# SIGNIFICANCE OF PREDATION AND EVALUATION OF PREDATION CONTROL 9007800

**SHORT DESCRIPTION:**
Estimate the relative magnitude of juvenile salmonid loss to northern squawfish throughout the Columbia River Basin. Provide support and analyses on the feeding response of predators to the predator management program, especially predator removal.

**SPONSOR/CONTRACTOR:** USGS/CRRL (formerly NBS)
US. Geological Survey, Columbia River Research Laboratory (formerly National Biological Service)
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**SUB-CONTRACTORS:**
No subcontractors.

## GOALS

**GENERAL:**
Adaptive management (research or M&E), Program coordination or planning

**ANADROMOUS FISH:**
Research, M&E

**NPPC PROGRAM MEASURE:**
5.7, 5.7A, 5.7B

**RELATION TO MEASURE:**
NPPC program measure 5.7 refers to reducing predation and competition on juvenile salmon in the Columbia River. The work proposed here specifically supports this measure by evaluating several major components of predation reduction, including performance standards (5.7A) and the squawfish removal program (5.7B).

**BIOLOGICAL OPINION ID:**
NMFS Biological Opinion (1995), Section IV Project Effects, Part 5 Squawfish Removal Program (p. 64)

**OTHER PLANNING DOCUMENTS:**
NMFS Proposed Recovery Plan for Snake River Salmon (1995). Task No. 2.8.b "Conduct research to determine the extent of predation problems and evaluate predation control measures" (BPA funded).

| TARGET STOCK | LIFE STAGE | MGMT CODE (see below) |
|---|---|---|
| Steelhead | Juveniles | W,? |
| Spring chinook salmon | Juveniles | W,? |
| Fall chinook salmon | Juveniles | W,? |

## BACKGROUND

**Project is an office site only**

**HISTORY:**
This project was initiated in 1990 and has accomplished several different goals related to predation evaluation. First, we estimated the relative magnitude of juvenile losses to northern squawfish Ptychocheilus oregonensis in reservoirs throughout the Columbia River Basin (Ward et al. 1995). This work was completed in 1995. Second, we have been examining mechanisms underlying northern squawfish recruitment and factors affecting year-class strength . This portion of the project included a year of beach seining funded by the Army Corps of Engineers. This work will be completed by 1998. Finally, we have been

providing data, methodology, and analyses for evaluating the predator removal program begun in 1991. Methods developed through this project have been used by other agencies (ODFW, e.g.) to estimate consumption rates and to estimate changes in salmon mortality due to predator removal. Evaluation of this program should be an ongoing process, which is the focus of the work proposed here.

**BIOLOGICAL RESULTS ACHIEVED:**

Previous project activities have indexed the consumption rate of salmonids by northern squawfish, and characterized diet and consumption rates for other piscivores. The relative abundance of northern squawfish was estimated in reservoirs throughout the basin. Additionally, predation rate and predator density were examined more closely by partitioning reservoirs. When this was done for the John Day Reservoir, estimated numbers of salmonids ingested annually by northern squawfish decreased from 2.9 million to 1.4 million.

The diel and vertical distributions of larval northern squawfish at Columbia River sample locations were identified. Variations in larval squawfish abundance in relation to water temperature and discharge were identified along with probable regions of spawning activity based on densities of larvae in icthyoplankton samples and corroboratory evidence provided from a radio telemetry study on patterns of adult squawfish movement and distribution. In addition, we identified and described variations in abundance of larval and juvenile northern squawfish in shoreline rearing habitats. Other findings described the relationship of northern squawfish larvae and juveniles to fish community composition in the lower Columbia and Deschutes rivers. Publications and reports are being prepared.

**PROJECT REPORTS AND PAPERS:**


Barfoot, C.A., D.M. Gadomski, J.M. Bayer, and G.T. Schultz. In Press. Early life history of northern squawfish Ptychocheilus oregonensis in the Columbia River. Annual report by the National Biological Service to the Bonneville Power Administration, Portland, OR.

Barfoot, C.A., D.M. Gadomski, A.M. Murphy, and G.T. Schultz. 1994. Reproduction and early life history of northern squawfish Ptychocheilus oregonensis in the Columbia River. pp. 7-40 In Gadomski, D.M. and Poe, T.P. (eds.), System-wide significance of predation on juvenile salmonids in Columbia and Snake River reservoirs and evaluation of predation control measures. Annual report by the National Biological Survey to the Bonneville Power Administration, Portland, OR.

Gadomski, D.M. and Barfoot, C.A. Diel patterns of distribution and abundance of larval fishes in the lower Columbia and Deschutes rivers. (In preparation, for submittal to Transactions of the North American Fisheries Society)

Gadomski, D.M., and C.A. Barfoot. 1994. American Fisheries Society, 18th Annual Larval Fish Conference, New Brunswick, Canada. Composition and distribution of larval fishes in the lower Columbia River basin.

Gadomski, D.M., and C.A. Barfoot. 1993. American Fisheries Society, Annual Meeting, Portland, OR. Larval and YOY juvenile northern squawfish in the lower Columbia River basin: Mainstem vs. tributary densities and distributions.

Gadomski, D.M., A.M. Murphy, and C.A. Barfoot. 1993. Reproduction and early life history of northern squawfish Ptychocheilus oregonensis in the Columbia River. pp. 26-42 In Petersen, J.H. and Poe, T.P. (eds.), System-wide significance of predation on juvenile salmonids in Columbia and Snake River reservoirs. Annual report by the U.S. Fish and Wildlife Service to the Bonneville Power Administration, Portland, OR

Gadomski, D.M., and A.M. Murphy. 1992. Reproduction and early life history of northern squawfish in the Columbia River. pp. 89-100 In Poe, T.P. (ed.), Significance of selective predation and development of prey protection measures for juvenile salmonids in Columbia and Snake River reservoirs. Annual report by the U.S. Fish and Wildlife Service to the Bonneville Power Administration, Portland, OR.

Kitchell, J.F. In Preparation (Spring 1997). Results of a Workshop on Fish Bioenergetics, Columbia River Research Laboratory, Cook, WA.

Petersen, J. H. and T. P. Poe. 1992. Approaches to estimating predation losses in a large river system: predation upon juvenile salmonids in the Columbia River. In C. D. Levings and G. A. Hunter (eds.), An account of the workshop on research approaches to predation/competition questions in river fish communities. Canadian Manuscript Report of Fisheries and Aquatic Science 2150:13-18.

Petersen, J. H. 1994. The importance of spatial pattern in estimating predation on juvenile salmonids in the Columbia River. Transactions of the American Fisheries Society 123:924-930.

Petersen, J. H. and D. L. Ward. MS in preparation. Field corroboration of a bioenergetics model for northern squawfish preying on juvenile salmon.

Poe, T. P., R. S. Shively, and R. A. Tabor. 1994. Ecological consequences of introduced piscivorous fishes in the lower Columbia and Snake rivers. Pages 347-360, in D. J. Stouder, K. Fresh, and R. J. Feller (eds.), Theory and Application in Fish Feeding Ecology. Bell W. Baruch Library and Marine Sciences, No. 18, University of South Carolina Press, Columbia, South Carolina.

Shively, R. S., T. P. Poe, and S. T. Sauter. 1995. Feeding response by northern squawfish to a hatchery release of juvenile salmonids in the Clearwater River, Idaho. Transactions of the American Fisheries Society 125.
Tabor, R. A., R. S. Shively, and T. P. Poe. 1993. Predation of juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. North American Journal of Fisheries Management 13: 831-838.
Ward, D. L., J. H. Petersen, and J. J. Loch. 1995. Index of predation on juvenile salmonids by northern squawfish in the lower and middle Columbia River and in the lower Snake River. Transactions of the American Fisheries Society 124:321-334.

**ADAPTIVE MANAGEMENT IMPLICATIONS:**

Evaluation of predation losses of juvenile salmonids migrating through Columbia River reservoirs will aid management efforts to reduce salmonid losses by controlling predator numbers or developing prey protection measures. If feeding compensation occurs for predators that remain in the system it would reduce the effectiveness of the predator removal program. Analyses of historic and monitoring data and will help direct refinements in the predator management program (i.e., adaptive management).

# PURPOSE AND METHODS

**SPECIFIC MEASUREABLE OBJECTIVES:**

The objective of this study is to provide technical support and analyses for evaluating the northern squawfish removal program. We have provided such support since the inception of the program in 1990, and our database on predation in the system goes back to 1983. Current support/analyses include examining the potential feeding compensation by predators in the system following the large-scale removal of northern squawfish through the predator management program. Compensation by predators that remain in the system, if it occurs, would reduce the effectiveness of the predator removal program.

**CRITICAL UNCERTAINTIES:**

The predator management program is due for a major review in 1997. If the predator management program is significantly changed following this review (canceled, reduced in scope or geographic area, or otherwise modified), then the need for the research described here could also change.

**BIOLOGICAL NEED:**

Predation is one of the primary causes of mortality for juvenile salmon, accounting for a large proportion of fish loss. Predator management continues to be an important option for minimizing mortality on migrating juvenile salmon. However, questions remain about such things as the effect of prey and predator density on salmonid loss. Reducing the density of predators through removal, for example, may reduce competition among those predators still in the system and thus stimulate "compensatory" feeding on juvenile salmon. Evaluation of the predator management program is needed to provide decision-makers with objective data that can be used to focus resources and produce the greatest gains.

**HYPOTHESIS TO BE TESTED:**

Null hypothesis: Removing northern squawfish through predator management will not cause the feeding rate of remaining predators (northern squawfish or other species) to increase (compensation). Alternative hypothesis: Removing northern squawfish through predator management will cause compensatory feeding by remaining predators (northern squawfish or other species).

**METHODS:**

Evaluation of feeding compensation by northern squawfish can be completed by analysis of existing data and data being collected as part of the ongoing program evaluation. No new field or laboratory work is proposed in this project.
Feeding compensation may be detected directly through comparison of diets of northern squawfish before and after the predator removal program. Our database includes over 5,000 northern squawfish collected during 1983-86 and these individuals provide a good “control” for diets of northern squawfish prior to removal. The Oregon Department of Fish and Wildlife collected diet information during the last 6 years, while the removal program was underway, and these data can be used as the “after” dataset. ODFW will continue to collect some diet information in the future, supplementing existing data.
Feeding compensation may occur at local scales through direct interactions between predators. Such compensation may not be detectable using pooled data as described above. To address this type of potential compensation, historic data from 1983-86 can be analyzed for the effects of predator density or prey/predator ratio on the feeding rate of northern squawfish.
Finally, other analytical approaches to evaluating feeding compensation will be explored. For example, we conducted a large predator removal experiment below Bonneville Dam in 1991 and 1992. Data from this experiment may be useful in determining

if compensation occurs in local populations of northern squawfish following a change in local predator density.

# PLANNED ACTIVITIES

**SCHEDULE:**

**Implementation Phase** **Start** 1998 **End** 2000 **Subcontractor**

**Task** Analysis and interpretation of data to assist predator removal evaluation. Additional data are available yearly, providing larger datasets for each analysis.

**PROJECT COMPLETION DATE:**
2000

**CONSTRAINTS OR FACTORS THAT MAY CAUSE SCHEDULE OR BUDGET CHANGES:**
No identifiable risks associated with the project.

# OUTCOMES, MONITORING AND EVALUATION

**SUMMARY OF EXPECTED OUTCOMES**

**Expected performance of target population or quality change in land area affected:**
N/A Research results apply to mainstem reservoirs.

**Present utilization and convservation potential of target population or area:**
N/A Research results apply to mainstem reservoirs.

**Assumed historic status of utilization and conservation potential:**
N/A Research results apply to mainstem reservoirs.

**Long term expected utilization and conservation potential for target population or habitat:**
N/A Research results apply to mainstem reservoirs.

**Indirect biological or environmental changes:**
N/A

**Physical products:**
N/A Research results apply to mainstem reservoirs.

**Environmental attributes affected by the project:**
N/A

**Changes assumed or expected for affected environmental attributes:**
N/A

**Measure of attribute changes:**
N/A Research results apply to mainstem reservoirs.

**Assessment of effects on project outcomes of critical uncertainty:**
N/A Research results apply to mainstem reservoirs.

**Information products:**
Annual reports, peer-reviewed publications, and presentations at meetings.

**MONITORING APPROACH**

**Data analysis and evaluation:**
Diet information from northern squawfish during before and after removal periods will be compared using a randomization technique described by Somerton (1990, "Detecting differences in fish diets", Fish. Bull. 89: 167-169). Local predator density effects will be analyzed using regression methods. Predator size effects will also be analyzed through regression. Individual-based models may be used to estimate the effects of removal at the local or population scale.

**Information feed back to management decisions:**
Information will be reported to management agencies through annual reports, presentations, and peer-reviewed publications.

**Critical uncertainties affecting project's outcomes:**
Analyses of existing data could be inconclusive. Specific studies could be conducted in the future to evaluate compensatory feeding responses, for example, but none are planned at this time.

**EVALUATION**
Publication of peer-reviewed manuscripts. Annual reports. Presentations at regional and national meetings.

**Incorporating new information regarding uncertainties:**
Analyses can be repeated when new information becomes available, or new analyses designed.

**Increasing public awareness of F&W activities:**
N/A

## RELATIONSHIPS

| RELATED BPA PROJECT | RELATIONSHIP |
|---|---|
| 9007700 Northern Squawfish Management Program | Provides supporting analyses to cooperating agencies. WDF? |

## COSTS AND FTE

**1997 Planned:** $284,742

**FUTURE FUNDING NEEDS:**

| FY | $ NEED | % PLAN | % IMPLEMENT | % O AND M |
|---|---|---|---|---|
| 1998 | $40,000 | | 100% | |
| 1999 | $40,000 | | 100% | |
| 2000 | $40,000 | | 100% | |
| 2001 | $40,000 | | 100% | |

**PAST OBLIGATIONS (incl. 1997 if done):**

| FY | OBLIGATED |
|---|---|
| 1990 | $253,641 |
| 1991 | $310,057 |
| 1992 | $471,241 |
| 1993 | $267,281 |
| 1994 | $379,241 |
| 1995 | $402,465 |
| 1996 | $444,145 |
| 1997 | $284,742 |

TOTAL: $2,812,813

Note: Data are past obligations, or amounts committed by year, not amounts billed. Does not include data for related projects.

**1997 OVERHEAD PERCENT:** 38%

**HOW DOES PERCENTAGE APPLY TO DIRECT COSTS:**
Total direct project costs

**SUBCONTRACTOR FTE:** 0