Draft Research Proposal
FY 2009 – 2011

Understanding the influence of predation by introduced fishes on juvenile salmonids in the Columbia River Basin: closing some knowledge gaps

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A. Technical background

Predation on juvenile salmonids by fish and birds in the Columbia River Basin (CRB) has long impacted fish survival and is a topic that has received considerable attention over the last three decades (e.g., see Poe et al. 1991; Rieman et al. 1991; Collis et al. 2002). Although much has been learned and management actions implemented to reduce the impact of predation on juvenile salmonid survival (e.g., the northern pikeminnow *Ptychocheilus oregonensis* management program; see Friesen and Ward 1999), there are still aspects of this topic that remain poorly understood. For example, understanding the influence of juvenile American shad *Alosa sapidissima* on the health and well being of piscivores, evaluating the predatory impact of channel catfish *Ictalurus punctatus* on juvenile salmonids in the CRB, and assessing the potential efficacy of localized removals of smallmouth bass *Micropterus dolomieu* for predation control, are all topics of interest. These subjects were discussed in detail at a recent Bonneville Power Administration (BPA) and Columbia Basin Fish and Wildlife Agencies (CBFWA)-hosted workshop on reviewing, evaluating, and developing strategies to reduce non-native piscivorous predation on juvenile salmonids. As a response to this workshop and subsequent meetings, this proposal presents research goals, objectives, and tasks designed to address these critical uncertainties.

Juvenile American shad are abundant in the fall in many reservoirs of the CRB. These fish represent a high energy food resource for introduced and native predators in the fall that historically did not exist (Petersen et al. 2003). The abundance of juvenile American shad in the fall may provide predators with an extended period of feeding on a high energy food source and lead to enhanced growth, physiological condition, and improved overwinter survival. Bigger and healthier fish emerging from winter may also have a greater reproductive capacity and a more severe predatory impact on juvenile salmonids. Although juvenile American shad do occur in the diets of some Columbia fish piscivores (Poe et al. 1991; Petersen et al. 1994), little is known about their influence on growth and condition of predators in the fall and entering winter. Sauter et al. (2004) predicted, in a series of bioenergetics analyses, that juvenile American shad would enhance the growth and condition of predators in the fall, which in turn would lead to increased consumption on juvenile salmonids by larger fish. Unfortunately, these model predictions have never been validated in the field. The work described herein will focus on the diet of piscivores in the fall, the contribution of juvenile American shad to that diet, the contribution of their diet in the fall to their overall growth rates, the physiological status of predators during the late fall and winter, and the potential for increased consumption on juvenile salmonids during the following spring and summer.

Over the past decade, sampling by the Oregon Department of Fish and Wildlife (ODFW) for white sturgeon *Acipenser transmontanus* in several reservoirs of the CRB has resulted in large incidental catches of channel catfish, particularly in the McNary, Ice Harbor, and Little Goose pools. This catch information suggests that channel catfish may be abundant in certain areas. The food habits and behavior of channel catfish have received little attention in the CRB. In fact, we are aware of only one study that had some focus on the diet of channel catfish in the CRB (Poe et al. 1991). Unfortunately, this work occurred only in the John Day pool and is now 20 years old. Many believe that channel catfish could be significant predators on juvenile salmonids, but the lack of information precludes detailed understanding. We are proposing a detailed study on the diet, relative abundance, movements, and growth of channel catfish in several reservoirs in the CRB during the juvenile salmonid outmigration. Such information will be useful to managers contemplating mitigative actions, such as predator control, for channel catfish in the CRB.

There are certain areas in the CRB where the abundance of smallmouth bass is presumably quite high, consumption rates on juvenile salmonids is high, and the predatory impact on salmonids may be relatively severe (Zimmerman 1999; Fritts and Pearsons 2004; Naughton et al. 2004). For example, biologists from the U. S. Army Corps of Engineers (USACE) have identified the John Day Dam forebay as a probable "hot spot" for smallmouth bass predation. In contrast, based on electrofishing catch rates, the McNary Dam tailrace in the same reservoir is apparently not an area of intense predation by smallmouth bass. The notion of intensively sampling in "hot spots" to remove predaceous-sized fish and reduce the predatory impact has been discussed by various regional groups, but not implemented. It may be possible to temporarily reduce predation on salmonids by smallmouth bass in areas where predator abundance is abnormally high. We propose to evaluate this idea by identifying one or more areas of localized high predation, identify the times when such predation occurs, and remove smallmouth bass from these areas. We will document changes in relative abundance and consumption rates to assess the efficacy of localized predator removals to reduce the predatory impact on juvenile salmonids.

In summary, the research described in this proposal addresses some key critical uncertainties identified at the predation workshop and finalized during subsequent meetings of relevant regional agencies. Specifically, we will address the influence of juvenile American shad on the health and well being of piscivores and their predation rates on juvenile salmonids, the predatory impact of channel catfish on juvenile salmonids, and the potential efficacy of localized removals of smallmouth bass for predation control. In the future, it may be worthwhile to try localized removals for other species, such as walleyes. This work will be a combined effort by the U. S. Geological Survey and the ODFW, both of which have a long history of conducting predation research in the CRB. Collectively, the results from this study should provide managers with the information needed to control or mitigate for the predatory impact of non-native piscivores on juvenile salmonids.

B. Rationale and significance to regional programs

Although managers and others have long been interested in evaluating and reducing predation by non-native fish, the specific impetus for this idea came from the 2008 Biological Opinion for the Federal Columbia River Power System (BiOp). The Biological Opinion includes various predation management strategies, and, specifically, Reasonable and Prudent Alternative (RPA) 44: *develop strategies to reduce non-indigenous fish*. The RPA specifies that "formation of a workshop will be an initial step in the process." As we mentioned earlier, the workshop has been completed and this proposal is a response to action items identified by workshop participants. The goals and objectives presented here were discussed and agreed upon by a subcommittee comprised of key agency representatives. In addition, the recent review of the BiOp by the Obama Administration, which resulted in an Adaptive Management Implementation Plan (AMIP), called for enhanced research on salmon predators and invasive species.

Management of non-native fish predators requires both technical and policy considerations. Technical concerns may be limited to determining effective methods of reducing predator abundance and consumption while minimizing negative impacts on native species. Policy concerns include, but are not limited to, financial and social impacts of potential actions (e.g., impacts to and response by angling groups, relative cost effectiveness of potential actions, etc.). State and federal fishery managers will undoubtedly have to deal with the dichotomy between the conservation and recovery of native salmonids and the management of nonnative sport fisheries. Recent opinions suggest that the two fishery types cannot be co-managed in sympatry if natives are to persist (Mueller 2005; Clarkson et al. 2005). Thus, addressing some of the knowledge gaps relevant to predator-prey interactions of fishes in the CRB seems especially prudent today.

C. Relationships to other projects

This project is directly related to ongoing efforts of the northern pikeminnow Management Program (NPMP), which monitors population characteristics of these fish and other non-native piscivorous fishes throughout the lower Columbia and Snake rivers. We plan on coordinating with this project to facilitate logistical and technical needs and perhaps reduce costs. This project would also be similar to work being conducted by the USGS in the mid-Columbia River. This project, which is being funded by the Grant County PUD, is investigating the predatory impact of smallmouth bass, walleye *Sander vitreus,* and northern pikeminnow on outmigrating juvenile salmonids in the Priest Rapids dam project area.

D. Project history (for ongoing projects)

This is a new project.

E. Proposal biological objectives, tasks, and methods

Objective 1. Evaluate the influence of juvenile American shad on growth and condition of piscivorous predators in John Day Reservoir (JDR) during the fall and early winter.

Null hypotheses addressed:

Ho_1: juvenile shad are not a significant contributor to the diet of predators in the fall (September through November)

Ho_2: the presence of juvenile shad does not significantly influence the growth rate of predators in the fall compared to fish in the spring-summer

Ho_3: the presence of juvenile shad does not influence the physiological condition of predators in the fall compared to fish in the spring-summer

Task 1.1. Collect northern pikeminnow, channel catfish, smallmouth bass, and walleye from select areas of JDR for analysis of size structure, diet, and other characteristics.

Methods. The evaluation of length frequency distribution of piscivores has been an effective indicator of predation on migrating juvenile salmonids. In the NPMP, many fish have been sampled throughout the lower Columbia and Snake rivers to estimate catch and consumption. This work is conducted during the juvenile salmon and steelhead migration periods in the spring and summer of each sampling year. Boat electrofishing is an effective, non-selective method to collect most piscivorous fishes, and we intend to use this method extensively for this objective. We will sample fish during the spring, summer, and fall using standard methods established by the NPMP and discussed in Poe et al. (1991). If possible, we will use fish collected by the NPMP to supplement our sampling. This task will add to our knowledge of predator growth, diet, and condition during the spring and summer and will provide new information for fish in the fall and early winter, when juvenile salmonids are less abundant.

Task 1.2. Collect and analyze stomach contents, blood, and perhaps other tissue samples from fish captured under Task 1.1.

Methods. Data collection in the John Day Reservoir and subsequent sample processing in the laboratory will be consistent with methods used by the NPMP for predator indexing. Diet information is needed to characterize and quantify the use of juvenile American shad by the various predators. Prey items will be identified and analyzed for diet composition and for relative importance. Diagnostic bone fragments will be analyzed to identify prey items. We will calculate consumption indices (Ward et al. 1995) to facilitate comparisons with those calculated for other seasons and areas in the future. Blood and tissue samples will be used to evaluate the relative physiological condition of fish during the fall and prior to winter. We will determine physiological correlates of condition, such as plasma triglycerides, percent body fat, or other metrics, and compare values to fish sampled in the spring or summer. We will review the literature for metrics of interest and assay for products in the laboratory. Our intent is estimate the contribution of shad in the diet of fish in the fall to their overall condition.

Objective 2. Evaluate the behavior of piscivorous fishes in John Day Reservoir and measure their growth during the fall and early winter.

Rationale: Understanding the seasonal movements and distribution of piscivores may identify alternative approaches to managing these fish in the future. Monitoring and defining seasonal variation in their locations, movements, and densities may provide important information to better manage their overall predation levels. Other beneficial outcomes of this objective may include increased efficiencies in the collection and re-location of piscivorous fish and direct estimates of growth rates of recaptured fish. We propose to use radio or acoustic telemetry to track the movements of fish during the fall and into winter.

Task 2.1. Collect and tag a sample of piscivorous fish with depth-sensitive acoustic or radio tags.

Methods. Fish will be collected by boat electrofishing as part of Task 1.1. A subset of fish will be surgically implanted with either a depth-sensitive radio or acoustic tag. We will decide on the tag type to be used after a literature review and discussions with colleagues. All fish collected under Task 1.1, except those that need to be sacrificed for diet analysis (i.e., some northern pikeminnow and channel catfish must be sacrificed to obtain stomach contents), will be implanted with PIT tags and released near their point of capture.

Task 2.2. Monitor the movements, locations, and depths of fish during the fall and winter.

Methods. We will track fish by boat and fixed receiving sites at select locations. Tracking efforts will occur on a regular schedule and will cover all relevant areas of the reservoir. We hope to take advantage of existing radio or acoustic telemetry arrays that may be present in the CRB. Fish locations, movements, and depths will be input into a GIS framework for analysis.

Task 2.3. Estimate the growth rate of recaptured fish during the fall and winter.

Methods. During the sampling for Task 1.1 and 2.1, we will be collecting, tagging, and releasing numerous fish. To provide estimates of growth rate of piscivores during the fall and winter, we will compare the size of fish that have been recaptured at least once. We will compare these growth rates with similar information from other seasons reported in other studies or collected by us.

Task 2.4. Conduct bioenergetics modeling to predict growth rates of fish in the fall using diet, water temperature, and growth information from the field.

Methods. We will use pre-existing bioenergetics models for northern pikeminnow, smallmouth bass, and walleye (and perhaphs channel catfish, if a model is available) to provide a greater understanding of how diet and water temperature influence the fall growth rates of fish. We will vary the diet composition and water temperature, alone and in combination, to assess their relative influence on fish growth rates. In particular, we hope to describe the influence of juvenile American shad in the diet relative to other prey items. These modeling exercises will provide new, heuristic information on piscivores in the fall and will be useful to compare with previous bioenergetics analyses of these fish (Sauter et al. 2004; Petersen and Kitchell 2001).

Objective 3. Evaluate the predatory impact of channel catfish in the John Day, McNary, Ice Harbor, and Little Goose reservoirs.

Null hypothesis addressed:

Ho_1: channel catfish are not significant predators on juvenile salmonids in the CRB

Rationale: Collections of large numbers of channel catfish are not common via boat electrofishing for piscivorous fish in the CRB. However, incidental catch of channel catfish during white sturgeon stock assessment work (primarily age-0 sampling, or young of the year gillnet sampling) in the fall has the potential to intercept several hundred channel catfish. Sampling these fish may fill information gaps related to their role and importance as a piscivore in the Columbia River. Additional information on seasonal diet and consumption rate may provide insight on density dependent relationships and foraging behavior of channel catfish. Inserting telemetry tags to these fish may provide insight to shifts in seasonal habitat use, which may better define appropriate sampling gears for capturing and monitoring these fish during peak migration periods for juvenile salmonids

Task 3.1. Collect data from incidentally caught channel catfish in the ongoing ODFW white sturgeon monitoring in the John Day and McNary reservoirs.

Methods. We will join staff from the ODFW during their annual sturgeon stock assessment sampling and collect channel catfish from their incidental catch. We may also work with fishing guides or sport fishermen to supplement our catch. For most fish, we will measure length and weight, collect a blood sample, and remove the stomach for diet analysis. Net sets will be for 30 min. This sampling will be used to supplement that described in Task .1.1.

Task 3.2. Analyze digestive tract samples to characterize channel catfish diet. Update diet information and consumption index.

Methods. This work will be identical to that described in Task 1.2.

Task 3.3. Capture and tag a subset of channel catfish with radio or acoustic transmitters.

Methods. Fish will be collected during the sampling described for Task 3.1. As previously described, a subset of fish will be surgically implanted with either a depth-sensitive radio or acoustic tag. These fish will also be implanted with PIT tags and released near their point of capture. We will track fish by boat and fixed receiving sites at select locations. Tracking efforts will occur on a regular schedule and will cover all relevant areas of the reservoirs. We hope to take advantage of existing radio or acoustic telemetry arrays that may be present in the CRB. Fish locations, movements, and depths will be input into a GIS framework for analysis. This effort will expand considerably that described under Objective 2. Our intent here is to provide more detailed information on the movements, distribution, and behavior of channel catfish in several reservoirs over several seasons.

Objective 4. Evaluate the response of smallmouth bass to localized removal.

Null Hypotheses Addressed:

Ho_1: a localized, intense removal of smallmouth bass will not significantly change their abundance or consumption rates on salmonids.

Ho_2: the abundance and consumption rates of smallmouth bass in a presumed "hot spot" do not differ from fish in other areas.

Rationale: Targeted removals of specific predators may be an effective way of reducing predation on juvenile salmonids (Harvey and Kareiva 2004). Monitoring trends in the relative abundance of fish provides a key indication of fisheries effects on fish populations and predation on juvenile salmonids. Identifying a change in a localized area where fish have been physically removed can be achieved by monitoring relative abundance over a set period of time. Measuring the efficacy of the removal action will also require the monitoring of control areas without removal action. Catch-per-unit effort has broad application in showing changes in abundance at the population level. The biological characteristics of fish populations such as abundance and length frequency distributions have been used as an indicator of compensatory responses related to removal fisheries. The analysis of smallmouth bass diet and the estimation of a consumption rate will likely provide insight on density dependent relationships and foraging behavior of piscivorous fish.

User groups may strongly object to lethal removals of a popular sport fish prior to evaluation of the benefits to salmon recovery. Holding, caring for, and releasing fish that were removed from an area of interest may minimize smallmouth bass losses, while creating a treatment of removal for hypothesis testing. Alternatively, we may transport removed fish to adjacent reservoirs or distant areas within the reservoir and monitor our catches for returning individuals. (

Task 4.1. Conduct boat electrofishing to sample and re-locate smallmouth bass from localized areas in the Columbia River.

Methods. We will conduct bi-weekly collection May through July 2010 using boat electrofishing to capture and re-locate smallmouth bass from localized areas in the Columbia River. Collections will use depletion sampling within predetermined transects that adhere to 15-minute periods. Sampling will be comprised of a minimum of 3 sequential sampling events per transect each visit. A count of total smallmouth bass captured during each run will be recorded. Catch, biological data (including length and weight), scale samples, and stomach samples will be acquired from each smallmouth bass prior to transporting to holding facilities. Stomach contents will be collected using lavage techniques that do not require sacrificing the animal. Captured smallmouth bass will be placed in live wells equipped with aerated circulating water for transport to holding facilities. Removal of captured smallmouth bass for the duration of the depletion study will assure that individual fish are not repeatedly captured, and that removal activities elicit a response within the localized area.

Task 4.2. Analyze catch and biological data for smallmouth bass to estimate changes in relative abundance and consumption characteristics among treatment and control areas and removal events.

Methods. Using data from collections described in Task 4.1., we will generate catch per unit of effort (CPUE) metrics, and CPUE data log transformed for determining relative change in abundance as well as for comparing among depletion sampling events. Since we are not sure of the level of movement in or around transects we will use an open population depletion model for our analysis. Biological characteristics of smallmouth bass removed from localized areas will be compared to similar data collected in nearby areas without fish removal activities These comparisons will include both size structure and age composition. We will conduct laboratory and data analysis from June through August, 2010, and complete an information report by March 31, 2011.

Task 4.3. Analyze digestive tract samples to estimate changes in diet. Compare diet of smallmouth bass among areas and removal events.

Methods. Using data from collections described in Task 4.1., we will provide a description of food habits and juvenile salmon consumption rates for smallmouth bass by localized area and removal event. Processing of individual content samples will be conducted in a laboratory environment, and will follow processing protocol used by Northern Pikeminnow Management Program Evaluation project (BPA project number 1990-077-00). These comparisons will explore including both size structure and age composition. We will conduct laboratory and data analysis from June through August, 2010, and complete information report by March 31, 2011.

Task 4.4. Hold, care for, and release smallmouth bass removed from localized area during sampling period.

Methods. To assure that individual fish are not repeatedly captured, and that removal activities elicit a response within the localized area we will remove all smallmouth captured in specified transects. We will maintain and provide a safe and secure holding area (net pens, ponds, raceway facilities) for removed fish May through July, 2010. Fish will be fed excess hatchery juvenile salmonids or other fishes as available. We will release smallmouth bass back in localized areas of their original capture or other undetermined locations August, 2010.

Task 4.5. Identify level of movement among areas of interest.

Methods. Following the completion of the removal study, we will tag each fish with a unique tag (e.g. PIT tag), and transport smallmouth bass for grouped releases in the area of their original capture and to an area of undetermined distance from the original site of capture site; which could include an area as far away as an adjacent reservoir. Follow-up monitoring during May through July 2011 will be required which repeats collection activities in transects used during initial year of the study, and will utilize depletion sampling techniques described in Task 4.1.

All information gathered during this study will be presented in annual reports of research and in articles submitted to peer-reviewed journals.

F. Facilities and equipment

The research proposed here will be conducted by personnel from the U. S. Geological Survey's Columbia River Research Laboratory (CRRL) and the Oregon Department of Fish and Wildlife. These agencies, which have a long history of conducting research throughout the basin, offer veteran professionals and modern office equipment (computers with latest software and internet connections, copiers, FAX machines, phones), vehicles appropriate for highways and field work, and a large array of sampling equipment (e.g., late-model backpack electrofishers, flow meters, nets and traps, GPS units, a variety of boats, ADV units, and temperature data loggers) to ensure that the highest quality professional research can be conducted. We are fully capable of working in a variety of field situations and have ample experience working with on predation issues. In short, the collaboration formed by these agencies already has much of the equipment, technology, and experience necessary to complete this research.

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c. Representative publications:

Mesa, M.G. and C.B. Schreck. 1989. Electrofishing mark-recapture and depletion methodologies evoke behavioral and physiological changes in cutthroat trout. Transactions of the American Fisheries Society 118:644-658.

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Beamesderfer, R .C. P., T. A. Rien, and A. A. Nigro. 1995. Dynamics and potential production of white sturgeon populations in three Columbia River reservoirs Transactions of the American Fisheries Society 124:857-872.

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4. Research specialties:

- Life history studies of fishes
- Fish behavior
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- Stream habitat evaluations
- Winter ecology of fishes
- Predator-prey interactions

5. Representative publications:

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