,624 different anglers who spent 24,406 angler days participating in the fishery during the 2011 season. Catch per unit effort for combined returning and non-returning anglers was 6.36 fish/angler day. The Oregon Department of Fish and Wildlife (ODFW) estimated that the northern pikeminnow harvest activities from the 2011 NPSRF resulted in an overall exploitation rate of 15.6% (M. Weaver, ODFW personal communication).

Anglers submitted 155 northern pikeminnow with external spaghetti tags, 153 of these also had ODFW PIT tags. There were also 68 northern pikeminnow with ODFW PIT tags only, but missing spaghetti tags. An additional 62 PIT tags were recovered from juvenile salmonids ingested by northern pikeminnow received during the 2011 NPSRF.

Peamouth *Mylocheilus caurinus*, smallmouth bass *Micropterus dolomieue*, and sculpins *Cottus* spp, were the fish species most frequently harvested by NPSRF anglers targeting northern pikeminnow. The incidental catch of salmonids *Oncorhynchus* spp, by participating anglers targeting northern pikeminnow continued to remain below established limits for the Northern Pikeminnow Management Program (NPMP).

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 FL (11 inches total length). The Northern Pikeminnow Management Program (NPMP) was created in 1990, with the goal of implementing fisheries to achieve the recommended 10-20% annual exploitation on northern pikeminnow >275 mm FL within the program area (Vigg and Burley 1989). In 2000, NPMP administrators reduced the minimum size for eligible (reward size) northern pikeminnow to 228 mm FL (9 inches total length) in response to recommendations contained in a review of NPMP justification, performance, and cost-effectiveness (Hankin and Richards 2000). Beginning in 1991, the Washington Department of Fish and Wildlife (WDFW) was contracted to conduct the NPSRF component of the NPMP (Burley et al. 1992). The NPSRF enlists recreational anglers to harvest reward sized ($\geq$9" total length) northern pikeminnow from within program boundaries on the Columbia and Snake Rivers using a monetary reward system. Since 1991, anglers participating in the NPSRF have harvested more than 3.67 million reward sized northern pikeminnow and spent over 767,000 angler days of effort to become 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).

The 2011 NPSRF maintained the tiered angler reward system developed in 1995 (Hisata et al. 1995) which paid anglers higher rewards per fish based on achieving designated harvest levels and a separate bonus reward for returning northern pikeminnow spaghetti tagged by the Oregon Department of Fish and Wildlife (ODFW) as part of the NPSRF's biological evaluation. Catch and harvest data were collected from returning anglers, and non-returning anglers in order to monitor the effects of the NPSRF on other Columbia basin fishes.

METHODS OF OPERATION

Fishery Operation

Boundaries and Season

The 2011 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 caught in backwaters, sloughs, and up to 400 feet from the mouth of tributaries within this area. The NPSRF was fully implemented, with all stations operating during a regular season from May 1 through September 30, 2011. In addition, twelve stations conducted a sixteen day "post-season extension" beginning on October 1, 2011 in order to take advantage of favorable river conditions and provide anglers with an extended opportunity to harvest northern pikeminnow.

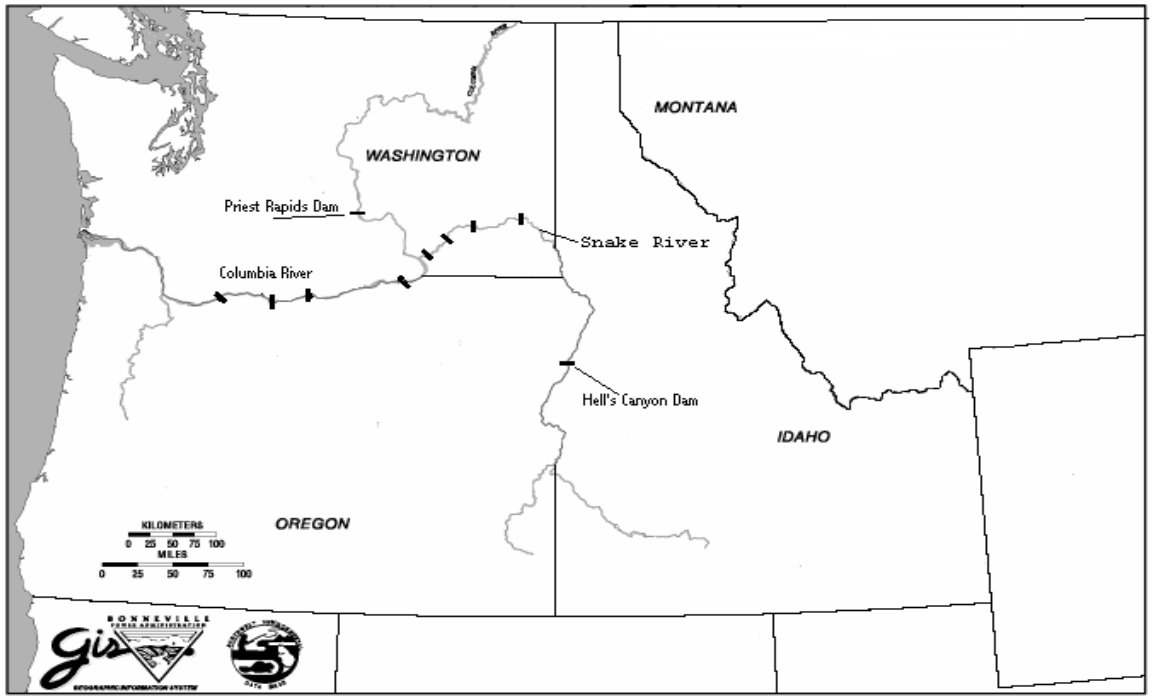


Figure 1. Northern Pikeminnow Sport-Reward Fishery Program Area

Registration Stations

Twenty-one registration stations (Figure 2) were located on the Columbia and Snake Rivers to provide anglers with access to the Sport-Reward Fishery. WDFW technicians set up registration stations daily (seven days a week) at designated locations (normally public boat ramps or parks) which were available to anglers between two and six hours per day during the season. Technicians registered anglers to participate in the NPSRF, collected angler 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.

1. Cathlamet Marina (10am-2 pm)
2. Willow Grove Boat Ramp (2:30-5:30 pm)
3. Rainier Marina (2:30pm-5:30 pm)
4. Kalama Marina (11:30am-2 pm)
5. Ridgefield (9am-12pm)
6. M. James Gleason Boat Ramp (11:30am-6 pm)
7. Portco Boat Ramp (9am-12pm)
8. Chinook Landing (9am-12pm)
9. Washougal Boat Ramp (1pm-5:30 pm)
10. Beacon Rock (9:30am-12:30pm)
11. Cascade Locks Boat Ramp (1pm-5:30 pm)
12. Bingen Marina (3:30pm-5:30pm)
13. The Dalles Boat Basin (9am-3pm)
14. Maryhill (9am-12pm)
15. Giles French (12:30pm-5:30 pm)
16. Umatilla Marina (4pm-6 pm)
17. Columbia Point Park (2pm-6:30 pm)
18. Vernita Bridge (10am-2:30 pm)
19. Lyon's Ferry (10:30am-12:30pm)
20. Boyer Park (10:30 am-2 pm)
21. Greenbelt (3:30pm-6:30 pm)

Figure 2. 2011 Northern Pikeminnow Sport Reward Fishery Registration Stations

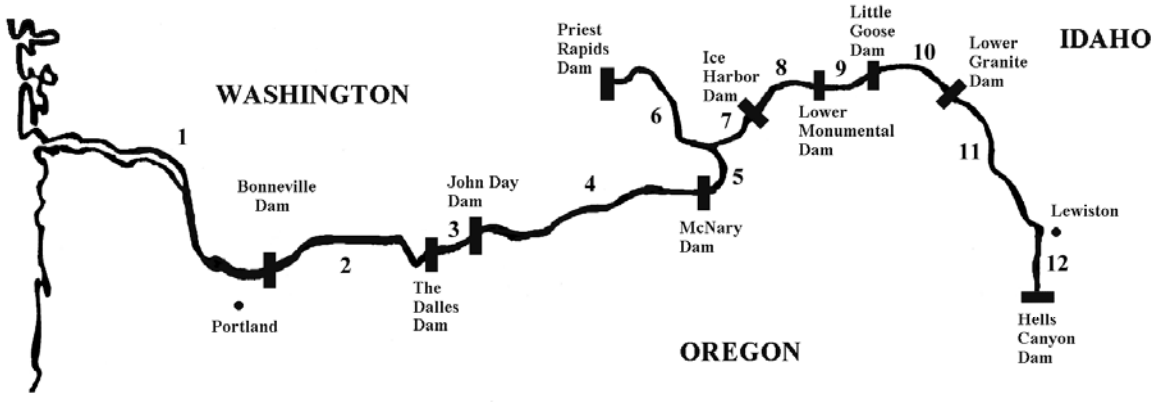
Reward System

The 2011 NPSRF rewarded anglers for harvesting northern pikeminnow $\geq$ 228mm TL (9 inches) and maintained the tiered angler reward system developed in 1995 (Hisata et al. 1995) which 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. WDFW technicians identified 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 to the angler by PSMFC. During the 2011 season, the NPSRF retained the pay levels first used in 2004 (Hone et al. 2004) which paid anglers $4 each for their first 100 northern pikeminnow, $5 each for numbers 101-400, and $8 each for all fish over 400. Anglers were paid $500 for each northern pikeminnow which retained a valid spaghetti tag used by ODFW for the biological evaluation of the NPMP.

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. Anglers were asked if they specifically fished for northern pikeminnow at any time during their fishing trip. A "No" response ended the exit interview. A "Yes" response prompted technicians to ask the angler (and record data), 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".



Fishing Locations:

1. Below Bonneville Dam
2. Bonneville Reservoir
3. The Dalles Reservoir
4. John Day Reservoir
5. McNary Reservoir to the Mouth of the Snake River
6. Mouth of the Snake River to Priest Rapids Dam
7. Mouth of the Snake River to Ice Harbor Dam
8. McNary Reservoir
9. Lower Monumental Reservoir
10. Little Goose Reservoir
11. Lower Granite Reservoir to the Mouth of the Clearwater River
12. Mouth of Clearwater River to Hell's Canyon Dam

Figure 3. Fishing location codes used for the 2011 Northern Pikeminnow Sport-Reward Fishery

Returning Anglers

Technicians interviewed all returning anglers at each registration station to obtain any missing angler data, and to record creel data from each participant's 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 were 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 attempted to survey 20% of the NPSRF's non-returning anglers using a telephone survey 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. Anglers were asked: "did you specifically fish for northern pikeminnow at any time during your fishing trip?" With a "Yes" response, anglers were asked to report the number and species of adult and/or juvenile salmonids and the number of reward size northern pikeminnow that were caught and harvested/released while they targeted northern pikeminnow. Angler catch and harvest data were not collected from non-returning anglers who did not target northern pikeminnow on their fishing trip. In addition, non-returning angler catch and harvest data for non-salmonid species were not collected in 2011 because they were collected in 2010 and trends for these species have remained consistent over the NPSRF's previous 20 year history (Winther et al. 1996). These data will be collected again in 2015 to identify any variance from non-returning angler trends observed to date within the Sport-Reward Fishery.

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 checked all northern pikeminnow for the presence of external tags (spaghetti or dart), fin-clip marks, and signs of tag loss. Fork lengths (FL) and sex of northern pikeminnow as well as any other harvested fish species were recorded whenever possible. Complete biological data were collected from all tag-loss and spaghetti tagged northern pikeminnow including FL, sex (determined by evisceration), and scale samples (if specified). Spaghetti tagged and tag-loss northern pikeminnow carcasses were then labeled and frozen for data verification and/or tag recovery at a later date. Data from spaghetti tags were recorded on a tag envelope as well as on WDFW data forms. The spaghetti tag was then placed in the tag envelope, stapled to the tag payment voucher and given to the angler to submit to ODFW for verification.

PIT Tag Detection

All northern pikeminnow collected during the 2011 NPSRF were also scanned for passive integrated transponder (PIT) tags. Northern pikeminnow harvested by anglers participating in the NPSRF have been found to ingest juvenile salmonids which have been PIT tagged by other studies within the basin (Glaser et al. 2000). In addition, PIT tags have also been used by ODFW as a secondary mark in all northern pikeminnow fitted with spaghetti tags (beginning in 2003) as part of the NPMP's biological evaluation activities (Takata and Koloszar 2004). The use of PIT tags rather than fin clips as a secondary mark in northern pikeminnow was intended to improve the NPSRF's estimate of tag loss, and result in a more accurate estimate of exploitation for the NPSRF. WDFW technicians were required to scan 100% of all northern pikeminnow returned to registration stations for PIT tags using one of two types of PIT tag "readers." Northern Pikeminnow submitted for payment to the NPSRF 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 units were not available. Scanning began on the first day of the NPSRF season and continued at all stations throughout the rest of the season. Technicians individually scanned all reward sized northern pikeminnow for PIT tag presence, and complete biological data were recorded from all 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 all PIT tag recovery data were provided to ODFW and the Pit Tag Information System (PTAGIS) on a regular basis.

Northern Pikeminnow Processing

During biological sampling, all northern pikeminnow were either eviscerated (to determine sex), or caudal clipped as an anti-fraud measure to eliminate the possibility of previously processed northern pikeminnow being resubmitted for payment. As in recent years, most northern pikeminnow harvested in 2011 were caudal clipped rather than eviscerated in order to facilitate more accurate recovery of 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 155,312 reward size northern pikeminnow (≥ 228 mm TL) during the 2011 season, operating during 23 weeks, plus a 16 day extension (at limited stations). The 2011 NPSRF had six more days of fishing than the 2010 NPSRF (Winther et al. 2010), but 2011 harvest was 18,977 fish lower than 2010, and lower than the mean 1991-2010 harvest of 175,973 fish (Figure 4). The 2011 NPSRF also achieved an exploitation rate of 15.6% (M. Weaver, ODFW personal communication) which was well within the 10-20% exploitation goal of NPMP. In addition to harvesting 155,312 reward size northern pikeminnow, the 2011 NPSRF also harvested 6,883 northern pikeminnow < 228 mm TL.

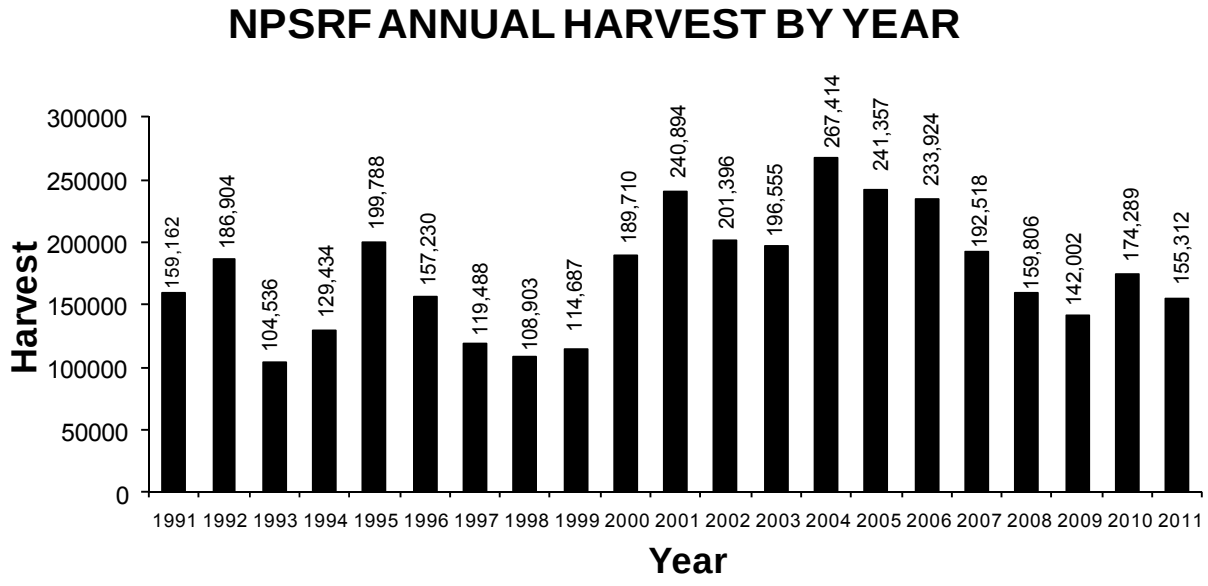


Figure 4. Annual Harvest Totals for the Northern Pikeminnow Sport Reward Fishery

Harvest by Week

Peak weekly harvest for the 2011 NPSRF was 11,581 fish and occurred during week 29 of the season (Figure 5). Mean weekly harvest (regular season + extension) was 6,212 fish, even though the data week for the May 1st opener only included only 1 day and 396 fish. Peak weekly harvest was slightly higher and mean weekly harvest was much lower than the 2010 levels (11,574 and 7,262 respectively). Peak harvest was two weeks later than 2010 and weekly harvest totals for the 2011 NPSRF were lower or nearly equal to the weekly totals for 2010 with the exception of 6 weeks when the weekly harvest was higher (Figure 6). Peak harvest was three weeks later than the NPSRF's historical 1991-2010 peak in week 26 (Fox et al. 1999) and for the first eleven weeks of the season (week 18- week 28), weekly harvest for the 2011 NPSRF

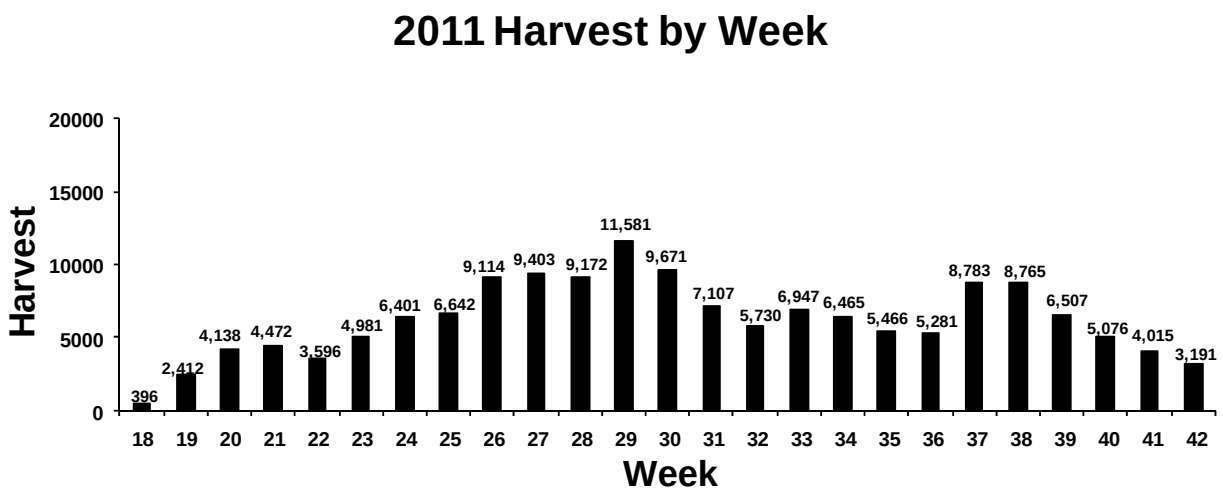


Figure 5. 2011 Weekly Northern Pikeminnow Sport-Reward Fishery Harvest.

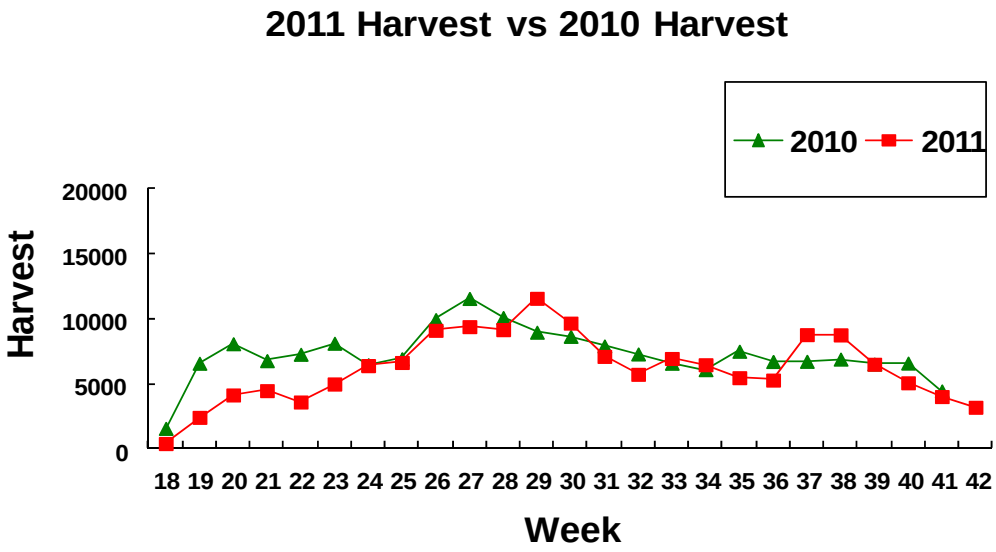


Figure 6. 2011 Weekly NPSRF Harvest vs. 2010 Weekly Harvest.

was lower than mean 1991-2010 weekly harvest levels (Figure 7). Weekly harvest then increased and stayed at or above historical 1991-2010 weekly harvest levels for the remainder of the regular season and through the extension. Early harvest levels were well below the mean harvest levels of the previous 20 NPSRF seasons and can best be explained by high river flows starting in week 21 (as a result of above average spring runoff) that typically cause lower harvest rates (Winther et al. 1996) .

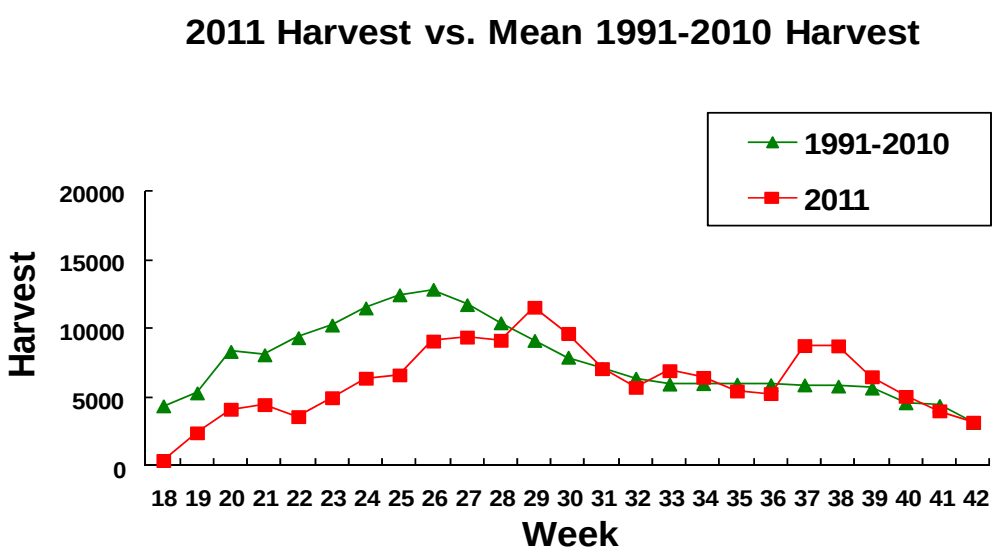


Figure 7. Comparison of 2011 NPSRF Weekly Harvest to 1991-2010 Mean Weekly Harvest.

Harvest by Fishing Location

The mean harvest by fishing location for the 2011 NPSRF was 12,943 northern pikeminnow and ranged from 54,294 reward size northern pikeminnow in fishing location 02 (Bonneville Reservoir) to 173 northern pikeminnow from fishing location 07 (Mouth of the Snake River to Ice Harbor Dam) (Figure 8). For the first time in the history of the NPSRF, harvest from Fishing Location 02 (the Columbia River above Bonneville Dam to The Dalles Dam) exceeded harvest for any of the other fishing locations, accounting for 35% of total NPSRF harvest. By becoming the top producing fishing location in the 2011 NPSRF, the Bonneville Pool (Fishing location 02), illustrated the harvest potential of this area first noticed when NPSRF technicians documented exceptionally large catches from anglers fishing the tailrace area of The Dalles Dam during the 2004 NPSRF (Hone et al. 2004). That, combined with an unprecedented late season surge of northern pikeminnow harvested from the area between Bonneville Dam and Cascade Locks pushed fishing location 02 above 01 for the first time. Fishing location 01 (below Bonneville dam), which had been the top fishing location for all of the previous 20 NPSRF seasons, had the second best harvest total in 2011, accounting for 29% of total 2011 NPSRF harvest. The area immediately below Lower Granite Dam (Fishing location 10) also continued to be a top producer with 14% of total 2011 NPSRF harvest.

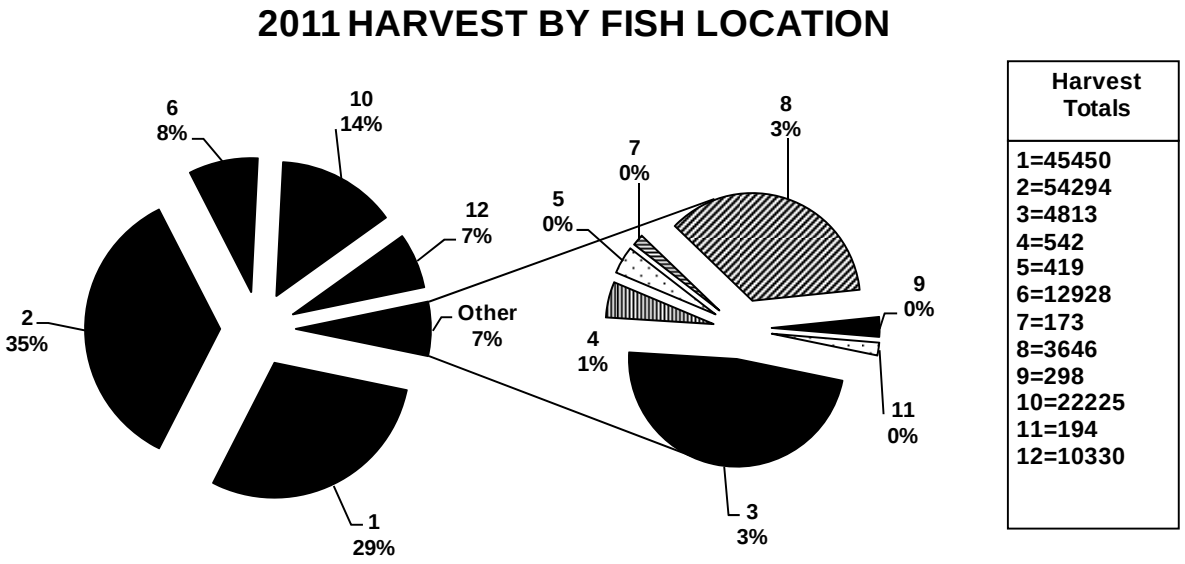


Figure 8. 2011 Northern Pikeminnow Sport-Reward Fishery Harvest by Fishing Location.*
*Fishing Location Codes for Columbia River; 1 = Below Bonneville Dam, 2 = Bonneville Reservoir, 3 = The Dalles Reservoir, 4 = John Day Reservoir, 5 = McNary Dam to the mouth of the Snake River, 6 = Mouth of the Snake River to Priest Rapids Dam. Fishing Location Codes for the Snake River; 7 = Mouth of the Snake River to Ice Harbor Dam, 8 = Ice Harbor Reservoir, 9 = Lower Monumental Reservoir, 10 = Little Goose Reservoir, 11 = Lower Granite Dam to the mouth of the Clearwater River, 12 = Mouth of the Clearwater River to Hell's Canyon Dam.

Harvest by Registration Station

Harvest in 2011 was down (from 2010 levels) at 15 of the 21 registration stations operated during the 2010 NPSRF (Maryhill was a new station in 2011). The Dalles registration station reclaimed the title of the NPSRF's top producing station for the first time since 2006 as anglers harvested 28,878 northern pikeminnow, equaling 18.6% of the total 2011 NPSRF harvest. The Boyer Park station which held the title for the four previous seasons (Figure 9), was the number two producer in 2011. The average harvest per registration station was 7,396 reward size northern pikeminnow, down from 8,299 per station in 2010. The registration station with the smallest harvest was the station at Portco where anglers harvested only 132 northern pikeminnow during the 2011 season. The Cascade Locks registration station showed the largest increase in harvest with 17,744 reward size northern pikeminnow, up from 6,822 in 2010. The Columbia Point registration station also deserves mention as it more than doubled its 2010 total of 4,363 to 9,390 in 2011.

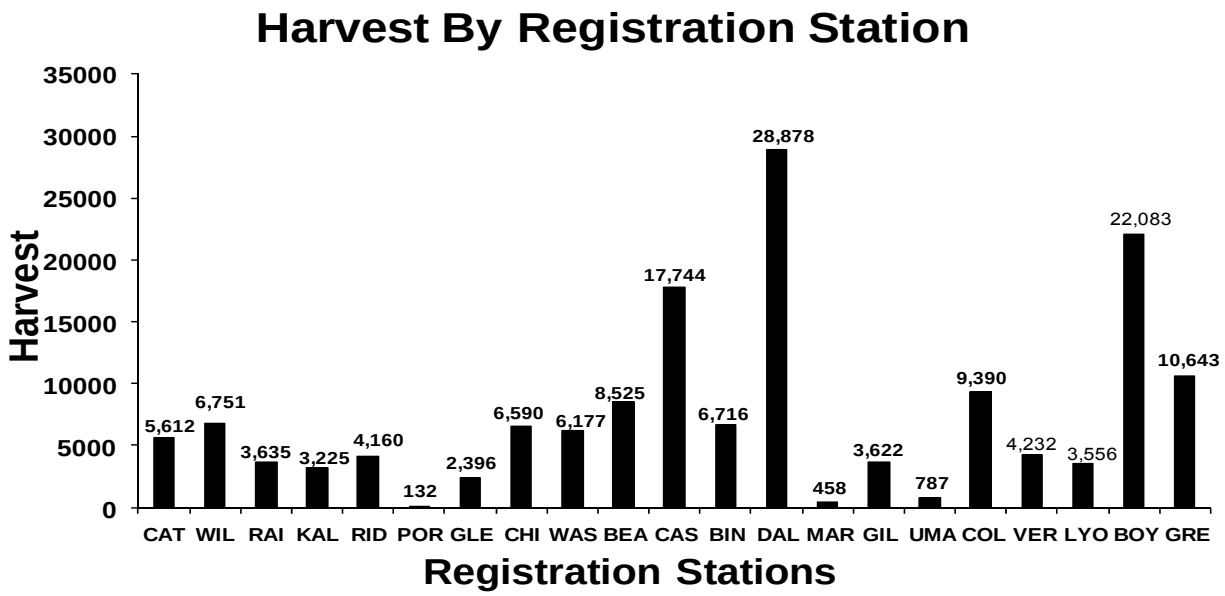


Figure 9. 2011 Northern Pikeminnow Sport-Reward Fishery Harvest by Registration Station.
CAT-Cathlamet, WIL-Willow Grove, RAI-Rainier, KAL-Kalama, RID-Ridgefield, POR-Portco, GLE-Gleason, CHI-Chinook, WAS-Washougal, BEA-Beacon Rock, CAS-Cascade Locks, BIN-Bingen, DAL- The Dalles, MAR-Maryhill, GIL-Giles, UMA - Umatilla, COL - Columbia Point, VER - Vernita, LYO - Lyon's Ferry, BOY-Boyer Park, GRE-Greenbelt.

Harvest by Species/ Incidental Catch

Returning anglers

In addition to northern pikeminnow, returning anglers participating in the 2011 NPSRF reported that they incidentally caught the salmonids listed in Table 1. Incidental salmonid catch by returning NPSRF anglers consisted mostly of juvenile chinook and unknown species of trout.

Table 1. Catch and Harvest of salmonids by Returning Anglers Targeting Northern Pikeminnow in 2011.

Salmon

Species	Caught	Harvest	Harvest Percent
Chinook (Adult)	35	14	40.00%
Chinook (Jack)	25	7	28.00%
Chinook (Juvenile)	106	0	0%
Coho(Adult)	7	3	42.86%
Coho(Juvenile)	6	0	0%
Cutthroat (Unknown)	29	5	17.24%
Steelhead Adult (Hatchery)	28	19	67.86%
Steelhead Adult (Wild)	30	0	0%
Steelhead Juvenile (Hatchery)	29	0	0%
Steelhead Juvenile (Wild)	59	0	0%
Trout (Unknown)	68	8	11.76%

Anglers reported that all juvenile salmonids caught during the 2011 NPSRF were released. Technicians recorded all juvenile steelhead caught by NPSRF anglers (except those specifically reported as missing the adipose fin), as "wild". Harvested adult salmonids (hatchery fin-clipped chinook and steelhead with missing adipose fins) were caught incidentally during the 2011 NPSRF, but were only retained during legal salmonid fisheries. Instances where NPSRF anglers reported harvesting "trout" from the Snake River during a legal fishery are typically residual hatchery steelhead smolts which are caught and kept by anglers and identified as "trout". Any NPSRF angler who reports illegally harvesting salmonids during the exit interview (whether juvenile or adult salmonids), are immediately reported to the appropriate enforcement entity by WDFW technicians.

Other fish species incidentally caught by returning NPSRF anglers targeting northern pikeminnow were most often peamouth, smallmouth bass, Sculpin, White Sturgeon, Channel Catfish, Walleye, Yellow Perch, and Suckers (Table 2).

Table 2. Catch and Harvest of non-salmonids by Returning Anglers Targeting Northern Pikeminnow in 2011.

Non-Salmonid

Species	Caught	Harvest	Harvest Percent
Northern Pikeminnow ≥228mm	155,378	155,312	99.96%
Northern Pikeminnow <228mm	52,016	6,883	13.23%
Peamouth	47,628	20,473	42.99%
Smallmouth Bass	9,989	1,087	10.88%
Sculpin (unknown)	6,672	3,527	52.86%
White Sturgeon	5,306	17	0.32%
Yellow Perch	1,458	433	29.70%
Sucker (unknown)	2,444	377	15.43%
Starry Flounder	328	53	16.16%
Channel Catfish	3,826	709	18.53%
Catfish (unknown)	880	146	16.59%
Walleye	1,722	671	38.97%
Carp	378	28	7.41%
Chiselmouth	389	59	15.17%
American Shad	184	37	20.11%
Bullhead (unknown)	360	56	15.56%
Redside Shiner	86	1	1.16%
Sandroller	236	0	0%
Pumpkinseed	41	0	0%
Bluegill	69	4	5.80%
Whitefish	20	1	5.00%
Largemouth Bass	39	11	28.21%
Crappie (unknown)	16	3	18.75%

Non-returning Anglers Catch and Harvest Estimates

We randomly surveyed 1,974 non-returning anglers (25% of all non-returning anglers) to record their catch and/or harvest of reward sized northern pikeminnow or any salmonid species. Catch and harvest data for other fish species caught by non-returning anglers were not collected in 2011 since harvest levels of those species by NPSRF anglers has been historically very low (Bruce et al. 2005) and was last collected during the 2010 NPSRF. We anticipate once again collecting full catch and harvest data for all species from surveyed non-retuning anglers in 2015 to determine whether this trend has changed per NPMP protocol (Fox et al. 1999). Surveyed non-returning anglers targeting northern pikeminnow reported that they caught and/or harvested the fish species listed in column 1 of Table 3 during the 2011 NPSRF. A simple estimator was applied to the catch and harvest totals obtained from the surveyed anglers to obtain Total Catch and Total Harvest estimates for all non-returning anglers participating in the 2011 NPSRF. Estimated totals are listed in columns 4 and 5 of Table 3.

Table 3. 2011 NPSRF Non-returning Angler phone survey Catch results, Estimated Harvest, and expanded Total Catch and Harvest estimates for all Non-returning anglers.

Species	Caught	Estimated Harvest	%Harvested*	Estimated Total Catch	Estimated Total Harvest
Northern Pikeminnow ≥ 228 mm	110	94	85%	440	374
Chinook Salmon (adult)	3	0	0%	12	0
Chinook Salmon (jack)	0	0	0%	0	0
Chinook Salmon (juvenile)	10	0	0%	40	0
Steelhead (adult)	0	0	0%	0	0
Steelhead (juvenile)	57	0	0%	228	0

*** Estimate based on average from 2006-2010 NPSRF**
N=7,760 n=1,974

Fork Length Data

The length frequency distribution of harvested northern pikeminnow (≥ 200 mm) from the 2011 NPSRF is presented in Figure 10. Fork length data for a total of 62,310 northern pikeminnow (40% of total) were taken during the 2011 NPSRF. The mean fork length for all measured northern pikeminnow (≥ 200 mm) in 2011 was 276.0 mm (SD= 64.9 mm), down from 281.7 in 2010.

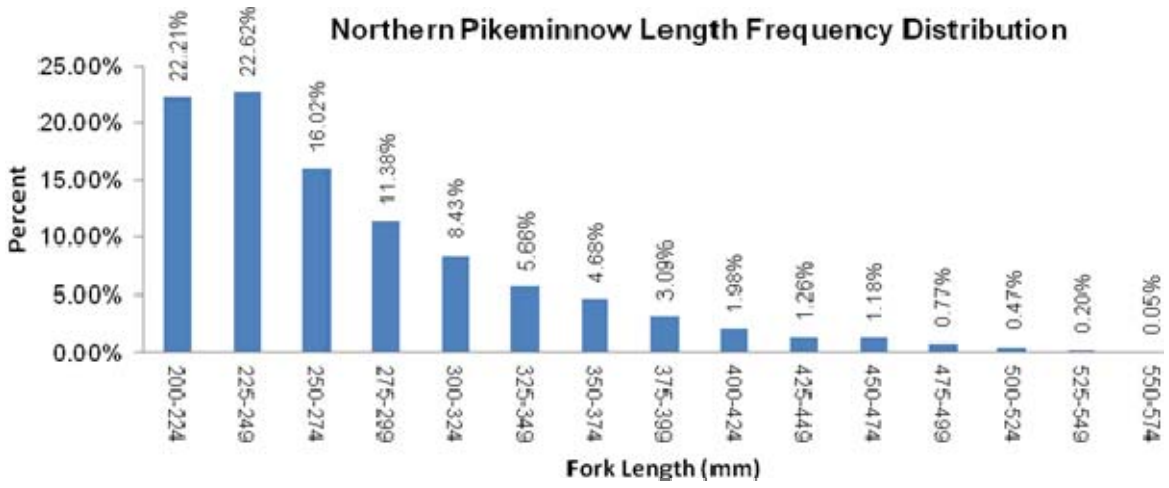


Figure 10. Length frequency distribution of northern pikeminnow ≥ 200 mm FL from 2011 NPSRF.

Angler Effort

The 2011 NPSRF recorded total effort of 24,406 angler days spent during the season, a decrease of 955 angler days from the effort total of the previous year (Winther et al. 2010) (Figure 11). When total effort is divided into returning and non-returning angler days, 16,646 angler days (68%) were recorded by returning anglers, and 7,760 were non-returns. The percentage of returning anglers showed a slight decrease from 2010 (69%). In addition, 57% of total effort, and 83% of returning angler effort (13,791 angler days), was attributed to successful anglers who harvested at least 1 northern pikeminnow in 2011.

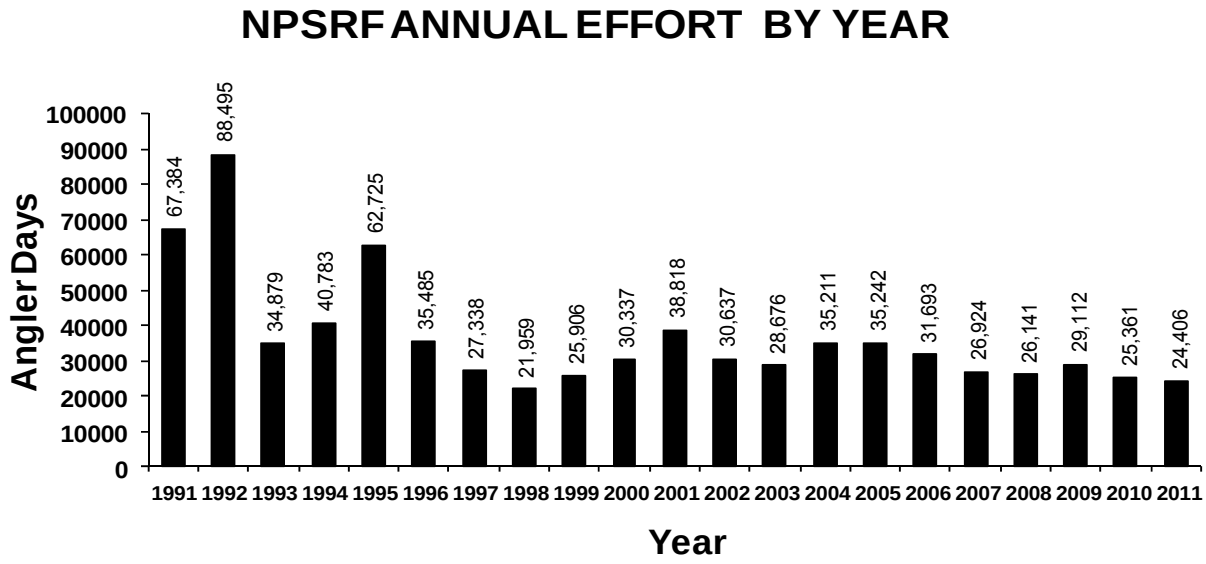


Figure 11. Annual Northern Pikeminnow Sport-Reward Fishery Effort.

Effort by Week

Mean weekly effort for the 2011 NPSRF was 976 angler days during the season, with the peak occurring in the twelfth week of the season (Figure 12). As observed in previous seasons, the peak effort occurred during the same week as peak harvest (week 29). Overall mean weekly effort decreased from 1,057 in 2010 to 976 in 2011 (Winther et al. 2010). The weekly effort totals for the 2011 NPSRF generally followed the pattern of previous seasons, although they were lower than historical 1991-2010 effort levels, which saw heavy initial participation (Figure 13).

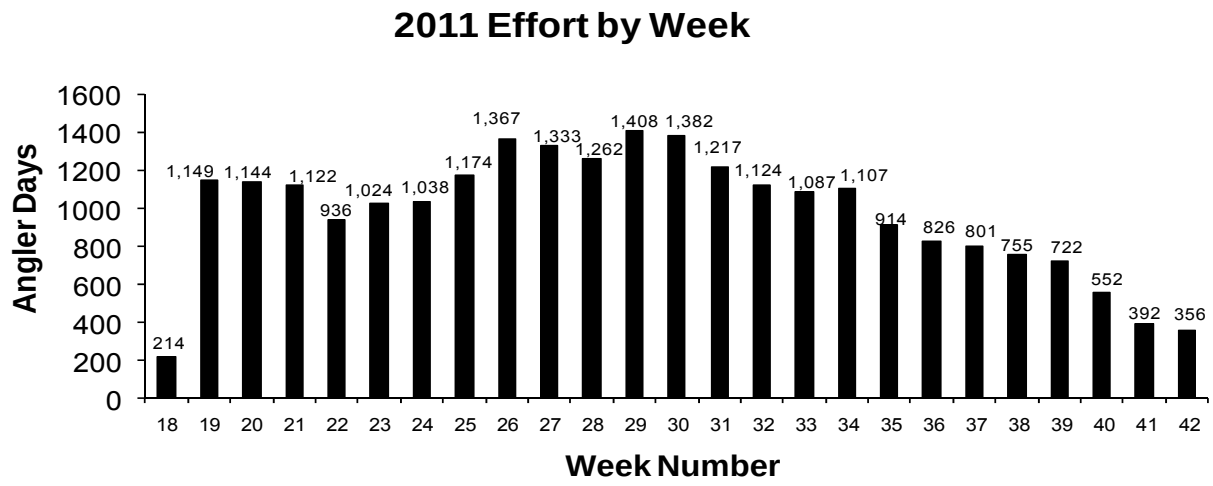


Figure 12. 2011 Weekly Northern Pikeminnow Sport-Reward Fishery Effort.

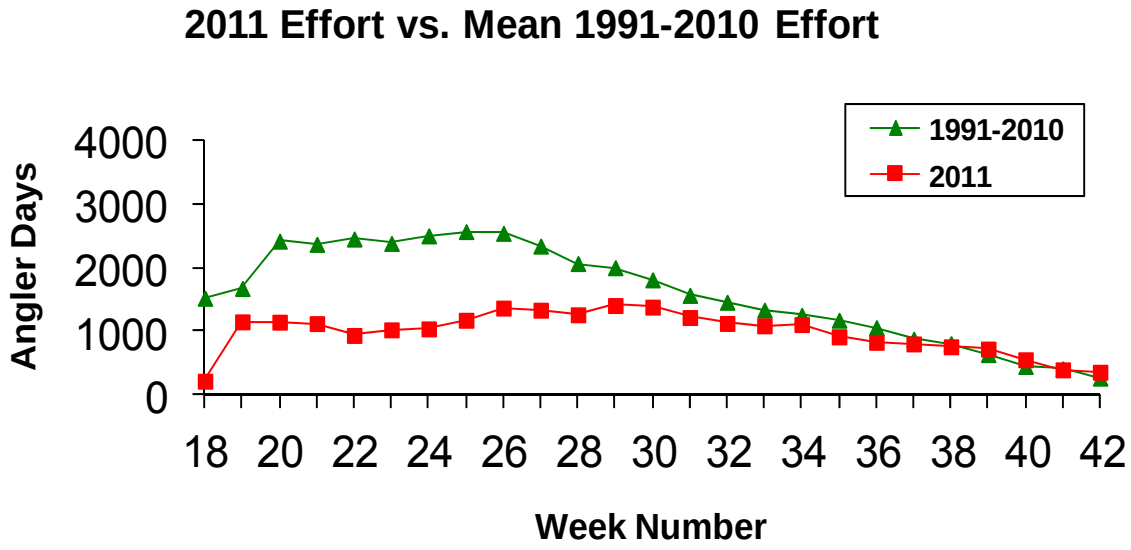


Figure 13. 2011 NPSRF Weekly Effort vs. Mean 1991-2010 Effort.

Effort by Fishing Location

Mean annual effort by fishing location for the 2011 NPSRF (returning anglers only) was 1,387 angler days compared to 1,449 angler days in 2010. Effort totals ranged from 5,195 angler days recorded below Bonneville Dam (fishing location 01) to only 20 angler days spent in fishing location 07 on the Snake River (Mouth of the Snake River to Ice Harbor Dam) (Figure 14). Effort at fishing location 02 (Bonneville Dam to The Dalles Dam) showed a large increase, 3,327 angler days in 2010 to 4,965 angler days in 2011 and helped compensate for the decrease in effort at half of the twelve NPSRF fishing locations.

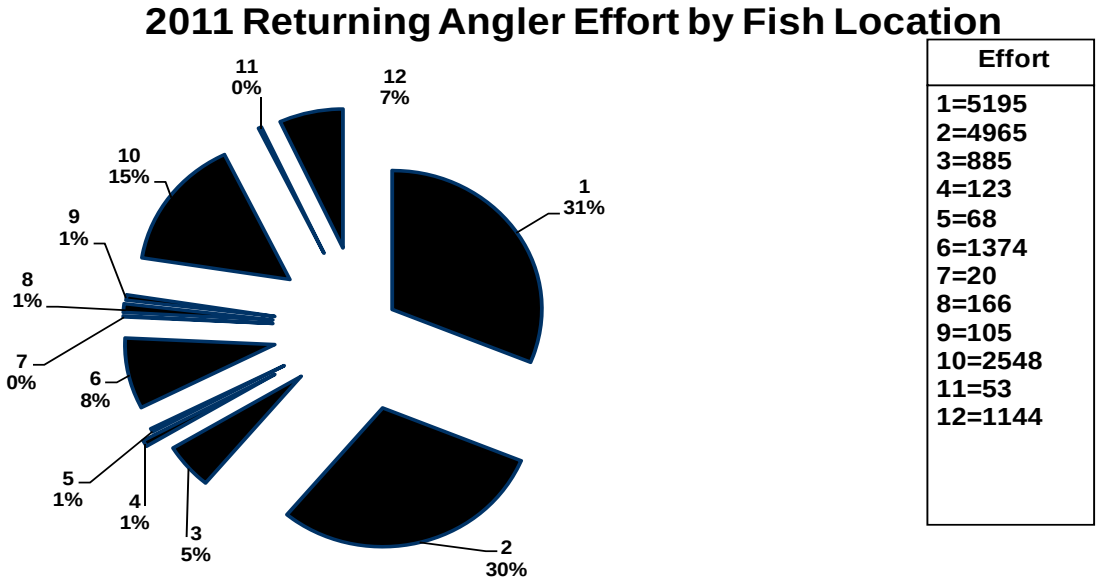


Figure 14. 2011 NPSRF Angler Effort by Fishing Location (returning anglers only).*
*Fishing Location Codes for Columbia River; 1 = Below Bonneville Dam, 2 = Bonneville Reservoir, 3 = The Dalles Reservoir, 4 = John Day Reservoir, 5 = McNary Dam to the mouth of the Snake River, 6 = Mouth of the Snake River to Priest Rapids Dam. Fishing Location Codes for the Snake River; 7 = Mouth of the Snake River to Ice Harbor Dam, 8 = Ice Harbor Reservoir, 9 = Lower Monumental Reservoir, 10 = Little Goose Reservoir, 11 = Lower Granite Dam to the mouth of the Clearwater River, 12 = Mouth of the Clearwater River to Hell's Canyon Dam.

Effort by Registration Station

Mean effort per registration station during the 2011 NPSRF was 1,162 angler days compared to 1,208 angler days in 2010. Effort totals ranged from 4,165 angler days at The Dalles station to 114 angler days at the new Maryhill station (Figure 15). Effort during the 2011 NPSRF decreased at 12 of the 21 registration stations operated in 2010. Effort increased at eight stations, most notably at the Cascade Locks station where effort increased by 81% with an additional 872 angler days spent in 2011. Columbia Point's effort also increased considerably up to 1,475 angler days in 2011 from 882 angler days in 2010. We saw the largest decline in effort (from 2010) at the Boyer Park station where we lost 671 angler days of effort.

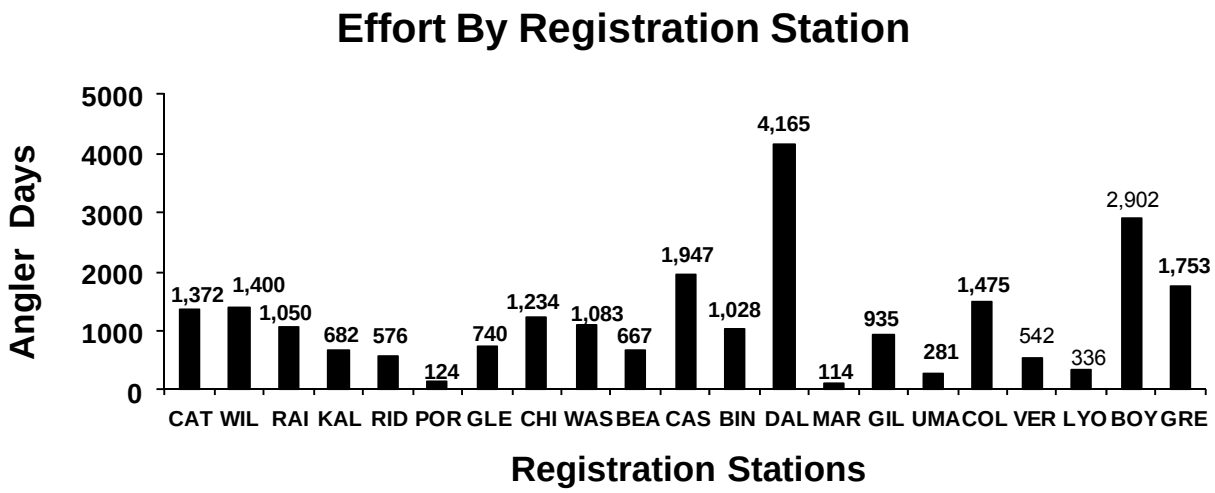


Figure 15. 2011 Northern Pikeminnow Sport-Reward Fishery Angler Effort by Registration Station.
CAT-Cathlamet, WIL-Willow Grove, RAI-Rainier, KAL-Kalama, RID-Ridgefield, POR-Portco, GLE-Gleason, CHI-Chinook, WAS-Washougal, BEA-Beacon Rock, CAS-Cascade Locks, BIN-Bingen, DAL-The Dalles, MAR-Maryhill, GIL-Giles, UMA-Umatilla, COL-Columbia Point, VER-Vernita, LYO-Lyon's Ferry, BOY-Boyer Park, GRE-Greenbelt.

Catch per Angler Day (CPUE)

The 2011 NPSRF recorded an overall (returning + non-returning anglers) catch per unit of effort (CPUE) of 6.36 northern pikeminnow harvested per angler day during the 2011 season. This catch rate decreased from 6.87 in 2010 (Winther et al. 2010) but was higher than the 4.88 CPUE recorded during the 2009 NPSRF (Hone et al. 2009) (Figure 16). Up through the 2007 season, angler CPUE had increased steadily throughout the NPSRF's history. During both the 2008 and 2009 NPSRF seasons, angler CPUE was considerably lower, most likely due to the influx of new or inexperienced anglers attracted to the NPSRF by the Pikeminnow Angler Random Drawing incentive (Hone et al. 2009). The angler CPUE for the 2010 and 2011 NPSRF were similar. Both seasons were conducted without the use of any random drawings or other incentives attracting inexperienced anglers. Returning angler CPUE during the 2011 NPSRF was 9.33 northern pikeminnow per angler day, down slightly from 2010 but up from 2009 (10.02 and 7.44 respectively), and near the 2008 level of 8.86. We estimate that CPUE for non-returning anglers is 0.05 reward sized northern pikeminnow per angler day based on 2011 NPSRF phone survey results.

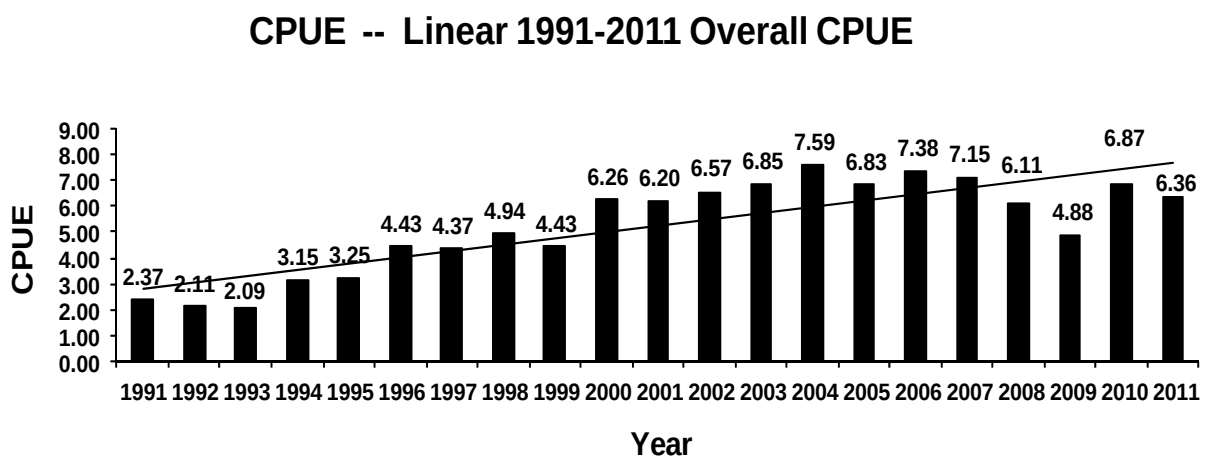


Figure 16. Annual NPSRF CPUE (returning + non-returning anglers) for the years 1991-2011.

CPUE by Week

Mean angler CPUE by week for the 2011 NPSRF was 6.55 fish per angler day compared to 7.05 in 2010. CPUE ranged from 1.85 in week 18 (May 1) to a peak of 11.61 in week 38 (September 12-September 18) (Figure 17). Weekly CPUE for the 2011 NPSRF followed the historical pattern where catch rates spike upward near peak harvest and then again late in the season.

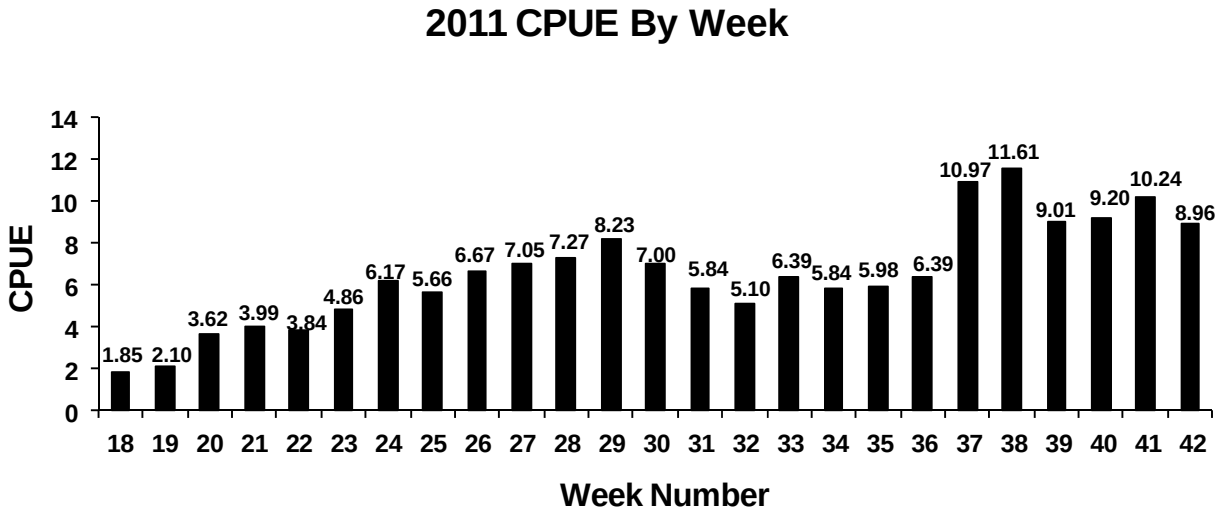


Figure 17. 2011 Northern Pikeminnow Sport-Reward Fishery Angler CPUE by Week.

CPUE by Fishing Location

Angler success rates for the 2011 NPSRF, as indicated by CPUE, are available for returning anglers only and varied by fishing location. Success rates ranged from a high of 21.96 fish per angler day in fishing location 08 (Ice Harbor Reservoir) to 2.84 fish per angler per day in fishing location 09 (Lower Monumental Reservoir) (Figure 18). Catch rates were up from 2010 at only fishing locations 05 (McNary Dam to mouth of Snake River), 06 (Mouth of Snake River Priest Rapids Dam, and 07 (the mouth of the Snake River to Ice Harbor Dam). The average CPUE by fishing location was 8.33 northern pikeminnow per angler day in 2011 compared to 9.24 in 2010.

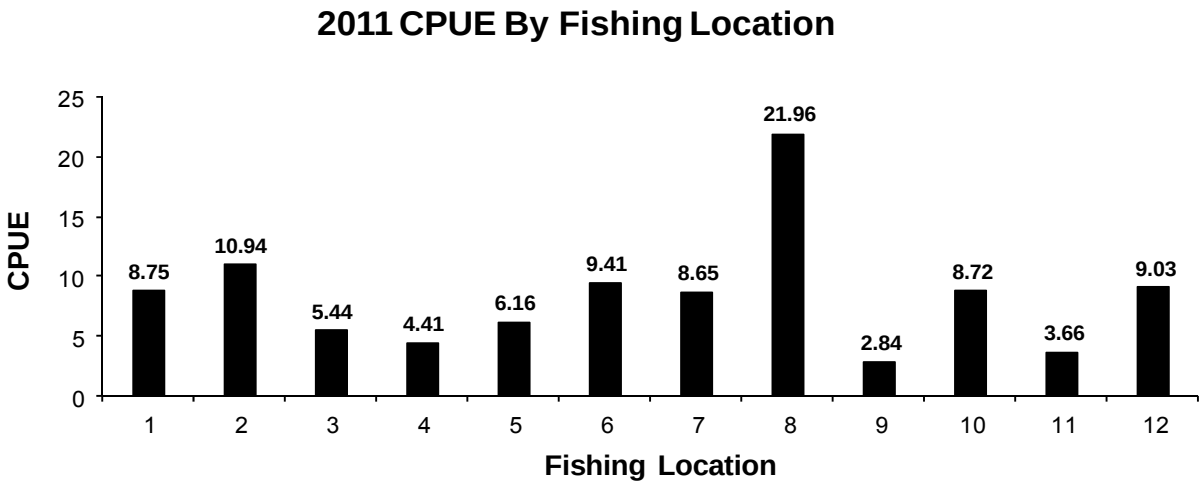


Figure 18. 2011 Northern Pikeminnow Sport-Reward Fishery Angler CPUE by Fishing Location.*
*Fishing Location Codes for Columbia River; 1 = Below Bonneville Dam, 2 = Bonneville Reservoir, 3 = The Dalles Reservoir, 4 = John Day Reservoir, 5 = McNary Dam to the mouth of the Snake River, 6 = Mouth of the Snake River to Priest Rapids Dam. Fishing Location Codes for the Snake River; 7 = Mouth of the Snake River to Ice Harbor Dam, 8 = Ice Harbor Reservoir, 9 = Lower Monumental Reservoir, 10 = Little Goose Reservoir, 11 = Lower Granite Dam to the mouth of the Clearwater River, 12 = Mouth of the Clearwater River to Hell's Canyon Dam.

CPUE by Registration Station

The registration Station with the highest CPUE during the 2011 NPSRF was the Beacon Rock station where anglers averaged 12.78 northern pikeminnow per angler day (Figure 19). The registration station with the lowest CPUE was the Portco station with a CPUE of 1.06 northern pikeminnow per angler day. The station average for angler CPUE was 5.91, down from 6.62 in 2010. Average angler CPUE by registration station increased at eight stations during the 2011 NPSRF. The Cascade Locks station had the largest increase in CPUE going from 6.35 in 2010 to 9.11 in 2011. The largest change in CPUE occurred at Ridgefield where the 2010 CPUE of 15.79 fell to 7.22 in 2011.

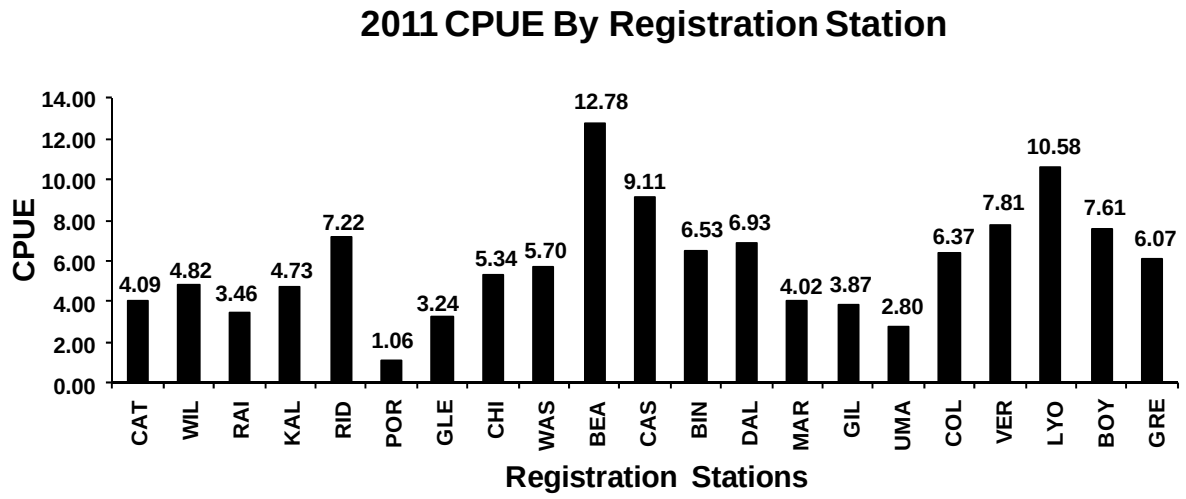


Figure 19. 2011 Northern Pikeminnow Sport-Reward Fishery Angler CPUE by Registration Station.
CAT-Cathlamet, WIL-Willow Grove, RAI-Rainier, KAL-Kalama, RID-Ridgefield, POR-Portco, GLE-Gleason, CHI-Chinook, WAS-Washougal, BEA-Beacon Rock, CAS-Cascade Locks, BIN-Bingen, DAL-The Dalles, MAR-Maryhill, GIL-Giles, UMA-Umatilla, COL-Columbia Point, VER-Vernita, LYO-Lyon's Ferry, BOY-Boyer Park, GRE-Greenbelt.

Angler Totals

There were 3,624 separate anglers who participated in the 2011 NPSRF, an increase of 311 participants from 2010 (Winther et al. 2010). Of the total number of participants, 39.3% (vs. 39.6% in 2010) were classified as successful, having harvested at least one reward size northern pikeminnow during the 2011 season. Of the successful anglers, 78% (1,108 anglers) sent in their vouchers to PSMFC for payment (PSMFC Payment Summary). Overall, the average successful angler harvested 109 northern pikeminnow during the 2011 NPSRF. A breakdown of the 1,426 successful anglers by tier-rate is as follows:

Tier 1 (0-100 fish), 1,226 anglers – 86% (vs. 83% in 2010)
Tier 2 (101-400 fish), 113 anglers – 8% (vs. 9% in 2010)
Tier 3 (401+ fish), 87 anglers – 6% (vs. 8% in 2010)

The 87 anglers who reached Tier 3 represent only 2.4% of all angler participants (both returning and non-returning anglers) during the 2011 NPSRF. The decline in anglers at Tier 3 (109 anglers in 2010 vs. 87 anglers in 2011) is significant, as this group of anglers typically catch the majority of reward size northern pikeminnow for the NPSRF.

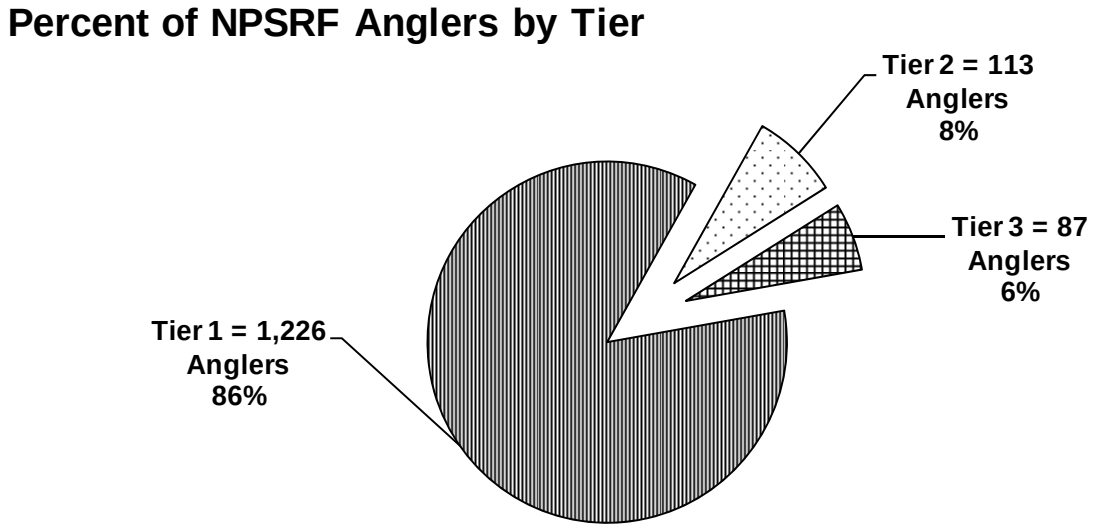


Figure 20. 2011 NPSRF Anglers by tier (returning only) based on total # of fish harvested.

While Tier 1 anglers comprised the largest group of all successful NPSRF participants in 2011, their total harvest (14,880 northern pikeminnow) accounted for only 10% of the total (Figure 21). This translated into an average of 12 fish per Tier 1 angler annually. The total harvested by Tier 2 anglers (25,252 northern pikeminnow) equal 16% of total; an average of 223 fish per Tier 2 angler annually. Tier 3 anglers harvested (115,180 northern pikeminnow) to equal 74% of the total; an average of 1,324 fish per Tier 3 angler annually. The percentage of total harvest for Tier 3 anglers decreased from 79% in 2010 to 74% in 2011. Conversely, the percentage of harvest for Tier 1 and Tier 2 anglers increased slightly.

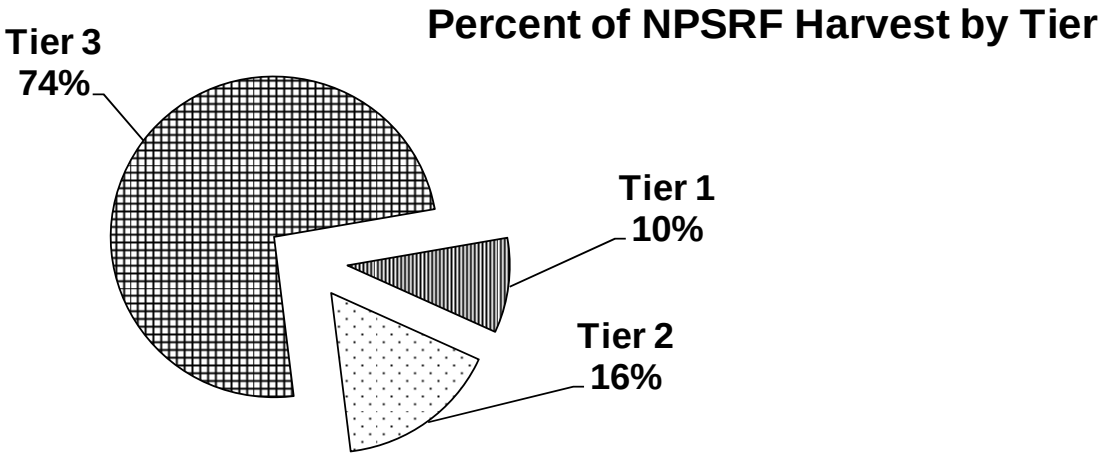


Figure 21. 2011 NPSRF Harvest by Angler Tier (Tier 1 = <100, Tier 2 =101-400, Tier 3 = > 400).

The average NPSRF participant (returning + non-returning anglers) expended less time (effort) pursuing northern pikeminnow during the 2011 season than in 2010 (6.73 vs. 7.67 angling days of effort). When we look at successful anglers only, Tier 1 anglers spent an average of 7 days fishing in the 2011 NPSRF compared to 8 days in 2010 (Figure 22). Tier 2 anglers spent an average of 45 days fishing for northern pikeminnow in 2011, up from 41 in 2010. Tier 3 anglers spent an average of 85 days fishing during the 2011 NPSRF, down from 86 days in 2010. As has been the trend in recent seasons, the NPSRF anglers who harvest the most fish (anglers from Tiers 2 and 3), also expend the most effort.

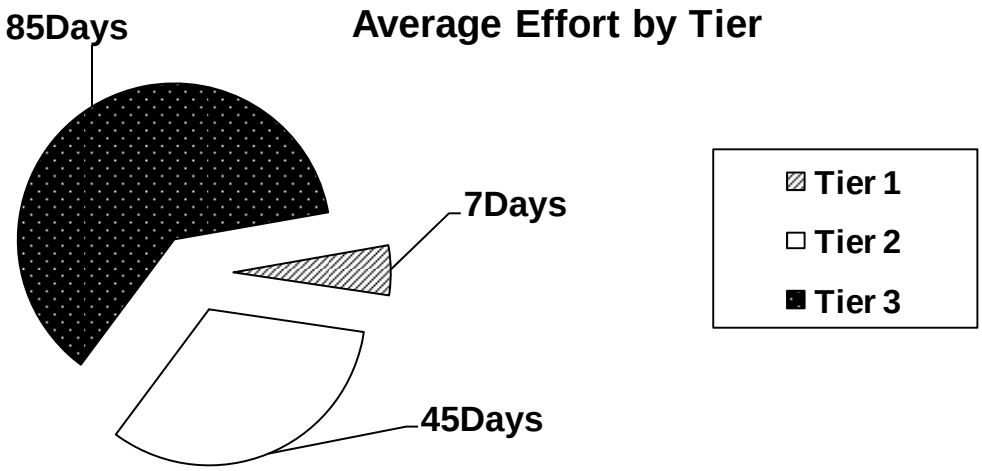


Figure 22. Average Effort of 2011 NPSRF Anglers by Tier (Tier 1 = <100, Tier 2 =101-400, Tier 3 = > 400) .

Overall angler effort for the 2011 NPSRF decreased from 2010. However, CPUE increased for all anglers at all tier levels (Figure 23), indicating that fishing was better than the previous year for successful anglers. CPUE for anglers at Tier 1 increased from 1.64 in 2010 to 1.76 in 2011. CPUE for Tier 2 anglers increased from 4.91 in 2010 to 4.98 in 2011, and CPUE for Tier 3 anglers went up from 14.77 in 2010 to 15.56 in 2011.

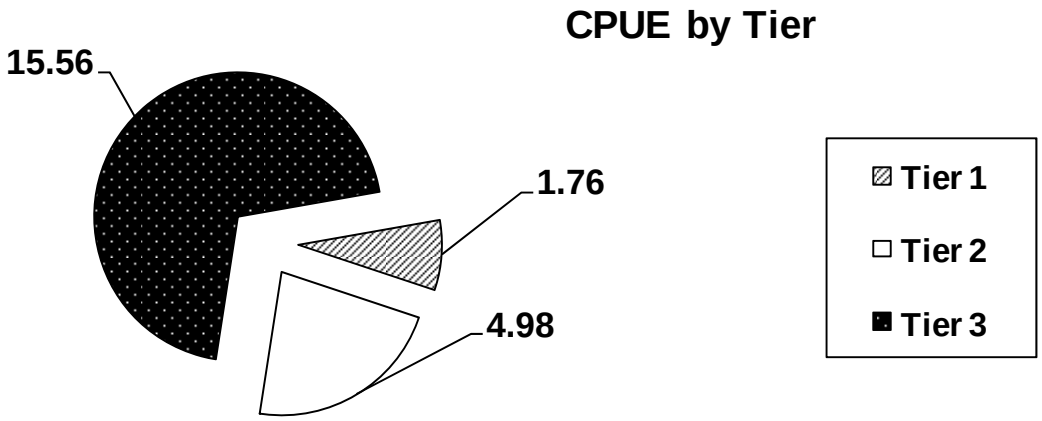


Figure 23. Average CPUE of 2011 NPSRF Anglers by Tier (Tier 1 = <100, Tier 2 =101-400, Tier 3 = > 400).

The top individual angler (based on number of fish caught) for the 2011 NPSRF harvested 8,972 northern pikeminnow and 2 spaghetti tagged northern pikeminnow worth a total earnings of $71,470 (PSMFC Sport Reward Payment Summary. November 16, 2011). The 2011 top angler caught 547 less fish than his record breaking 2010 season, but still managed to catch 2,176 more fish than the 2011 second place angler. The CPUE for this year's top angler (86.3 fish per angler day) was up from what he had as the top angler in 2010 (80.7 fish per angler day). The top angler for the 2011 season spent 14 fewer days (effort) fishing than in 2010 (118 days). This decrease in effort may have accounted for a lower total harvest. By comparison, the top angler (in terms of participation rather than harvest) for the 2011 NPSRF fished 166 days and harvested 696 northern pikeminnow.

Tag Recovery

Northern Pikeminnow Tags

Returning anglers harvested 155 northern pikeminnow tagged by ODFW with external spaghetti tags during the 2011 NPSRF compared to 213 spaghetti tags paid in 2010 (Winther et al., 2010). Tag recoveries peaked in week 27, two weeks earlier than peak NPSRF harvest (Figure 24). Of these spaghetti tagged northern pikeminnow, 153 had also been PIT tagged by ODFW as a secondary mark. WDFW technicians recovered an additional 68 northern pikeminnow which had ODFW PIT tags and wounds and/or fin-clips indicating that the fish had "lost" an ODFW spaghetti tag. The recovered spaghetti and PIT tags, as well as the potential tag loss data was estimated by ODFW to equal a 15.6% exploitation rate for the 2011 NPSRF (M. Weaver, ODFW, personal communication).

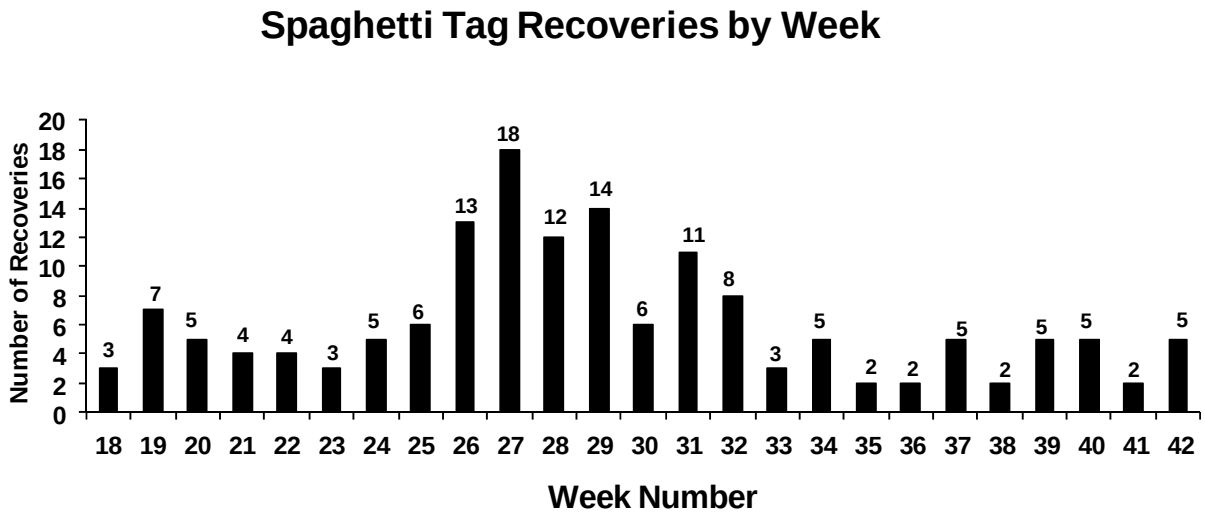


Figure 24. 2011 NPSRF Spaghetti Tag Recoveries by Week.

Ingested Tags

A total of 155,312 northern pikeminnow were individually scanned for the presence of PIT tags. This represents 100% of the total harvest of reward-size fish for the 2011 NPSRF. Northern pikeminnow not qualifying for rewards were scanned whenever possible. We recovered a total of 62 PIT tags from consumed smolts that had been ingested by northern pikeminnow harvested during the 2011 NPSRF; an overall occurrence ratio of 1:2,505 (vs. 1:1,599 in 2010). Total ingested tag recoveries in 2011 were lower (47 less) than the previous year which accounted for a lower rate of occurrence (Winther et al., 2010). PIT tag recoveries (of salmonid smolts ingested by northern pikeminnow) peaked during the twelfth week of the season at 13. Additional recoveries occurred through mid-September (Figure 25).

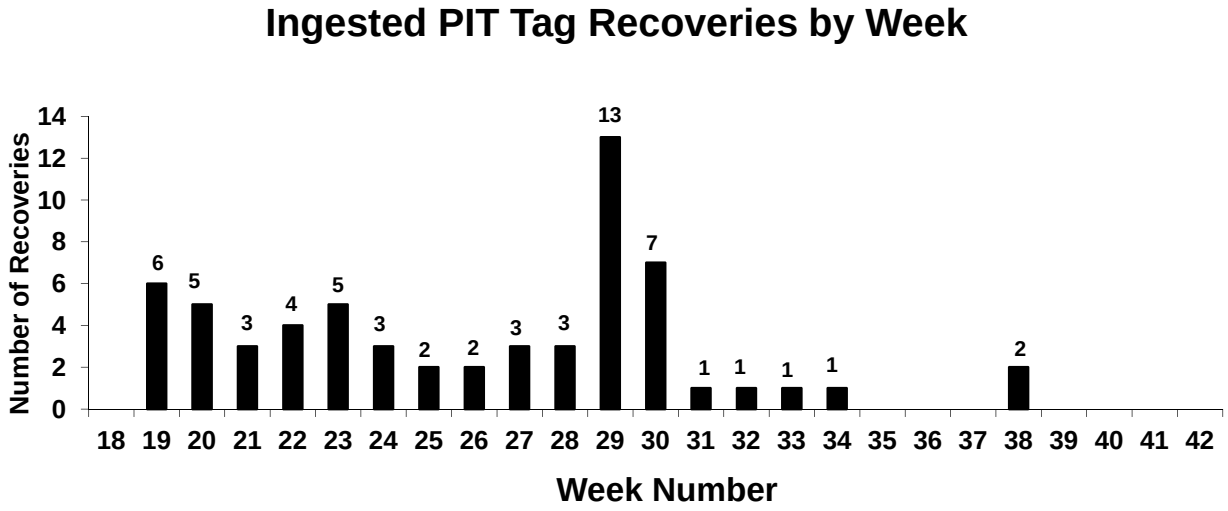


Figure 25. 2011 NPSRF PIT Tag Recoveries by Date.

In 2011, PIT tag recoveries peaked at both fishing locations 08 (Ice Harbor Reservoir) and 10 (Little Goose Reservoir); with each station having 13 recoveries of ingested salmonid smolts containing PIT tags (Figure 26). This contrasts with 2010, where peak recoveries (33 PIT tags) occurred at only one fishing location (Bonneville Reservoir).

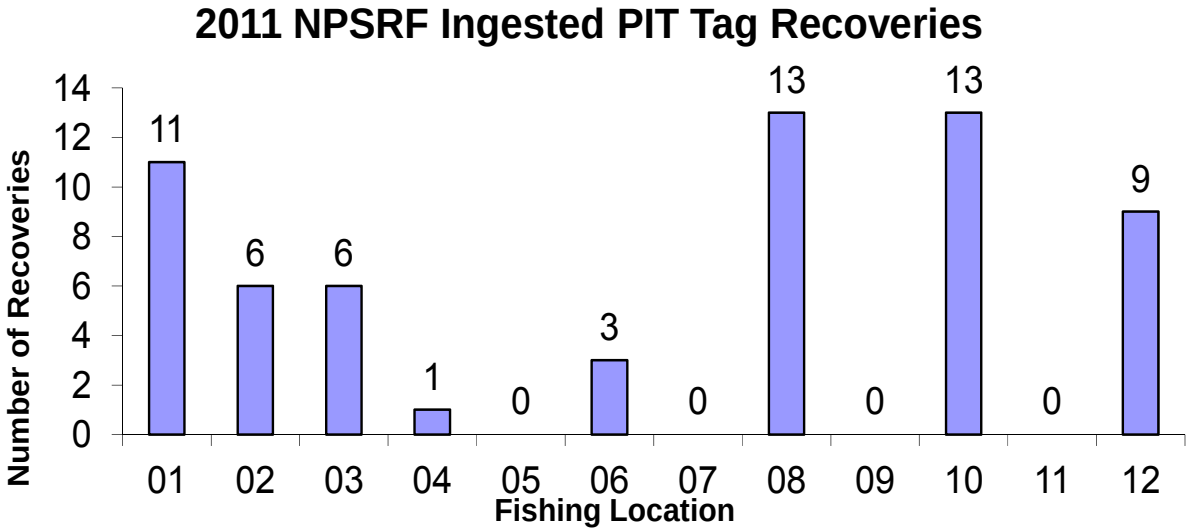


Figure 26. 2011 NPSRF ingested PIT Tag Recoveries by Fishing Location.
*Fishing Location Codes for Columbia River; 1 = Below Bonneville Dam, 2 = Bonneville Reservoir, 3 = The Dalles Reservoir, 4 = John Day Reservoir, 5 = McNary Dam to the mouth of the Snake River, 6 = Mouth of the Snake River to Priest Rapids Dam. Fishing Location Codes for the Snake River; 7 = Mouth of the Snake River to Ice Harbor Dam, 8 = Ice Harbor Reservoir, 9 = Lower Monumental Reservoir, 10 = Little Goose Reservoir, 11 = Lower Granite Dam to the mouth of the Clearwater River, 12 = Mouth of the Clearwater River to Hell's Canyon Dam.

Species composition of PIT tagged smolts recovered from northern pikeminnow harvested in the 2011 NPSRF were obtained from PTAGIS and indicated that fifty-two (84%) of the 62 ingested PIT tag recoveries were from chinook smolts. The other 10 PIT tags were from 2 sockeye, 1 coho, 2 steelhead and 5 unknown species accounting for the remaining 16% (Figure 27). About half of the chinook PIT tags were recovered in July, while the coho and steelhead recoveries were in May and the only sockeye showed up in June . PTAGIS queries revealed that the PIT tag recoveries from chinook smolts consisted of 37 fall chinook, 7 spring chinook, 2 unknown chinook and 6 summer chinook). PIT tag queries of PTAGIS also indicated that 4 of the 52 recovered PIT tags (8%) were from salmonids of wild origin.

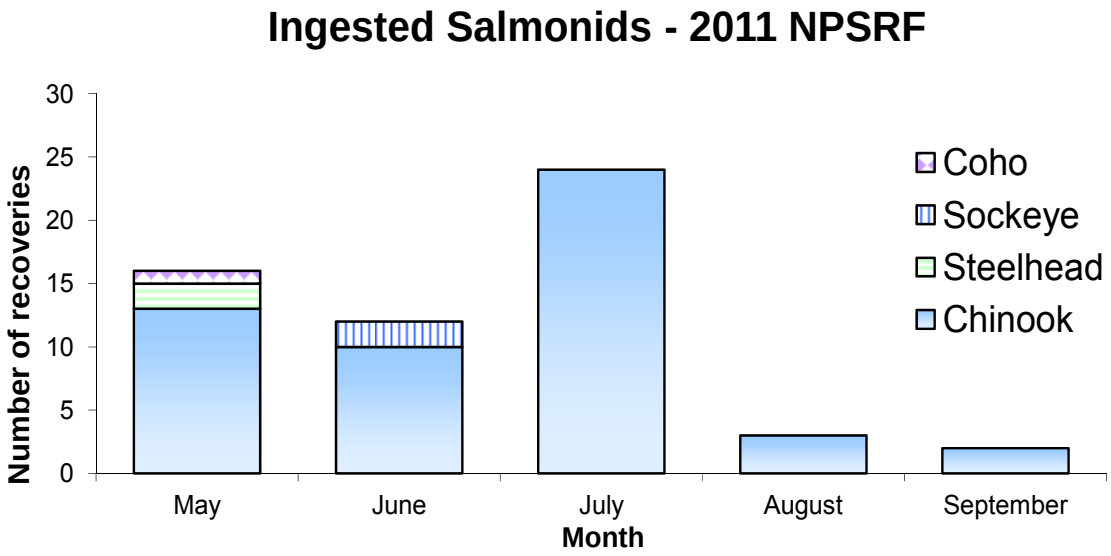


Figure 27. Recoveries of ingested salmonid PIT Tags from the 2011 NPSRF.

Analysis of PIT tag recovery data from the 2011 NPSRF continues to document northern pikeminnow predation on downstream migrating juvenile salmonids. 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 salmonid smolts and the factors affecting the vulnerability of smolts to predation while migrating through the Columbia River System.

SUMMARY

The 2011 NPSRF succeeded in reaching the NPMP's 10-20% exploitation goal for the fourteenth consecutive year, achieving an estimated exploitation rate of 15.6%. NPSRF harvest in 2011 was down from 2010 and well below average 1991-2010 harvest levels. Peak weekly harvest was also a week later than in 2010 and three weeks later than the 1991-2010 average. Once again, high runoff from late-May through mid-June (just prior to the spawn) caused angler harvest to drop at a time when harvest often is building toward the Fishery's historical peak in the second half of June. With the high river levels and timing of the runoff, the 2011 NPSRF recorded two noteworthy shifts in harvest patterns. The Dalles registration station was the SRF's top producing station in 2011 for the first time in 5 years (2006). More importantly, for the first time in the 21 year history of the NPSRF, more northern pikeminnow were harvested from the area between Bonneville and The Dalles dams (Fishing location 02) than from the area below Bonneville Dam (Fishing location 01 had been the top producing location for each of the previous 20 seasons). We recovered 155 spaghetti tagged northern pikeminnow and 68 missing spaghetti tags and retaining ODFW PIT tags. Mean fork length (FL) for northern pikeminnow harvested in the 2011 NPSRF was 276.0 mm, down from 281.7 mm in 2010. Incidental catch consisted primarily of peamouth, smallmouth bass and sculpin, most of which were released and juvenile steelhead (for salmonids), all of which were released.

Total angler effort dropped from 2010, but the number of separate anglers participating increased by 9.4% (311 anglers) from 2010. Overall CPUE was down slightly from 2010, but the SRF's recent trend of recording the highest angler CPUE toward the end of the SRF season (weeks 37-42) continued in 2011. There were also a number of key windows of "fishing opportunity" during the 2011 SRF season where excellent angler success (as indicated by CPUE) was available. These areas included Fishing location 08 (Lower Monumental Dam to Little Goose Dam) where angler CPUE was 21.96 fish per angler day, and at the Beacon Rock and Cascade Locks registration stations where angler CPUE was 12.78 and 9.11 fish per angler day respectively.

Analysis of NPSRF anglers based on their presence in one of the three reward tiers indicated that the average successful angler harvested less northern pikeminnow, and spent less time fishing in 2011 than in 2010. The number of anglers reaching each of the three tiers in 2011 also shifted downwards from 2010 with less anglers reaching Tier 3. The drop in the number of anglers able to reach Tier 3 was likely due to these anglers spending less time fishing during the period of poor river conditions early in the 2011 season. Losing this effort during that critical time of the season is one of the main reasons that the 2011 NPSRF harvest was below the 1991-2010 season average.

The top angler during the 2011 NPSRF caught 547 fewer fish than he did as the top angler in 2010 earning $71,470 in reward payments. This angler fished 14 fewer days than he did as the top angler last season, but had a higher CPUE for the days that he did fish, indicating that fishing was actually better for him than in 2010. The second place angler harvested 2,176 less northern pikeminnow than the top angler during the 2011 NPSRF.

Detection of PIT tags from juvenile salmonids ingested and retained in the gut of northern pikeminnow continues to yield valuable data about northern pikeminnow predation on juvenile salmonids. We recovered less PIT tags from ingested salmonids than last year (62 vs. 109) and peak recoveries occurred later in the season (week 27 vs. week 23). Species composition of recovered PIT tags again showed that they were primarily from chinook smolts (52), mostly fall chinook of hatchery origin. We also recovered a small number of PIT tags from steelhead (2), sockeye (2), and coho (1), as well as 5 of unknown origin (according to PTAGIS). We continue to consider the use of PIT tag recovery data as a way to identify and document angler fraud from northern pikeminnow tagged outside NPSRF boundaries.

RECOMMENDATIONS

1.) Continue use of standardized season dates (May 1st-Sept 30th) for implementation of the 2012 NPSRF in order to enhance promotional opportunities, build angler familiarity, and ultimately to maximize predation reduction.

2.) Continue to investigate and develop angler incentives designed to improve returning angler effectiveness during, and recruit new anglers to the 2012 NPSRF.

   a) Review angler participation patterns and adjust NPSRF registration stations and/or times as needed to encourage angler participation.

   b) Review NPSRF station times and routes for efficiencies which may allow adding additional stations or provide additional angler opportunities for participation.

   c) Continue to pursue feasibility of paying for tag-loss NPM retaining ODFW PIT tags in response to repeated angler requests and to improve NPSRF public relations.

   d) Continue use of coupons as a tool to recruit new anglers and promote NPSRF awareness.

   e) Investigate use of internet and social media for advertising NPSRF and for angler recruitment and education.

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

4.) Retain the option to extend the NPSRF season on a site-specific basis if warranted by high harvest, angler effort, and/or CPUE levels.

5.) Continue to scan all northern pikeminnow for PIT tags from ingested juvenile salmonids, from northern pikeminnow tagged by ODFW as part of the biological evaluation of the NPMP, and as a way to deter fraud by identifying fish from outside NPSRF boundaries.

6.) Survey at least 20% of non-returning anglers to record non-returning angler catch of northern pikeminnow and all salmonids and estimate total catch and harvest of northern pikeminnow and all salmonids per NPMP protocol. Analyze and monitor this data to identify any changes in non-returning angler catch trends.

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We are grateful to the City of Rainier for the use of the Rainier boat ramp; The City of Richland for the use of Columbia point Park; The City of Vancouver Parks and Recreation Department for the use of the Marine Park (PORTCO) boat ramp; the Cowlitz County Parks and Recreation Department for the use of the Willow Grove boat ramp; the Port of Bingen for the use of Bingen Marina; The Port of Camas/Washougal for the use of the Camas/Washougal boat ramp; the Port of Cascade Locks for the use of Marine Park; the Port of Cathlamet for the use of the Cathlamet Marina; the Port of Kalama for the use of the Kalama Marina; the Port of Ridgefield for the use of the Ridgefield boat ramp; the Port of The Dalles for the use of The Dalles Boat Basin; the Port of Umatilla for the use of the Umatilla Marina; the Portland Metro Regional Parks Department for the use of the M.J. Gleason Boat Ramp and Chinook Landing; the U.S. Army Corps of Engineers for the use of Giles French Park and the Greenbelt Boat Ramp; The Washington Department of Transportation for the use of the Vernita Bridge Rest Area; Washington State Parks for the use of Beacon Rock and Maryhill State Parks; Jim MacArthur for the use of Lyon's Ferry Marina; and Dave and Linda Petersen for the use of Boyer Park.

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We also recognize Diana Murillo for her excellent work in computer data entry and document verification, Maria Holmes for her numerous phone survey interviews, Kathleen Moyer for serving as the lead technician for the PIT tag recovery portion of the program, and Melissa Dexheimer for producing our weekly field activity reports, overseeing the Sport-Reward hotline, and helping to keep the program operating smoothly throughout the season.

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REPORT B

Northern Pikeminnow Sport Reward Payments – 2011

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March, 2012

INTRODUCTION

The **Northern Pikeminnow Predator Control Program** was administered by PSMFC in 2011. 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, and food habit studies, as well as exploitation rate estimates. PSMFC provided technical administration, and the fiscal and contractual oversight for all segments of the Program and processed all reward vouchers for the sport-reward anglers.

CATCH AND PAYMENTS

In 2011 a total of 155,312 fish were harvested in the sport-reward fishery. Of this total 155 were tagged fish and 155,157 were untagged. Vouchers for 153,999 of the untagged fish were submitted for payment totaling rewards of $984,688. Rewards were paid at $4 for the first 100 fish caught during the season, $5 for fish in the 101-400 range, and $8 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 1,108 anglers who registered were successful in catching one or more fish in 2011. The 2011 season ran from May 1, 2011 through October 16, 2011. At the beginning of the season, coupons were issued to all anglers in the pikeminnow database and to those who signed up for our mailing list at the various sportsmen's shows. In addition, all the newspaper ads announcing the opening of the season contained the coupon. The 2011 Coupon was worth a $10 bonus when attached to a voucher for a qualifying pikeminnow caught and turned in for the reward payment

TAGGED FISH PAYMENTS

A total of 155 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 $500 tagged fish reward. Of this total, 155 tagged vouchers were submitted for payment. This resulted in tag reward payments of $77,500 in addition to the regular reward payments above.

ACCOUNTING

Total payments for the season of regular vouchers, coupons, and tagged fish, totaled $1,062,188. All IRS Form 1099-MISC Statements were sent to the qualifying anglers for tax purposes in the fourth week of January, 2012. Appropriate reports and copies were provided to the IRS by the end of February, 2012.

A summary of the catch and rewards paid is provided in Table 1. For further information contact Russell Porter, PSMFC, Field Programs Administrator at (503) 595-3100 or email at: rporter@psmfc.org.

2011 SPORT REWARD PAYMENTS SUMMARY

The following is a summary of the vouchers received and paid as of November 16, 2011

	Fish	Incentives	$ Paid		
Fish paid @ tier 1 ($4 each):	33,519	N/A	$134,076		
Fish paid @ tier 2 ($5 each):	39,746	N/A	$198,730		
Fish paid @ tier 3 ($8 each):	80,734	N/A	$645,872	$978,678	$153,999
Tags paid (@ $500 each):	155	N/A	$77,500		
Coupons issued (@ $10 each)	N/A	601	$6,010		
Total:	**154,154**	**601**	**$1,062,188**		

Anglers @ tier 1	911			
Anglers @ tier 2	110	Anglers with 10 fish or less:		579
Anglers @ tier 3	87	Anglers with 2 fish or less:		271
Number of separate anglers	1,108			

	Top Twenty Anglers *	TIER 1	TIER 2	TIER 3	TAGS	TOTAL FISH	COUPONS	BALANCE
1.	NIKOLAY N ZAREMSKIY	100	300	8,570	2	8,972	$10	$71,470
2.	DAVID R VASILCHUK	100	300	6,380	16	6,796	$10	$60,950
3.	THOMAS H PAPST	100	300	4,102	1	4,503	$10	$35,226
4.	EDWARD R WILLIAMS	100	300	3,352	2	3,754	$10	$29,726
5.	IVAN R VASILCHUK	100	300	2,988	7	3,395	$10	$29,314
6.	VIKTOR M ORLOVSKIY	100	300	2,547	4	2,951	$10	$24,286
7.	TIMOTHY L HISTAND	100	299	2,520	2	2,921	$10	$23,065
8.	OLEG R VASILCHUK	100	299	2,517	3	2,919	$10	$23,541
9.	DUANE P BLETH	100	300	2,182	0	2,582	$10	$19,366
10.	ANATOLIY A GUTSAL	100	300	1,981	0	2,381	$0	$17,748
11.	PETR S LYUBCHIK	100	300	1,863	1	2,264	$10	$17,314
12.	DANIEL J GEIGER	100	299	1,847	6	2,252	$10	$19,681
13.	MATTHEW R TENNISON	100	299	1,807	3	2,209	$10	$17,861
14.	RALPH L FONTANA	100	300	1,779	1	2,180	$10	$16,642
15.	RUSSELL R MCKEE SR	100	300	1,572	2	1,974	$10	$15,486
16.	ROBERT D PAULSEN	100	300	1,454	1	1,855	$10	$14,042
17.	EDWARD A BAZYUK	100	300	1,411	5	1,816	$0	$15,688
18.	HANK J RARDIN	100	300	1,311	0	1,711	$10	$12,398
19.	STEVEN A WEBER	100	300	1,229	0	1,629	$10	$11,742
20.	HOLLIE DARDEN JR	100	300	1,040	1	1,441	$0	$10,720
	* (by total fish caught)	2,000	5,996	52,452	57	60,505	$170	$486,266

System-wide Predator Control Program:

Report C

Indexing and Fisheries Evaluation

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March 2012

SUMMARY

The Northern Pikeminnow Management Program (NPMP), with its fisheries aimed at reducing predation on juvenile salmonids by northern pikeminnow *Ptychocheilus oregonensis* in the Columbia and Snake rivers, was assessed for the 2011 season (1 May–15 October 2011). We report on 1) northern pikeminnow exploitation rates, predation estimates, and tag loss, 2) population parameters of northern pikeminnow, smallmouth bass *Micropterus dolomieu*, and walleye *Sander vitreus* in the lower Columbia River downstream of Bonneville Dam and in Bonneville Reservoir, and 3) possible compensatory responses by these species.

To evaluate exploitation during 2011, we tagged and released 682 northern pikeminnow greater than 200 mm fork length (FL) throughout the lower Columbia and Snake rivers. Of these fish, 450 were in the size group (≥250 mm FL) that we have used to monitor trends in system-wide exploitation and predation reduction since the start of this program. System-wide exploitation by the sport-reward fishery of northern pikeminnow greater than or equal to 250 mm FL was 15.6% (95% confidence interval 10.2–21.0%). Exploitation rates were adjusted using an estimated tag loss of 2.7%. Based on sport-reward exploitation rates and the model of Friesen and Ward (1999), we estimated that 2011 predation levels were 36% (range: 21–53%) lower than pre-program levels.

We conducted biological indexing in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir in 2011 as part of our predator community evaluation. Northern pikeminnow abundance indices in these reservoirs remained at low levels. Occurrence of salmonids in northern pikeminnow digestive tracts was highest downstream of Bonneville Dam, and the relative weight of female northern pikeminnow was also highest in this study reach. Salmonids comprised 64% of the prey fish found in digestive tracts collected from fish downstream of Bonneville Dam. Albeit sparsely informed (N=13), both salmonids and lamprey comprised 31% of the prey fish found in Bonneville Reservoir. Although not a unique observation, lamprey were observed at a higher percentage than during previous sampling activities in this reservoir. The Dalles tailrace was the only indexed area in Bonneville Reservoir that had a consumption index value greater than zero. Predation indices in 2011 are among the lowest observed across all reaches and seasons—since predation monitoring first began in 1990. Proportional stock density downstream of Bonneville Dam in 2011 was the highest for the period of record while in Bonneville Reservoir it was second lowest.

During both seasons sampled in 2011, smallmouth bass abundance was greatest in the middle reach of Bonneville Reservoir. Consumption index values in Bonneville Reservoir were similar in each indexed area during spring and summer. Among smallmouth bass containing fish, cottids were the most frequently occurring fish species; appearing in 43% and 59% of the diets containing fish for the area below Bonneville Dam and Bonneville Reservoir, respectively. Smallmouth bass stomach samples containing salmonids occurred between 4 and 10% of the time. Proportional stock density values for smallmouth bass were within the range of previous years. Relative weights in both areas have been between 94 and 99 since 2005.

In Bonneville Reservoir we caught more walleye (n=22) during 2011 than in previous years, but our encounters of walleye continue to be less frequent than that of northern pikeminnow and

smallmouth bass. Salmonids continued to be the most prevalent prey fish observed in walleye stomachs. Cyprinids were the second most prevalent prey item observed in walleye samples.

During 2011, we evaluated 326 and 288 northern pikeminnow diet samples collected during angling at The Dalles and John Day dams, respectively. We found fish to be the primary prey type consumed at The Dalles dam; however, other invertebrates were the primary prey type consumed at John Day Dam. Salmon and lamprey made up the highest percentage of prey fish species consumed by northern pikeminnow.

At this time, a predator response to the NPMP in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir does not seem apparent. However, because responses to fisheries management programs may not be detected for several years, we recommend continued monitoring of predator populations in the Columbia River.

INTRODUCTION

The Columbia and Snake rivers once supported large numbers of anadromous salmonids *Oncorhynchus* spp. Declines in adult returns have been attributed to many factors, including habitat degradation and overexploitation (Nehlsen et al. 1991; Wismar et al. 1994), hydroelectric and flood control activities during the 1970's (Raymond 1988), and predation (Rieman et al. 1991; Collis et al. 2002). The mean annual loss of juvenile salmonids to predators can be equivalent to mortality associated with dam passage (Rieman et al. 1991), which historically could approach 30% at a single dam (Long and Ossiander 1974). The Northern Pikeminnow Management Program (NPMP) is a set of targeted fisheries aimed at reducing predation on juvenile salmonids by northern pikeminnow *Ptychocheilus oregonensis* in the lower Columbia and Snake rivers (Rieman and Beamesderfer 1990; Beamesderfer et al. 1996). The Oregon Department of Fish and Wildlife (ODFW) quantified baseline levels of predation and northern pikeminnow population characteristics prior to the implementation of the northern pikeminnow fisheries. Abundance, consumption, and predation were estimated 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). We continue to sample northern pikeminnow populations in standardized areas, and to compare results among years when sample sizes are adequate to avoid biasing estimates (Zimmerman and Ward 1999; Zimmerman et al. 2000; Takata et al. 2007). This report describes our activities and findings for 2011, and wherever possible, evaluates changes from previous years.

Our objectives in 2011 were to 1) evaluate northern pikeminnow exploitation, potential predation, and tag loss, 2) define population parameters of northern pikeminnow, smallmouth bass and walleye in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir, and 3) assess evidence of possible compensatory responses by these predators in response to the sustained removal of northern pikeminnow.

METHODS

Fishery Evaluation, Predation Estimates, and Tag Loss

Field Procedures—We collected northern pikeminnow for tagging using electrofishing boats in the Columbia River from rkm 76 (near Clatskanie, Oregon) upstream to rkm 639 (Priest Rapids Dam), and in the Snake River from rkm 112 (Little Goose Dam) to rkm 248 (Figure 1). To balance our system-wide tagging effort, we used four 15-minute electrofishing periods per river mile (1.6 river kilometers). We were unable to cover every river kilometer prior to the fisheries

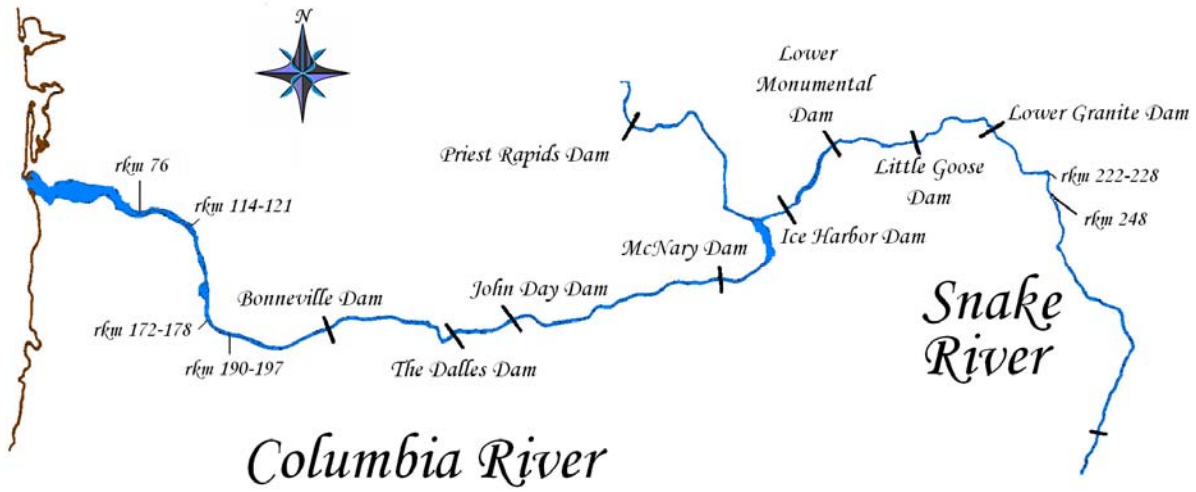

Figure 1. The lower Columbia and Snake rivers.

opener. Fish were tagged in the area below The Dalles Dam (rkm 306) before the beginning of the fisheries. Fish were tagged upstream of rkm 306 concurrent with the fisheries. Sampling was conducted between 1 April and 24 June between the hours of 1800 and 0200, except in the Hanford Reach, rkm 572–658 where river navigation necessitated daytime sampling.

We tagged and released northern pikeminnow ≥ 200 mm FL with uniquely numbered Floy FT-4 lock-on loop tags to estimate annual exploitation rates. Tags were inserted posteriolaterally of the dorsal fin through the sub-dermal rays. To evaluate tag retention, we injected a passive integrated transponder (PIT) tag into the dorsal sinus of all loop tagged fish.

We worked in cooperation with Washington Department of Fish and Wildlife (WDFW) to acquire tag recovery information from the sport-reward and dam-angling fisheries. The sport-reward fishery occurred from 1 May to 15 October, 2011, during which participating anglers received payment for all harvested northern pikeminnow ≥ 230 mm (9 inches) in total length (TL). This size limit corresponds to the minimum size (200 mm FL) of northern pikeminnow we tagged. The payment schedule consisted of three tiers (Porter 2012, this report), and anglers were eligible for a $500 reward for each loop-tagged fish turned in at a participating station.

In addition to the Sport Reward Fishery, an NPMP-administered dam-angling fishery (Report D, this document) that occurred from 10–12 May and 22 June –16 August and was confined to the downstream areas directly accessible from The Dalles and John Day dams. For this effort, a

team of anglers caught by hook and line and removed northern pikeminnow ≥230 mm TL (9 inches), but were ineligible for rewards available under the public fishery payment schedule.

Data Analysis—We estimated the proportion of the northern pikeminnow population removed during program fisheries using mark-and-recapture data from the entire area fished (system-wide) and for continuous zones separated by dams (area-specific). We accounted for the change in minimum length of northern pikeminnow eligible for sport-reward payment being reduced from 11 inches (≥278 mm TL; equivalent ≥250 mm FL) to 9 inches TL (≥230 mm TL; equivalent ≥200 mm FL) in 2000, by calculating exploitation rates for 1) all fish tagged (≥200 mm FL); 2) the subset of fish from 200 to 249 mm FL; and 3) the subset of fish ≥ 250 mm FL. We used the subset of fish ≥ 250 mm FL whenever comparing trends among years. In areas where tagging was completed prior to the start of the fishery, we calculated the annual rate of exploitation, u, of the population using the Petersen method (Ricker 1975) as

$$u = R / M, \tag{1}$$

where

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

We calculated 95% confidence intervals for exploitation estimates when $R > 3$ using the formula

$$u \pm \frac{z\sqrt{R}}{M}, \tag{2}$$

where

z = the multiplier from the standard normal distribution,

We also used a multiple sample approach to compute system-wide exploitation rates to account for tagging and fishing that occurred concurrently (Styer 2003). Weekly estimates of exploitation were calculated by dividing the number of tagged northern pikeminnow recovered by the number of tagged fish at-large. We summed weekly rates to estimate system-wide exploitation for the season (Styer 2003). Appendix Table A-1 shows sampling weeks used in 2011. For areas where four tags or more were recovered we calculated 95% confidence intervals for each estimate using the formula

$$u \pm t\sqrt{ks}, \tag{3}$$

where

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).

We did not calculate exploitation when the number of recaptures was less than four (Styer 2003). We adjusted exploitation estimates and confidence intervals for tag loss. An estimate of the annual tag loss rate, L, was calculated using the formula

$$L = [m / (m + r)] , \quad (4)$$

where

m = the number of northern pikeminnow recaptured with a PIT tag from the 2011 season and no loop tag, and
r = the number of northern pikeminnow recaptured with 2011 loop tags intact.

We used a model based on Friesen and Ward (1999) to estimate predation on juvenile salmonids relative to predation before the implementation of the NPMP. The model estimates potential predation reduction from preprogram conditions using the parameters 1) population structure before removals by fisheries, 2) consumption of juvenile salmonids by northern pikeminnow, 3) fish length, 4) size-specific exploitation rates, and 5) annual mortality. We used a 10-year average age structure (based on catch curves) for a pre-exploitation base, and assumed constant recruitment. The model has been updated to include fork length increments derived from annual mark-recapture growth observations rather than growth estimates obtained from length and age data. Given these inputs, the model predicts changes in potential predation that were directly related to removals, provided that all other variables held constant. We estimated the potential predation during 2011 based on observed exploitation rates and predicted future predation rates using a mean level of exploitation observed during current program rules (2001; 2004–2011). See Friesen and Ward (1999) for additional model documentation.

Biological Evaluation

Field Procedures—We used standardized electrofishing techniques described in Ward et al. (1995) and Zimmerman and Ward (1999) to evaluate northern pikeminnow, smallmouth bass, and walleye populations in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir during 2011. We conducted early morning (0200–1200) sampling during spring (10–27 May) and summer (27 June–15 July) in three areas of Bonneville Reservoir (forebay, rkm 223-238; mid-reservoir, rkm 227–283; The Dalles Dam tailrace, rkm 299–306), and in four areas below Bonneville Dam (rkm 114–121, rkm 172–178, rkm 190–197, and Bonneville Dam tailrace, rkm 224–232). Each area contained 24 transects approximately 500 m long that occurred along both shores of the river. Effort at each transect consisted of a 15-min electrofishing period with continuous output of approximately 4 amperes.

We also sampled the northern pikeminnow collected during the dam angling portion of this project (Winther et al. 2012, this report). We sampled the dam anglers' catch once or twice a week throughout the season 10–12 May and 22 June–16 August; dam angling was halted from mid-May to mid-June due to the unusually high flow conditions. During the fishery, we selected sampling days randomly and distributed them at each dam equally.

We recorded catch and biological data for all northern pikeminnow, smallmouth bass, and walleye collected during sampling. We measured fork length (nearest mm) on all fish captured and total body weight (nearest 10 g) for fish ≥ 200 mm FL. We removed scales from 25 fish per 25 mm FL size increment by species in each reservoir sampled. We sacrificed all untagged northern pikeminnow ≥ 200 mm FL to collect and preserve digestive tracts for diet analysis. We removed the digestive tract by securing both ends with hemostats and pulling free the connective tissue. We removed all external tissues prior to placing the digestive tract into a Whirl-pak bag for storage. Whenever possible, we noted gender and stage of maturity for each sacrificed fish. Stomach contents from smallmouth bass and walleye ≥ 200 mm FL were collected using a modified Seaburg sampler (Seaburg 1957), which used a jet of water to flush contents from the foregut of the fish (gastric lavage) without sacrificing the animal. We collected the contents in a 200 μm meshed container prior to transferring it to a Whirl-pak bag. All bags were kept on ice while in the field, and stored in a freezer prior to analysis in a laboratory.

Laboratory Procedures.—We examined digestive tract contents of northern pikeminnow, smallmouth bass, and walleye to measure relative consumption rates of juvenile salmonids. Each digestive sample was thawed in the laboratory and the contents sorted into trays by prey category. Stomach contents were weighed to the nearest 0.01 g before being returned to the original Whirl-pak bag for chemical digestion of the soft tissues. We added a solution of lukewarm tap water, pancreatin (2% wet weight; 8 X porcine digestive enzyme), and sodium sulfide nonahydrate (1% wet weight) to each bag. Bags were sealed and placed in a desiccating oven at approximately 48°C for 24 h. After removal from the oven, a solution of tap water and sodium hydroxide (3% wet weight) was added to the bag to dissolve any remaining fats. The contents that remained in the bag were poured into a 425 μm sieve and rinsed with tap water. The remaining bones were identified to the lowest possible taxon (Hansel et al. 1988, Frost 2000, and Parrish et al. 2006) using a dissecting microscope.

We randomly selected 10 scale samples from each 25mm scale group to be aged for northern pikeminnow and smallmouth bass. Scale samples were sorted by species and assigned to scale cards for cleaning and mounting. Northern pikeminnow scales were not sorted with regard to size, while smallmouth bass scales were grouped with similarly sized scales to obtain good impressions. Scales were cleaned under a dissecting microscope by submerging them in water and brushing away any tissue using an interdental brush. Once the scales were sufficiently cleaned they were mounted on a gummed scale card. A clear acetate sheet was placed over the scale card and pressed in a heated hydraulic press to transfer scale impressions to the acetate. Scale impressions were independently viewed through a microfiche reader by two trained technicians. Ages were assigned by counting the number of annuli present on each scale. In cases where the readers assigned differing ages, they worked together to agree on a final age assignment. Aging occurred according to the standard methods described by DeVries and Frie (1996). Once ages were assigned, we calculated the percentage of age 3–5 northern pikeminnow and age 4–5 smallmouth bass that were in our samples.

Data Analysis.—We used catch per unit of effort (CPUE) and area-specific surface areas to calculate predator abundance indices (Ward et al. 1995). We used the following formulas from Ward et al. (1995) to calculate consumption indices for northern pikeminnow (CI_{NPM}) and smallmouth bass (CI_{SMB}; Ward and Zimmerman 1999)

$$CI_{\mathrm{NPM}} = 0.0209 \cdot T^{1.60} \cdot W^{0.27} \cdot (S \cdot GW^{-0.61}), \quad (6)$$

and

$$CI_{\mathrm{SMB}} = 0.0407 \cdot e^{(0.15)(T)} \cdot W^{0.23} \cdot (S \cdot GW^{-0.29}), \quad (7)$$

where

T = water temperature (^{o}C),
W = mean predator weight (g),
S = mean number of salmonids per predator, and
GW = mean gut weight (g) per predator.

The consumption index is not a direct estimate of the number of juvenile salmonids eaten per day by an average predator; however, it is linearly related to the consumption rate of northern pikeminnow (Ward et al. 1995) and smallmouth bass (Ward and Zimmerman 1999).

We used the product of annual abundance and seasonal consumption indices to generate predation indices for northern pikeminnow during spring and summer periods. Ward and Zimmerman (1999) observed that smallmouth bass densities varied seasonally in the Columbia and Snake rivers; therefore, we calculated predation indices for smallmouth bass using seasonal abundance and consumption indices.

To evaluate age structure, we compared the frequency percentage by age and size of northern pikeminnow and smallmouth bass collected in 2011 to previous years. To address differential vulnerability to the electrofisher associated with northern pikeminnow size, as well as inter-annual variation in exploitation rates (Friesen and Ward 1999), we limited our comparisons to abundance of northern pikeminnow large enough to be effectively sampled and small enough to be excluded from the NPMP (ages 3–5). Based on electrofishing catch curves for smallmouth bass and walleye (ODFW, unpublished data), we limited our comparisons for those species to ages 4–5 and ages 5–6, respectively.

Northern pikeminnow exploitation rates are believed to be greater for larger fish than for smaller fish (Zimmerman et al. 1995); therefore, sustained fisheries should decrease the abundance of large fish relative to the abundance of smaller fish. We used proportional stock density (Anderson 1980) to compare the size structure of northern pikeminnow, smallmouth bass, and walleye populations among years. Proportional stock density, PSD_i, was calculated using the formula

$$PSD_i = 100 \cdot (FQ_i / FS_i), \quad (8)$$

where

FQ_i = number of fish ≥ quality length for species i, and
FS_i = number of fish ≥ stock length for species i.

In addition to calculating proportional stock densities for all three species, we also calculated relative stock densities, *RSD-P,* for smallmouth bass and walleye (Gabelhouse 1984) using the formula

$$RSD\text{-}P = 100 \cdot (FP_i / FS_i), \quad (9)$$

where

FP_i = number of fish ≥ preferred length, and
FS_i = number of fish ≥ stock length.

Stock and quality minimum length categories used for northern pikeminnow were 250 and 380 mm FL, respectively (Beamesderfer and Rieman 1988; Parker et al. 1995). Stock, quality, and preferred minimum length categories for smallmouth bass were 180 mm, 280 mm, and 350 mm TL, respectively. For walleye, stock, quality, and preferred minimum length categories were 250 mm, 380 mm, and 510 mm TL, respectively (Willis et al. 1985). We converted fork length to total length for smallmouth bass and walleye to conform to the established standards for each species. The conversion for smallmouth was $TL_{SMB} = FL_{SMB} \cdot 1.040$, and the conversion for walleye was $TL_{WAL} = FL_{WAL} \cdot 1.060$.

Beyond a shifting size structure, changes in body condition may indicate a response by remaining predators to the sustained exploitation of pikeminnow. We used relative weight (W_r; Anderson and Neumann 1996) to compare the condition of northern pikeminnow, smallmouth bass, and walleye in 2010 with previous years. We used the length-specific standard weight — predicted by a weight–length regression [$\log_{10}(W_s) = a' + b \cdot \log_{10}(L)$] — for northern pikeminnow (Parker et al. 1995), smallmouth bass (Kolander et al. 1993), and walleye (Murphy et al. 1990) to calculate percent relative weight [$W_r = 100 \cdot (W/W_s)$]. We calculated median W_r for male and female northern pikeminnow and all smallmouth bass and walleye, which were not sexed.

RESULTS

Fishery Evaluation, Predation Estimates, and Tag Loss

We tagged and released 682 northern pikeminnow ≥ 200 mm FL throughout the lower Columbia and Snake rivers during 2011, of which 450 were ≥ 250 mm FL (Table 1). Removal fisheries harvested 159,838 northern pikeminnow ≥ 200 mm during 2011 (Winther et al. 2012, this report). The sport-reward fishery harvested 155,312 of these fish and the dam-angling fishery removed 4,526. The sport-reward fishery recaptured 72 northern pikeminnow tagged in 2011; two were recovered by dam anglers. Fish tagged in 2011 that were subsequently recaptured in the sport reward fishery were at-large from zero to 170 days (average of 71 days). Eighty-two percent of Sport-reward fishery recaptures were ≥ 250 mm FL (Table 1), whereas 54.8% of the total measured harvest (tagged and untagged) consisted of northern pikeminnow ≥ 250 mm FL. The median fork length of the total fishery catch was 256 mm (J. Hone, WDFW, pers. comm.). Two of the northern pikeminnow tagged (PIT tag and spaghetti tag) and recaptured in the 2011 sport-reward fishery had a PIT tag present and loop tag absent. Exploitation was adjusted to reflect an estimated tag loss of 2.7%.

Table 1. Number of northern pikeminnow tagged and recaptured in the sport-reward fishery during 2011 that were used to calculate exploitation rates.

	200–249 mm FL		≥ 250 mm FL		All combined	
Area	Tagged	Recaptured	Tagged	Recaptured	Tagged	Recaptured
Below Bonneville Dam	23	4	184	26	207	30
Bonneville	27	1	109	11	136	12
The Dalles	8	0	16	0	24	0
John Day	5	0	5	1	10	1
McNary	60	6	90	14	150	20
Little Goose	81	1	9	1	90	2
Lower Granite	28	1	37	2	65	3
All areas combined	232	13	450	59*	682	72*

* Recapture combined totals include tagged fish recovered in a different area than they were released which are removed for reservoir specific exploitation calculations, but are included in system wide exploitation calculations.

System-wide exploitation of northern pikeminnow ≥ 200 mm FL by the sport-reward fishery was 13.5% (95% confidence interval 9.0–18.0%; Appendix Tables B-1 and B-2). Tag returns were adequate for area-specific exploitation rate estimation (N>3) in the reaches downstream of Bonneville Dam, Bonneville Reservoir, and McNary Reservoir. Estimates for these areas were 14.9, 9.1 and 14.7%, respectively (≥200 mm, Appendix B-2).

The system-wide exploitation rate of northern pikeminnow 200–249 mm FL was 9.8% for the sport-reward fishery (95% confidence interval 1.8–17.7%; Appendix Table B-2). Reaches downstream of Bonneville Dam and McNary reservoirs had sufficient tag recoveries to calculate area-specific exploitation rates with 2011 exploitation rate of 17.9% (95% confidence interval 0.6–35.2%) and 11.0% (95% confidence interval 1.2–20.8%), respectively (Appendix Tables B-1 and B-2).

For northern pikeminnow ≥ 250 mm FL, system-wide exploitation was 15.6% (95% confidence interval 10.2–21.0%; Figure 2, Appendix Table B-2). Within the three areas that had greater than 3 recaptures, we estimated exploitation rates to be 14.5% (95% confidence interval 9.0–20.0%) below Bonneville Dam, 10.4% (95% confidence interval 4.3–16.4%) in Bonneville Reservoir, and 17.8% (95% confidence interval 6.7–28.9%) in McNary Reservoir (Appendix Table B-2). Tag returns were insufficient for producing area-specific estimates for ≥250 mm fish elsewhere.

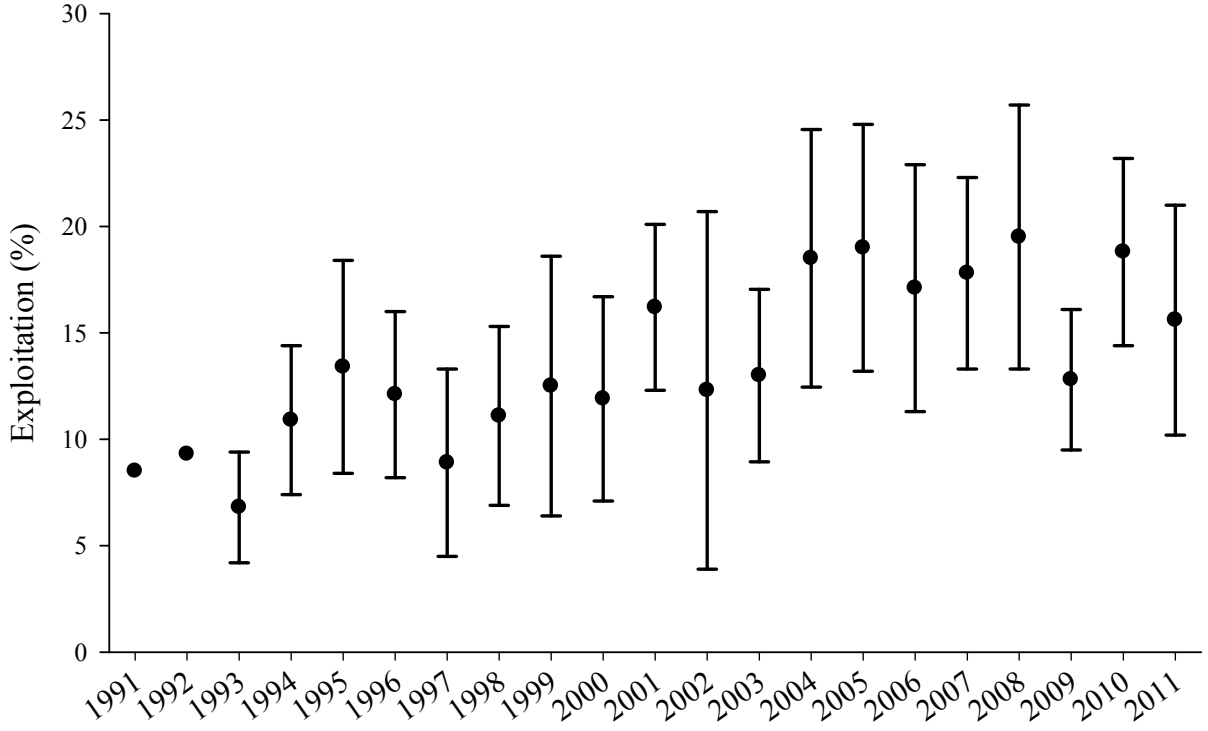

Figure 2. System-wide exploitation rates of northern pikeminnow ≥250 mm fork length for the sport-reward fishery, 1991–2011. Error bars denote the 95% confidence interval. Confidence intervals were not available for 1991–1992.

Based on our 2011 estimate of exploitation, our predation model predicted a 36% (range: 21–53%) reduction in northern pikeminnow consumption of juvenile salmonids relative to pre-program levels (Figure 3). Projections based on the current fishery and population structure imply predation by northern pikeminnow may remain static through 2015.

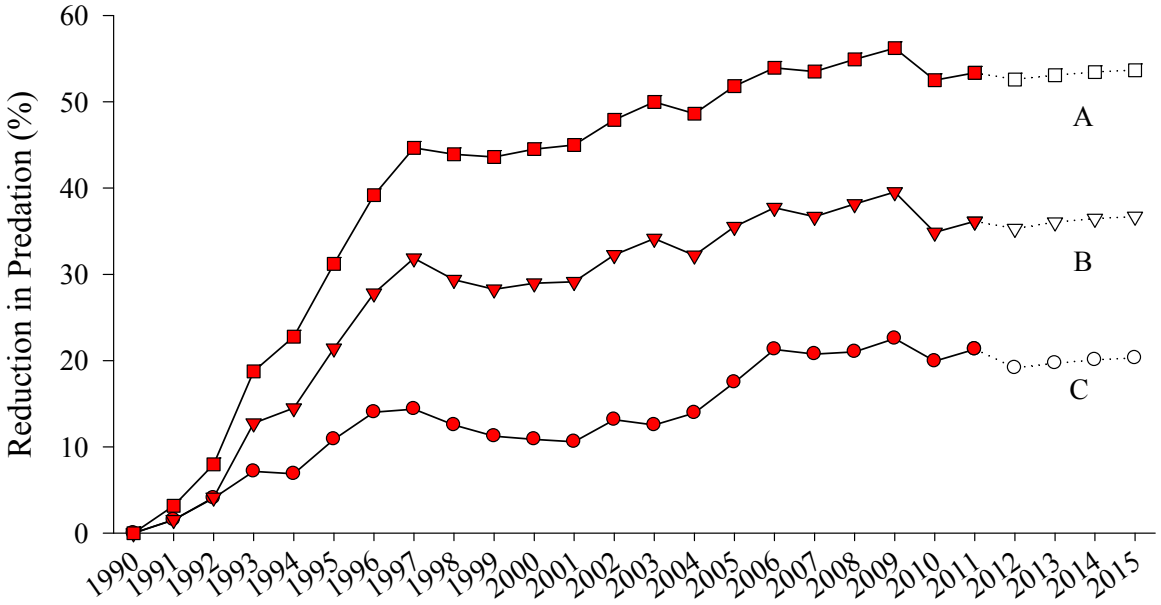

Figure 3. Maximum (A), median (B), and minimum (C) estimates of predation reduction by northern pikeminnow on juvenile salmonids relative to predation prior to implementation of the Northern Pikeminnow Management Program. Estimates of predicted predation after 2011 are based on 9-year average values.

Biological Evaluation

We conducted 38 to 96 electrofishing runs in each sampling area to collect fish for biological evaluation (Appendix Table A-2). Across all lower Columbia River sample sites, spring CPUE (fish per 900 s electrofishing run) ranged from 0.17 to 0.61 for northern pikeminnow, 0.00 to 2.53 for smallmouth bass, and 0.00 to 0.53 for walleye (Table 2). Summer CPUE ranged from 0.08 to 2.19 for northern pikeminnow, 0.04 to 3.78 for smallmouth bass, and 0.00 to 0.17 for walleye. Across areas, catch rates for northern pikeminnow were the greatest in the Bonneville Dam tailrace during both sampling periods. For smallmouth bass, CPUE was the highest in the mid-reservoir and tailrace of Bonneville Reservoir (i.e., The Dalles Dam tailrace) with higher CPUE occurring in summer than spring. Walleye CPUE was highest in the Bonneville Reservoir tailrace during spring.

Abundance indices calculated for northern pikeminnow during 2011 ranged between 0.0 and 5.0 below Bonneville Dam, and between 0.2 and 2.0 in Bonneville Reservoir (Appendix Table C-1). When expressed relative to site-specific pikeminnow-habitable area estimates (Ward et al. 1995), annual northern pikeminnow abundance indices were generally greater in the reaches downstream of Bonneville Dam than in Bonneville Reservoir. Across sites, abundance indices continue to remain lower than those calculated during the early 1990's, which have shown a decreasing trend over time (Figure 4).

Table 2. Catch per 15-minute electrofishing run (CPUE) for northern pikeminnow (≥250 mm FL), smallmouth bass (≥200 mm FL), and walleye (≥200 mm FL) that were captured during indexing in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir during spring and summer 2011 by area and river reach.

	Downstream of Bonneville Dam				Bonneville Reservoir		
Species, Season	rkm 114 to 121	rkm 172 to 178	rkm 190 to 197	Tailrace	Forebay	Middle	Tailrace
Northern pikeminnow,							
Spring	0.42	0.33	0.29	0.61	0.17	0.40	0.38
Summer	0.13	0.08	0.46	2.19	0.21	0.15	0.53
Smallmouth bass,							
Spring	0.00	0.67	0.00	0.28	0.43	2.40	2.53
Summer	0.04	0.71	0.58	0.81	1.66	3.13	3.78
Walleye,							
Spring	0.00	0.08	0.07	0.17	0.00	0.04	0.53
Summer	0.00	0.04	0.17	0.14	0.00	0.04	0.03

In 2011, smallmouth bass abundance indices were greatest in the reach from rkm 172 to 178 downstream of Bonneville Dam and in the mid-Bonneville Reservoir during spring and summer (Appendix Table C-2). Abundance indices ranged from zero to 22.5 during both spring and summer sampling.

Walleye were not captured in all reaches during 2011(Appendix Table C-3). Abundance indices in 2011 ranged from zero to 2.1 during both spring and summer sampling. These values are on par with values seen across the period of record to date for all areas and remain below the greatest abundance index quantified thus far (4.4, for the rkm 172–178 in spring of 1992).

To quantify consumption, we examined 446 northern pikeminnow digestive tracts from Bonneville Reservoir and the Columbia River downstream of Bonneville Dam. Fifty-one percent of these contained food items (e.g., crayfish, insects, and fish), and across seasons, twelve percent of these samples contained fish; 7% contained remains that were identified as salmonid (*Oncorhynchus* sp.). The proportion of northern pikeminnow and smallmouth bass digestive tracts containing salmonids was greatest in the Bonneville Dam tailrace during the spring sample period (Table 3). The proportion of walleye digestive tracts containing salmonids was greatest in the reach downstream of Bonneville Dam and the Bonneville Dam tailrace during the spring sampling period.

When prey fish could be identified, Salmonidae was the most common fish family identified in northern pikeminnow and walleye samples (Table 4). Cottidae was the most common fish family identified in small mouth bass samples.

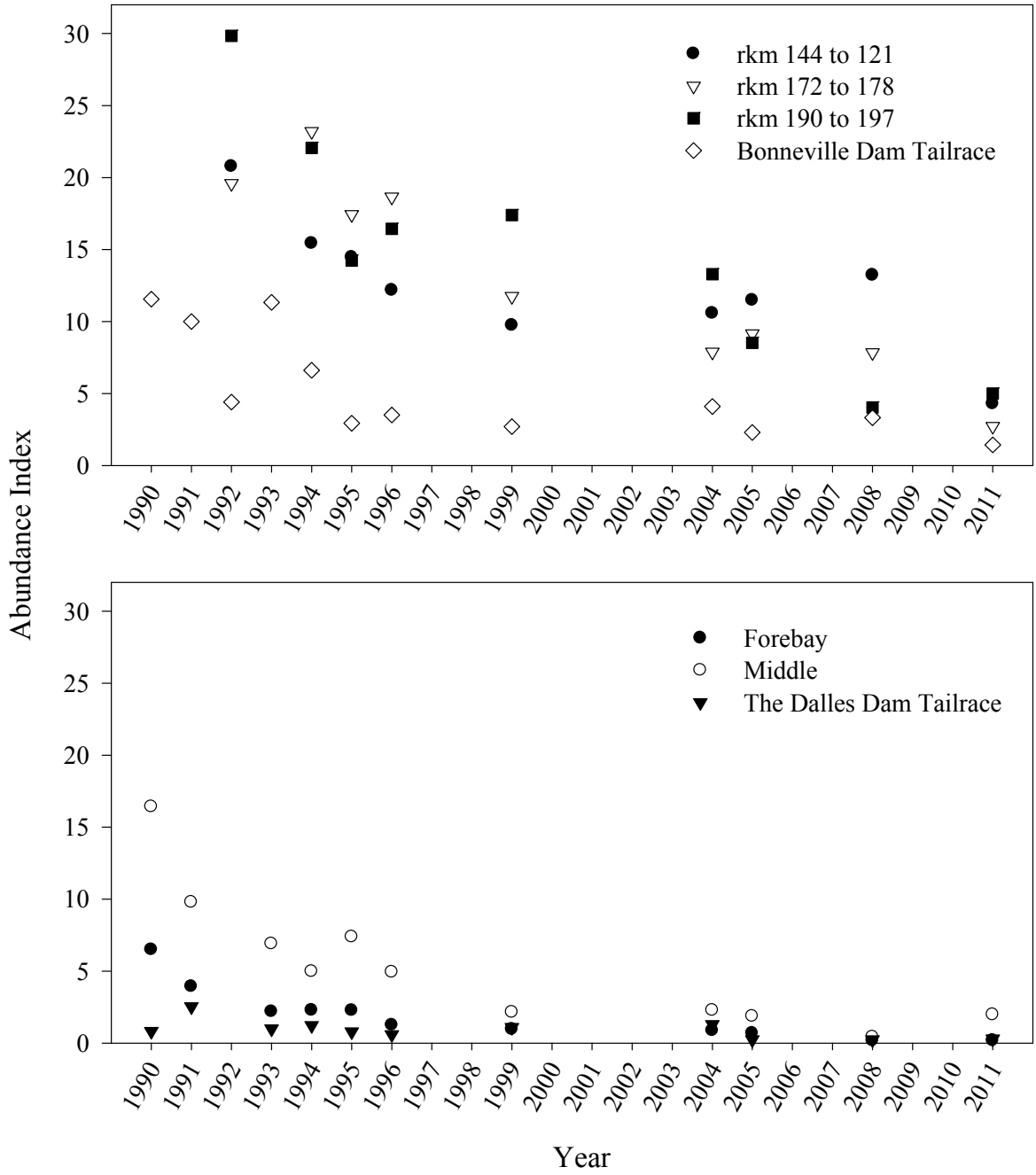

Figure 4. Abundance indices for northern pikeminnow for (a) the Columbia River downstream of Bonneville Dam and (b) Bonneville Reservoir, 1990–2011.

Table 3. Number (*N*) of northern pikeminnow, smallmouth bass, and walleye digestive tracts examined from the lower Columbia River downstream of Bonneville Dam (BBD), Bonneville Dam Tailrace (BDT), Bonneville Reservoir (BON), and all three areas combined (ALL) in 2011, and percent that contained food (i.e., non-empty), fish, and salmonid remains (Sal).

Season,	Northern pikeminnow				Smallmouth bass				Walleye			
Area	*N*	% Food	% Fish	% Sal	*N*	% Food	% Fish	% Sal	*N*	% Food	% Fish	% Sal
Spring,												
BBD	25	68	52	28	16	88	25	6	3	100	67	67
BDT	25	56	48	44	10	70	30	10	6	83	83	67
BON	113	37	6	2	211	85	19	5	18	67	16	11
ALL	163	45	20	12	237	85	20	5	27	74	36	29
Summer,												
BBD	19	79	32	16	32	81	31	9	5	100	100	60
BDT	101	54	13	6	29	79	38	7	5	100	100	20
BON	163	51	3	1	329	93	16	3	3	67	33	33
ALL	283	54	8	4	390	91	19	4	13	92	77	38

Table 4. Percent frequency of occurrence of prey fish families consumed by northern pikeminnow, smallmouth bass, and walleye in the lower Columbia River in 2011 (only includes samples containing identifiable fish). BBD = below Bonneville Dam, BON = Bonneville Reservoir. Some samples contained multiple families.

	Northern pikeminnow		Smallmouth bass		Walleye	
Family	BBD	BON	BBD	BON	BBD	BON
Clupeidae	2	0	0	0	0	0
Cobitidae	2	0	0	0	0	0
Cottidae	20	8	46	61	12	0
Cyprinidae	7	0	7	1	35	25
Gasterosteidae	7	0	21	6	6	0
Petromyzontidae	7	33	0	2	0	0
Salmonidae	64	33	25	18	59	75
Other	2	25	7	14	0	0

We also examined 627 smallmouth bass stomach samples, 89% of which contained food, 20% of which contained fish, and 4% of which contained salmonid remains (seasons combined). The proportion of smallmouth bass stomach samples containing salmonids was the greatest downstream of the Bonneville Dam tailrace during spring (Table 3). Overall, however, cottids were the most frequently found prey fish (Table 4).

We collected 27 stomach samples from walleye during spring and 13 during summer (Table 3). Eighty percent of the walleye samples contained food, 53% had fish remains, and 33% contained salmonids. Salmonids were the most frequently occurring prey species followed by cyprinids (Table 4).

In 2011, consumption indices for northern pikeminnow were highest in the Bonneville Dam tailrace during spring and in The Dalles Dam tailrace during summer (Appendix Table C-4). Consumption indices ranged from zero to 0.84 across all areas and seasons. Northern pikeminnow predation indices ranged from zero to 2.4. The greatest predation index value was observed in the lowest reach downstream of Bonneville dam during spring (Appendix Table C-5). Predation indices in 2011 are among the lowest observed across all reaches and seasons for the 21-year period of record.

Consumption indices for smallmouth bass ranged from zero to 0.44 in 2011 (Appendix Table C-6). The highest smallmouth bass consumption index was observed at the rkm 172–178 site (downstream of Bonneville Dam) during summer. Within Bonneville Reservoir, consumption indices were not appreciably different among seasons but were highest in the forebay site. Smallmouth bass predation indices ranged from zero to 0.73 during spring, and zero to 3.95 during summer (Appendix Table C-7). Predation indices were the greatest in the mid-reservoir area of Bonneville Reservoir and in the rkm 172–178 site reach during both seasons. Summer predation indices were lower in 2011 than they were during the most recent sampling period (2008), and within the range observed in prior years.

We examined the diets of northern pikeminnow collected during the dam angling portion of this project (Winther et al. 2012, this report) from 2006 to 2011. We collected a total of 3,055 northern pikeminnow digestive tracts from fish removed during the dam angling fishery. These fish ranged in size from 185 to 575 mm FL and had an average length of 368 mm FL (Appendix Table D-1). Sample origin has typically been split evenly between The Dalles and John Day dams, with the exception of John Day Dam in 2008, where catch rates were lower. The percent of samples with food ranged from 36% to 82% (Appendix Table D-2), fish were the most common prey observed in diets over the period of record. Among fish, lamprey were often the most frequently consumed taxon. Salmonids were also an important prey item, with the percent of samples containing salmon ranging from 4% to 36% across the period of record. During 2011, salmonids proved to be the primary prey fish during each month except for May (June through August; Appendix Table D-3). Lamprey were the most prevalent fish family observed in May and second most common during June through August.

In 2011, we aged 147 northern pikeminnow from below Bonneville Dam and 97 from Bonneville Reservoir. In both the areas, the percentage of age-3 fish in our aged sample was higher than in previous years, particularly in Bonneville Reservoir where age-3 made up nearly

40% of the sample total (Figure 5). The percentages of age 4 and 5 northern pikeminnow in our sample were similar to observations from previous years.

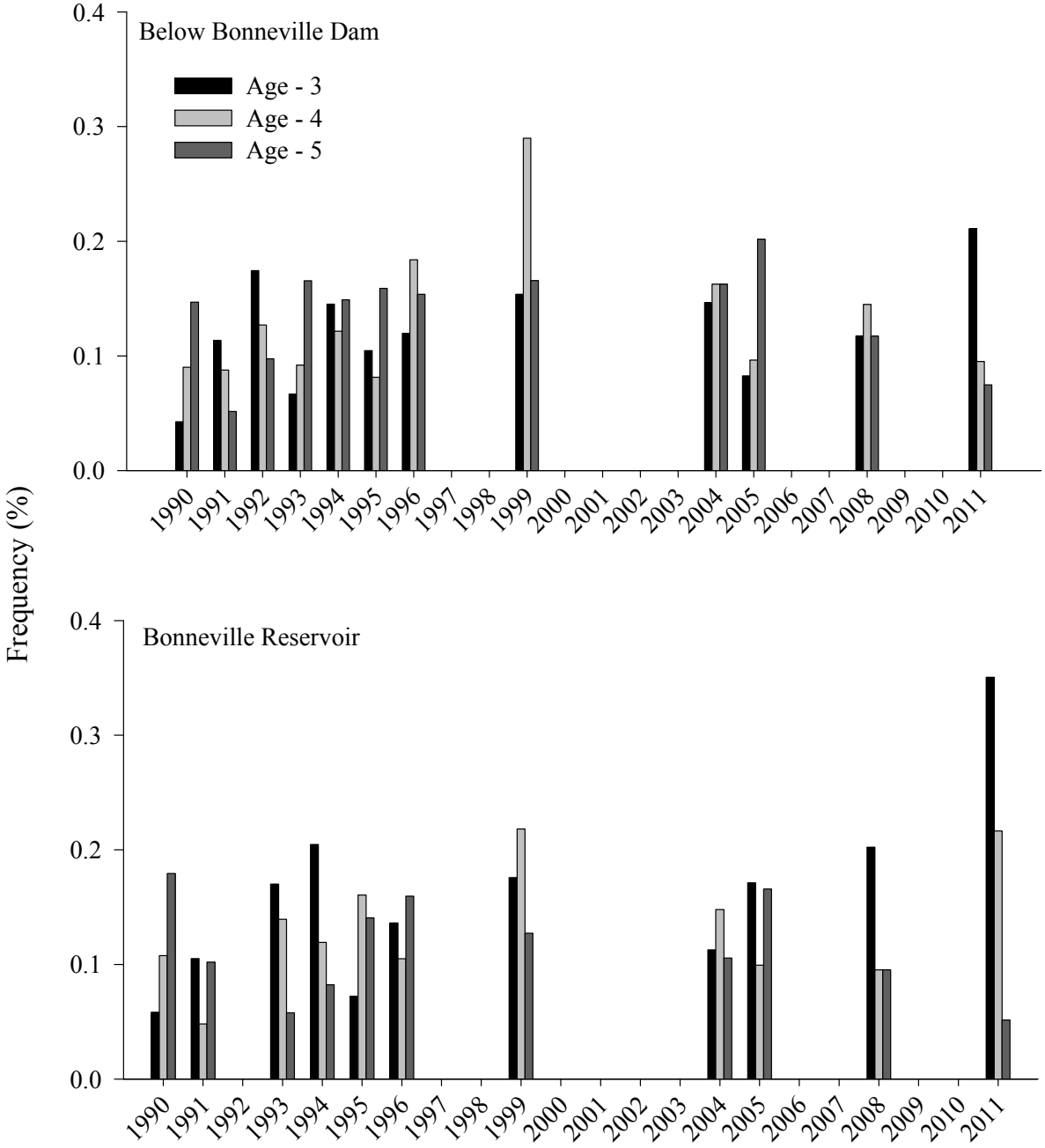

Figure 5. Percent composition of age 3–5 northern pikeminnow in samples collected in the Columbia River below Bonneville Dam and Bonneville Reservoir for sampling years between 1991 and 2011. Years with blanks indicate either no sampling.

For smallmouth bass, we aged 98 fish from the area below Bonneville Dam and 156 fish from Bonneville Reservoir. In the area below Bonneville Dam, the percentage of age-4 smallmouth

bass in our aged sample continued to suggest a positive trend for this group, while the percentage of age-5 bass was similar to what has been observed in previous years (Figure 6). The percent of age 4 and 5 bass from Bonneville Reservoir was similar to samples collected in previous years.

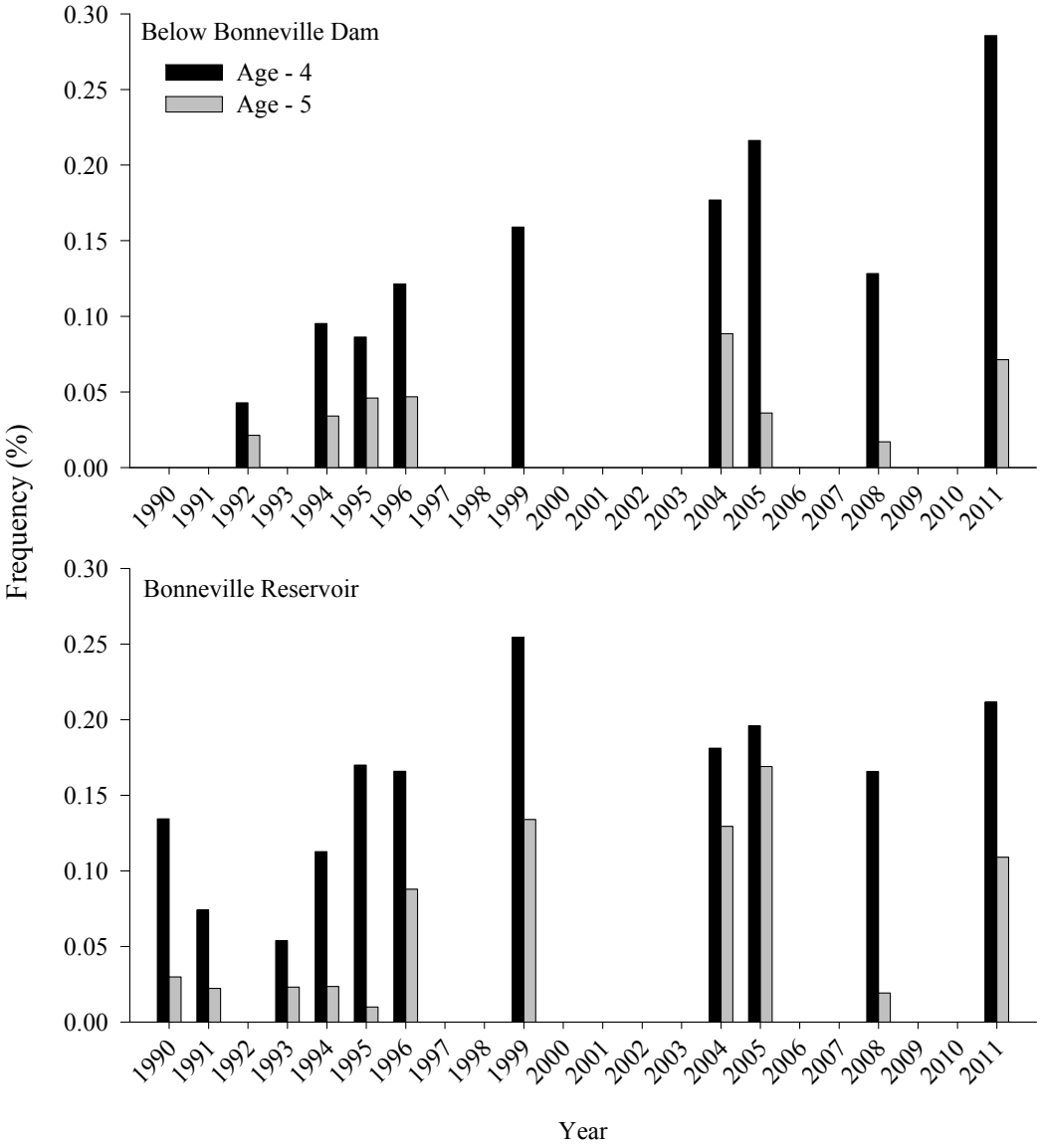

Figure 6. Percent composition of age 4–5 smallmouth bass, relative to the total sample, in the Columbia River below Bonneville Dam and Bonneville Reservoirs for sampling years between 1991 and 2011. Years with blanks indicate either no sampling.

Proportional stock density for northern pikeminnow was estimated to be 68 downstream of Bonneville Dam, and 20 in Bonneville Reservoir (Appendix Table C-8). The PSD observed downstream of Bonneville Dam in 2011 was the highest for the period of record whereas that for Bonneville Reservoir was the second lowest. No clear trend in PSD exists for either area.

For smallmouth bass, PSD was 31 downstream of Bonneville Dam and 48 in Bonneville Reservoir (Appendix Table C-8). PSD in 2011 was higher than the previous sampling year (2008) both upstream and downstream of Bonneville Dam, and within the range observed for the period of record. Smallmouth bass RSD-P was 3 and 22 in the area downstream of Bonneville Dam and in Bonneville Reservoir, respectively (Appendix Table C-8).

During 2011, too few walleye were caught below Bonneville Dam to reliably estimate PSD and RSD-P. However, we capture enough walleye to reliably estimate these parameters for the first time since we began indexing in the Bonneville Reservoir. The estimate for PSD and RSD-P were 86 and 41, respectively (Appendix Table C-8).

Median W_r for male northern pikeminnow during 2011 was 103 downstream of Bonneville Dam and 101 in Bonneville Reservoir (Appendix Table C-9). These values are among the highest measured since the first sampling occurred in 1990 (Figure 7). Median W_r for female northern pikeminnow was estimated at 111 downstream of Bonneville Dam and 97 in Bonneville Reservoir (Appendix Table C-9), both of which fall within the range of values observed in past years (Figure 7). With the exception of males below Bonneville Dam, there is no clear evidence of a temporal trend in in W_r across sexes/sites. Recent patterns (since mid-1990s) in W_r for the former fish, however, are suggestive of a positive trend worthy of future examination.

Median W_r for smallmouth bass ranged from 87 to 107 downstream of Bonneville Dam and from 89 to 100 in Bonneville Reservoir since 1990 (Appendix Table C-9). 2011 point estimates for both areas are similar to the average for all years (Figure 8).

Median W_r for walleye ranged from 81 to 95 downstream of Bonneville Dam and from 84 to 109 in Bonneville Reservoir since 1990 (Appendix Table C-9). These point estimates of W_r for 2011 are similar to estimates observed in prior years (Figure 8). However, owing to the limited walleye catch for this and past years, W_r estimates for this species continue to be imprecise.

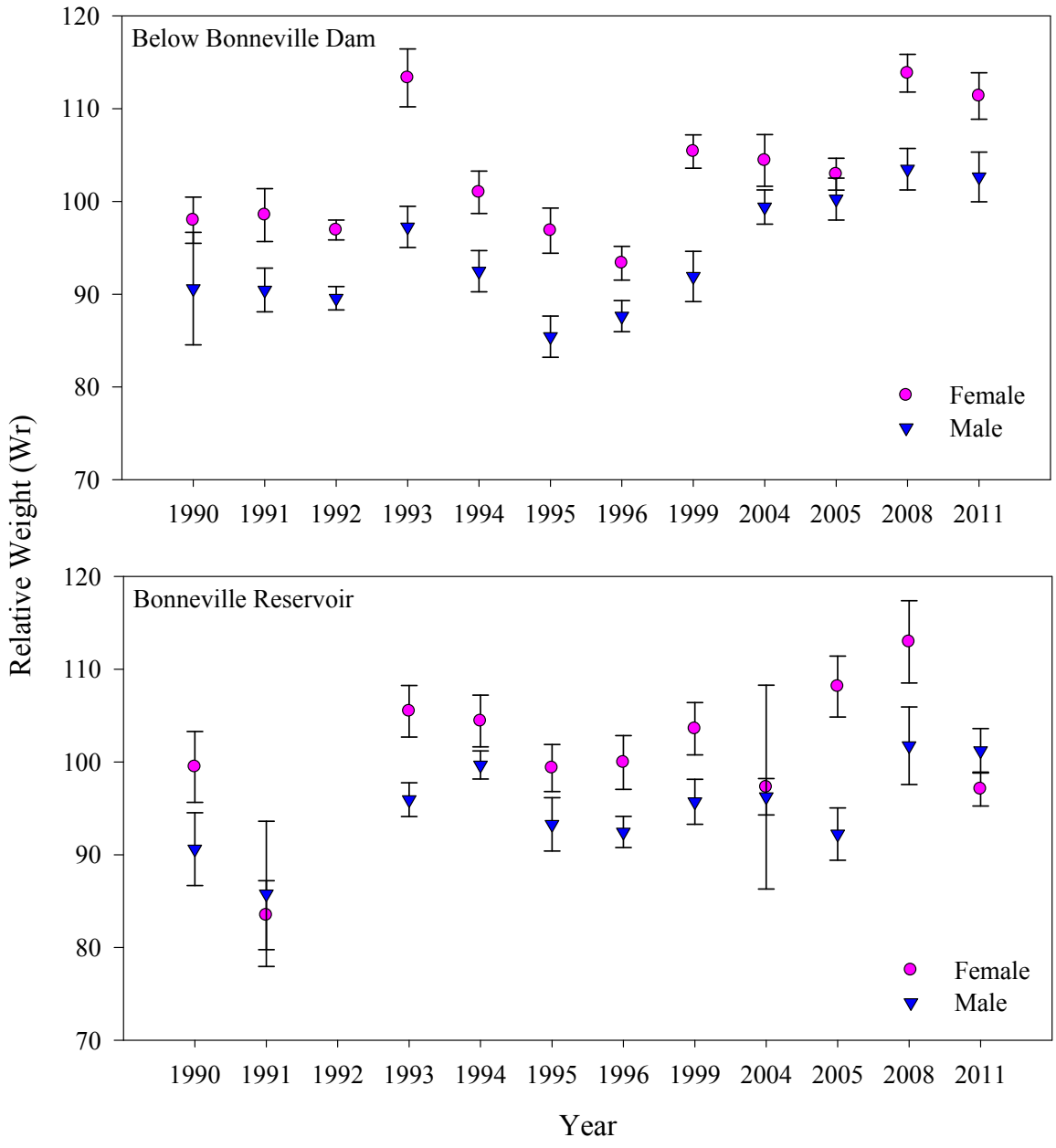

Figure 7. Median relative weight (W_r) of male and female northern Pikeminnow in the Columbia River downstream of Bonneville Dam and in Bonneville Reservoir. Years with blanks indicate either no sampling or no fish caught. Error bars correspond to 95% confidence intervals.

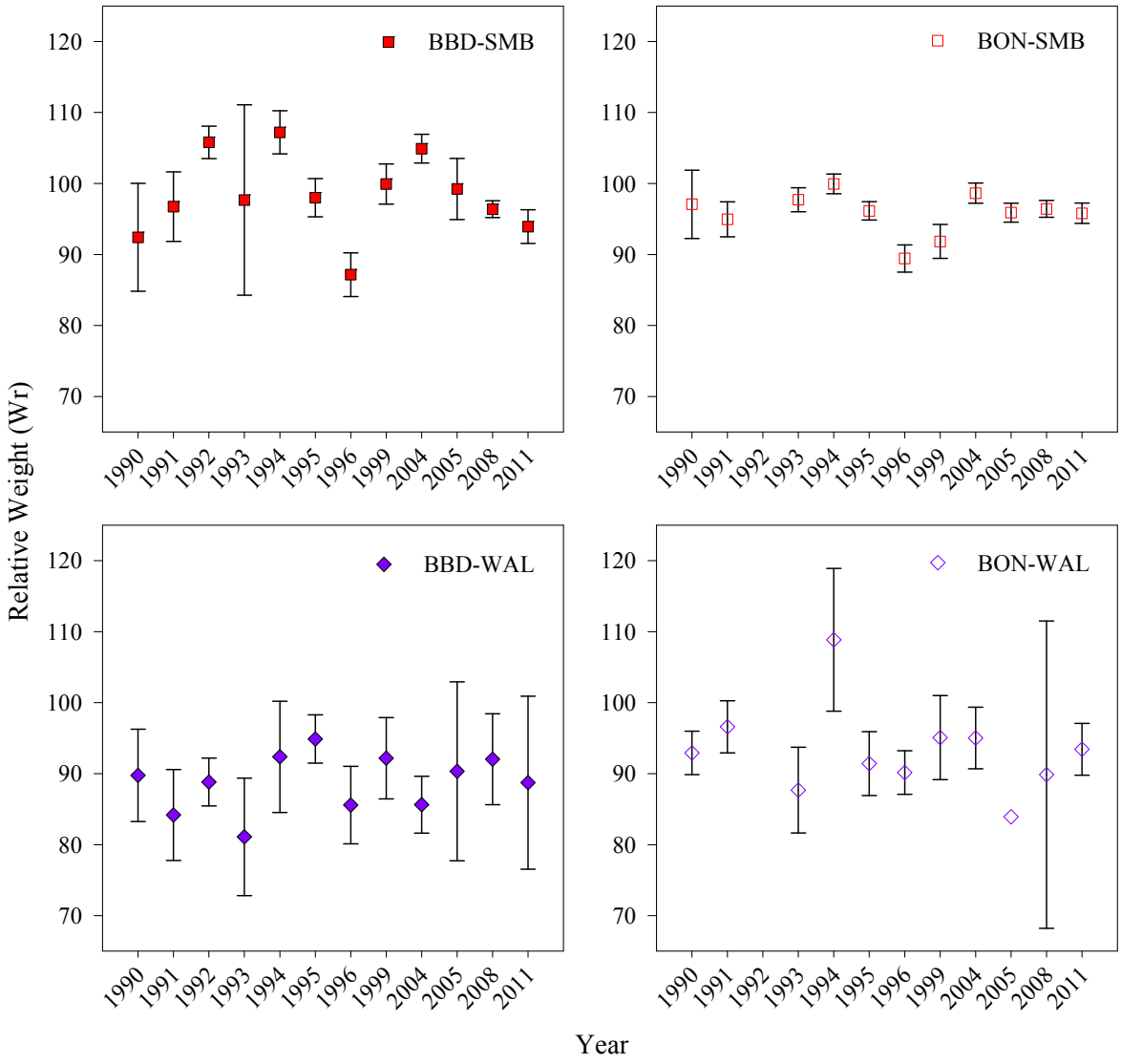

Figure 8. Median relative weight (Wr) of smallmouth bass (SMB) and walleye (WAL) in the Columbia River downstream of Bonneville Dam (BBD) and in Bonneville Reservoir (BON). Years with blanks indicate either no sampling or no fish caught. Error bars correspond to 95% confidence intervals.

DISCUSSION

Our estimate of the system-wide exploitation rate of the Northern Pikeminnow Management Program is one of the lowest observed for the previous several years. In particular, system-wide exploitation of fish ≥200 mm FL (13.5%) and ≥250 mm FL (15.6%) averaged 2–3% lower than the most recent fishery year (2010). However, overall exploitation for the sport-reward fishery continued to achieve the target range of 10–20% required to maintain reduced predation on salmonids (Rieman and Beamesderfer 1990). Exploitation rates have been on the upper end of the 10–20% target range in recent years (2004, 2005, 2008, and 2010), ranging from 18.5–19.5% and with the upper bounds of uncertainty on these estimates exceeding the target range. The 2011 exploitation rate falls toward the middle of the range on a system-wide level and exceeded it locally (i.e., McNary Reservoir). If exploitation rates in the future continue to rise, it may be necessary to assess the consequences of exploitation beyond the target range.

Recaptures of northern pikeminnow 200–249 mm FL were inadequate (≤ 3 tagged fish) to calculate area-specific rates of exploitation in all but two areas during 2011 (Below Bonneville Dam and in McNary Reservoir) even though they comprised 11% and 60% of the total fish tagged in those two areas respectively (Table 1). Ricker (1975) identified differential mortality and behavioral differences between marked and unmarked fish as violations of the assumptions of the Petersen mark-recapture methodology. Although we were able to calculate a system-wide estimate for this subset of the population, their disproportionate representation among areas within the system could influence the efficacy of our evaluation (Styer 2003). Since these smaller fish are also included in estimating exploitation rates for all northern pikeminnow ≥ 200 mm FL, they could be reducing the estimated proportion being exploited by NPMP fishery activities. Our evaluation has documented these concerns in previous reports (Takata and Koloszar 2004; Weaver et al. 2008; Weaver et al. 2009). For this reason, we continue to recommend using exploitation rates for northern pikeminnow ≥ 250 mm FL when comparing between or among years of program fisheries.

The 2011 dam-angling fishery accounted for 2.9% of the total northern pikeminnow harvested, which is similar to the 2.3% during 2010 (Takata et al. 2011). Twelve tagged northern pikeminnow were recovered by dam anglers, two of them were tagged in 2011. As in previous years, northern pikeminnow collected during the 2011 dam-angling fishery were considerably larger (median; 365 mm FL) than those collected in the 2011 sport-reward fishery (median; 256 mm FL). Vigg et al. (1991) found that larger northern pikeminnow consumed more smolts than smaller northern pikeminnow. On average, dam anglers may have a better opportunity for harvesting larger mature northern pikeminnow than sport anglers (Martinelli and Shively 1997). In addition, dam anglers harvested fish from the boat restricted zones, which were not accessible to sport-anglers. For these reasons, we support continued angling from the dams, and will continue to monitor dam-angling activities during 2012.

Reductions in the northern pikeminnow population may improve out-migrating salmonid survival if an equal compensatory response by the remaining northern pikeminnow or other predators does not minimize the benefits (Beamesderfer et al. 1996; Friesen and Ward 1999). An increase in the abundance, population size structure, condition factor, or consumption and predation indices might indicate such a response (Knutsen and Ward 1999). Sustained

exploitation should decrease the proportion of large fish and increase the proportion of small fish (Zimmerman et al. 1995), and smaller northern pikeminnow consume fewer salmonids than their larger counterparts (Vigg et al. 1991). Continued monitoring of the fisheries should provide the program with the information needed to identify status of compensatory response being expressed by these populations of fish.

Northern pikeminnow stock density indices appear to be fluctuating in habitats below Bonneville Dam and in Bonneville Reservoir. Rieman and Beamesderfer (1990) suggested that a decreasing trend in proportional stock density may predict the effect of the sport-reward fishery by qualifying the direction of change in the size structure of northern pikeminnow. Neumann and Allen (2007) indicate that proportional stock density can be high in low density populations. Proportional stock density values can be related to lower abundance index values. Everhart and Youngs (1981) found that overexploited fish populations may show oscillating patterns of year class strength. Changes in northern pikeminnow abundance, year class strength, and size structure may be related to exploitation, thus continued monitoring is needed to better understand the fisheries association with the functional dynamics of the population.

Increased northern pikeminnow consumption and predation indices could also be signs of compensation by remaining northern pikeminnow to prolonged exploitation by the Northern Pikeminnow Management Program (Zimmerman and Ward 1999). Although generally lower than previous years, northern pikeminnow consumption and predation indices have increased within several localized reaches of the study area relative to recent years. Intra-specific competition for home range and forage resources might be harmful to fish populations (Crowder 1990; Byorth and Magee 1998). If localized increases in northern pikeminnow consumption in high harvest areas occur, a localized reduction of intra-specific competition could also be occurring, possibly as a compensatory response by remaining northern pikeminnow. The predation index is composed of two components, consumption and abundance (Ward et al. 1995). Overall, most reductions in northern pikeminnow predation below Bonneville Dam and in Bonneville Reservoir can be attributable to changes in abundance, which was generally lower in 2011 than in previous indexing years.

The efficacy of the Northern Pikeminnow Management Program depends on the lack of response by other piscivores

in the Columbia Basin to the sustained removal of northern pikeminnow (Ward and Zimmerman 1999). As reported in earlier work (Poe et al. 1991; Zimmerman 1999; Naughton et al. 2004), juvenile salmonids comprised a small but consistent portion of smallmouth bass diets in the Columbia River. This was observed during 2011 and the primary prey consumed by smallmouth bass continued to be sculpin. Ward and Zimmerman (1999) suggested the first evidence of any response by smallmouth bass would likely be a change in diet. Therefore, the smallmouth bass population structure should continue to be monitored to identify any compensatory response related to northern pikeminnow fisheries.

The abundance of walleye below Bonneville Dam and in Bonneville Reservoir is minimal compared to northern pikeminnow and smallmouth bass. Because the number of walleye we catch is low, we have not been able to calculate proportional or relative stock density values.

Juvenile salmonids have been found to be an important component of lower Columbia River walleye diets (Poe et al. 1991; Vigg et al. 1991; Zimmerman 1999). Takata et al. (2007) found salmonids most often in walleye digestive tracts in The Dalles and John Day reservoirs. In 2011, salmonids and cyprinids were the primary fish found in the walleye diets downstream of Bonneville Dam and in Bonneville Reservoir. Therefore, the impact walleye predation has on salmonid populations could differ among areas. Further monitoring of walleye population parameters and diets would be prudent.

Previous evaluations of the Northern Pikeminnow Management Program have not detected responses by the predator community to the sustained removal of northern pikeminnow (Ward et al. 1995; Ward and Zimmerman 1999; Zimmerman and Ward 1999). However, fishery management programs have been described as needing sustained annual sampling to effectively evaluate if a response has occurred (Beamesderfer et al. 1996). Therefore, it is critical to continue monitoring to assess the impact of the Northern Pikeminnow Management Program.

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APPENDIX TABLES A

Sampling Effort and Timing in the Lower Columbia and Snake Rivers

Appendix Table A-1. Dates of sampling weeks with range of days in 2011.

Sampling Week	Begin Date		End Date
18	1-May	—	7-May
19	8-May	—	14-May
20	15-May	—	21-May
21	22-May	—	28-May
22	29-May	—	4-Jun
23	5-Jun	—	11-Jun
24	12-Jun	—	18-Jun
25	19-Jun	—	25-Jun
26	26-Jun	—	2-Jul
27	3-Jul	—	9-Jul
28	10-Jul	—	16-Jul
29	17-Jul	—	23-Jul
30	24-Jul	—	30-Jul
31	31-Jul	—	6-Aug
32	7-Aug	—	13-Aug
33	14-Aug	—	20-Aug
34	21-Aug	—	27-Aug
35	28-Aug	—	3-Sep
36	4-Sep	—	10-Sep
37	11-Sep	—	17-Sep
38	18-Sep	—	24-Sep
39	25-Sep	—	1-Oct
40	2-Oct	—	8-Oct
41	9-Oct	—	15-Oct

Appendix Table A-2. Number of 15-minute electrofishing runs conducted for biological indexing in the Columbia River downstream of The Dalles Dam for all sampling years. — = not sampled.

	Below Bonneville Dam				Bonneville Reservoir		
Year	rkm 114 to 121	rkm 172 to 178	rkm 190 to 197	Tailrace	Forebay	Mid-reservoir	The Dalles Tailrace
1990	—	—	—	39	47	52	52
1992	68	65	64	60	—	—	—
1993	—	—	—	25	35	28	31
1994	36	33	43	35	97	84	68
1995	45	36	40	24	79	45	80
1996	43	35	40	31	80	57	69
1999	44	47	40	29	62	57	71
2004	22	31	32	55	35	35	43
2005	48	48	48	82	101	58	74
2008	48	48	48	78	87	69	73
2011	48	48	38	72	80	96	64

APPENDIX TABLES B

Exploitation Rates for Northern Pikeminnow, 1991–2011

Appendix Table B-1. System-wide weekly exploitation rates of northern pikeminnow ≥200 mm FL for the sport-reward fishery in 2011. — = no tagging effort, no recapture effort, or no exploitation calculated.

Sampling Week	Tagged	Recaptured	At-Large	Exploitation[a] (%)
15	26	—	0	—
16	99	—	26	—
17	81	—	124	—
18	137	1	205	0.5
19	26	4	341	1.2
20	7	1	362	0.3
21	1	2	368	0.6
22	1	1	367	0.3
23	109	2	367	0.6
24	40	1	474	0.2
25	65	2	513	0.4
26	90	7	576	1.2
27	—	12	659	1.9
28	—	6	647	1.0
29	—	3	641	0.5
30	—	3	638	0.5
31	—	4	635	0.6
32	—	7	631	1.1
33	—	2	624	0.3
34	—	2	622	0.3
35	—	0	620	0.0
36	—	2	620	0.3
37	—	2	618	0.3
38	—	0	616	0.0
39	—	2	616	0.3
40	—	4	614	0.7
41	—	0	610	0.0
42	—	2	610	0.3
43		—	608	—
Total	682	72	608	13.5

a) Exploitation rates adjusted for tag loss (2.7%).

Appendix Table B-2. Exploitation rates (%) of northern pikeminnow fork length groups in the sport-reward fishery. *a* = no exploitation rate calculated (n<4) and — = not sampled.

Group, Year	Below Bonneville	Bonneville	The Dalles	John Day	McNary	Little Goose	Lower Granite	All areas
≥200 mm								
2000	9.9	12.4	*a*	*a*	10.2	*a*	10.5	10.9
2001	15.9	8.6	*a*	*a*	26.0	—	9.4	15.5
2002	10.8	5.0	*a*	*a*	7.6	—	11.6	10.6
2003	11.8	11.0	*a*	*a*	6.6	—	*a*	10.5
2004	18.8	11.7	*a*	*a*	*a*	—	19.6	17.0
2005	21.6	8.0	14.9	*a*	9.6	—	*a*	16.3
2006	14.6	10.5	22.4	*a*	10.7	20.0	*a*	14.6
2007	18.4	9.6	*a*	*a*	5.9	35.0	11.8	15.3
2008	20.6	9.6	13.8	*a*	14.1	8.3	4.1	14.8
2009	8.4	15.2	*a*	*a*	8.4	9.0	*a*	8.8
2010	17.2	10.1	*a*	*a*	9.2	15.0	63.1	15.9
2011	14.9	9.1	*a*	*a*	14.8	*a*	*a*	13.5
200–249 mm								
2000	9.7	4.1	*a*	*a*	*a*	*a*	*a*	6.6
2001	*a*	*a*	*a*	*a*	*a*	—	*a*	10.6
2002	3.1	*a*	*a*	*a*	*a*	—	*a*	3.4
2003	*a*	*a*	*a*	*a*	*a*	—	*a*	*a*
2004	*a*	13.5	*a*	*a*	*a*	—	*a*	10.9
2005	*a*	*a*	*a*	*a*	*a*	—	*a*	*a*
2006	9.6	6.7	*a*	*a*	*a*	17.4	*a*	9.9
2007	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*
2008	4.6	5.8	10.5	*a*	4.9	4.8	1.3	5.7
2009	*a*	*a*	*a*	*a*	*a*	5.6	*a*	1.8
2010	*a*	*a*	*a*	*a*	12.4	*a*	*a*	7.6
2011	17.9	*a*	*a*	*a*	11.0	*a*	*a*	9.8
≥250 mm								
1991	7.6	10.9	23.6	2.8	5.3	2.4	20.0	8.5
1992	11.4	4.0	6.2	3.4	5.6	11.9	15.0	9.3
1993	6.0	2.1	7.0	2.4	15.9	3.3	12.5	6.8
1994	13.6	2.2	9.8	3.2	14.0	6.1	8.7	10.9
1995	16.1	3.5	14.9	0.0	22.4	2.9	6.4	13.4
1996	12.7	6.1	15.5	0.0	18.2	8.9	11.7	12.1
1997	7.8	8.0	5.8	0.0	16.5	0.0	15.5	8.9
1998	8.2	7.8	12.8	0.0	13.6	0.0	12.1	11.1

Appendix Table B-2. Continued.

Group, Year	Below Bonneville	Bonneville	The Dalles	John Day	McNary	Little Goose	Lower Granite	All areas
≥250 mm cont.								
2001	16.2	8.5	*a*	*a*	26.0	—	*a*	16.2
2002	12.6	6.0	*a*	*a*	7.7	—	14.3	12.3
2003	13.6	16.7	*a*	*a*	8.2	—	*a*	13.0
2004	20.1	9.3	*a*	*a*	*a*	—	23.8	18.5
2005	23.1	8.2	18.0	*a*	13.0	—	*a*	19.0
2006	15.6	13.7	25.3	*a*	11.2	26.3	*a*	17.1
2007	19.4	11.1	*a*	*a*	7.5	*a*	17.3	17.8
2008	22.2	10.5	15.0	*a*	16.8	21.7	9.2	19.5
2009	11.3	15.9	*a*	*a*	11.6	25.8	*a*	12.8
2010	19.8	13.1	*a*	*a*	*a*	*a*	*a*	18.8
2011	14.5	10.4	*a*	*a*	17.8	*a*	*a*	15.6

APPENDIX TABLES C

Biological Evaluation of Northern Pikeminnow, Smallmouth Bass, and Walleye in the Lower Columbia River Downstream of Bonneville Dam and Bonneville Reservoir, 1990–2011

Appendix Table C-1. Annual abundance indices for northern pikeminnow (≥250 mm FL) that were captured during indexing years in the Columbia River downstream of Bonneville Dam and Bonneville Reservoir by area and river reach, 1990–2011. — = no sampling conducted.

	Downstream of Bonneville Dam					Bonneville Reservoir			
Year	rkm 114 to 121	rkm 172 to 178	rkm 190 to 197	Tailrace	Tailrace BRZ	Forebay	Mid-reservoir	Tailrace	Tailrace BRZ
1990	—	—	—	4.5	3.0	5.5	15.1	0.4	0.9
1992	20.1	20.5	30.4	2.7	2.8	—	—	—	—
1993	—	—	—	7.6	3.2	2.1	8.5	0.8	0.2
1994	15.4	23.2	22.1	2.3	4.1	2.3	5.0	0.5	1.1
1995	14.5	17.4	14.2	1.8	1.0	2.3	7.4	0.8	—
1996	12.2	18.7	16.4	2.2	1.3	1.3	4.9	0.7	—
1999	9.8	11.8	17.4	2.7	—	1.0	2.2	1.1	—
2004	10.6	8.1	13.3	1.3	2.6	0.9	2.3	1.3	—
2005	11.2	9.2	8.2	0.6	1.8	0.7	1.9	0.2	—
2008	13.2	7.8	4.5	1.1	2.6	0.2	0.4	0.2	—
2011	4.3	2.6	5.0	1.2	0.0	0.2	2.0	0.3	—

Appendix Table C-2. Annual abundance indices for smallmouth bass (≥200 mm FL) that were captured during indexing years in the Columbia River downstream of Bonneville Dam and Bonneville Reservoir by season, area, and river reach, 1990–2011. — = no sampling conducted.

	Downstream of Bonneville Dam				Bonneville Reservoir		
Season, Year	rkm 114 to 121	rkm 172 to 178	rkm 190 to 197	Tailrace	Forebay	Mid-reservoir	Tailrace
Spring,							
1990	—	—	—	0.0	0.1	11.7	2.4
1991	—	—	—	0.1	0.1	0.9	2.0
1992	0.0	11.1	—	—	—	—	—
1993	—	—	—	1.1	0.4	4.2	4.7
1994	0.0	33.5	6.7	0.6	0.1	9.6	2.7
1995	1.5	49.2	23.9	2.2	0.3	11.8	2.3
1996	0.0	17.8	7.0	0.4	0.4	7.8	4.1
1999	0.0	2.7	1.1	0.3	0.3	1.8	1.8
2004	0.0	19.6	9.5	1.4	0.6	—	2.7
2005	2.1	6.3	12.6	1.0	1.1	8.4	1.6
2008	3.3	17.3	14.8	1.7	2.0	4.5	3.1
2011	0.0	8.4	0.0	0.3	0.4	17.3	1.9
Summer,							
1990	—	—	—	0.8	0.3	5.0	1.0
1991	—	—	—	0.9	0.0	3.4	1.9
1992	1.4	2.6	7.1	0.6	—	—	—
1993	—	—	—	1.2	0.2	4.2	1.8
1994	4.0	11.0	5.3	0.6	0.2	4.8	1.5
1995	1.3	10.5	9.8	0.7	0.3	2.5	2.3
1996	0.7	3.9	4.4	0.4	0.2	3.6	0.7
1999	0.0	4.2	7.7	0.8	0.7	3.3	2.2
2004	1.3	2.6	10.5	0.4	—	11.6	1.9
2005	0.7	9.4	8.4	0.7	1.2	12.5	0.8
2008	4.0	22.5	15.8	0.7	1.8	13.8	2.9
2011	0.7	8.9	7.4	0.6	1.6	22.5	2.9

Appendix Table C-3. Annual abundance indices for walleye (≥200 mm FL) that were captured during indexing years in the Columbia River downstream of Bonneville Dam and Bonneville Reservoir by season, area, and river reach, 1990–2011. —= no sampling conducted.

	Downstream of Bonneville Dam				Bonneville Reservoir		
Season, Year	rkm 114 to 121	rkm 172 to 178	rkm 190 to 197	Tailrace	Forebay	Mid-reservoir	Tailrace
Spring,							
1990	—	—	—	0.0	0.0	0.0	0.2
1991	—	—	—	0.5	0.0	0.0	0.3
1992	0.0	4.4	—	—	—	—	—
1993	—	—	—	0.1	0.0	0.0	0.1
1994	0.0	1.4	0.7	1.0	0.0	1.0	0.1
1995	0.0	4.2	0.0	0.6	0.0	0.8	0.1
1996	0.0	0.7	0.6	0.5	0.0	0.9	0.2
1999	0.0	0.0	1.1	0.2	0.0	0.4	0.0
2004	0.0	0.0	0.0	0.3	0.0	—	0.2
2005	0.0	0.0	0.0	0.1	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.3	0.1
2011	0.0	1.0	0.9	0.2	0.0	0.3	0.4
Summer,							
1990	—	—	—	0.4	0.0	0.0	0.1
1991	—	—	—	0.1	0.0	0.0	0.1
1992	0.0	0.5	0.3	0.0	—	—	—
1993	—	—	—	0.0	0.0	0.2	0.0
1994	0.0	2.6	1.1	0.2	0.0	0.0	0.0
1995	0.0	2.1	1.1	0.3	0.0	0.6	0.1
1996	0.0	0.0	0.6	0.4	0.0	0.6	0.1
1999	0.0	0.0	1.4	0.2	0.0	0.2	0.1
2004	0.0	0.7	0.5	0.2	—	0.8	0.0
2005	0.0	0.0	0.0	0.0	0.0	0.2	0.0
2008	0.0	0.5	0.0	0.1	0.0	0.2	0.0
2011	0.0	0.5	2.1	0.1	0.0	0.3	0.0

Table C-4. Spring and summer consumption indices for northern pikeminnow ≥250 mm fork length in the lower Columbia River, 1990, 1992–1996, 1999, 2004, 2005, 2008, and 2011. BRZ = boat-restricted zone; rkm = river kilometer; — = area not sampled, and *a* = no consumption index calculated (N < 6).

	Below Bonneville Dam					Bonneville Reservoir			
Season, Year	rkm 114 to 121	rkm 172 to 178	rkm 190 to 197	Tailrace	Tailrace BRZ	Forebay	Mid-reservoir	Tailrace	Tailrace BRZ
Spring,									
1990	—	—	—	1.2	2.7	0.6	0.0	0.3	2.3
1992	0.5	1.0	1.1	0.5	1.0	—	—	—	—
1993	—	—	—	0.8	1.1	0.7	0.0	0.0	—
1994	0.5	1.1	1.5	3.2	0.6	0.2	0.2	0.0	—
1995	0.5	0.2	0.7	0.8	1.7	0.3	0.0	0.2	—
1996	0.4	0.1	0.4	0.4	0.6	0.0	0.1	0.0	—
1999	0.8	0.4	0.4	0.1	—	0.0	0.6	0.2	—
2004	0.2	0.3	0.1	0.3	1.0	0.5	—	0.0	*a*
2005	0.2	0.0	0.5	0.4	1.6	0.3	*a*	1.5	—
2008	0.8	0.0	0.0	1.0	0.9	1.3	*a*	0.6	—
2011	0.6	0.6	a	0.7	1.0	0.0	0.0	0.5	—
Summer,									
1990	—	—	—	0.5	5.5	1.8	0.0	*a*	0.8
1992	0.3	1.3	1.9	2.1	7.8	—	—	—	—
1993	—	—	—	1.2	1.0	0.5	0.0	0.0	1.0
1994	1.8	1.5	0.4	0.4	2.1	0.3	0.0	0.0	3.2
1995	1.5	0.4	1.2	0.9	1.3	0.0	0.0	0.8	—
1996	0.0	0.0	0.0	0.6	3.1	0.3	0.0	0.0	—
1999	1.0	0.0	0.5	0.2	—	0	0.0	0.3	—
2004	0.4	0.7	0.2	0.2	4.0	—	0.0	1.1	*a*
2005	1.2	0.3	0.6	0.0	3.8	0.0	*a*	*a*	—
2008	1.7	1.2	0.4	0.3	1.0	*a*	*a*	*a*	—
2011	*a*	*a*	0.0	0.3	—	0.0	0.0	0.8	—

Table C-5. Spring and summer predation indices for northern pikeminnow ≥250 mm fork length in the lower Columbia River, 1990, 1992–1996, 1999, 2004, 2005, 2008, and 2011. Rkm = river kilometer; — = area not sampled, and *a* = no consumption index (N < 6).

Season, Year	Below Bonneville Dam					Bonneville Reservoir			
	Rkm 114 to 121	Rkm 172 to 178	Rkm 190 to 197	Tailrace	Tailrace BRZ	Forebay	Mid-reservoir	Tailrace	Tailrace BRZ
Spring,									
1990	—	—	—	5.5	8.0	3.3	0.0	0.1	2.0
1992	10.4	20.9	34.4	1.4	2.8	—	—	—	—
1993	—	—	—	6.1	3.5	1.5	0.0	0.0	—
1994	8.0	26.2	33.3	7.4	2.5	0.3	1.0	0.0	—
1995	7.3	3.5	9.9	1.4	1.7	0.7	0.0	0.2	1.5
1996	4.9	1.9	6.6	0.9	0.8	0.0	0.5	0.0	—
1999	7.5	5.0	7.1	0.4	—	0.0	1.3	0.2	—
2004	1.8	2.5	1.5	0.3	2.5	0.5	—	0.0	—
2005	2.0	0.0	4.4	0.3	2.8	0.2	2.2	0.3	—
2008	10.4	0.0	0.0	1.1	2.4	0.3	*a*	0.1	—
2011	2.4	1.5	*a*	1.0	*a*	0.0	0.0	0.2	—
Summer,									
1990	—	—	—	2.3	16.4	9.9	0.0	0.0	0.7
1992	6.2	27.0	57.8	5.7	21.9	—	—	—	—
1993	—	—	—	9.1	3.2	1.1	0.0	0.0	0.2
1994	27.3	35.0	9.5	1.0	8.9	0.6	0.0	0.0	3.5
1995	14.5	7.0	17.0	1.6	1.2	0.0	0.0	0.6	—
1996	0.0	0.0	0.0	1.3	4.0	0.4	0.0	0.0	—
1999	9.4	0.0	9.5	0.6	—	0.0	0.0	0.3	—
2004	4.7	5.8	2.3	0.3	10.2	—	0.0	1.4	—
2005	13.3	3.1	5.1	0.0	6.8	0.0	*a*	*a*	—
2008	22.0	9.4	1.7	0.3	2.4	*a*	*a*	*a*	—
2011	9.0	5.3	0.0	0.4	—	0.0	0.0	0.3	—

Table C-6. Spring and summer consumption indices for smallmouth bass ≥200 mm fork length in the lower Columbia River, 1990, 1992–1996, 1999, 2004, 2005, 2008, and 2011. BRZ = boat-restricted zone; rkm = river kilometer; — = area not sampled, and *a* = no consumption index calculated (N < 6).

Season, Year	Below Bonneville Dam				Bonneville Reservoir		
	Rkm 114 to 121	Rkm 172 to 178	Rkm 190 to 197	Tailrace	Forebay	Mid-reservoir	Tailrace
Spring,							
1990	—	—	—	—	*a*	*a*	0.0
1992	*a*	0.1	*a*	*a*	—	—	—
1993	—	—	—	—	*a*	*a*	0.0
1994	*a*	0.0	0.3	0.0	*a*	0.0	0.0
1995	*a*	0.1	0.0	0.0	0.1	0.1	0.0
1996	—	0.0	0.0	0.0	0.0	0.0	0.0
1999	—	*a*	*a*	*a*	0.0	*a*	<0.1
2004	*a*	0.0	0.2	0.0	0.0	—	0.0
2005	*a*	0.3	0.1	0.1	0.1	0.0	<0.1
2008	*a*	*a*	<0.1	<0.1	<0.1	0.0	<0.1
2011	*a*	0.1	*a*	0.1	0.1	<0.1	0.0
Summer,							
1990	—	—	—	—	*a*	*a*	*a*
1992	*a*	0.0	0.4	*a*	—	—	—
1993	—	—	—	—	*a*	0.0	0.0
1994	0.0	0.2	0.3	0.0	0.4	0.0	0.1
1995	*a*	0.3	0.8	0.0	0.0	0.0	0.1
1996	*a*	*a*	0.0	*a*	0.0	0.0	0.0
1999	—	0.0	0.0	0.0	0.2	0.0	0.0
2004	*a*	0.0	0.2	0.4	—	0.0	0.0
2005	*a*	0.2	0.6	0.1	0.1	0.1	0.1
2008	0.8	0.5	0.6	0.1	0.1	0.1	<0.1
2011	*a*	0.4	0.1	0.1	0.1	0.1	0.0

Table C-7. Spring and summer predation indices for smallmouth bass ≥200 mm fork length in the lower Columbia River, 1990, 1992–1996, 1999, 2004, 2005, 2008, and 2011. Rkm = river kilometer; — = area not sampled, and *a* = no consumption index (N < 6).

	Below Bonneville Dam				Bonneville Reservoir		
Season, Year	Rkm 114–121	Rkm 172–178	Rkm 190–197	Bonneville Tailrace	Forebay	Mid-reservoir	The Dalles Tailrace
Spring,							
1990	—	—	—	*a*	*a*	*a*	*a*
1992	*a*	0.8	0.0	*a*	—	—	—
1993	—	—	—	*a*	*a*	*a*	0.0
1994	*a*	0.0	1.8	0.0	*a*	0.0	0.0
1995	*a*	2.6	0.0	0.0	<0.1	0.4	0.0
1996	*a*	0.0	0.0	*a*	0.0	0.0	0.0
1999	*a*	0.0	*a*	*a*	0.0	*a*	<0.1
2004	*a*	0.0	2.2	0.0	0.0	—	0.0
2005	*a*	2.2	0.7	0.0	0.1	0.0	0.1
2008	*a*	0.8	0.6	<0.1	0.1	0.0	0.1
2011	*a*	0.6	*a*	*a*	0.1	0.7	0.0
Summer,							
1990	—	—	—	*a*	*a*	0.0	*a*
1992	*a*	0.0	2.6	*a*	—	—	—
1993	—	—	—	—	*a*	0.0	0.0
1994	0.0	1.8	1.6	0.0	0.1	0.0	0.1
1995	*a*	3.1	7.8	0.0	0.0	0.0	0.1
1996	*a*	*a*	0.0	0.0	0.0	0.0	0.0
1999	*a*	0.8	0.0	0.0	0.1	0.0	0.0
2004	*a*	0.0	2.2	*a*	—	0.0	0.0
2005	*a*	1.7	5.3	0.1	0.2	1.0	0.1
2008	3.4	11.7	10.2	0.1	0.2	1.9	0.1
2011	*a*	4.0	0.8	0.1	0.2	1.2	0.0

Table C-8. Proportional stock density (PSD), relative stock density (RSD-P), and number of stock sized fish (*N*) of northern pikeminnow, smallmouth bass, and walleye in the lower Columbia River (1990, 1992–1996, 1999, 2004, 2005, 2008, and 2011). — = no sample and *a* = PSD and RSD not calculated where N ≤ 20.

Location,	Northern pikeminnow		Smallmouth bass			Walleye		
Year	PSD	*N*	PSD	RSD	*N*	PSD	RSD	*N*
Below Bonneville Dam								
1990	53	172	*a*	*a*	8	*a*	*a*	4
1991	52	411	*a*	*a*	16	*a*	*a*	8
1992	29	710	22	7	153	*a*	*a*	20
1993	51	291	63	13	30	*a*	*a*	0
1994	33	409	31	12	141	80	23	26
1995	41	206	41	15	181	*a*	*a*	19
1996	33	245	30	6	83	*a*	*a*	16
1999	39	226	46	13	54	*a*	*a*	9
2004	35	356	30	6	172	*a*	*a*	16
2005	49	287	19	2	238	*a*	*a*	4
2008	65	344	25	4	314	*a*	*a*	7
2011	68	139	31	3	124	*a*	*a*	18
Bonneville Reservoir								
1990	43	245	39	15	111	*a*	*a*	4
1991	61	350	48	20	97	*a*	*a*	7
1992	—	—	—	—	—	—	—	
1993	44	213	26	10	236	*a*	*a*	2
1994	40	378	37	12	332	*a*	*a*	9
1995	26	319	33	11	285	*a*	*a*	10
1996	24	199	58	14	256	*a*	*a*	15
1999	33	169	46	13	239	*a*	*a*	6
2004	18	136	44	17	235	*a*	*a*	6
2005	40	106	40	19	418	*a*	*a*	2
2008	45	40	46	15	573	*a*	*a*	4
2011	20	70	48	22	668	86	41	22

Appendix Table C-9. Sample size (*N*), median relative weight (Wr), and 95% confidence interval (CI) of northern pikeminnow ≥ 250 mm FL, smallmouth bass ≥ 200 mm TL, and walleye ≥ 200 mm TL in the lower Columbia River downstream of Bonneville Dam and in Bonneville Reservoir during all sampling years. — = not sampled.

Area,	Northern Pikeminnow						Smallmouth bass			Walleye		
	Male			Female								
Year	N	Wr	CI	N	Wr	CI	N	Wr	CI	N	Wr	CI
Downstream of Bonneville Dam,												
1990	73	91	6.1	176	98	2.5	12	92	7.6	11	90	6.5
1991	120	90	2.4	264	99	2.9	23	97	4.9	10	84	6.4
1992	541	90	1.3	663	97	1.1	120	106	2.3	34	89	3.4
1993	159	97	2.2	218	113	3.1	29	98	13.4	2	81	8.3
1994	213	92	2.2	335	101	2.3	92	107	3.0	4	92	7.8
1995	63	85	2.2	156	97	2.4	156	98	2.7	20	95	3.4
1996	102	88	1.7	171	93	1.8	62	87	3.1	16	86	5.5
1999	75	92	2.7	146	105	1.8	40	100	2.8	9	92	5.7
2004	161	99	1.8	203	104	2.8	129	105	2.0	16	86	4.0
2005	94	100	2.3	213	103	1.7	139	99	4.3	4	90	12.6
2008	84	103	2.2	264	114	2.0	244	96	1.2	7	92	6.4
2011	37	103	2.7	112	111	2.5	87	94	2.4	19	89	12.2
Bonneville Reservoir,												
1990	40	91	3.9	120	99	3.8	28	97	4.8	2	93	3.1
1991	33	86	7.8	51	83	3.7	93	95	2.5	12	97	3.7
1992	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
1993	157	96	1.8	164	105	2.8	179	98	1.7	3	88	6.0
1994	220	100	1.5	295	104	2.8	230	100	1.4	3	109	10.0
1995	164	93	2.9	161	99	2.5	260	96	1.3	13	91	4.5
1996	98	92	1.7	112	100	2.9	231	89	1.9	14	90	3.1
1999	93	96	2.4	72	104	2.8	195	92	2.4	6	95	5.9
2004	136	96	2.0	124	97	11.0	197	99	1.4	7	95	4.3
2005	46	92	2.8	70	108	3.3	298	96	1.3	1	84	0.0
2008	29	102	4.2	29	113	4.4	513	96	1.2	5	90	21.6
2011	60	101	2.4	154	97	1.8	536	96	1.4	22	93	3.7

APPENDIX TABLES D

Diets of Northern Pikeminnow Captured While Dam Angling at Bonneville, The Dalles, and John Day Dams, 2006–2011

Appendix Table D-1. Number (*N*) and fork length description of northern pikeminnow collected for digestive tract evaluation from Bonneville, The Dalles, and John Day dams during 2006–2011. — = not sampled.

Dam,	Northern pikeminnow			
Year	*N*	FL-range	Mean	Median
Bonneville				
2006	22	267–544	425	438
2007	—	—	—	—
2008	—	—	—	—
2009	—	—	—	—
2010	—	—	—	—
2011	—	—	—	—
The Dalles				
2006	129	212–549	360	342
2007	340	229–550	343	333
2008	209	200–518	356	350
2009	223	187–545	377	370
2010	395	185–545	366	364
2011	326	219–574	367	370
John Day				
2006	—	—	—	—
2007	453	230–553	366	358
2008	64	265–550	377	365
2009	224	251–572	403	394
2010	382	233–575	376	376
2011	288	230–515	362	363
Combined totals	3,055	185–575	368	361

Appendix Table D-2. Number (*N*) of northern pikeminnow digestive tracts examined from Bonneville, The Dalles, and John Day dams in 2006–2011, and percent of prey items contained. — = not sampled, SAL=salmonid, LAM=lamprey, ASH=American shad.

Dam, Year	*N*	Food	Fish	Crayfish	Other Invert	Misc.	SAL	LAM	ASH	Other fish
Bonneville										
2006	22	82	41	9	23	23	36	0	0	9
2007	—	—	—	—	—	—	—	—	—	—
2008	—	—	—	—	—	—	—	—	—	—
2009	—	—	—	—	—	—	—	—	—	—
2010	—	—	—	—	—	—	—	—	—	—
2011	—	—	—	—	—	—	—	—	—	—
The Dalles										
2006	129	36	21	8	4	11	4	17	0	5
2007	340	61	40	4	22	9	13	31	0	6
2008	209	63	44	4	33	5	11	31	0	12
2009	223	70	64	6	19	10	9	50	1	14
2010	395	62	49	6	14	17	16	18	15	18
2011	329	66	44	7	19	13	36	9	0	0
John Day										
2006	—	—	—	—	—	—	—	—	—	—
2007	453	58	37	2	27	3	13	8	11	21
2008	64	81	36	3	69	11	9	23	0	8
2009	224	61	56	8	31	4	11	40	0	14
2010	382	55	29	7	34	25	16	10	2	7
2011	283	70	22	6	56	2	15	7	0	2

Appendix Table D-3. Percent of prey fish families identified from northern pikeminnow digestive tract samples collected from The Dalles and John Day dams during 2011 that contained fish remains.

Family	May	June	July	August	Total
Petromyzontidae	61	52	16	22	25
Salmonidae	50	61	84	74	77
Cottidae	0	0	3	4	2
Centrarchidae	0	0	1	0	0
Unknown	6	9	6	7	6

Northern Pikeminnow Dam Angling on the Columbia River

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ABSTRACT

We are reporting on the 2011 Northern Pikeminnow Dam Angling component of the Northern Pikeminnow Management Program (NPMP) as implemented by the Washington Department of Fish and Wildlife (WDFW). The angling took place within the tailraces areas of The Dalles and John Day dams for 18 weeks from May 2nd to October 6th. The objectives of the project were to (1) implement a recreational-type hook and line fishery that harvests northern pikeminnow from within the boat restricted areas (BRZ) unavailable to the public at The Dalles and John Day dams, (2) allocate Dam Angler effort between The Dalles and John Day dams based on angler CPUE in order to maximize harvest of northern pikeminnow, (3) collect, compile and report data on angler harvest, CPUE, gear/techniques, and incidental catch for each project, (4) scan, record and report Passive Integrated Transponder (PIT) tag data from all northern pikeminnow, smallmouth bass, walleye, and channel catfish caught by the angling crew and record with the presence of any external spaghetti tags, fin-clips, or signs of tag loss from these fishes for use in coordination with other Oregon Department of Fish and Wildlife (ODFW) predation studies, (5) collect biological data on all northern pikeminnow and other fishes caught by the 2011 Dam Angling crew.

A Dam Angling crew of four anglers harvested 1,204 northern pikeminnow at The Dalles Dam and 3,322 at the John Day Dam for a total harvest of 4,526 in 2011. The crew fished a total of 2,050.4 hours during the 18 week fishery for a combined overall average catch per angler hour of 2.21, and the crew's average catch per week equaling 251.4 fish. At The Dalles Dam, crew members averaged 1.60 fish per angler hour (CPUE), and cumulatively 36.48 northern pikeminnow per day. At the John Day Dam, crew member CPUE was 2.56 (fish per angler hour) with a cumulative crew total of 60.4 fish per day.

Based on the knowledge gained from implementing the Dam Angling project in 2010, back bouncing soft plastic lures was the primary angling method used by the Dam Angling crew for harvesting northern pikeminnow from The Dalles and John Day dams in 2011. Incidental species most frequently caught and released by the Dam Angling crew in 2011 were smallmouth bass *Micropterus dolomieue*, white sturgeon *Acipenser transmontanus,* walleye *Sander vitreus*, and peamouth *Mylocheilus caurinus*.

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 FL (11 inches total length). The Northern Pikeminnow Management Program (NPMP) was created in 1990, with the goal of implementing fisheries to achieve the recommended 10-20% annual exploitation on northern pikeminnow >275 mm FL within the program area (Vigg and Burley 1989). The primary component of the NPMP is the Northern Pikeminnow Sport-Reward Fishery (NPSRF) implemented by the Washington Department of Fish and Wildlife (WDFW). Beginning in 2010, WDFW was also contracted to conduct the Dam Angling component of the NPMP (Hone et al. 2010) and 2011 marks the second consecutive year that WDFW has implemented this component. The Dam Angling component of the NPMP utilized a four person crew of experienced anglers to harvest northern pikeminnow from within the boat restricted zones (BRZ's) of The Dalles and John Day dams on the Columbia River using recreational-type hook and line angling techniques.

The objectives of the 2011 Dam Angling component of the NPMP were to (1) implement a recreational-type hook and line fishery that harvests northern pikeminnow from within the boat restricted areas (BRZ) unavailable to the public at The Dalles and John Day dams, (2) allocate Dam Angler effort between The Dalles and John Day dams based on angler CPUE in order to maximize harvest of northern pikeminnow, (3) collect, compile and report data on angler harvest, CPUE, gear/techniques, and incidental catch for each project, (4) scan, record and report Passive Integrated Transponder (PIT) tag data from all northern pikeminnow, smallmouth bass, walleye, and channel catfish caught by the angling crew and record the presence of any external spaghetti tags, fin-clips, or signs of tag loss from these fishes for use in coordination with other Oregon Department of Fish and Wildlife (ODFW) predation studies, (5) collect biological data on all northern pikeminnow and other fishes caught by the 2011 Dam Angling crew.

METHODS

Project Area

In 2011, northern pikeminnow removal activities utilizing a Dam Angling crew were conducted by WDFW at The Dalles and John Day Dams on the Columbia River as a supplemental component to the NPMP (Figure 1). Dam Angling activities in 2011 were planned for a four month period originally scheduled to be from May 2nd (week 19) through the end of August (week 36), but high, turbid river flows in the second week of angling (week 20) created unfishable conditions and the decision was made to suspend dam angling activities until river conditions were more suitable. Full angling activities resumed in week 26 and the five weeks that were missed were added to the end of the season, extending dam angling activities to October 7th (week 42). At both The Dalles, and John Day Projects, all angling activities were conducted within the tailrace boat restricted zones where no public angling was permitted. At The Dalles Dam, the Dam Angling crew fished primarily along the turbine wall, near the ice-trash sluiceway and in the other highlighted areas in Figure 2. At the John Day Dam, the crew fished exclusively along the turbine wall (Figure 3).

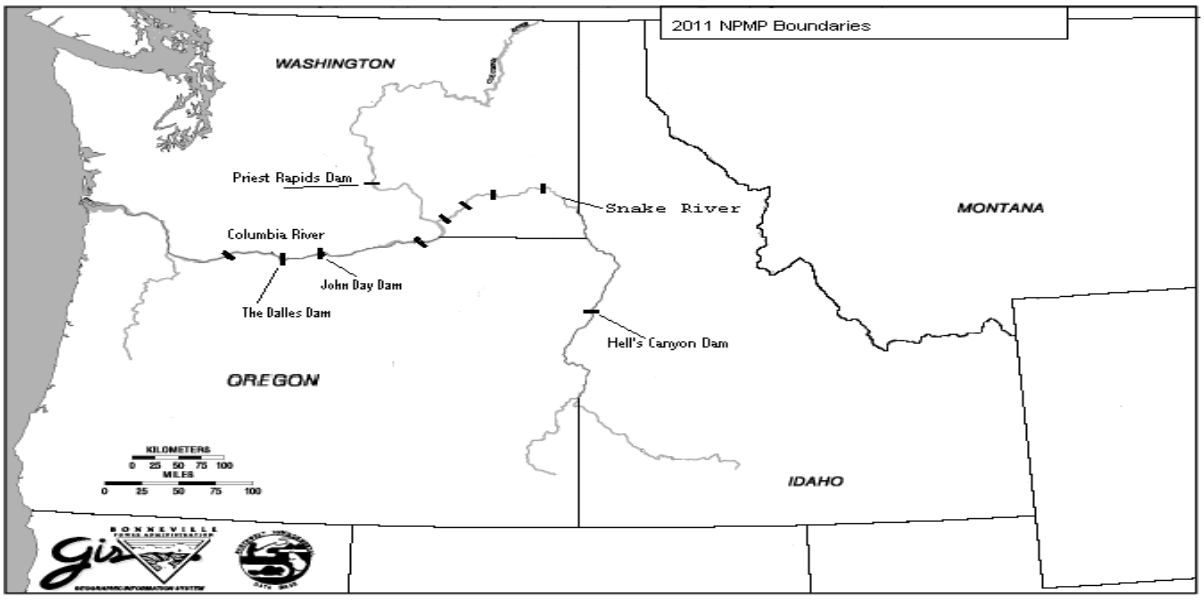

Figure 1. Northern Pikeminnow Management Program boundaries, including 2011 Dam Angling sites.

Figure 2. Angling locations for the 2011 Dam Angling crew at The Dalles Dam.

Figure 3. Angling locations for the 2011 Dam Angling crew at the John Day Dam.

The Dam Angling Crew

A four person angling crew worked either four ten hour days a week or five eight hour days per week depending on CPUE, and usually alternating days between the two dams. Shift start times (on site, actually fishing) varied from approximately 4:30 am to 6:00 am at The Dalles Dam and 5:00 am to 6:00 am at the John Day Dam. In addition to the four man angling crew, a crew leader was also present each day for angler safely and supervision, to collect and record data on northern pikeminnow harvest as well as biological data on other fish species, and to ensure adherence to project protocols.

Figure 4. The Dam Angling crew at The Dalles Dam.

Angling Gear

Dam anglers used Berkley Air IM8 Graphite 10'6" (2-8 oz. extra heavy casting) rods equipped with either Daiwa TD Luna 253 or Shimano Calcutta 400 series reels. Each reel was spooled with a 20# test braided main line (Power Pro), tied to a size 10 barrel swivel and a 24"-30" monofilament leader of 15-20# Maxima (Figure 5). For weight, a cannonball sinker was attached to the swivel using four to six inch dropper line of 12# monofilament leader. The cannonball sinker varied in weight from one to six ounces depending on river flow. Terminal gear consisted primarily of assorted soft plastic lures rigged with two octopus style hooks (size 1 to 1/0 Gamakatsu hooks) spaced 1 1/8" apart (Figure 6). Hook size varied in order to match the size of the soft plastic bait, with the soft plastic lure most preferred by the crew being a 3-5" tube bait. Other effective soft plastics were flukes, grubs and sassy shad in similar 3"-5" sizes.

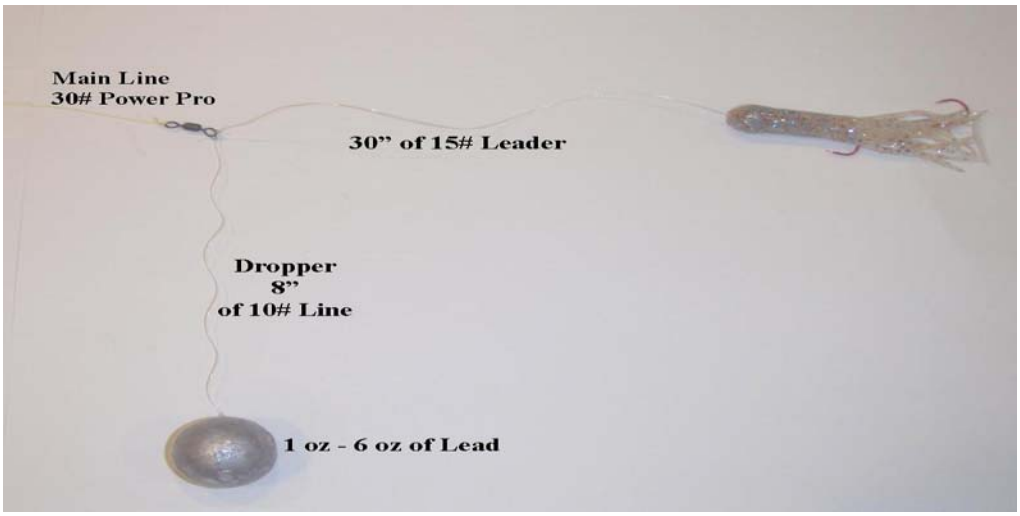

Figure 5. Example of typical rigging used by 2011 NPMP Dam Anglers.

Figure 6. Examples of soft Plastic lures and tube baits used by 2011 NPMP Dam Anglers.

DATA COLLECTION

Creel data were recorded for each individual angler for their day of angling and then the combined crew totals were summarized for either The Dalles Dam or the John Day Dam. Collected data included hours of effort per angler, northern pikeminnow harvest per angler, incidental catch per angler, location of all caught fishes by angler, and specific terminal gear (lure) used by angler. Weekly catch and harvest totals (by project) for Dam Anglers were submitted to PSMFC using a Weekly Field Activity Report (WFAR) as is done for the NPSRF.

Biological Sampling

Fork lengths (FL) and sex of all northern pikeminnow harvested by the Dam Angling crew were recorded on biological data sheets provided by the NPSRF. Technicians also examined all northern pikeminnow for the presence of external tags (spaghetti or dart), fin-clip marks, and signs of tag loss. Complete biological data were collected from all tag-loss and spaghetti tagged northern pikeminnow including FL, sex (determined by evisceration), and scale samples if specified. Spaghetti tagged and tag-loss northern pikeminnow carcasses were labeled and frozen for data verification and/or tag recovery at a later date. Spaghetti tags from harvested northern pikeminnow along with biological data were recorded on a tag envelope provided by the NPSRF and were submitted to ODFW for verification.

PIT Tag Detection

All northern pikeminnow collected by Dam Anglers during 2011 were also scanned for passive integrated transponder (PIT) tags. Northern pikeminnow harvested by anglers participating in the NPSRF have been found to ingest juvenile salmonids which have been PIT tagged by other studies within the basin (Glaser et al. 2000). In addition, PIT tags have also been used by ODFW as a secondary mark in all northern pikeminnow fitted with spaghetti tags (beginning in 2003) as part of the NPMP's biological evaluation activities (Takata and Koloszar 2004). Dam Angling technicians were required to scan 100% of all harvested northern pikeminnow for PIT tags using Destron Fearing portable transceiver systems (model #FS2001F). Technicians were also asked to scan incidental catch for PIT tags whenever possible and 100% of all incidentally caught smallmouth bass. Scanning began on the first day of angling and continued throughout the duration of Dam Angling activities. Technicians individually scanned all reward sized northern pikeminnow for PIT tag presence, and complete biological data were recorded from all pikeminnow with positive readings. All northern pikeminnow with PIT tags were labeled and preserved for later dissection and tag recovery. All PIT tag data were verified after recovery of PIT tags by WDFW personnel and all data were provided to ODFW and the Pit Tag Information System (PTAGIS) once verified.

Northern Pikeminnow Processing

During biological sampling, all northern pikeminnow were caudal clipped as an anti-fraud measure to eliminate the possibility of previously processed northern pikeminnow being resubmitted to the Sport-Reward Fishery for payment. 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

Combined John Day/Dalles Dam Angling Findings

Angling Gear and Techniques

Using the knowledge obtained during the 2010 Dam Angling Project, the Dam Angling crew targeted fishing areas at each dam that had been productive in 2010 (Hone et al. 2010). Early results confirmed that fishing in the currents created by specific turbines was essential to find and catch northern pikeminnow. Since the majority of angling activities were conducted off the turbine deck, the back bouncing technique developed in 2010 was once again the primary angling method used. The back bouncing method was the most effective way to present terminal gear as in most cases, maintaining contact with the bottom was critical for maximum pikeminnow harvest. Soft plastic tube baits again proved to be the Dam Angling crew's most effective lure, accounting for the vast majority of northern pikeminnow harvest in 2011. Specifically, the 3.75" dark smoke hologram and the smoke/black copper glitter Gitzit tube baits were the top two producers in 2011 (Table 1). Other productive soft plastics that were new to the top 10 compared to last season were the 3.75" Rainbow trout Gitzit, the 5" white pearl and smoking silver Zoom Super Flukes and the 4" pearl Sassy Shad. As was the case in 2010, dark colors tended to be more effective in low light conditions and larger sized lures worked better when water clarity was poor.

Table 1. Top 10 Northern Pikeminnow Lures used by 2011 WDFW Dam Angling Crew.

Northern Pikeminnow Lures

Brand/style	Size	Color	# N. Pikeminnow Caught
Gitzit/ tube bait	3.75"	Dark Smoke Hologram	999
Gitzit/ tube bait	3.75"	Smoke/Black Copper Glitter	915
Gitzit/ tube bait	3.75"	Bluegill	490
Gitzit/ tube bait	3.75"	Smoke Green Gold Glitter	329
Dry Creek/ tube bait	2.75"	Flash Minnow	252
Zoom/ Super Fluke	5"	White Pearl	248
Gitzit/ tube bait	3.75"	Rainbow Trout	234
Sassy Shad	4"	Pearl	181
Gitzit/ tube bait	3.75"	Smoke Silver Glitter	124
Zoom/ Super Fluke	5"	Smokin Silver	112

Angling Times

Time of day also made a difference when it came to Dam Angler harvest success during the 2011 season. Fishing results from the 2010 Dam Angling season indicated that morning hours were consistently the most productive times for harvest and that after 12:00 pm, harvest rates declined significantly (Table 2). Based on those results, WDFW Dam Anglers began the 2011 season fishing five days per week (8 hours/day) in order to maximize the hours spent fishing during those most productive hours before noon. After the high water event where the full Dam Angling crew did not fish during weeks 21-25, the crew returned to fishing four days per week (10 hours/day) through the remainder of the season. We also continued to do some limited test

fishing in evening hours (on occasion) and had some moderate success late in the 2011 season at the John Day Dam, indicating there may be cause for further investigation in the future.

Table 2. 2011 WDFW Dam Angler Harvest of Northern Pikeminnow by hour (TD and JD combined).

Hourly Northern Pikeminnow Harvest

Time of day	Harvest	% of Harvest
Prior to 6:00 am	459	10%
6:00 am – 7:00 am	597	13%
7:00 am – 8:00 am	683	15%
8:00 am – 9:00 am	626	14%
9:00 am – 10:00 am	583	13%
10:00 am – 11:00 am	583	13%
11:00 am – 12:00 pm	604	13%
12:00 pm – 1:00 pm	210	5%
After 1:00 pm	181	4%
Total	4,256	100%

Incidental Catch

The Dam Angling crew incidentally caught and released the fish species listed on Table 3 while targeting northern pikeminnow from The Dalles and John Day hydroelectric projects in 2011. Incidental species most often caught were smallmouth bass *Micropterus dolomieue,* white sturgeon *Acipenser transmontanus*, (and walleye *Sander vitreus* at the John Day Project). In addition, the Dam Angling crew once again noted large numbers of juvenile lamprey *Entosphenus* spp. and/or *Lampetra* spp. that were regurgitated by northern pikeminnow caught at The Dalles Dam during early May and when angling resumed in mid-June.

Table 3. 2011 WDFW Dam Angler Incidental Catch by project.

Incidental Catch

Species	The Dalles Dam	John Day Dam
Smallmouth Bass	79	283
White Sturgeon	39	145
Walleye	11	125
Peamouth	3	64
Sculpin	10	36
American Shad	0	32
Channel Catfish	0	19

Tag Recovery

All northern pikeminnow harvested by Dam Anglers in 2011 were examined for the presence of external spaghetti tags and individually scanned for the presence of PIT tags. Two northern pikeminnow with external ODFW spaghetti tags were recovered by the Dam Angling crew at The Dalles Dam in 2011, and two additional spaghetti tagged northern pikeminnow were caught at the John Day Dam. In addition, there were eight northern pikeminnow recovered that had lost spaghetti tags, but retained PIT tags implanted by ODFW as a secondary tag mark. All of these

PIT tagged fish were caught by the Dam Angling crew at the John Day Dam. The Dam Angling crew also recovered four PIT tags from salmonid smolts that had been ingested by northern pikeminnow for an occurrence rate of 1:1,132 compared to 1:2,505 for the Sport-Reward Fishery (Hone et al. 2011). Finally, the Dam Angling crew recovered six smallmouth bass with PIT tags (likely from an affiliated ODFW predation study), and these data were later provided to ODFW.

The Dalles Dam

Harvest

The four man angling crew harvested 1,204 northern pikeminnow during the sixteen weeks that they fished at The Dalles Dam compared to the 1,323 northern pikeminnow harvested during 16 weeks in 2010. Harvest for the Dam Angling crew averaged 75.25 fish per week (down from 83 fish per week in 2010) and ranged from 26 fish in week 26 (June 20-26) to 189 fish in week 30 (July 18-24) (Figure 7). Due to extremely high runoff which created unfishable conditions, the 2011 full Dam Angling crew did not fish at The Dalles Dam during weeks 21-25. Based on improving river conditions, test fishing was attempted during weeks 24 and 25, but only 5 northern pikeminnow were harvested in that two week period). The full Dam Angling crew was able to return to angling activities at The Dalles Dam in week 26, with limited success initially.

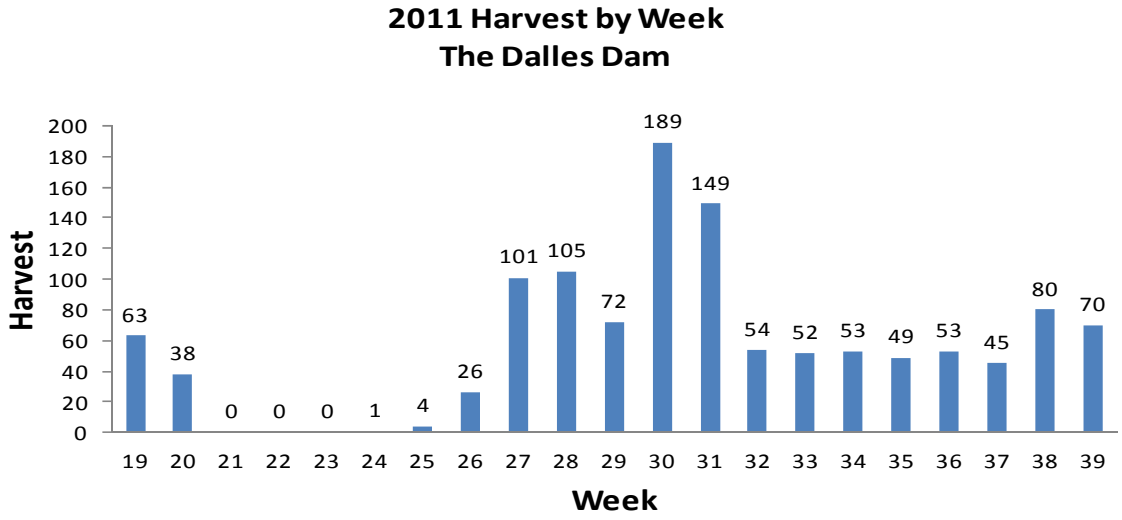

Figure 7. 2011 Weekly Dam Angler Harvest of Northern Pikeminnow at The Dalles Dam.

As you can see in Figure 8, weeks 21 through 25 corresponded with a period of high outflow at The Dalles Dam and harvest numbers for the Dam Angling crew did not really pick up until after flows dropped. Peak harvest for the Dam Angling crew at The Dalles Dam occurred the week of July 18th through 24th (week 30), one week later than peak harvest for the Sport-Reward Fishery (Winther et al. 2010).

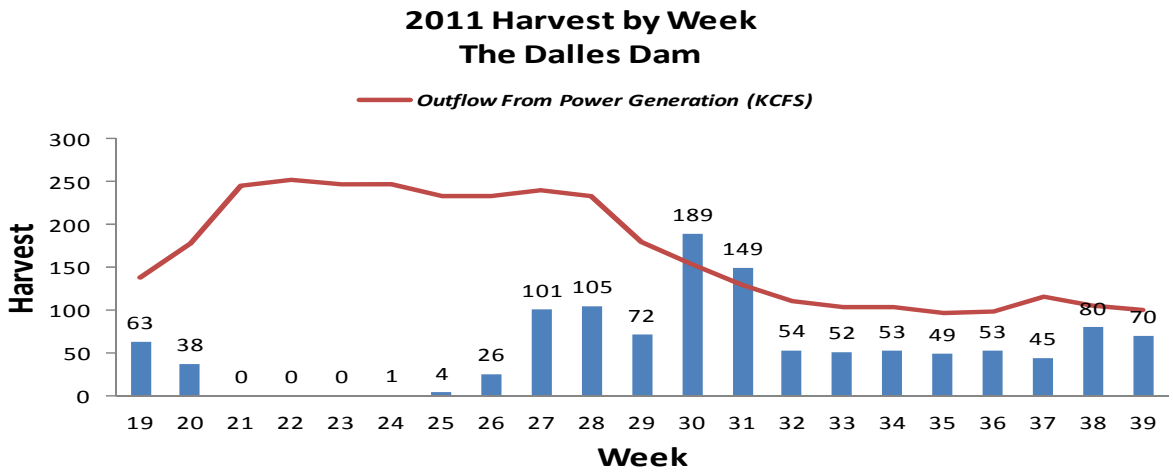

Figure 8. 2011 Weekly Northern Pikeminnow Harvest Compared to Outflow.

As was the case in 2010, certain areas and/or turbines at The Dalles Dam produced better harvest than others (Figure 9). Turbine 12 was the top producing turbine at The Dalles Dam with 17% of the harvest in 2011 compared to turbine 13 which had 18% of the harvest last season. In a change from what we saw in 2010, the area between Turbine 2 and the Ice/Trash Sluiceway accounted for 52% of the total northern pikeminnow harvest at The Dalles Dam in 2011. The specific area in front of the fishway (F) was also one of the better locations to harvest northern pikeminnow at The Dalles Dam in 2011 with 16% of total harvest. When we look at harvest over the course of the 2011 Dam Angling season, our harvest data once again indicates that there

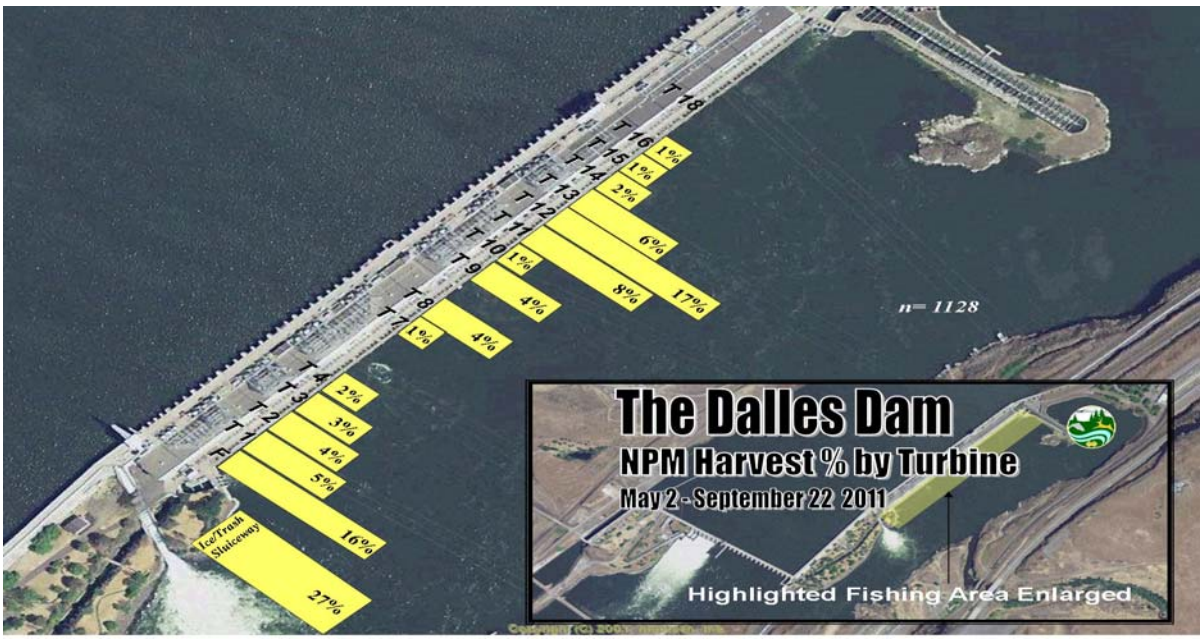

Figure 9. 2011 Overall Percent of Northern Pikeminnow Harvest by Area (T=turbine# , F = fishway).

was an obvious shift in the location of harvest as the season progressed (Figure 10). As was the case in 2010, in May and June nearly all harvest occurred between turbines 10-16 and there was no harvest at the sluiceway. In July and August, harvest shifted to the area around the fishway, and in September, harvest was once again somewhat spread out across the dam.

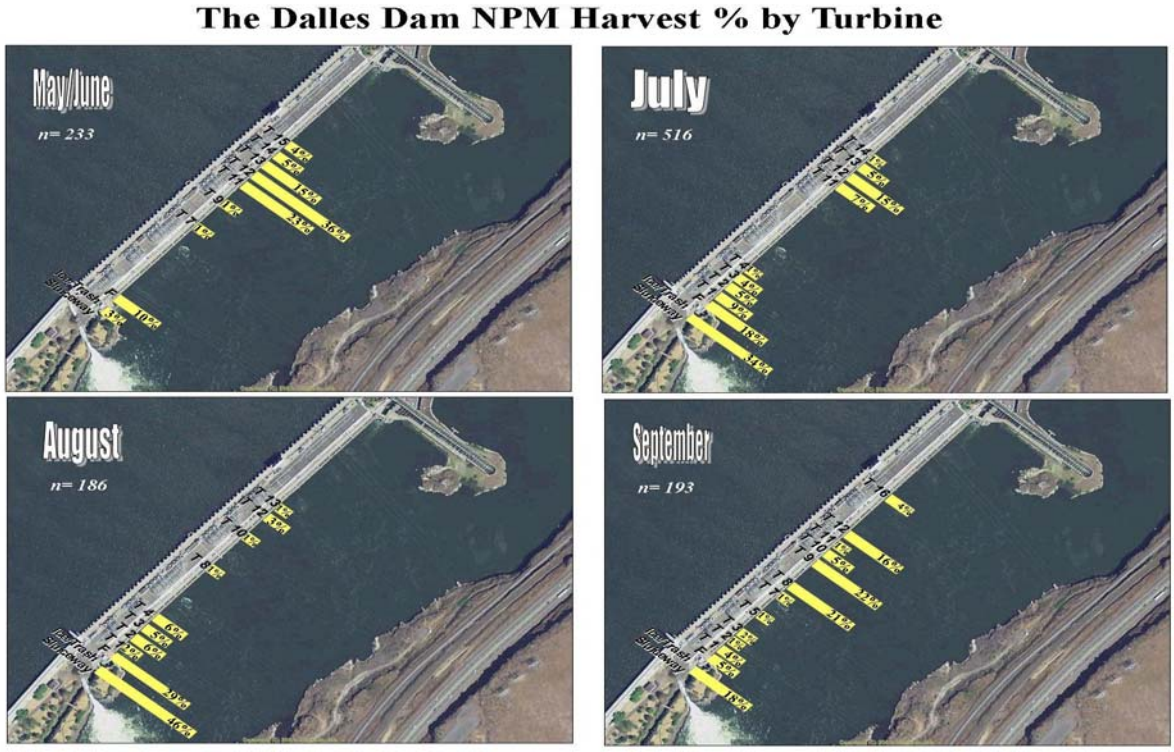

Figure 10. 2011 Monthly Harvest Percent by area (T=turbine# , F = fishway) at The Dalles Dam

CPUE

During the sixteen weeks that the Dam Angling crew conducted northern pikeminnow removal activities (harvesting 1,204 northern pikeminnow) at The Dalles Dam, the anglers fished 33 days, expending 754.4 total hours of effort for an average catch rate (CPUE) of 1.60 fish per angler per hour. Weekly CPUE (fish per hour) ranged from a high of 4.4 fish per angler hour in week 39 (Sept 19-25) (Figure 11), to a low of .6 fish per hour in week 26 when the full Dam Angling crew resumed activities after the high water period and the associated drop in water temperature and water clarity. High CPUE rates in week 30 corresponded to peak harvest in the Sport-Reward Fishery which typically occurs near the peak of northern pikeminnow spawning. The high late season CPUE rate in week 39 appeared to be related to increasing numbers of juvenile shad that were available as prey items during the first hour or two in the morning off of the turbine deck. If we look at CPUE rates for the 2011 Dam Angling season versus the 2010 season, we can see that some of the highest CPUE rates in 2010 came at a time of the season when the 2011 Dam Angling crew was unable to fish due to poor river conditions (Figure 12). If conditions would have been more conducive to angling, overall CPUE would likely have been closer to our target rate of 2.0 that had been established in 2010.

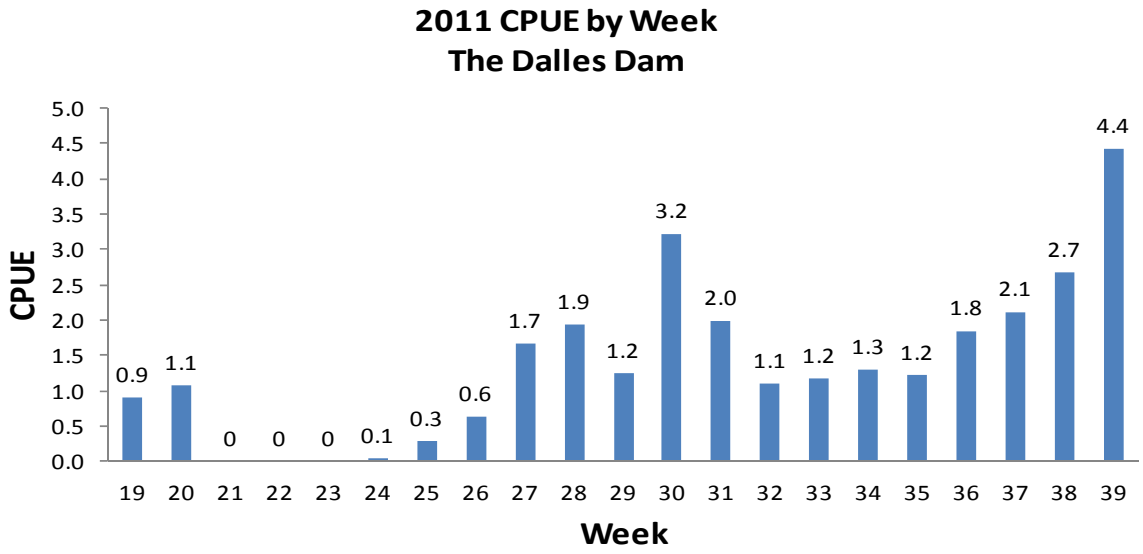

Figure 11. 2011 Weekly Dam Angler CPUE at The Dalles Dam.

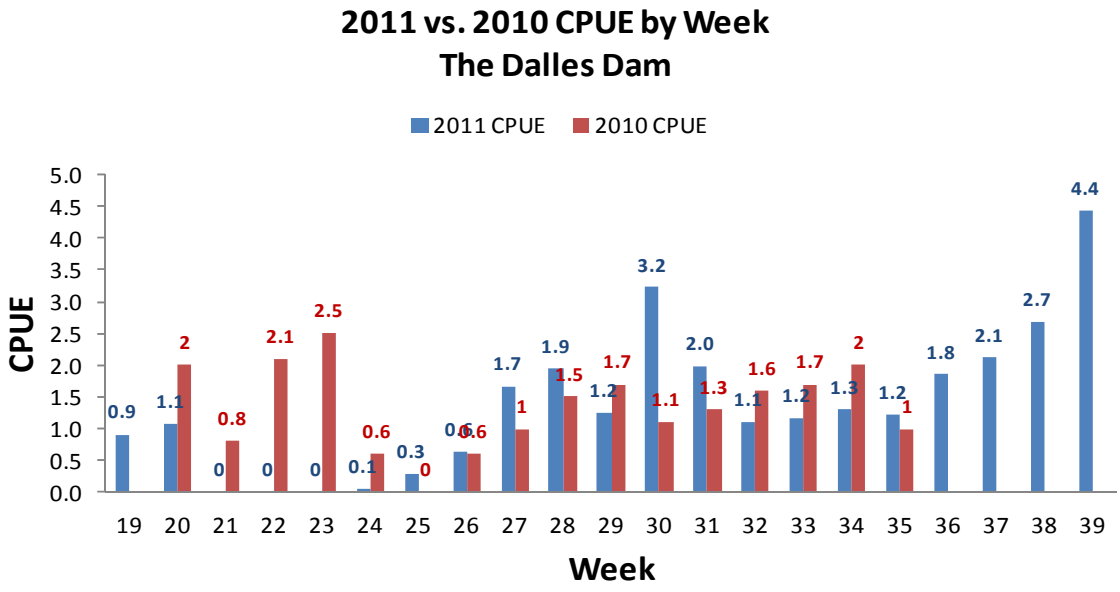

Figure 12. Weekly Dam Angler CPUE at The Dalles Dam in 2011 versus 2010.

Fork Length Data

Fork lengths were taken from 100% of all northern pikeminnow harvested during the 2011 Dam Angling Season. The length frequency distribution of harvested northern pikeminnow from The Dalles Dam in 2011 is presented in Figure 13. Mean fork length for all measured northern pikeminnow at The Dalles Dam in 2011 was 361.0 mm compared to 365.5 mm in 2010.

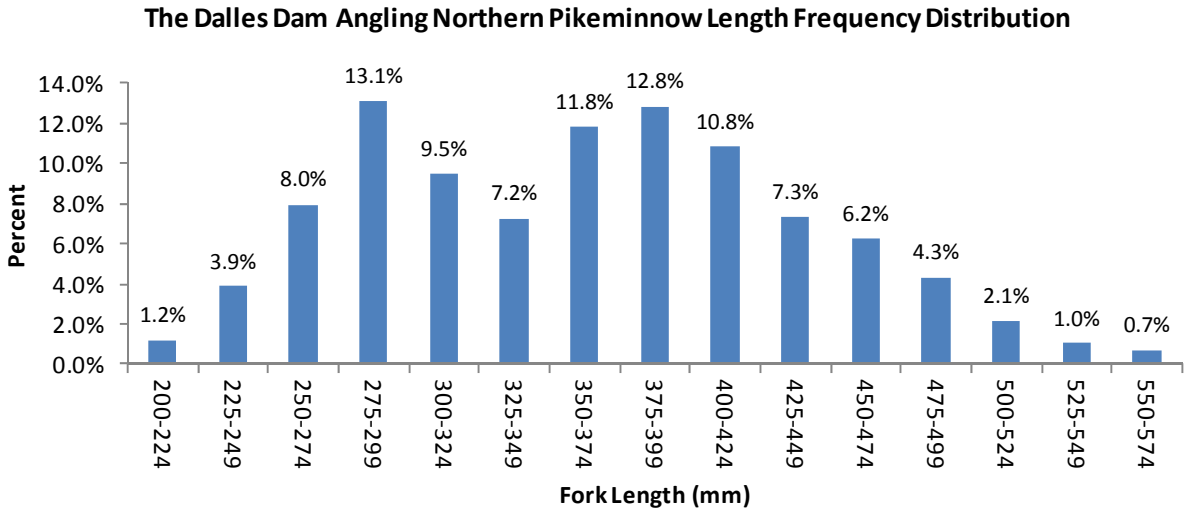

Figure 13. Northern pikeminnow Length Frequency Distribution at The Dalles dam in 2011 (N=1,204).

Incidental Catch

While the Dam Angling crew did not target smallmouth bass in their angling activities during 2011, incidental catch of smallmouth bass at The Dalles Dam did by occur. The Dam Angling crew caught 79 smallmouth bass at The Dalles Dam in 2011, primarily in area between the fishway (F) and the Ice/Trash Sluiceway (Figure 14). All smallmouth bass caught by the Dam Angling crew in 2011 were released. The inset in figure 14 also shows that smallmouth bass were most likely to be caught at The Dalles Dam by the Dam Angling crew in July and August.

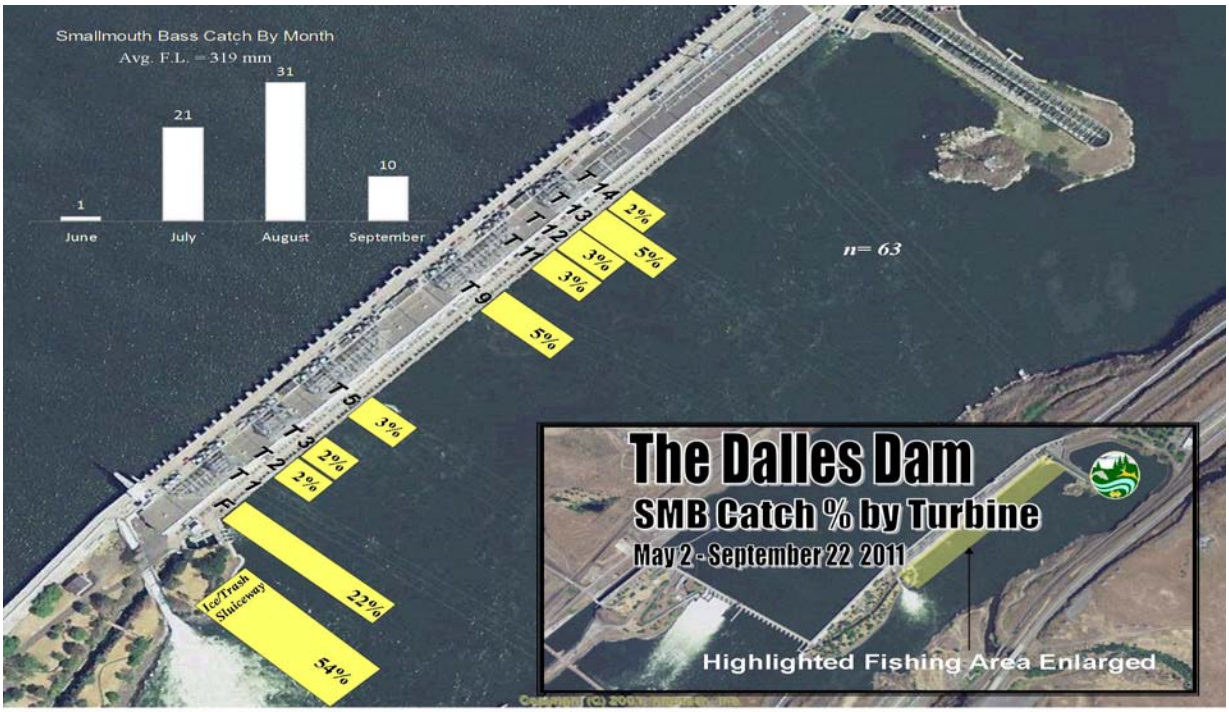

Figure 14. 2011 Incidental catch of smallmouth bass by Dam Angling crew at The Dalles Dam.

John Day Dam

Harvest

The Dam Angling crew harvested 3,322 northern pikeminnow from the John Day Dam during their 18 week season in 2011 compared to 2,675 northern pikeminnow harvested in 16 weeks during 2010. Harvest averaged 185 fish per week for the crew in 2011 (versus 167 fish/week in 2010) and ranged from a peak of 495 fish in week 37 (August 29-Sept 4) to 15 fish in week 26 (June 20-26) (Figure 15). As was the case at The Dalles Dam, the full Dam Angling crew did not fish at the John Day Dam weeks 20-25 due to high river levels and poor angling conditions. Missed angling weeks were added to the end of the season, pushing the final angling day at the John Day Dam to October 7th.

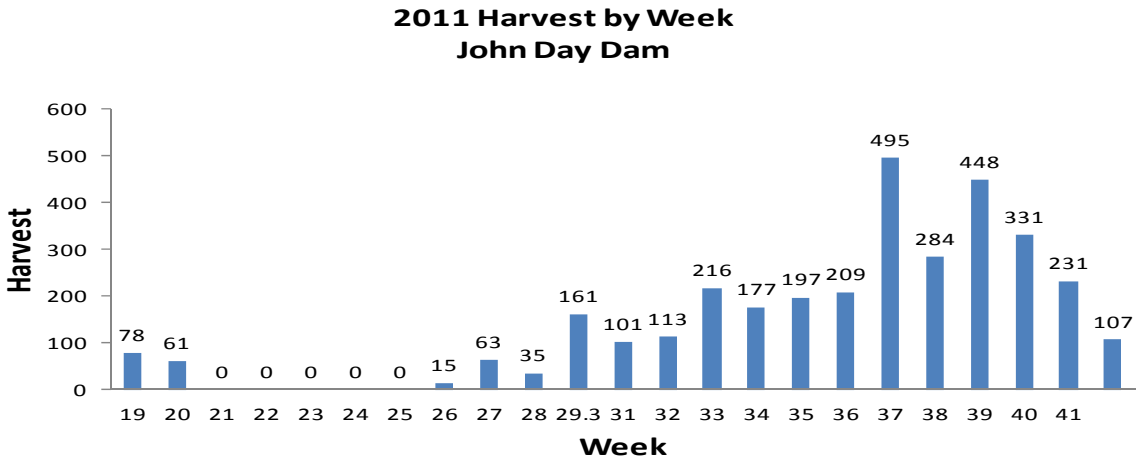

Figure 15. 2011 Weekly Dam Angler Harvest of Northern Pikeminnow at the John Day Dam.

As you can see in Figure 16, harvest at the John Day Dam did not pick up until after the high water from spring runoff in May and June had passed after week 26. Fortunately, some of the Dam Angling crew's best harvest days at the John Day Dam occurred late in the year during the weeks that were added to the end of the season in order to make up for those weeks lost due to high water.

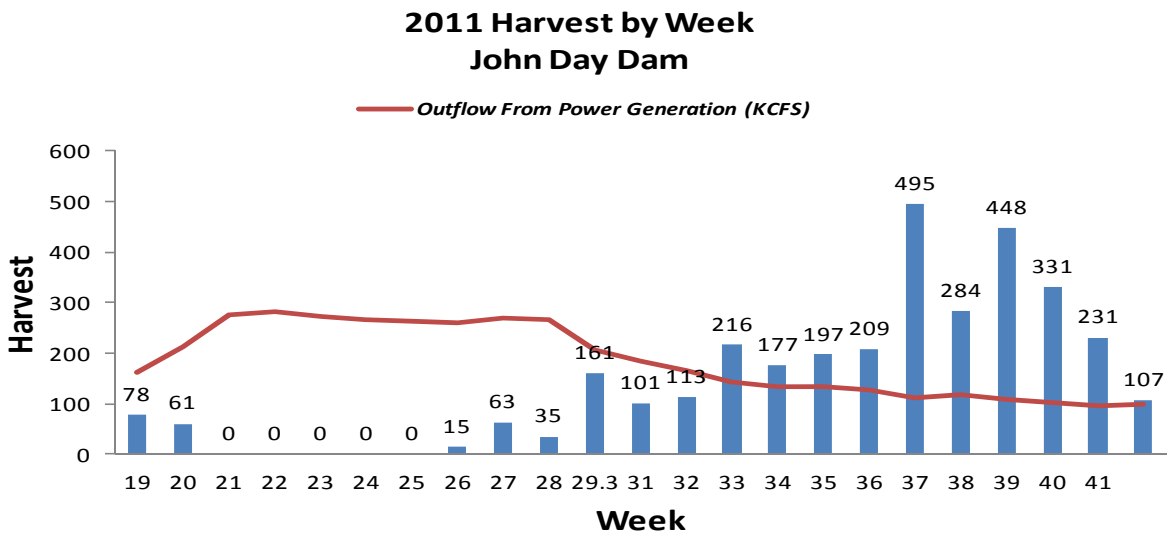

Figure 16. 2011 Weekly Dam Angler Harvest of Northern Pikeminnow at the John Day Dam vs. Outflow.

Just like at The Dalles dam, certain turbines at the John Day dam created water flows more favorable for harvesting northern pikeminnow. Of the total pikeminnow harvest at the John Day Dam in 2011, turbine #3 (T3) was the single best producing area with 20% of the total documented harvest (Figure 17). Turbine 5 (T5) had been the best location in 2010 with 22% of

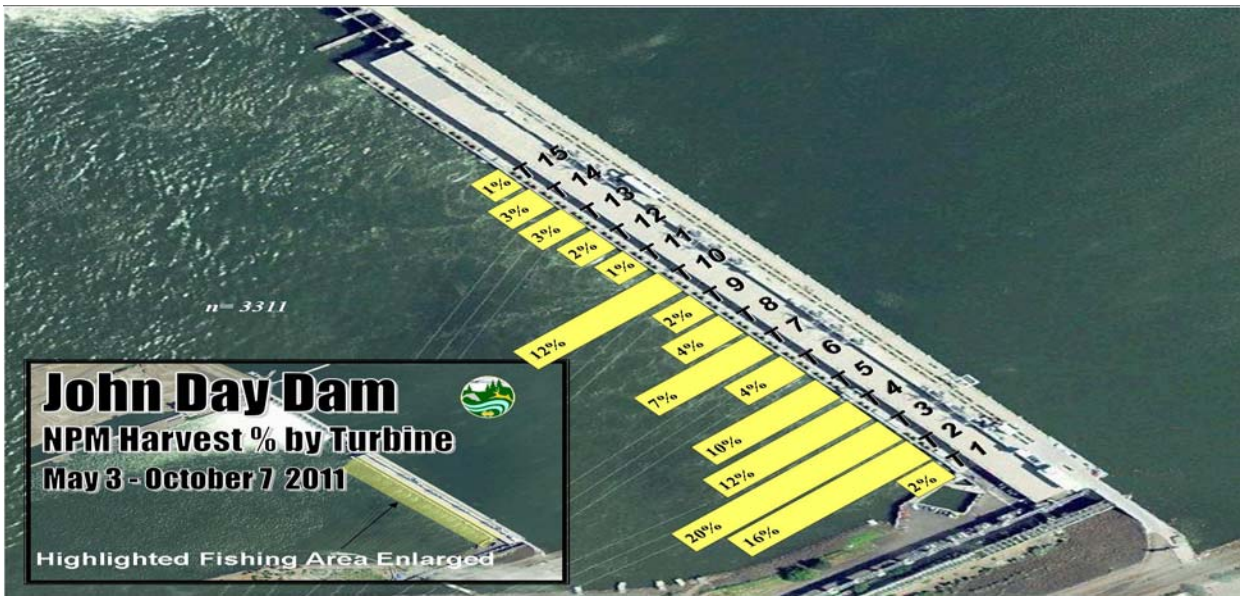

Figure 17. 2011 Overall Percent of Northern Pikeminnow Harvest by Area (T=turbine#)

harvest. Similar to what we saw in 2010, harvest also shifted away from the spillway and towards the Oregon shore over the course of the 2011 Dam Angling season. Early in the 2011 season (May and June) there was very little northern pikeminnow harvest coming from the corner area (turbines 1-4) while turbines 11-14 were producing well (Figure 18). In July and August, turbine 10 was the top harvest location and by September, most of the Dam Angling

crew's harvest of northern pikeminnow at the John Day Dam was coming from turbines 1-4 with virtually nothing coming from turbines 11-14.

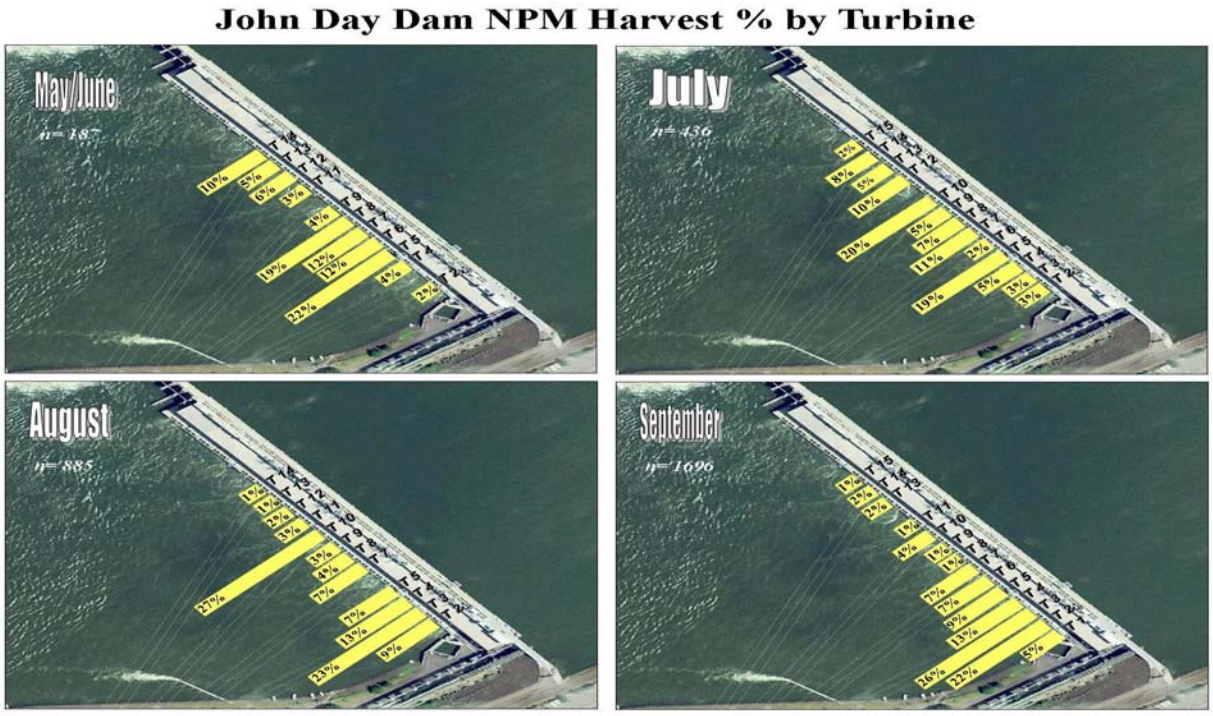

Figure 18. 2011 Monthly Percent of Northern Pikeminnow Harvest by area (T=turbine#)

CPUE

During the eighteen weeks that the Dam Angling crew fished at the John Day Dam, they fished 55 days and expended 1,296.1 total hours of effort for a CPUE of 2.56 northern pikeminnow per angler hour. In 2010, the Dam Angling crew fished 16 weeks (31 days), expending 882.4 hours of effort for a CPUE of 3.03 fish per angler hour. Weekly CPUE during the 2011 season ranged from a high of 5.4 in week 36 (August 22-28) to 0.7 in week 26 (June 20-26) (Figure 19). By temporarily suspending Dam Angling activities during high water period of weeks 20-25 and then rescheduling those activities for later in the year, the Dam Angling crew at the John Day Dam was able to take advantage of good CPUE rates in September 2011 which would have been missed if the original May through August schedule had been used.

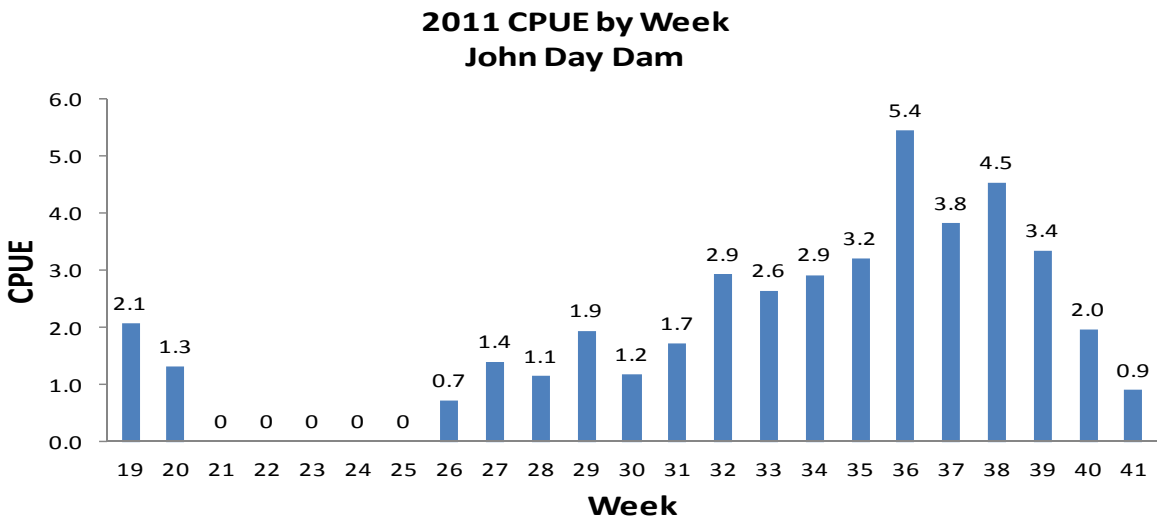

Figure 19. 2011 Weekly Dam Angling CPUE at John Day Dam.

When we look at weekly CPUE rates for the 2011 versus 2010 at the John Day Dam, we see that the 2011 weekly CPUE rates were considerably lower, and peaked later than in 2010 (Figure 20). We also see that the period of poor river conditions, where the crew was unable to fish was of much longer duration in 2011 than it was in 2010.

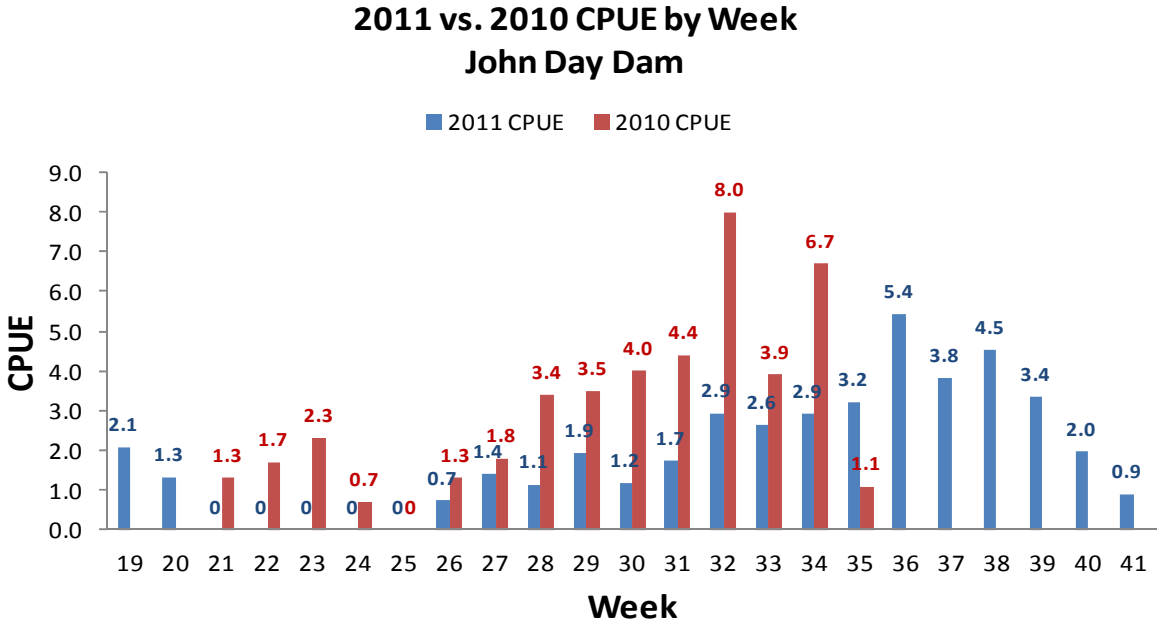

Figure 20. Weekly Dam Angler CPUE at the John Day Dam in 2011 versus 2010.

Fork Length Data

Fork lengths were taken from 100% of all northern pikeminnow harvested at the John Day Dam during the 2011 Dam Angling Season. The length frequency distribution of harvested northern pikeminnow from the John Day Dam in 2011 is presented in Figure 21. The mean fork length for all measured northern pikeminnow harvested from the John Day Dam in 2011 was 380.0 mm, compared to 368.9mm in 2010.

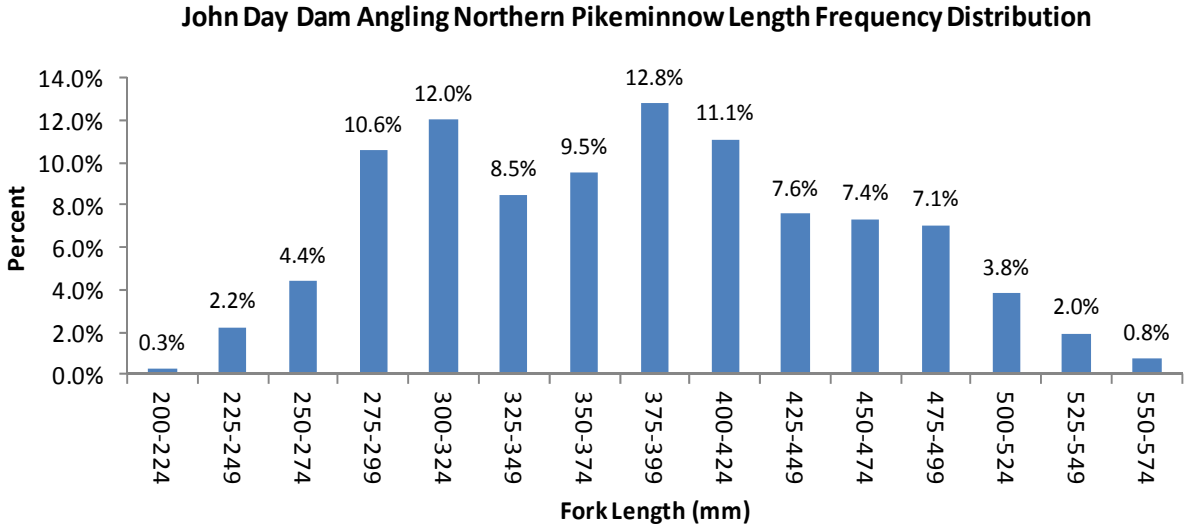

Figure 21. Northern pikeminnow Length Frequency Distribution at the John Day Dam in 2011 (N=3,322).

Incidental Catch

While the Dam Angling crew did not target smallmouth bass in their angling activities during 2011, incidental catch of smallmouth bass and walleye at the John Day Dam did by occur. The Dam Angling crew caught 283 smallmouth bass and 125 walleye at the John Day Dam in 2011. The largest numbers of smallmouth bass were caught between turbines 2-5 (Figure 22) and were most commonly caught in August and September as the inset in the upper right corner shows. Walleye were more likely to be caught by the Dam Angling crew all across the turbine deck, although turbine 10 was the best producer of walleye (Figure 23). The inset also shows that August was the month that the Dam Angling crew caught the most walleye in 2011. As was also the case at The Dalles Dam, all smallmouth bass and walleye caught by the Dam Angling crew in 2011 were released.

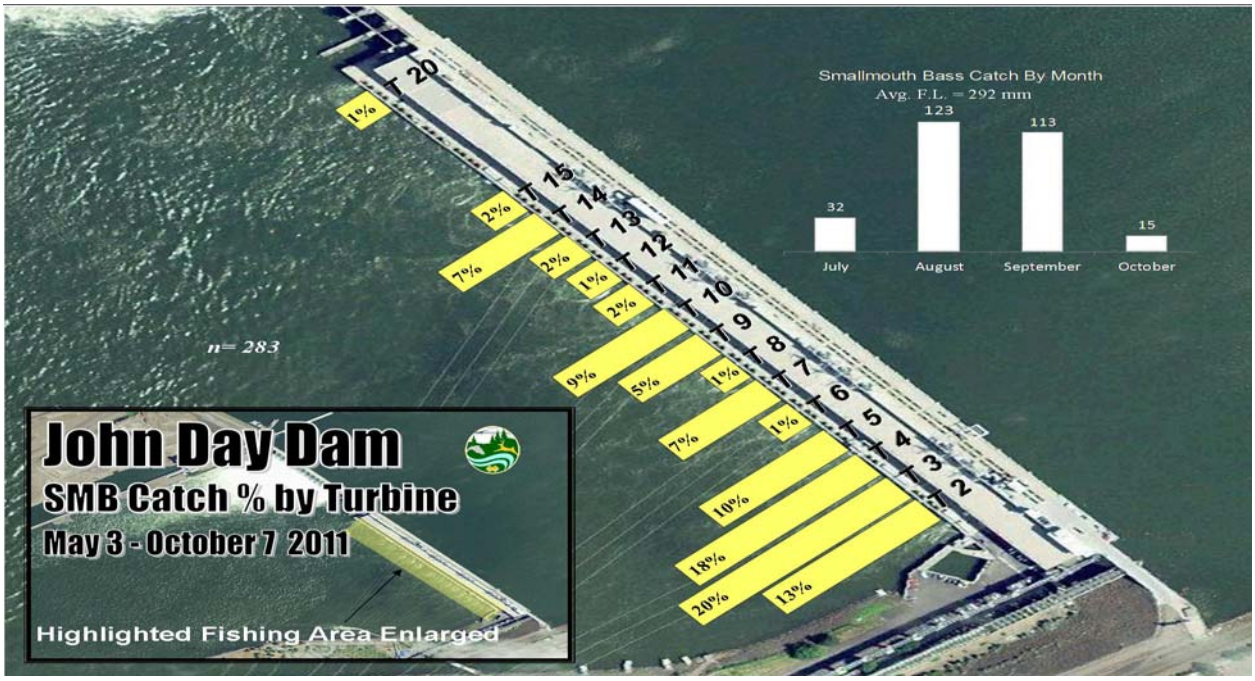

Figure 22. 2011 Incidental catch of smallmouth bass by Dam Angling crew at the John Day Dam.

SUMMARY

The second year of WDFW implementing the Dam Angling component of the NPMP at The Dalles and John Day dams had mixed results in 2011. On the positive side, overall combined harvest for The Dalles and John Day dams was up from 3,998 in 2010 to 4,526 in 2011. Overall CPUE was virtually the same (2.20 in 2010 vs. 2.21 in 2011), so the increase in harvest in 2011 was a product of spending more effort than last year (+233.7 hours in 2011). Five weeks of high water from spring runoff created unfishable conditions that would have severely crippled total 2011 harvest if those weeks had not been rescheduled to extend the season through September and into the first week of October. With the main objective of the 2011 Dam Angling component of the NPMP shifting towards maximizing harvest, we endeavored to maximize harvest by concentrating effort on the project which had the highest CPUE. Even though CPUE was down at the John Day Dam compared to 2010, it was still much higher than at The Dalles Dam so more angling effort was spent at the John Day Dam than at The Dalles Dam in 2011. With effort at The Dalles Dam lower, and CPUE only slightly higher, it was not surprising that harvest there was down from 2010. At the John Day Dam, CPUE was lower than in 2011, but increased effort resulted in higher harvest in 2011 than in 2010.

The Dam Angling component of the NPMP also recorded similar seasonal fluctuations in harvest and CPUE during the 2011 season related to turbine power generating activity, river flow and availability of prey species (salmonid smolts, juvenile lamprey, and juvenile shad). Angling techniques were similar to 2010 and consisted of back bouncing soft plastic (tube bait) lures in and around the currents created by select turbines. Noteworthy in 2011, was unexpected success fishing the rock pile between the fish ladder and the Ice/Trash Sluiceway at The Dalles Dam.

Fork length data from northern pikeminnow harvested by the Dam Angling component of the NPMP indicated that mean fork lengths of northern pikeminnow harvested at both The Dalles and John Day dams were considerably larger than the mean fork length of northern pikeminnow harvested in the Sport-Reward Fishery (361mm at The Dalles, 380mm John Day and 276mm in the SRF). Tag recovery data indicated that two spaghetti tagged northern pikeminnow were recovered at each project by the Dam Angling crew and that 8 additional northern pikeminnow with PIT tags and lost spaghetti tags were also recovered between the two projects.

The 2011 Dam Angling crew incidentally caught 362 smallmouth bass, 184 white sturgeon, and 136 walleye between the two projects while attempting to harvest northern pikeminnow. Of those, 283 of the smallmouth bass, 145 of the white sturgeon and 125 of the walleye were caught at the John Day Dam. The Dam Anglers also caught 4 northern pikeminnow that had ingested PIT tagged juvenile salmonids, and 6 smallmouth bass with PIT tags from a concurrently implemented ODFW predation study.

Given the extended period of difficult river conditions which occurred early in the 2011 season, harvesting more northern pikeminnow than in 2010 was quite noteworthy for the Dam Angling crew. Adjusting the schedule to adapt to changing river conditions (by moving angling to later in the season) was the key to achieving that success in 2011. Fishery data collected in 2011 will continue to allow us to better understand the Dam fishery and allow us to improve Dam Angler effectiveness and overall project efficiency.

RECOMMENDATIONS FOR 2012

1.) Continue to implement Dam Angling component the NPMP in order to remove predatory northern pikeminnow from the Boat Restricted Zones in the tailrace areas of The Dalles and John Day dams where participants in the Northern Pikeminnow Sport-Reward Fishery are not able to access.

2.) Plan for Dam Angling activities to occur during similar times of year as the 2011 NPSRF in order to take advantage of fishery knowledge gained during over the 2010 and 2011 Dam Angling seasons as related to maximizing harvest.

3.) Continue to improve data collection in the area of PIT tag scanning other incidentally caught predator fishes, and in enumerating juvenile lamprey regurgitated by northern pikeminnow caught by Dam Anglers in 2012.

4.) Continue to investigate and further develop northern pikeminnow angling techniques in 2012 that will improve Dam Angler CPUE and/or allow exploitation of northern pikeminnow in areas not currently fishable.

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We appreciate the efforts of Bill Fleenor, our Dam Angling crew leader, along with the efforts of Ray Lais, Steve Lines, Scott Mengis and Tim Miller who made up our 2011 dam angling crew.

We also recognize Diana Murillo and Dennis Werlau for their work in data entry and document verification, and Melissa Dexheimer for producing our weekly field activity reports throughout the season.

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