United States Department of the Interior

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26 April 2010

To: **Tony Grover**, Director, Fish and Wildlife Division, Northwest Power and Conservation Council (NPPC), **Mark Fritsch**, NPPC, **Erik Merrill** NPPC, and **Eric Loudenslager**, Chair, Independent Scientific Review Panel

From: **Matthew G. Mesa**, U. S. Geological Survey, and **Tom A. Rien**, Oregon Department of Fish and Wildlife

Subject: Revision of BiOp proposal #2008-719-00 to study non-native predator impacts on salmon

Gentlemen:

Enclosed please find a revision of our draft research proposal entitled *Understanding the influence of predation by introduced fishes on juvenile salmonids in the Columbia River Basin: closing some knowledge gaps*. We want to thank the ISRP for reviewing our proposal and believe it has resulted in a much improved, more specific and detailed product. In this letter, we'd like to highlight some of the major changes to the proposal and provide point-by-point responses—where needed—to some comments presented in the ISRP review.

The proposal has undergone an extensive revision as a result of the ISRP review. First, we eliminated Objective 3 of the original proposal—primarily dealing with the abundance, distribution, and food habits of channel catfish. Second, we eliminated several tasks under the remaining objectives proposing the use of telemetry to document the movements and distribution of non-native predators. Third, we eliminated proposed bioenergetics modeling approaches. Finally, we eliminated all sampling of native northern pikeminnow. These previous proposal components had added significantly to our workload and budgets. Upon further discussion, we considered them not critical to achieving our goals in terms of addressing key issues identified by Predation Workshop participants. In summary, while the previously proposed telemetry and bioenergetics modeling work elements were deleted, some data on channel catfish will be obtained through our revised Objective 1.

For the proposal in general, we have cited many additional relevant references throughout, bolstered the background and justification in the introduction section, added detailed protocols—including experimental design elements, sample sizes, areas to be sampled, statistics, etc.—to the methods section, and attempted to better document the rationale and significance of the proposed work to regional programs and its relation to other projects.

Following are our responses to specific comments presented in the ISRP review:

1. *The Technical Justification, Objectives, and Methods sections must be fully developed and significantly revised before the ISRP reviews it again.*

   Response: As stated above, we substantially revised and bolstered all sections of the proposal.

2. *The research questions and objectives are of interest in potentially shedding light into food web relationships among key native and non-native species.*

   Response: While we agree with this statement, and other statements on food web concepts that were provided in the review, we need to clarify and reiterate that our proposal is not intended to fully address food web issues in the Columbia River basin. Rather, this proposal focuses on specific issues discussed at the recent Predation Workshop and in other documents and hence will provide insight and support to a potential future study aimed at evaluating complex food web relationships among native and non-native fishes in the CRB. We discuss this in more detail toward the end of our introduction section.

3. *In addition, the methods utilized, in the few instances when they are identified, appear to be the same methods used in past studies.*

   Response: We added more detail on our proposed methods and agree with your assessment that many of our protocols will be similar to those used in previous studies. However, this proposal is now focused on two straightforward objectives: (1) the influence of juvenile American shad in the diet of non-native predators in the fall and (2) the potential efficacy of reducing the numbers of smallmouth bass in areas of intense predation. In our opinion, addressing these objectives does not necessarily require new or cutting-edge technologies to gain useful information. Tried and trusted methods used in the past should suffice. We are, however, proposing some new methods, including the use of hoop-net series for sampling channel catfish and the use of the Distell Fish Fat Meter to assess the condition of fish in the fall. This, combined with proximate analysis and a suite of blood chemistry variables, will provide an unprecedented look into the health and condition of non-native predators prior to the onset of the winter season.

4. *Although all three of the proposal proponents have relevant specialized skills, none appear to have conducted much bioenergetics modeling research.*

   Response: After considering the review and our own subsequent discussions, we removed the bioenergetics modeling analyses from the proposal. We believe the remaining proposed work needs to focus on the basic objectives first—before more complex analyses should be undertaken. It is our goal to first simply document the food habits of non-native predators in the fall and more specifically, determine the influence of American shad in the diet of these fish. Following the initial investigation and if necessary, we may propose and discuss other research directions, such as bioenergetics modeling, in the future.

5. *Other ISRP review comments specific to Objectives 2 and 3 in the original proposal*

Response: Since these objectives were eliminated, we will not address any related review comments at this time.

In conclusion, we hope that we have addressed your comments in a satisfactory manner and trust that the merit of conducting this research is apparent, as well as the need for providing this information to the scientific community. Because of the ISRP review of our original proposal, we produced a more focused research proposal that addresses discrete issues related to the impacts of non-native predaceous fishes on juvenile salmonid survival.

We are looking forward to a final decision regarding our revised proposal. Please feel free to contact us with any questions. Thank you.

Sincerely,

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Tom A. Rien
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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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Submitted to: John Skidmore
Bonneville Power Administration

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A. Technical background

Predation on juvenile salmonids by fish in the Columbia River Basin (CRB) has long impacted salmon survival and is a topic that has received considerable attention over the last three decades. Some of the earliest and most detailed research focused on the food habits, consumption rates, abundance, and distribution of predaceous northern pikeminnow *Ptychocheilus oregonensis*, smallmouth bass *Micropterus dolomieu*, walleyes *Sander vitreus*, and channel catfish *Ictalurus punctatus* in John Day Reservoir (Beamesderfer and Rieman 1991; Poe et al. 1991; Vigg et al. 1991). This group of researchers also estimated the loss of juvenile salmonids to predation by some of these predators (Rieman et al. 1991). Since this pioneering effort, others have evaluated various aspects of predation-related mortality on juvenile salmonids in the CRB, focusing mostly on northern pikeminnow and smallmouth bass (e.g., Tabor and Shively 1993; Zimmerman 1999; Naughton et al. 2004).

Perhaps the most significant finding coming from this body of research was that the native northern pikeminnow was the dominant predator of juvenile salmonids in the CRB. Indeed, Beamesderfer et al. (1996) estimated that northern pikeminnow consumed about 16 million (8%) of the estimated 200 million juvenile salmonids emigrating annually in the CRB, far surpassing the consumption rates of smallmouth bass, walleye, and channel catfish combined. Because of this, large-scale management fisheries (i.e., the northern pikeminnow management program, or NPMP; see Rieman and Beamesderfer 1990; Beamesderfer et al. 1996) have been implemented in the CRB since 1990 to achieve a 10-20% exploitation rate on northern pikeminnow and reduce predation on juvenile salmonids. The NPMP has been a success, resulting in up to 38% potential reductions in predation (Friesen and Ward 1999; Knutsen and Ward 1999; Ward and Zimmerman 1999; Zimmerman and Ward 1999).

The NPMP has been, and still is, the most significant—in terms of logistical scope and financial outlay—action taken by regional fish managers to curb predation on juvenile salmonids in the CRB. In addition to evaluating the system-wide response of the northern pikeminnow population to sustained fisheries, the NPMP also monitors for potential compensatory mechanisms by non-native piscine predators. To date the NPMP has not observed compensation occurring. However, additional data that focuses on characterizing predation on juvenile salmonids by non-native smallmouth bass, walleye, and channel catfish in the lower Columbia River is not available. In contrast, outside of the impounded areas of the lower Columbia and Snake rivers, others have reported that smallmouth bass predation rates on juvenile salmonids can be high (Tabor et al. 1993; Zimmerman 1999; Naughton et al. 2004).

Oregon and Washington state fish and wildlife agencies manage and enhance recreational fisheries for smallmouth bass and walleye by implementing size and harvest limit regulations. Recently, many biologists and fish managers have become concerned about the impact of non-native predaceous fishes on juvenile salmonid survival. For example, Poe and Shively (1994) warned that smallmouth bass, walleye, and channel catfish were expanding their populations in some areas, that these fish could be significant predators on juvenile salmonids, and that they may compete with northern pikeminnow for common prey items, resulting in higher consumption rates of salmonids by the native predator. Sanderson et al. (2009) reported on the impact of non-indigenous species (including piscivorous fishes) on salmon survival within the

Columbia River Basin. They concluded that the impact of non-native predators on juvenile salmonids can be severe and "suggest that managing nonindigenous species may be imperative for salmon recovery". Assessing the current condition in the lower Columbia River may fill information gaps associated with the impact of non-native piscine predators on the survival of juvenile salmonids in the area.

In response to these recent concerns about the potential predatory impact of non-native piscivores on salmon survival, the lack of management actions aimed at reducing or mitigating this predation, and the fact that some of these fish (e.g., walleye and channel catfish) have received very little study, the Bonneville Power Administration (BPA) and the Columbia Basin Fish and Wildlife Authority (CBFWA) co-hosted a workshop to address predation on juvenile salmonids in the CRB by non-native fish (Halton 2008). The purpose of the workshop was to review, evaluate, and develop strategies to reduce predation by non-native fishes on juvenile salmonids. In the end, discussion at the workshop and at subsequent meetings focused on six potential ideas to reduce predation by non-native fish on juvenile salmonids, two of which received serious consideration and are the focus of this proposal: (1) understanding the role of juvenile American shad *Alosa sapidissima* in the diet of non-native predators in the fall; and (2) the effects of localized, intense reductions of smallmouth bass in areas of particularly high salmonid predation. The rationale and ideas underlying these two areas of research and management are described below.

Juvenile American shad are present during the late summer and early fall in reservoirs of the lower Columbia River (Gadomski and Barfoot 1998; Petersen et al. 2003; Haskell et al. 2006) and represent a potential high energy food resource for predators during this time that historically did not exist (Petersen et al. 2003). If juvenile American shad comprise a significant portion of the diet of smallmouth bass, walleye, and channel catfish in the fall, it could contribute to faster rates of growth, a larger size-at-age, enhanced physiological condition, and improved overwinter survival of these predators. Sauter et al. (2004) predicted, in a series of bioenergetics analyses, that the growth of smallmouth bass and walleye increased significantly when the proportion of juvenile American shad in the diet increased from zero to 15-20% during the fall, which in turn could lead to increased consumption on juvenile salmonids by larger fish. However, despite these predictions, little is known about the diet of these fish in the fall because almost all sampling from previous food habits studies was timed to correspond to the outmigration of juvenile salmonids and usually ended in August (e.g., Poe et al. 1991; Zimmerman 1999; Naughton et al. 2004). In fact, only northern pikeminnow are known to consume significant quantities of juvenile American shad in the late summer (Poe et al. 1991; Petersen et al. 1994). We are aware of no published information documenting the consumption of juvenile American shad by smallmouth bass, walleye, or channel catfish in the lower Columbia River, even in August. This does not mean, however, that these predators do not eat juvenile shad, but instead probably reflects the consequences of sample timing and location. Most of the intensive sampling for these predators has occurred in John Day Reservoir and, as we mentioned earlier, usually went through August. Evidence suggests that juvenile American shad move downstream as summer progresses into fall (Haskell et al. 2006), thus previous sampling for smallmouth bass, walleye, and channel catfish in the lower Columbia River may have taken place at times and in locations where the spatial overlap between them and juvenile shad was minimal. The work described herein will focus on documenting the food habits of smallmouth bass, walleye, and channel catfish in the late summer and fall in three reservoirs of the lower Columbia River. We are also proposing to evaluate the physiological condition of fish during the fall. Collectively, we hope to increase our knowledge of the contribution of juvenile American shad to their diets and whether their diet in the fall contributes significantly to their general health and condition. Managers should be able to include this information in their decision whether to control the population of American shad in the CRB, perhaps by discouraging adult passage at dams by modifications to the fishways (Monk et al. 1989; Haro and Kynard 1997; Kynard and Buerkett 1997).

There are certain areas in the CRB where smallmouth bass abundance and consumption rates on juvenile salmonids are presumed high. Past research has indicated such conditions could have a debilitating impact on juvenile salmonid survival in the region (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 (Bob Cordie, USACE, personal communication). In contrast, dam angling catch rates from the John Day Dam tailrace have reported few smallmouth bass in annual collection efforts (USDA 2009) and this area may be considered low impact for predation on juvenile salmonids by smallmouth bass. The notion of intensively sampling in "hot spots" to assess the predatory impact of predaceous-sized fish on the survival of juvenile salmonids has been discussed by various regional groups, but has not been implemented. This may in part be related to the lack of evidence for the efficacy of reduction efforts in larger river systems. Non-native predator removals in the main stem Colorado River have been on-going for over 10 years, but they have yet to observe a positive response from the native fish community (Mueller 2005). If similar results occurred in the lower Columbia River, it may lead to the conclusion that large-scale predator reduction efforts are not feasible in very large river systems. Although it has not been demonstrated, it may be possible to temporarily reduce predation on juvenile salmonids by displacing non-native piscivores in locations (i.e., at hydropower projects) where predation occurs and predator abundance is abnormally high. Therefore, we propose to determine whether smallmouth bass are highly abundant in localized Boat Restricted Zones (BRZ) of McNary, John Day and The Dalles dams. Initially, we will compare relative abundance and consumption rates of smallmouth bass in BRZ forebay (presumed hot spots) and tailrace (not considered hot spots) areas to inform future directives on the implementation of system-wide management actions. Ultimately, we hope to assess the efficacy of reducing predatory impacts on juvenile salmonids in the lower Columbia River, particularly in BRZ areas.

In summary, the research described in this proposal addresses two key critical uncertainties identified at the Predation Workshop and finalized during subsequent meetings of relevant regional agencies. Specifically, we will document: (1) the food habits of non-native predators in the lower Columbia River during the late summer and fall to assess the role of juvenile American shad in their diets and any impacts on their health and condition; and (2) the potential efficacy of localized reductions of smallmouth bass for predation control. We wish to point out that we are not proposing a food-web based analysis of relations between key native and non-native species. While this would be a laudable goal, it goes beyond our scope and the direct issues discussed at the Predation Workshop. When finished, however, our results should be an important contribution to a food-web analysis of the lower Columbia River, should such an effort be undertaken in the future. The proposed work will be a combined effort by the U. S.

Geological Survey and the Oregon Department of Fish and Wildlife, both of which have a long history of conducting predation research in the CRB. Collectively, the results from this study should provide managers with some key information to assess the need for actions 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 BiOp 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. Aspects of the research described herein has also been called for by the Independent Scientific Advisory Board in their recent report on non-native species impacts (ISAB 2008), by the Northwest Power and Conservation Council in their 2009 Amendments to the Fish and Wildlife Program (NPCC 2009), and by recent publications dealing with the impacts of non-native species in the CRB (Harvey and Kareiva 2005; Sanderson et al. 2009).

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 non-native sport fisheries. Recent opinions suggest that the two fishery types cannot be co-managed in sympatry in the Colorado River if natives are to persist (Clarkson et al. 2005; Mueller 2005). Determining if these findings translate to the lower Columbia River is an appropriate first-step. 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 related to ongoing efforts of the NPMP, which is funded by the BPA (Project # 1990-077-00) and monitors population characteristics of northern pikeminnow and other piscivorous fishes throughout the lower Columbia and Snake rivers. Since ODFW staff on this proposal also work on the NPMP, we plan on coordinating between projects to develop sampling designs and locations, facilitate logistical and technical needs, share data, and reduce costs. Our proposed 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, and northern pikeminnow on outmigrating juvenile salmonids in the Priest Rapids dam project area. We plan on discussing sample design, methods, and logistics with staff from this project and will also share data and analysis methods, which could benefit both projects.

D. Project history (for ongoing projects)

This is a new project.

E. Proposal biological objectives, tasks, and methods

Objective 1. Document the food habits of smallmouth bass, walleye, and channel catfish in three reservoirs of the lower Columbia River during the late summer and fall.

Null hypothesis addressed:

Ho_1: Juvenile shad are not a significant contributor to the diet of non-native predators in the fall (August through November)

Task 1.1. Collect smallmouth bass, walleye, and channel catfish from select areas of John Day, The Dalles, and Bonneville reservoirs.

Methods. Predators will be collected at fixed sites established in the John Day, The Dalles, and Bonneville pools. Sites will include near-dam areas (forebay and tailrace zones) and mid-reservoir areas away from dams and will be similar to those being used by the NPMP. Each site will be subdivided into several nearshore transects, each about 500 m long. The number of transects will depend on the length of the site. Predators will be collected primarily by electrofishing, although we plan on using gill or hoop nets at each site to collect channel catfish and walleyes. For electrofishing, we will sample a minimum of six randomly selected transects per day at each site, spending two days at each site within a reservoir. For example, we will sample for two days each in the forebay, tailrace, and mid-reservoir sites of the Bonneville pool, for a total of six days of sampling. Standardized effort for each transect will be 15 min of continuous output at 4-5 A. The reservoir to be sampled will be determined randomly and each will be visited once in August, September, October, and November. Thus, each pool will be sampled for six days each month, with two days being spent sampling random transects at the three general fixed sites. For netting operations, we will deploy sets of sinking experimental gill nets (60 m long × 1.8 m deep, with panels of 13-, 19-, 25-, 32-, and 38-mm-bar mesh). Two to four nets will be set perpendicular to shore, stretching from near shore to deeper water, for 1-2 h. Effort at each site will be allocated as described for electrofishing. If, for ESA related reasons, we will not be allowed to use gill nets, we propose using hoop-net series for collecting channel catfish, as described in Buckmeier and Schlechte (2009). A summary of our sampling design is shown in Table 1.

Table 1.—The number of days of fish sampling proposed in three general areas (FB = forebay, Mid = mid-reservoir, TR = tailrace) of three reservoirs (BON = Bonneville, TD = The Dalles, JD = John Day) of the lower Columbia River during August through November, 2010.

	August			September			October			November		
Reservoir	FB	Mid	TR	FB	Mid	TR	FB	Mid	TR	FB	Mid	TR
BON	2	2	2	2	2	2	2	2	2	2	2	2
TD	2	2	2	2	2	2	2	2	2	2	2	2
JD	2	2	2	2	2	2	2	2	2	2	2	2

Task 1.2. Collect stomach contents from fish captured under Task 1.1.

Methods. Every smallmouth bass, walleye, and channel catfish will be measured (fork length in mm) and weighed (g). We will remove a scale sample from smallmouth bass and walleye and collect a pectoral fin spine from channel catfish for later meristic analysis. Stomachs of smallmouth bass and walleyes 150 mm and larger will be pumped with a modified Seaburg sampler (Seaburg 1957). Entire digestive tracts will be removed from channel catfish longer than 250 mm. All samples will be placed in labeled Whirl-Pak bags on ice and later stored in freezers. All smallmouth bass and walleye will be tagged with a unique identifier (either floy tags or PIT tags inserted intramuscularly near the dorsal sinus) prior to release. We may also mark and release a sample of channel catfish at each site. Although not a focus of our study, recapture information from these fish could provide valuable information on the behavior and growth of individual fish.

Task 1.3. Analyze stomach contents from samples collected under Task 1.2.

Stomach contents will be thawed, blotted dry, and sorted into three categories: fish, crayfish, and other prey (e.g., mollusks, insects, plant matter). The prey types will be weighed to the nearest 0.01 g, returned to their bags, and digested according to the methods of Ward et al. (1995) to identify prey fish. Diagnostic bones (dentaries, cleithra, and pharyngeal arches) will be examined under dissecting microscopes and fish will be identified to the lowest possible taxon (Hansel et al. 1988). We will count the number of prey fish eaten by adding the number of paired diagnostic bones to remaining unpaired bones. We will estimate the length of consumed fish using the regression equations developed by Hansel et al. (1988). We will calculate consumption indices (Ward et al. 1995) for each predator at each site and compare them across forebay, mid-reservoir, and tailrace areas and months. Finally, for each area and month, we will estimate the total daily ration of smallmouth bass, walleye, and channel catfish using methods outlined in Zimmerman (1999).

Objective 2. Evaluate the physiological condition of smallmouth bass, walleye, and channel catfish during the late summer and fall in three reservoirs of the lower Columbia River

Task 2.1. Collect predators for calibration of physiological assessment during the mid-summer.

Methods. During June and July, 2010, we will collect 30 each of smallmouth bass, walleye, and channel catfish using the methods described above. The location of this sampling is not critical and will be determined based on catch information from previous studies (e.g., predation indexing work done by ODFW for the NPMP). In other words, we will sample in areas known to have high abundances of our target fish, which should minimize the time needed to obtain our sample size. For channel catfish, we hope to join staff from the ODFW during their annual white sturgeon stock assessment project and collect channel catfish from their incidental catch, which has the potential to accommodate our need for individual specimens.

Task 2.2. Process fish, estimate somatic energy content, and collect blood samples.

Methods. All fish will be placed singly in a lethal dose of MS-222 (ca. 200 mg/L), weighed and measured, and we will collect a blood sample from the caudal vasculature using a heparinized Vacutainer. Blood samples will be lightly shaken and stored on ice until processing. Next, we will estimate the somatic energy content of each fish using a Distell Model 692 Fish Fatmeter (Distell Inc., West Lothian, Scotland), hereinafter referred to as the energy meter. These meters use microwave transmission for assessing the fat content of market fish and are widely used in the aquaculture industry. Recently, these devices have been used with great success in fisheries research to estimate the energy content of wild, freely swimming fish (Crossin and Hinch 2005; Sang et al. 2009). Briefly, the meter emits a low-powered microwave that interacts with water in fish tissues at a given location. The microwave sensors then use the strong inverse relation between water and lipid content in fish tissues to convert estimates of water concentration to lipid concentration. We will interrogate each fish with the meter at four positions along the left side, similar to that described by Crossin and Hinch (2005). At each position, we will take three readings and average them to obtain a value for that position. We anticipate interrogation to take about a minute for each fish. When finished, fish will be placed singly in a plastic bag and transported on ice to our laboratory for proximate analysis. At the end of each day, blood samples will be placed in a centrifuge, spun at 3,000 × g for 3 min, and the resulting plasma aspirated off, placed in a new tube, and frozen at -80°C until analysis.

Task 2.3. Conduct a proximate analysis (i.e., the percent water, protein, fat, and ash) of predator carcasses.

Methods. Proximate analysis of predator carcasses was done according to methods outlined by Crossin and Hinch (2005) and Mesa and Magie (2006). Briefly, each carcass (less gonads) will be homogenized in an industrial food processor and a 250-g aliquot of the homogenate will be placed in an airtight freezer bag and stored at -80°C until analysis. To measure water content, we will thaw the homogenates and place a 2-g aliquot in a small tin vessel and dry them at 100°C in a mechanical convection oven until they reach a constant mass (ca. 24-h). A second aliquot of each homogenate, about 15-20 g, will be dried in the same manner and sent to Washington State University for determination of lipid and ash content. The lipid and ash proportions will be converted to wet mass by multiplying them by the percent dry solids in the original sample. The protein content of each sample will be determined by subtracting ash, lipid, and water content from the total sample weight. Lipid and protein contents by wet mass will be multiplied by their energy equivalents (36.4 kJ/g for lipid and 20.1 kJ/g for protein; Brett 1995) to yield mass-specific tissue energy values.

Task 2.4. Assay plasma samples from predators for blood-chemistry indicators of nutritional status

Methods. Blood chemistry correlates of nutritional condition have been useful in studies of the health and condition of mammals (e.g., Hellegren et al. 1993; Rea et al. 1998) and birds (Jenni-Eierman and Jenni 1998; Hollmen et al. 2001). Recent studies have also indicated that some blood constituents can be useful for evaluating the condition of fish (Wagner and Congleton 2004; Congleton and Wagner 2006). We will measure the concentrations of plasma Na^+, Cl^-, K^+, total calcium, total magnesium, glucose, total protein, cholesterol, and triglycerides and the activities of alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase, creatinine kinase, lipase, and alkaline phosphatase using an auto-analyzer. To ensure accuracy and reproducibility, auto-analyzer assays (to be performed by personnel at the Gritman Medical Center, Moscow, ID, U.S.A.) will follow procedural guidelines for standardization and quality control established by the Joint Commission for Accreditation of Health Care Organizations and by the College of American Pathologists.

Task 2.5. Analyze energy meter readings, proximate composition data, and blood chemistry indicators.

Methods. The overall intent of Objective 2 is to develop non-lethal, safe, and effective methods for assessing the health and condition of predaceous fish. In theory, the energy meter should suffice for this purpose but, to our knowledge, it has never been used with our species of interest and thus will require a full calibration. Therefore, we will use a variety of statistical techniques to evaluate the relations between energy meter readings, proximate composition of carcasses, and blood chemistry variables, as described in Wagner and Congleton (2004), Congleton and Wagner (2006), and Crossin and Hinch (2006). We will consult with a USGS statistician prior to analysis to ensure use of valid and effective procedures.

Task 2.6. Assess the somatic energy content and general health and condition of predators in the late summer and fall.

Methods. If the results of Task 2.5 demonstrate that the energy meter can be used to generate highly accurate measures of somatic energy and lipid content in smallmouth bass, walleye, and channel catfish, we will use the energy meter to assess the condition of these fish in the late summer and fall. Briefly, during our sampling for Objective 1, after a fish has been weighed and measured, we will interrogate it with the energy meter and record the values. We will compare mean values within a species across months and locations using Analysis of Variance. We will also assess any relations between the diet of individual fish (as determined in Objective 1) and their somatic energy content. Ultimately, we hope to gain understanding of the general health and condition of predators prior to over-wintering and the role their diet in the fall plays in determining their condition. Such information would be useful for validating previous bioenergetics analyses (Sauter et al. 2004) and for conducting new analyses.

Objective 3. Describe and compare relative density and diet of smallmouth bass between sites perceived to be "hot spots" and sites nearby

Null hypotheses addressed:

Ho_1: The catch per angler hour (CPUE) of smallmouth bass captured from the forebay boat restricted zones (BRZ) of The Dalles, John Day and McNary dams is not greater than that of fish captured from the tailrace BRZ of the same dams.

Ho_2: The rate of salmonid consumption by smallmouth bass captured from the forebay BRZ of The Dalles, John Day and McNary dams is not greater than that of fish captured from the tailrace BRZ of the same dams.

Rationale: Angler catch rates of smallmouth bass in certain dam tailraces are considered low, primarily because they are captured at much lower rates than northern pikeminnow (USDA 2009). For example, anglers fishing for northern pikeminnow from the John Day Dam during 2008 captured 2,428 northern pikeminnow and 62 smallmouth bass in 1,005 hours of angling (2.42 and 0.06 fish/h). As such, smallmouth bass have not been considered a problem in the tailrace area. However, USACE biologists observed that areas in the forebay of John Day Dam had perceivably more smallmouth bass than the tailrace areas. At the request of the USACE (Bob Cordie, personal communication), NPMP dam-anglers used a brief portion of their scheduled effort day (total time not recorded) to capture smallmouth bass directly off the forebay side of the dam. This abbreviated effort yielded 50 smallmouth bass, and thus demonstrated that smallmouth bass could be readily captured. Herein we describe a directed field effort to assess whether catch rate and relative abundance of smallmouth bass in forebay areas is significantly greater than in tailrace areas.

Juvenile smolts seen leaping at the surface of the forebay of John Day Dam prompted USACE biologists to postulate about the possible association between this behavior and possible smallmouth bass feeding in this area. Using the 50 smallmouth bass mentioned above,, biologists performed gastric lavage to collect foregut contents to identify if juvenile salmonids were present in these samples. Preliminary observations of 15 samples identified salmonids in some of these fish (Bob Cordie, personal communication), but information had not been quantified using a documented protocol. No stomach contents have been collected from smallmouth bass captured during dam angling in the tailrace of John Day Dam. Yet, the NPMP consumption index for smallmouth bass captured in The Dalles and John Day reservoirs has remained relatively static over the course of the program (Weaver et al. 2009). Of the 823 foregut samples collected in these reservoirs during 2009, eight contained identifiable juvenile salmonids. However, since access has been restricted in the BRZ areas near the dams in recent years, the NPMP information does not include piscivores captured in these areas. Assessing the level of predation on juvenile salmonids in areas near the dam may fill knowledge gaps needed to establish the efficacy of future management actions.

Task 3.1. Conduct dam angling to capture smallmouth bass in the BRZ of The Dalles, John Day and McNary dams.

Methods. We will conduct hook-and-line sampling May through August 2010, and again May through August 2011, to capture smallmouth bass directly off The Dalles, John Day, and McNary dams. A simulated power analysis, based on an expected mean catch rate and subsequent standard deviation in dam tailraces (not considered hot spots) showed that angling for 100 hours in each of two test areas should detect a 5-fold increase in catch rates between "hot spots" and areas not thought of as "hot spots" (Table 3.1.1). Therefore, we will undertake 100 1-hr collection periods each in two forebay areas (The Dalles and John Day dams) and at McNary dam forebay and tailrace areas. The corresponding two tailrace areas at The Dalles and John Day dams will be sampled as part of the NPMP dam angling project. Sampling periods will be balanced by synchronizing angling in the tailrace and forebay of a given dam during the same day and hour. Specific sites that anglers fish in forebay and tailrace areas will be fixed to locations used by NPMP dam anglers in the tailrace, and those areas identified in earlier USACE observations in the forebay. This cycle will be repeated each month totaling 400 h per area (four areas combined equaling 1,600 angler hours) May through August 2010, and again May through August 2011 (Table 3.1.2).

Each smallmouth bass captured will be placed in live wells equipped with aerated circulating water for holding prior to data collection. A count of the total smallmouth bass captured during each 1-hour period will be recorded with corresponding fork length (nearest 1 mm), weight (nearest g), scale sample, and foregut content sample from each fish. A PIT tag will be inserted into the dorsal sinus of each fish prior to their release to identify recaptures during the study and to avoid collecting redundant information. Foregut contents will be collected using lavage techniques used by the NPMP evaluation that do not require sacrificing the animal (Seaburg 1957; Foster 1977; Bowen 1996). Following data collection, each fish will be returned to the live well, and allowed to fully recover prior to release. Every smallmouth bass will be released back into their original area of capture. A field sampling plan to implement this investigation will entail deploying a crew of four people, in conjunction with the NPMP dam angling project, to supplement fishing effort in each of the areas mentioned above over several months (to ensure that potential seasonal variation is encompassed).

Table 3.1.1. Simulated one-tailed Student's t-test using expected dam angling catch-per-hour at standard levels of Type I ($\alpha = 0.05$) and Type II ($\beta = 0.80$) errors, which would effectively detect a 5-fold increase from the simulated mean fish/h.

Statistic	Control	5-fold increase
Mean	0.06 fish/h	0.30
Standard Deviation (simulated)	0.24	0.90
N (1-hour sampling efforts)	93	93

Table 3.1.2. Hours of angling effort expended in four sampling areas, 2010-2011.

	TDA TR (existing program)	TDA FB	JDA TR (existing program)	JDA FB	MCN TR	MCN FB
April	100	100	100	100	100	100
May	100	100	100	100	100	100
June	100	100	100	100	100	100
July	100	100	100	100	100	100

Task 3.2. Analyze catch and biological data for smallmouth bass to estimate changes in relative abundance and consumption characteristics.

Methods. Using data from collections described in Task 3.1., we will generate catch per unit of effort (CPUE) metrics for comparing relative abundance of smallmouth bass between forebay and tailrace areas of each dam. We will test for significant difference in CPUE using either paired t-tests, generalized linear models, or non-parametric alternatives. Monthly CPUE in each area will be analyzed using Repeated-Measures ANOVA ($P < 0.05$) as described by Hubert and Fabrizio (2007). We will characterize salmonids found in smallmouth bass stomach contents as proportion composition by number (N_i) and frequency of prey occurrence ($O_i = J_i/P$ where J_i is the number of fish containing prey *i*, and *P* is the number of fish with food in their stomachs; Bowen 1996; Chipps and Garvey 2007). We will use the consumption measures mean proportion by number of salmonid (MN*i*) to test for significant difference using Repeated-Measures ANOVA ($P < 0.05$) at each dam by area each month. We will conduct laboratory and data analysis from May through September, 2010, and again May through September, 2011 followed by a complete information report by March 31, 2012.

Task 3.3. Analyze digestive tract samples to document changes in diet and compare diet of smallmouth bass between forebay and tailrace areas.

Methods. Using data from collections described in Task 3.1., we will provide a description of food habits and juvenile salmon consumption rates for smallmouth bass by forebay and tailrace areas. Processing of stomach samples will be done in the laboratory and will follow protocols used by the NPMP. These analyses will explore both size structure and age composition. We will conduct laboratory and data analysis from May through December 2010, and again May through December 2011 followed by a complete information report by March 31, 2012.

This initial assessment should quantify the relative density and juvenile salmonid consumption rates at perceived smallmouth bass “hot spots” in dam forebay areas. This will inform fishery and hydrosystem managers in decisions regarding the relative value of further investigation or actions. Depending on our findings next steps could include, but may not be limited to:

- Taking no further action.
- Assessing perceived “hot spots” that may be reported in other areas.

- Estimating the potential benefit of actions to reduce smallmouth bass predation in terms of increased juvenile salmonid survival at local and systemwide scales.
- Exploring practicable means to reduce smallmouth bass predation.
- Measuring the effectiveness of any experimental implementation.

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 electro-fishing boats, flow meters, nets and traps, GPS units, 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 on piscine 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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