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

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CONTENTS

ABSTRACT

Predator control fisheries aimed at reducing predation on juvenile salmonids by northern pikeminnow *Ptychocheilus oregonensis* were implemented for the tenth consecutive year in the mainstem Columbia and Snake rivers. We report on (1) exploitation rates of northern pikeminnow and catch rates of incidental fishes among the three management fisheries in 2000, (2) estimated reductions in predation on juvenile salmonids since implementation of the fisheries, (3) estimated tag loss rates for two types of tags and their relative effectiveness, and (4) validation of aging methodology for northern pikeminnow based on scale readings.

System-wide exploitation of northern pikeminnow ≥ 250 mm fork length (FL) was 11.9% for sport-reward, 0.0% for dam angling, and 0.0% for site-specific gillnet fisheries. For northern pikeminnow 200-249 mm FL, system-wide exploitation was 6.6% in the sport-reward fishery, 0.4% in the dam angling fishery, and 0.0% in the site-specific fishery. System-wide exploitation of all northern pikeminnow ≥ 200 mm was 10.9% for sport-reward, 0.1% for dam angling, and 0.0% for the site-specific fishery. Among reservoirs/river areas, exploitation of northern pikeminnow ≥ 200 mm by the sport-reward fishery was highest in Bonneville, McNary (including the Hanford Reach), Little Goose, and Lower Granite reservoirs, as well as the area downstream of Bonneville Dam. Mean length of northern pikeminnow harvested in the site-specific gillnet and dam angling fisheries exceeded that of fish in the sport-reward fishery.

Incidental fish composed 29.4% of the catch by sport-reward anglers targeting northern pikeminnow, 6.2% of the dam angling catch, and 51.6% of the site-specific gillnet catch. The proportion of the northern pikeminnow catch consisting of predator-sized (≥ 200 mm FL) fish was highest in the dam angling (100%) and gillnet (100%) fisheries, and lowest in the sport-reward fishery (86.5%). The incidental catch of salmonids by all fisheries combined comprised 0.3% of the total catch.

Assuming system-wide exploitation of northern pikeminnow remains constant through 2006, we estimate that juvenile salmonid predation will be held to 77% of levels estimated prior to implementation of predator control fisheries. If exploitation decreases to below mean 1994-2000 levels, potential predation may increase in the future.

Within-season tag loss was estimated to be 2.6% for spaghetti tags and 33.3% for dart tags. We concluded that spaghetti tags were a more effective means of tagging northern pikeminnow.

The rate of agreement between two readings for independent age assignments of northern pikeminnow scales was 39%, but increased to 84% with a margin of error of ± one year. This level of precision is probably adequate for assessing changes in relative age structure in the northern pikeminnow population.

INTRODUCTION

The goal of the Northern Pikeminnow Management Program (NPMP) is to reduce mainstem mortality of juvenile salmonids attributed to predation by northern pikeminnow *Ptychocheilus oregonensis* in the lower Columbia River Basin. We established baseline levels of predation and described northern pikeminnow population characteristics prior to the implementation of sustained predator control fisheries by estimating abundance, consumption, and predation in Columbia River reservoirs in 1990 and 1993, Snake River reservoirs in 1991, and the unimpounded lower Columbia River downstream from Bonneville Dam in 1992 (Ward et al. 1995). From 1994 to 1996, we sampled in areas where sufficient numbers of northern pikeminnow could be collected to compare changes in predation among years (Zimmerman and Ward 1999). Ward (1998) provided a comprehensive summary of NPMP evaluation from 1990 to 1996. In this report, we describe our activities and findings for 2000, and wherever possible, evaluate changes from previous years.

Our objectives in 2000 were to (1) evaluate the relative efficiency of each northern pikeminnow fishery by comparing exploitation rate and incidental catch, (2) estimate reductions in predation on juvenile salmonids since implementation of the NPMP, (3) estimate tag loss rates for two types of tags and evaluate their relative effectiveness, and (4) validate aging methods through collection and reading of scale samples from tagged and recaptured northern pikeminnow. The later two objectives were included based on the recommendations of an independent review of the NPMP (Hankin and Richards 2000).

METHODS

Fishery Evaluation, Predation Estimates, and Tag Loss

Field Procedures

Three northern pikeminnow fisheries were conducted in 2000. The sport-reward fishery was implemented by the Washington Department of Fish and Wildlife (WDFW) from May 15 to October 15 throughout the lower Columbia and Snake rivers. This year, for the first time, northern pikeminnow as small as 9 inches (228 mm) total length (TL) (approximately equivalent to 200 mm FL) were eligible for a reward. The dam angling fishery was implemented by the Yakama Nation from June 12 to October 5 at Bonneville, The Dalles, and John Day dams. A site-specific gillnet fishery was implemented by the Yakama Nation and Nez Perce Tribe from May 15 to June 11 in Bonneville, McNary, and Lower Granite reservoirs. Both the dam angling and site-specific gillnet fisheries also targeted northern pikeminnow ≥ 228 mm TL.

We tagged and released northern pikeminnow ≥ 200 mm FL to estimate exploitation rates for each fishery. We used electrofishing boats and bottom gillnets to collect northern pikeminnow from April 6 to June 22. A detailed description of sampling gears and methods is given in Parker et al. (1995). We allocated equal sampling effort in all river kilometers (RKm), with few exceptions, from RKm 78 through RKm 634 (Priest Rapids Dam tailrace) on the Columbia River, and on the Snake River from RKm 72 to RKm 171 and RKm 190 to RKm 246

(downstream of the Grande Ronde River mouth). In the Columbia River, and Snake River downstream of Lower Granite Dam, northern pikeminnow ≥ 200 mm FL were tagged with a serially-numbered spaghetti tag. Above Lower Granite Dam, northern pikeminnow ≥ 200 mm FL were tagged with a serially-numbered dart tag. To evaluate tag loss rates, we clipped the left ventral fins on all tagged fish.

Data Analysis

We used mark-and-recapture data to compare exploitation rates of northern pikeminnow ≥ 200 mm FL among fisheries and reservoirs in 2000. Weekly estimates of exploitation for each fishery were calculated by dividing the number of tagged northern pikeminnow recovered (including fish tagged in 2000 that had lost their tags) by the number of tagged fish at large and summed to yield total exploitation rates (Beamesderfer et al. 1987).

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

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

where

m = the mean number of tagged fish recovered per week (Elliott 1977), and
n = the number of sampling weeks remaining.

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

We compared incidental catch among fisheries by calculating the percent of the total catch composed of fish other than northern pikeminnow ≥ 200 mm FL. We also estimated the proportion of predator-sized northern pikeminnow (≥ 200 mm FL) relative to the total northern pikeminnow catch, and the catch rate of salmonids in each fishery.

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

We estimated the potential relative predation in 2000 based on observed exploitation rates, and the eventual minimum potential predation assuming continuing exploitation at mean 1994-2000 levels. Because inputs to the model included three potential relationships between

age of northern pikeminnow and consumption, and three estimates of exploitation (point estimate plus confidence limits), we computed nine estimates of relative predation for each year (Friesen and Ward 1999). We report the maximum, median, and minimum estimates.

To estimate tag loss, we used the formula

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

where

L = percent tag loss,
m = number of northern pikeminnow recaptured with missing tags and left ventral fin clips, and
r = number of northern pikeminnow recaptured with year 2000 tags intact.

We estimated tag loss separately for the spaghetti and dart tags; therefore, the dataset for each tag type only included the areas where each tag type was applied. Because approximately 24 river kilometers and a dam (Lower Granite) separated the areas where different tags were used, we believe it unlikely that any mixing of tag groups occurred.

Age Validation

Field and Laboratory Procedures

We collected scale samples from all northern pikeminnow that we tagged. In addition, WDFW personnel collected scale samples from tagged northern pikeminnow recaptured in the sport-reward fishery. Scales were cleaned, mounted, and pressed onto acetate sheets for viewing on a microfiche reader. Methods of age determination were described by Parker et al. (1995). Scales were read independently by two people and we kept track of the number of times that the readers disagreed on an age. Age differences were resolved by the two readers re-viewing the scale in question together until they agreed on a final age.

Data Analysis

We compared assigned ages of scales collected at the time of tagging and recapture to identify discrepancies in age identification. For example, northern pikeminnow tagged in 2000 and recaptured in the same year should theoretically be assigned the same age at recapture and tagging because less than a full year had elapsed. Different ages assigned to the same fish at tagging and recapture in 2000 were considered an aging discrepancy. When discrepancies occurred, we noted the number of years that the ages differed and whether ages were overestimated or underestimated.

RESULTS

Fishery Evaluation, Predation Estimates, and Tag Loss

We tagged and released 1,218 northern pikeminnow throughout the lower Columbia and Snake rivers in 2000. Two hundred and forty-two of these fish were 200 to 249 mm FL and 976 were ≥ 250 mm FL. A total of 123 northern pikeminnow tagged in 2000 were recaptured in the three fisheries: 122 in the sport-reward fishery, 1 in the dam-angling fishery, and 0 in the site-specific gillnet fishery. Of these 123 recaptures, 16 were 200-249 mm and 107 were ≥ 250 mm.

System-wide exploitation of northern pikeminnow ≥ 200 mm by all fisheries combined in 2000 was 11.0% (95% confidence interval of 6.8% to 16.8%), and reservoir/area-specific exploitation ranged from 12.7% in Bonneville Reservoir to 0.0% in John Day Reservoir. The system-wide exploitation rate on northern pikeminnow 200-249 mm by all fisheries was 7.1% (confidence interval not available due to mn < 30), and ranged from a high of 33.3% in McNary Reservoir to a low of 0.0% in The Dalles, John Day, Lower Monumental, and Little Goose reservoirs. For northern pikeminnow ≥ 250 mm, all fisheries combined had a system-wide exploitation rate of 11.9% (95% confidence interval of 7.3% to 19.1%), ranging from 16.7% in Lower Monumental and Little Goose reservoirs to 0.0% in John Day Reservoir (Figure 1; Appendix A).

System-wide exploitation of northern pikeminnow ≥ 200 mm FL by the sport-reward fishery was 10.9% in 2000. Exploitation on these fish ranged from a high of 12.4% in Bonneville Reservoir to a low of 0.0% in John Day Reservoir. Sport-reward exploitation of northern pikeminnow 200-249 mm was 6.6% system-wide. The range in reservoir/area-specific exploitation rates for these fish by the sport-reward fishery was similar to that for all fisheries combined because the vast majority of tagged northern pikeminnow were recaptured in the sport-reward fishery. For northern pikeminnow ≥ 250 mm, sport-reward exploitation was the same as that stated for all fisheries combined (11.9%) and had the same range of reservoir/area exploitation rates (Figure 1; Appendix A). John Day Reservoir was the only reservoir/area in which no year 2000-tagged northern pikeminnow were recaptured by the sport-reward fishery. Mean length of northern pikeminnow harvested in the sport-reward fishery (including only those eligible for reward payment) was 290 mm FL (M. Wachtel, WDFW, personal communication).

Only one tagged northern pikeminnow was recaptured in the dam angling fishery in 2000. This fish was caught in Bonneville Reservoir and was in the 200-249 mm size class. The system-wide exploitation rate on these fish by the dam angling fishery was estimated to be 0.4%. Because no tagged northern pikeminnow ≥ 250 mm were recaptured in this fishery,

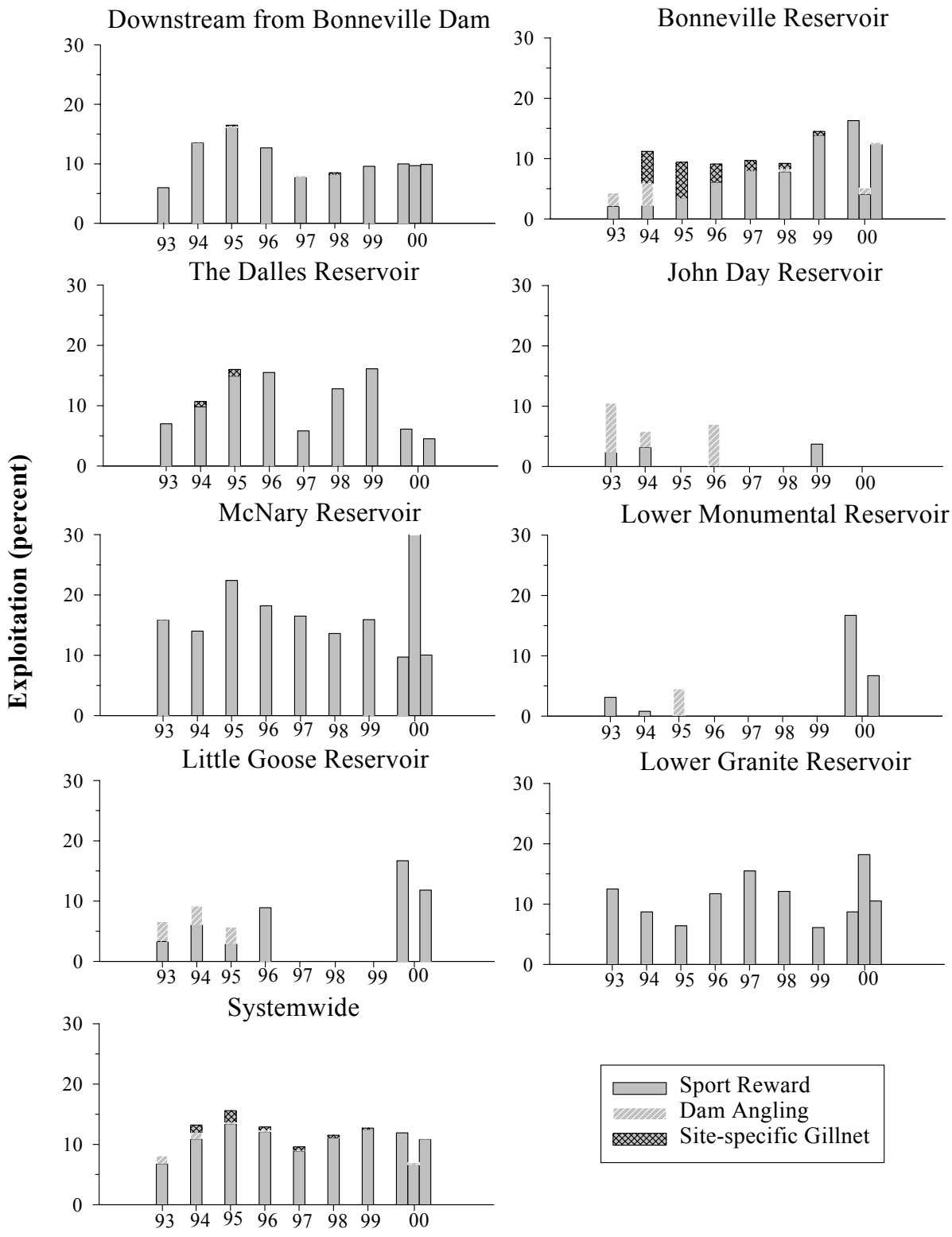

Figure 1. Exploitation of northern pikeminnow ≥ 250 mm fork length (FL) by reservoir/area and fishery, 1993-2000. For 2000, vertical bars, from left to right, show exploitation for northern pikeminnow ≥ 250 mm FL, 200-249 mm FL, and ≥ 200 mm FL.

overall exploitation of northern pikeminnow ≥ 200 mm was slightly lower at 0.1% (Figure 1; Appendix A). Northern pikeminnow were not measured in the dam angling fishery in 2000; therefore, mean size of harvested fish was unknown.

No tagged northern pikeminnow were recaptured by the site-specific gillnet fishery in 2000 (Figure 1; Appendix A). For the site-specific fishery, mean length of harvested northern pikeminnow was 363 mm FL (R. Beaty, CRITFC, personal communication).

Appendix Tables A-5 through A-7 show weekly system-wide exploitation rates for the various fisheries. Weekly exploitation rates are also presented in Appendix Tables A-8 through A-11 for John Day and McNary reservoirs (including Hanford Reach), where tagging and fishing occurred simultaneously.

In 2000, the three management fisheries reported a total incidental catch of 79,352 fish, including northern pikeminnow < 200 mm FL (Table 1). The most common incidental fishes were northern pikeminnow < 200 mm, other cyprinids, centrarchids, ictalurids, catostomids, and white sturgeon *Acipenser transmontanus*. The incidental catch rate was 29.4% for anglers who targeted northern pikeminnow in the sport-reward fishery, 6.2% in the dam angling fishery, and 51.6% in the site-specific gillnet fishery. The proportion of the northern pikeminnow catch consisting of predator-sized (≥ 200 mm) fish was highest in the site-specific gillnet and dam angling fisheries (100%), and lowest in the sport-reward fishery (86.5%). In the sport-reward fishery, 0.3% of the total catch consisted of salmonids. Salmonids made up 2.3% of the total catch in the site-specific gillnet fishery. No salmonids were caught in the dam angling fishery. For all fisheries combined, salmonids made up 0.3% of the total catch.

Modeling results indicate that potential predation by northern pikeminnow on juvenile salmonids in 2000 ranged from 64% to 89% of pre-program levels, with a median estimate of 77% (Figure 2). Continued harvest at mean 1994-2000 exploitation levels will result in minimal additional reductions in predation.

The within-year loss rate of spaghetti tags was 2.6% (97.4% retention). We tagged 1,161 northern pikeminnow with spaghetti tags and recaptured 117 (after 3-185 days at large), of which 3 had lost tags. For dart tags, the within-year loss rate was 33.3% (66.7% retention). We tagged 57 northern pikeminnow with dart tags and recaptured 6 (after 6-60 days at large), of which 2 had lost tags. Therefore, we found the spaghetti tags to be more effective for tagging northern pikeminnow.

Age Validation

Agreement on initial ages assigned to tagged and recaptured northern pikeminnow averaged 60% between the two scale readers. Most disagreements consisted of a one-year difference. When final ages assigned to scales collected at tagging were compared to final ages assigned to scales collected at recapture for the same fish, the two ages matched exactly

Table 1. Number of northern pikeminnow and incidental fishes in each fishery in 2000. Northern pikeminnow < 200 mm fork length (FL) are considered incidental catch. Sport-reward

catches of incidentals are estimates based upon exit surveys of anglers who targeted northern pikeminnow.

Species or family	Sport-reward	Dam angling	Gillnet
Northern pikeminnow			
≥ 200 mm FL	189,054	423	557
< 200 mm FL	29,578	0[a]	0
Salmonidae			
Chinook (adult/jack)	73	0	4
Coho (adult/jack)	4	0	0
Sockeye (adult)	3	0	1
Steelhead (adult)	65	0	15
Cutthroat trout	34	0	0
Juvenile salmon/steelhead	206	0	1
All other salmonids[b]	327	0	5
White sturgeon	4,572	2	57
Walleye	325	0	2
Smallmouth bass	6,020	--[c]	--[c]
Yellow perch	1,205	0	0
American shad	559	0	10
Cyprinidae[d]	26,121	0	98
Catostomidae	2,289	0	266
Ictaluridae	3,563	0	87
Centrarchidae	269[e]	26	22
Other/unidentified	3,516	0	27
Total (all species)	267,783	451	1,152
Percent incidental catch	29.4	6.2	51.6

[a] Estimate based on 1999 catch proportion. Northern pikeminnow were not measured in 2000.
[b] Includes juveniles and adults of *Oncorhynchus* spp., *Salvelinus* spp., and mountain whitefish *Prosopium williamsoni*.
[c] Included in centrarchidae catch.
[d] Excluding northern pikeminnow.
[e] Excluding smallmouth bass.

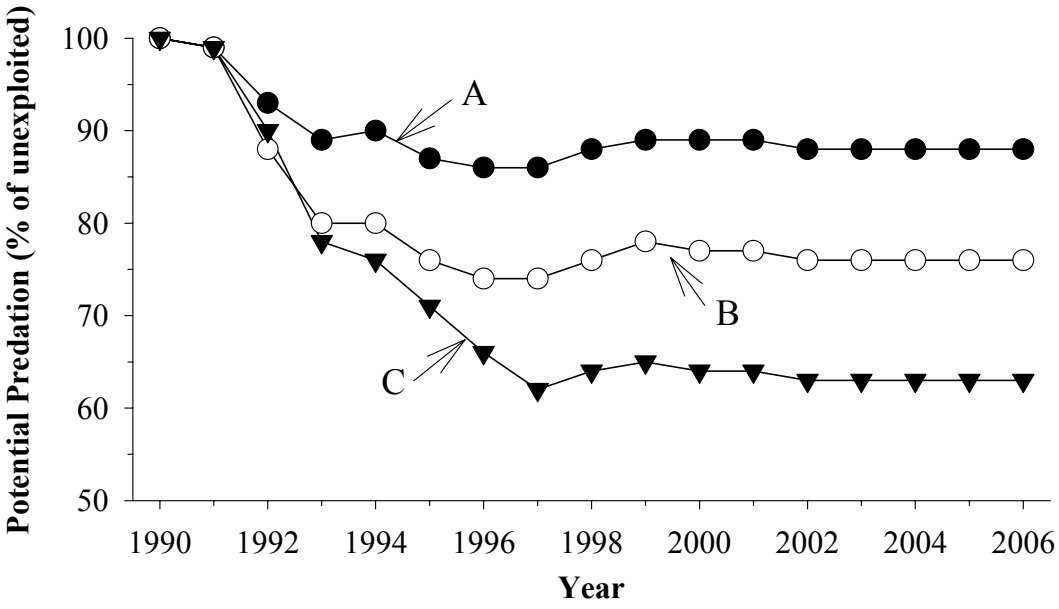

Figure 2. Maximum (A), median (B), and minimum (C) estimates of potential predation on juvenile salmonids by northern pikeminnow relative to predation prior to implementation of the northern pikeminnow management program. Trends after 2000 indicate predicted predation in future years if exploitation is maintained at mean 1994-2000 levels.

(ie. zero discrepancy) 39% of the time (Figure 3). However, agreement within ± one year occurred 84% of the time. The most common discrepancy was to overestimate by one year the "target" age of the fish on the scales collected at tagging relative to those collected at recapture.

DISCUSSION

System-wide exploitation of northern pikeminnow ≥ 250 mm by the three management fisheries in 2000 matched the 11.9% mean exploitation rate for the period 1993-1999. The 2000 exploitation rate was slightly lower than the 12.7% exploitation rate in 1999, reversing a modest increasing trend since 1997 (Figure 1). Exploitation of northern pikeminnow ≥ 250 mm by all fisheries combined increased from 1999 levels in the area below Bonneville Dam and in Bonneville, Lower Monumental, Little Goose, and Lower Granite reservoirs. In particular, exploitation in Lower Monumental and Little Goose reservoirs had been 0% for the

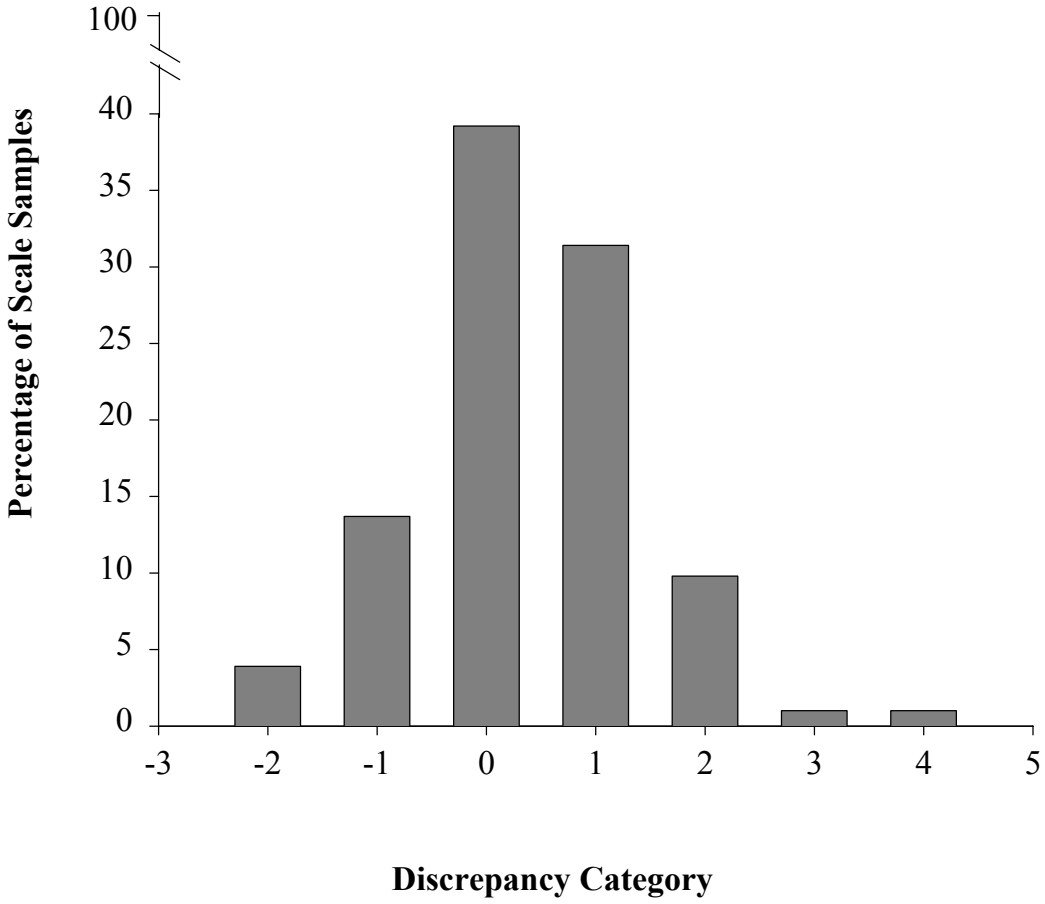

Figure 3. Distribution of discrepancies (in years) for northern pikeminnow aged at tagging and then recapture in 2000. A discrepancy of zero would indicated a fish was assigned the same age at tagging and recapture.

past 3 to 4 years and increased sharply to 16.7% in both reservoirs in 2000. However, these unusually high exploitation rates were probably due to the small sample sizes in those reservoirs. One of only six tagged northern pikeminnow ≥ 250 mm and 2 of 12 tagged northern pikeminnow ≥ 250 mm were recaptured in Lower Monumental and Little Goose reservoirs, respectively. In John Day Reservoir in 2000, 29 northern pikeminnow ≥ 200 mm were tagged, and 2,318 were harvested by the sport-reward fishery; however, no tagged northern pikeminnow were recaptured. Exploitation in that reservoir has been 0% in four of the last eight years.

Because 2000 was the first year that rewards were paid for northern pikeminnow 200-249 mm, exploitation on these fish cannot be compared to other years. As expected, exploitation on these smaller fish was lower than exploitation of fish ≥ 250 mm. Although this reduced the overall exploitation rate on northern pikeminnow ≥ 200 mm, exploitation of fish ≥ 250 mm was

near the mean exploitation rate for previous years. Exploitation rate of the smaller fish will probably always be relatively low; however, harvest will these fish from reaching the size of maximum predation on juvenile salmonids.

As in previous years, sport-reward exploitation greatly exceeded exploitation by other fisheries. The dam angling and site-specific gillnet fisheries, while contributing less to exploitation, harvested localized concentrations of northern pikeminnow that may have aggregated to feed on juvenile salmonids (Beamesderfer and Rieman 1991; Poe et al. 1991; Collis et al. 1995). In addition, the dam angling fishery was able to harvest northern pikeminnow in boat restricted zones below dams that are inaccessible to sport-reward anglers. Compared to the sport-reward fishery, mean size of harvested northern pikeminnow was greater in the site-specific gillnet fishery, and probably also the dam angling fishery, based on mean length data for that fishery in previous years.

The incidental catch rate of salmonids for all three fisheries combined has averaged only 0.3% for the past six years. The dam angling fishery, in particular, encounters few salmonids. With the increasing number of salmonid stocks becoming listed under the Endangered Species Act in recent years, the relatively low impact on salmonids of the NPMP may become an important consideration in making management decisions on the Columbia and Snake rivers.

If exploitation rates remain similar to mean 1994-2000 levels, it is unlikely that further reductions in potential predation will be realized. Predation will likely remain at approximately 77% of pre-program levels. Exploitation rates lower than mean 1994-2000 levels may result in increases in potential predation. In accordance with recommendations made in the audit of the NPMP (Hankin and Richards 2000), preliminary estimates of potential predation using sex-specific growth and natural mortality rates were calculated and did not result in appreciable differences in potential predation compared to the model currently used. The model will continue to be refined and may include changes in length-at-age data based upon ongoing evaluation of aging accuracy and precision. We plan to use this new model in subsequent years to estimate potential predation.

The tag loss rate for dart tags far exceeded that for spaghetti tags. Although the sample size was small for the dart tags (2 tag loss fish out of 6 recaptures), intuitively, dart tags would be expected to have a higher tag loss rate compared to spaghetti tags because they do not penetrate through the body as the spaghetti tags do. Although the larger wound created by spaghetti tags may increase the likelihood of infection, the relatively high recapture rate for these tags suggests that this probably is not a significant problem. These findings, coupled with the fact that spaghetti tags are 25% less expensive than dart tags, lead us to conclude that spaghetti tags are more appropriate for use on this project.

Empirically-based within-year loss for the spaghetti tags was estimated to be 2.6%, lower than the 4.2% estimate used to adjust recapture rates in previous years. However, some fish were recaptured in 2000 with missing tags and fin clips reported to be different from the left ventral clip used this year. Because no other fin clips have been used for several years, some or all of these fish could have been additional year-2000 tag loss fish, with either the wrong fin clipped at tagging or wrong fin reported clipped at recapture. In addition, severely eroded fins

could have been mistaken for clipped fins. Due to this uncertainty, these fish were not included in calculating tag loss rates. However, if they were all actually tag-loss fish from this year, this would have increased tag loss rates to 6.6% for the spaghetti tags and 55.6% for the dart tags.

We found that absolute agreement of ages assigned by two readers to scales taken from northern pikeminnow at tagging and recapture in 2000 was relatively low. However, agreement within a margin of ± one year was relatively high. Although this creates some uncertainty regarding the ages assigned to sampled northern pikeminnow, a margin of error of ± one year is probably sufficient for estimating relative differences in age class strength. Alternative structures, as well as the use of oxytetracycline as a temporal marker, are being evaluated as a means of improving aging accuracy and precision.

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APPENDIX A

Exploitation of Northern Pikeminnow, 1993-2000

Appendix Table A-1. Exploitation rates (%) of northern pikeminnow ≥ 250 mm fork length (FL) for all fisheries combined, 1993-2000.

Area or Reservoir	1993	1994	1995	1996	1997	1998	1999	2000[a]
Downstream from Bonneville Dam	6.0	13.8	16.5	12.7	8.0	8.4	9.6	10.0 (9.7)[a1](9.9)[a2]
Bonneville	4.3	11.2	9.4	9.1	9.7	9.2	14.5	16.3 (5.2)[a1](12.7)[a2]
The Dalles	7.0	10.7	16.0	15.5	5.8	12.8	16.1	6.1 (0.0[c])[a1](4.5)[a2]
John Day	10.5	5.8	0.0[c]	7.0	0.0[c]	0.0[c]	3.7	0.0[c] (0.0[c])[a1](0.0[c])[a2]
McNary	16.0	14.0	22.4	18.2	16.5	13.6	15.9	9.7 (33.3)[a1](10.2)[a2]
Ice Harbor	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]
Lower Monumental	3.1	0.8	4.5	0.0[c]	0.0[c]	0.0[c]	0.0[c]	16.7 (0.0[c])[a1](6.7)[a2]
Little Goose	6.6	9.2	5.7	8.9	0.0[c]	0.0[c]	0.0[c]	16.7 (0.0[c])[a1](11.8)[a2]
Lower Granite	12.5	8.7	6.4	11.7	15.5	12.1	6.1	8.7 (18.2)[a1](10.5)[a2]
System-wide	8.1	13.2	15.5	12.9	9.6	11.5	12.7	11.9 (7.1)[a1](11.0)[a2]

[a] In 2000, rewards were paid for northern pikeminnow ≥ 200 mm FL. Figures in parentheses indicate the exploitation rate for northern pikeminnow 200-249 mm FL ( )[a1] and the total exploitation rate for northern pikeminnow ≥ 200 mm FL ( )[a2].
[b] No northern pikeminnow tagged.
[c] Northern pikeminnow harvested, but no tags recovered.

Appendix Table A-2. Exploitation rates (%) of northern pikeminnow ≥ 250 mm fork length (FL) for the sport-reward fishery, 1993-2000.

Area or Reservoir	1993	1994	1995	1996	1997	1998	1999	2000[a]
Downstream from Bonneville Dam	6.0	13.6	16.1	12.7	7.8	8.2	9.6	10.0 (9.7)[a1](9.9)[a2]
Bonneville	2.1	2.2	3.5	6.1	8.0	7.8	13.9	16.3 (4.1)[a1](12.4)[a2]
The Dalles	7.0	9.8	14.9	15.5	5.8	12.8	16.1	6.1 (0.0[c])[a1](4.5)[a2]
John Day	2.4	3.2	0.0[c]	0.0[c]	0.0[c]	0.0[c]	3.7	0.0[c] (0.0[c])[a1](0.0[c])[a2]
McNary	15.9	14.0	22.4	18.2	16.5	13.6	15.9	9.7 (33.3)[a1](10.2)[a2]
Ice Harbor	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]
Lower Monumental	3.1	0.8	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	16.7 (0.0[c])[a1](6.7)[a2]
Little Goose	3.3	6.1	2.9	8.9	0.0[c]	0.0[c]	0.0[c]	16.7 (0.0[c])[a1](11.8)[a2]
Lower Granite	12.5	8.7	6.4	11.7	15.5	12.1	6.1	8.7 (18.2)[a1](10.5)[a2]
System-wide	6.8	10.9	13.4	12.1	8.9	11.1	12.5	11.9 (6.6)[a1](10.9)[a2]

[a] In 2000, rewards were paid for northern pikeminnow ≥ 200 mm FL. Figures in parentheses indicate the exploitation rate for northern pikeminnow 200-249 mm FL ( )[a1] and the total exploitation rate for northern pikeminnow ≥ 200 mm FL ( )[a2].
[b] No northern pikeminnow tagged.
[c] Northern pikeminnow harvested, but no tags recovered.

Appendix Table A-3. Exploitation rates (%) of northern pikeminnow ≥ 250 mm fork length (FL) for the dam-angling fishery, 1993-2000.

Area or Reservoir	1993	1994	1995	1996	1997	1998	1999	2000[a]
Downstream from Bonneville Dam	0.0[c]	0.1	0.2	0.0[c]	0.2	0.0[c]	0.0[c]	0.0[c] (0.0[c])[a1](0.0[c])[a2]
Bonneville	2.2	3.7	0.0[c]	0.0[c]	0.0[c]	0.5	0.0[c]	0.0[c] (1.0)[a1](0.3)[a2]
The Dalles	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c] (0.0[c])[a1](0.0[c])[a2]
John Day	8.1	2.6	0.0[c]	7.0	0.0[c]	0.0[c]	0.0[c]	0.0[c] (0.0[c])[a1](0.0[c])[a2]
McNary	0.1	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	--[d]	--[d]
Ice Harbor	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]
Lower Monumental	0.0[c]	0.0[c]	4.5	0.0[c]	--[d]	--[d]	--[d]	--[d]
Little Goose	3.3	3.1	2.8	0.0[c]	--[d]	--[d]	--[d]	--[d]
Lower Granite	0.0[c]	0.0[c]	0.0[c]	0.0[c]	--[d]	--[d]	--[d]	--[d]
System-wide	1.3	1.1	0.3	0.3	0.1	0.1	0.0[c]	0.0[c] (0.4)[a1](0.1)[a2]

[a] In 2000, rewards were paid for northern pikeminnow ≥ 200 mm FL. Figures in parentheses indicate the exploitation rate for northern pikeminnow 200-249 mm FL ( )[a1] and the total exploitation rate for northern pikeminnow ≥ 200 mm FL ( )[a2].
[b] No northern pikeminnow tagged.
[c] Northern pikeminnow harvested, but no tags recovered.
[d] No fishing effort.

Appendix Table A-4. Exploitation rates (%) of northern pikeminnow ≥ 250 mm fork length (FL) for the site-specific gillnet fishery, 1994-2000.

Area or Reservoir	1994	1995	1996	1997	1998	1999	2000[a]
Downstream Bonneville Dam	--[d]	0.2	0.0[c]	0.0[c]	0.3	0.0[c]	--[d]
Bonneville	5.3	5.9	3.0	1.7	0.9	0.6	0.0[c] (0.0[c])[a1](0.0[c])[a2]
The Dalles	0.9	1.1	0.0[c]	0.0[c]	0.0[c]	0.0[c]	--[d]
John Day	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	--[d]	--[d]
McNary	0.0[c]	0.0[c]	0.0[c]	--[d]	--[d]	--[d]	0.0[c] (0.0[c])[a1](0.0[c])[a2]
Ice Harbor	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]	--[b]
Lower Monumental	0.0[c]	0.0[c]	--[d]	0.0[c]	--[d]	--[d]	--[d]
Little Goose	--[d]	0.0[c]	--[d]	--[d]	--[d]	--[d]	--[d]
Lower Granite	0.0[c]	0.0[c]	--[d]	--[d]	--[d]	--[d]	0.0[c] (0.0[c])[a1](0.0[c])[a2]
System-wide	1.2	1.9	0.5	0.6	0.3	0.2	0.0[c] (0.0[c])[a1](0.0[c])[a2]

[a] In 2000, rewards were paid for northern pikeminnow ≥ 200 mm FL. Figures in parentheses indicate the exploitation rate for northern pikeminnow 200-249 mm FL ( )[a1] and the total exploitation rate for northern pikeminnow ≥ 200 mm FL ( )[a2].
[b] No northern pikeminnow tagged.
[c] Northern pikeminnow harvested, but no tags recovered.
[d] No fishing effort.

Appendix Table A-5. Weekly exploitation of northern pikeminnow ≥ 200 mm fork length system-wide in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net
14	6	--	--	--	--	--	--	--
15	221	--	--	--	6	--	--	--
16	329	--	--	--	227	--	--	--
17	303	--	--	--	556	--	--	--
18	54	--	--	--	859	--	--	--
19	57	--	--	--	913	--	--	--
20	126	8	--	--	970	0.8	--	--
21	69	8	--	--	1088	0.7	--	--
22	12	9	--	--	1149	0.8	--	--
23	8	12	--	--	1152	1.0	--	--
24	15	11	--	--	1147[a]	1.0	--	--
25	18	8	--	--	1151	0.7	--	--
26	--	14	--	--	1161	1.2	--	--
27	--	15	--	--	1147	1.3	--	--
28	--	7	--	--	1132	0.6	--	--
29	--	7	--	--	1125	0.6	--	--
30	--	8	--	--	1118	0.7	--	--
31	--	--	1	--	1110	--	0.1	--
32	--	--	--	--	1109	--	--	--
33	--	3	--	--	1109	0.3	--	--
34	--	3	--	--	1105[b]	0.3	--	--
35	--	--	--	--	1102	--	--	--
36	--	1	--	--	1102	0.1	--	--
37	--	2	--	--	1101	0.2	--	--
38	--	1	--	--	1099	0.1	--	--
39	--	2	--	--	1098	0.2	--	--
40	--	1	--	--	1095[c]	0.1	--	--
41	--	2	--	--	1094	0.2	--	--
Total	1218	122	1	0	--	10.9	0.1	0.0

[a] A tagged northern pikeminnow was caught by a commercial fisher in the Columbia River.
[b] A tagged northern pikeminnow was caught by a Washington Department of Fish and Wildlife sampling crew in the Toutle River.
[c] A tagged northern pikeminnow was caught by an angler in the North Fork Lewis River.

Appendix Table A-6. Weekly exploitation of northern pikeminnow 200-249 mm fork length system-wide in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net
14	--	--	--	--	--	--	--	--
15	24	--	--	--	--	--	--	--
16	68	--	--	--	24	--	--	--
17	97	--	--	--	92	--	--	--
18	11	--	--	--	189	--	--	--
19	11	--	--	--	200	--	--	--
20	3	1	--	--	211	0.5	--	--
21	5	--	--	--	213	--	--	--
22	5	3	--	--	218	1.4	--	--
23	4	--	--	--	220	--	--	--
24	9	1	--	--	223	0.4	--	--
25	5	--	--	--	231	--	--	--
26	--	1	--	--	236	0.4	--	--
27	--	2	--	--	235	0.9	--	--
28	--	1	--	--	233	0.4	--	--
29	--	2	--	--	232	0.9	--	--
30	--	2	--	--	230	0.9	--	--
31	--	--	1	--	228	--	0.4	--
32	--	--	--	--	227	--	--	--
33	--	1	--	--	227	0.4	--	--
34	--	--	--	--	225	--	--	--
35	--	--	--	--	225	--	--	--
36	--	--	--	--	225	--	--	--
37	--	--	--	--	225	--	--	--
38	--	--	--	--	225	--	--	--
39	--	--	--	--	225	--	--	--
40	--	1	--	--	224	0.4	--	--
41	--	--	--	--	223	--	--	--
Total	242	15	1	0	--	6.6	0.4	0.0

Appendix Table A-7. Weekly exploitation of northern pikeminnow ≥ 250 mm fork length system-wide in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net
14	6	--	--	--	--	--	--	--
15	197	--	--	--	6	--	--	--
16	261	--	--	--	203	--	--	--
17	206	--	--	--	464	--	--	--
18	43	--	--	--	670	--	--	--
19	46	--	--	--	713	--	--	--
20	123	7	--	--	759	0.9	--	--
21	64	8	--	--	875	0.9	--	--
22	7	6	--	--	931	0.6	--	--
23	4	12	--	--	932	1.3	--	--
24	6	10	--	--	923	1.1	--	--
25	13	8	--	--	919	0.9	--	--
26	--	13	--	--	924	1.4	--	--
27	--	13	--	--	911	1.4	--	--
28	--	6	--	--	898	0.7	--	--
29	--	5	--	--	892	0.6	--	--
30	--	6	--	--	887	0.7	--	--
31	--	--	--	--	881	--	--	--
32	--	--	--	--	881	--	--	--
33	--	2	--	--	881	0.2	--	--
34	--	3	--	--	878	0.3	--	--
35	--	--	--	--	875	--	--	--
36	--	1	--	--	875	0.1	--	--
37	--	2	--	--	874	0.2	--	--
38	--	1	--	--	872	0.1	--	--
39	--	2	--	--	871	0.2	--	--
40	--	--	--	--	868	--	--	--
41	--	2	--	--	868	0.2	--	--
Total	976	107	0	0	--	11.9	0.0	0.0

Appendix Table A-8. Weekly exploitation of northern pikeminnow ≥ 200[a] mm fork length in John Day Reservoir in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net
14	--	--	--	--	--	--	--	--
15	--	--	--	--	--	--	--	--
16	--	--	--	--	--	--	--	--
17	--	--	--	--	--	--	--	--
18	9	--	--	--	--	--	--	--
19	--	--	--	--	9	--	--	--
20	--	--	--	--	9	--	--	--
21	--	--	--	--	9	--	--	--
22	12	--	--	--	9	--	--	--
23	8	--	--	--	21	--	--	--
24	--	--	--	--	29	--	--	--
25	--	--	--	--	29	--	--	--
26	--	--	--	--	29	--	--	--
27	--	--	--	--	29	--	--	--
28	--	--	--	--	29	--	--	--
29	--	--	--	--	29	--	--	--
30	--	--	--	--	29	--	--	--
31	--	--	--	--	29	--	--	--
32	--	--	--	--	29	--	--	--
33	--	--	--	--	29	--	--	--
34	--	--	--	--	29	--	--	--
35	--	--	--	--	29	--	--	--
36	--	--	--	--	29	--	--	--
37	--	--	--	--	29	--	--	--
38	--	--	--	--	29	--	--	--
39	--	--	--	--	29	--	--	--
40	--	--	--	--	29	--	--	--
41	--	--	--	--	29	--	--	--
Total	29	0	0	--[b]	--	0.0	0.0	--[b]

[a] Exploitation rates for northern pikeminnow 200-249 mm FL and ≥ 250 mm FL were the same as that for northern pikeminnow ≥ 200 mm FL.
[b] No fishing effort.

Appendix Table A-9. Weekly exploitation of northern pikeminnow ≥ 200 mm fork length in McNary Reservoir (including Hanford Reach) in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net[a]
14	--	--	--	--	--	--	--	--
15	--	--	--	--	--	--	--	--
16	--	--	--	--	--	--	--	--
17	--	--	--	--	--	--	--	--
18	--	--	--	--	--	--	--	--
19	--	--	--	--	--	--	--	--
20	125	--	--	--	--	--	--	--
21	70	2	--	--	125	1.6	--	--
22	--	--	--	--	193	--	--	--
23	--	3	--	--	193	1.6	--	--
24	--	3	--	--	190	1.6	--	--
25	--	--	--	--	187	--	--	--
26	--	4	--	--	187	2.1	--	--
27	--	3	--	--	183	1.6	--	--
28	--	1	--	--	180	0.6	--	--
29	--	--	--	--	179	--	--	--
30	--	1	--	--	179	0.6	--	--
31	--	--	--	--	178	--	--	--
32	--	--	--	--	178	--	--	--
33	--	--	--	--	178	--	--	--
34	--	--	--	--	178	--	--	--
35	--	--	--	--	178	--	--	--
36	--	--	--	--	178	--	--	--
37	--	--	--	--	178	--	--	--
38	--	--	--	--	178	--	--	--
39	--	1	--	--	178	0.6	--	--
40	--	--	--	--	177	--	--	--
41	--	--	--	--	177	--	--	--
Total	195	18	--[a]	0	--	10.2	--[a]	0.0

[a] No fishing effort.

Appendix Table A-10. Weekly exploitation of northern pikeminnow 200-249 mm fork length in McNary Reservoir (including Hanford Reach) in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net[a]
14	--	--	--	--	--	--	--	--
15	--	--	--	--	--	--	--	--
16	--	--	--	--	--	--	--	--
17	--	--	--	--	--	--	--	--
18	--	--	--	--	--	--	--	--
19	--	--	--	--	--	--	--	--
20	3	--	--	--	--	--	--	--
21	5	1	--	--	3	33.3	--	--
22	--	--	--	--	7	--	--	--
23	--	--	--	--	7	--	--	--
24	--	--	--	--	7	--	--	--
25	--	--	--	--	7	--	--	--
26	--	--	--	--	7	--	--	--
27	--	--	--	--	7	--	--	--
28	--	--	--	--	7	--	--	--
29	--	--	--	--	7	--	--	--
30	--	--	--	--	7	--	--	--
31	--	--	--	--	7	--	--	--
32	--	--	--	--	7	--	--	--
33	--	--	--	--	7	--	--	--
34	--	--	--	--	7	--	--	--
35	--	--	--	--	7	--	--	--
36	--	--	--	--	7	--	--	--
37	--	--	--	--	7	--	--	--
38	--	--	--	--	7	--	--	--
39	--	--	--	--	7	--	--	--
40	--	--	--	--	7	--	--	--
41	--	--	--	--	7	--	--	--
Total	8	1	--[a]	0	--	33.3	--[a]	0.0

[a] No fishing effort.

Appendix Table A-11. Weekly exploitation of northern pikeminnow ≥ 250 mm fork length in McNary Reservoir (including Hanford Reach) in 2000.

Sampling Week	Tagged	Recaptures			At Large	Exploitation (%)		
		Sport	Dam	Net		Sport	Dam	Net[a]
14	--	--	--	--	--	--	--	--
15	--	--	--	--	--	--	--	--
16	--	--	--	--	--	--	--	--
17	--	--	--	--	--	--	--	--
18	--	--	--	--	--	--	--	--
19	--	--	--	--	--	--	--	--
20	122	--	--	--	--	--	--	--
21	65	1	--	--	122	0.8	--	--
22	--	--	--	--	186	--	--	--
23	--	3	--	--	186	1.6	--	--
24	--	3	--	--	183	1.6	--	--
25	--	--	--	--	180	--	--	--
26	--	4	--	--	180	2.2	--	--
27	--	3	--	--	176	1.7	--	--
28	--	1	--	--	173	0.6	--	--
29	--	--	--	--	172	--	--	--
30	--	1	--	--	172	0.6	--	--
31	--	--	--	--	171	--	--	--
32	--	--	--	--	171	--	--	--
33	--	--	--	--	171	--	--	--
34	--	--	--	--	171	--	--	--
35	--	--	--	--	171	--	--	--
36	--	--	--	--	171	--	--	--
37	--	--	--	--	171	--	--	--
38	--	--	--	--	171	--	--	--
39	--	1	--	--	171	0.6	--	--
40	--	--	--	--	170	--	--	--
41	--	--	--	--	170	--	--	--
Total	187	17	--[a]	0	--	9.7	--[a]	0.0

[a] No fishing effort.

APPENDIX B

Dates of Sampling in 2000

Appendix Table B-1. Dates of each sampling week in 2000.

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