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White Sturgeon Management Plan in the Snake River between Lower Granite and Hells Canyon Dams

Nez Perce Tribe

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NEZ PERCE TRIBE

WHITE STURGEON MANAGEMENT PLAN

IN THE SNAKE RIVER BETWEEN

LOWER GRANITE AND HELLS CANYON DAMS

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EXECUTIVE SUMMARY

White sturgeon in the Hells Canyon reach (HCR) of the Snake River are of cultural importance to the Nez Perce Tribe. However, subsistence and ceremonial fishing opportunities have been severely limited as a result of low numbers of white sturgeon in the HCR. Hydrosystem development in the Columbia River Basin has depressed numbers and productivity of white sturgeon in the HCR by isolating fish in impounded reaches of the basin, restricting access to optimal rearing habitats, reducing the anadromous forage base, and modifying early life-history habitats. Consequently, a proactive management plan is needed to mitigate for the loss of white sturgeon production in the HCR, and to identify and implement feasible measures that will restore and rebuild the white sturgeon population to a level that sustains viability and can support an annual harvest.

This comprehensive and adaptive management plan describes the goals, objectives, strategies, actions, and expected evaluative timeframes for restoring the white sturgeon population in the HCR. The goal of this plan, which is to maintain a viable, persistent population that can support a sustainable fishery, is supported by the following objectives: 1) a natural, stable age structure comprising both juveniles and a broad spectrum of spawning age-classes; 2) stable or increasing numbers of both juveniles and adults; 3) consistent levels of average recruitment to ensure future contribution to reproductive potential; 4) stable genetic diversity comparable to current levels; 5) a minimum level of abundance of 2,500 adults to minimize extinction risk; and 6) provision of an annual sustainable harvest of 5 kg/ha.

To achieve management objectives, potential mitigative actions were developed by a Biological Risk Assessment Team (BRAT). Identified strategies and actions included enhancing growth and survival rates by restoring anadromous fish runs and increasing passage opportunities for white sturgeon, reducing mortality rates of early life stages by modifying flows in the HCR, reducing mortality imposed by the catch and release fishery, augmenting natural production through translocation or hatchery releases, and assessing detrimental effects of contaminants on reproductive potential. These proposed actions were evaluated by assessing their relative potential to affect population growth rate and by determining the feasibility of their execution, including a realistic timeframe (short-term, mid-term, long-term) for their implementation and evaluation.

A multi-pronged approach for management was decided upon whereby various actions will be implemented and evaluated under different timeframes. Priority management actions include: Action I- Produce juvenile white sturgeon in a hatchery and release into the management area; Action G- Collect juvenile white sturgeon from other populations in the Snake or Columbia rivers and release them into the management area; and Action D- Restore white sturgeon passage upriver and downriver at Lower Snake and Idaho Power dams. An integral part of this approach is the continual monitoring of performance measures to assess the progressive response of the population to implemented actions, to evaluate the actions' efficacy toward achieving objectives, and to refine and redirect strategies if warranted.

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ACKNOWLEDGEMENTS

The Bonneville Power Administration provided funding for this project and we appreciate the COTR's (Jonathan McCloud) support in completing contract deliverables. We thank Neil Ward for helping to facilitate the numerous meetings, as well as his contributions to the plan. We thank the Biological Risk Assessment Team members for comments and suggestions. Members include: Tom Rein, Dave Ward, John Devore, Brad James, Glen Mendel, Michael Parsley, Dena Gadomski, Steve Yundt ,Tim Cochnauer, Fred Partridge, Sue Ireland, Jack Siple, Paul Anders, Ken Lepla, Phil Bates, Jim Chandler and Blaine Parker. We thank Selina Heppell, Molly Webb, Kevin Kappenman, Rishi Sharma and Shawn Narum for their work on the Biological Risk Assessment and helpful comments on the plan.

INTRODUCTION: ORGANIZATION OF THE CHAPTERS

- Chapter 1 describes the purpose, goals and history of the project
- Chapter 2 describes the status of Hells Canyon Reach (HCR) white sturgeon (*Acipenser transmontanus*)
- Chapter 3 describes the development and assessment of proposed management actions
- Chapter 4 describes the monitoring and evaluation plan

CHAPTER 1: BACKGROUND

1.1 Purpose
1.2 Management Decision Process
1.3 Goals and Objectives
1.4 Project History
1.5 Relationship to Other Programs and Projects

1.1 PURPOSE

The Nez Perce Tribe (Tribe) has a vision of restoring all fish species native to the Nez Perce Indian Claims Commission's Treaty Territory (Figure 1.1). To that end, the Tribe has engaged in management of all fish species- both resident and anadromous- for all streams, lakes and watersheds within their management authority. The management of white sturgeon in the Snake River between Hells Canyon Dam and Lower Granite Dam is one component this multi-species approach. The need to rebuild the white sturgeon population is motivated by several factors. Specifically, the Tribe recognizes that:

- white sturgeon were abundant and are a natural feature of the Snake River ecosystem;
- the treaty signed by the United States government with the NPT in 1855 reserved harvest rights for the NPT;
- white sturgeon are of cultural importance to the NPT; and
- reduction of white sturgeon productivity from the Hell Canyon Reach of the Snake River remains unmitigated.

The Nez Perce were a large tribe in the Northwest (Walker 1978) with a culture tied closely to fish (Moffit 2000). Since time immemorial, the Tribe occupied a territory over 13 million acres that included what is today north central Idaho, southeastern Washington and northeastern Oregon. The Tribe has always fished. Their economy and culture evolved around Northwest fish runs. Their persistence can be attributed in large part to the abundance of fish, which has served as a primary food source, trade item and cultural resource for thousands of years. Settlement by others in the last 130 years has disrupted people of the Tribe and the natural resources.

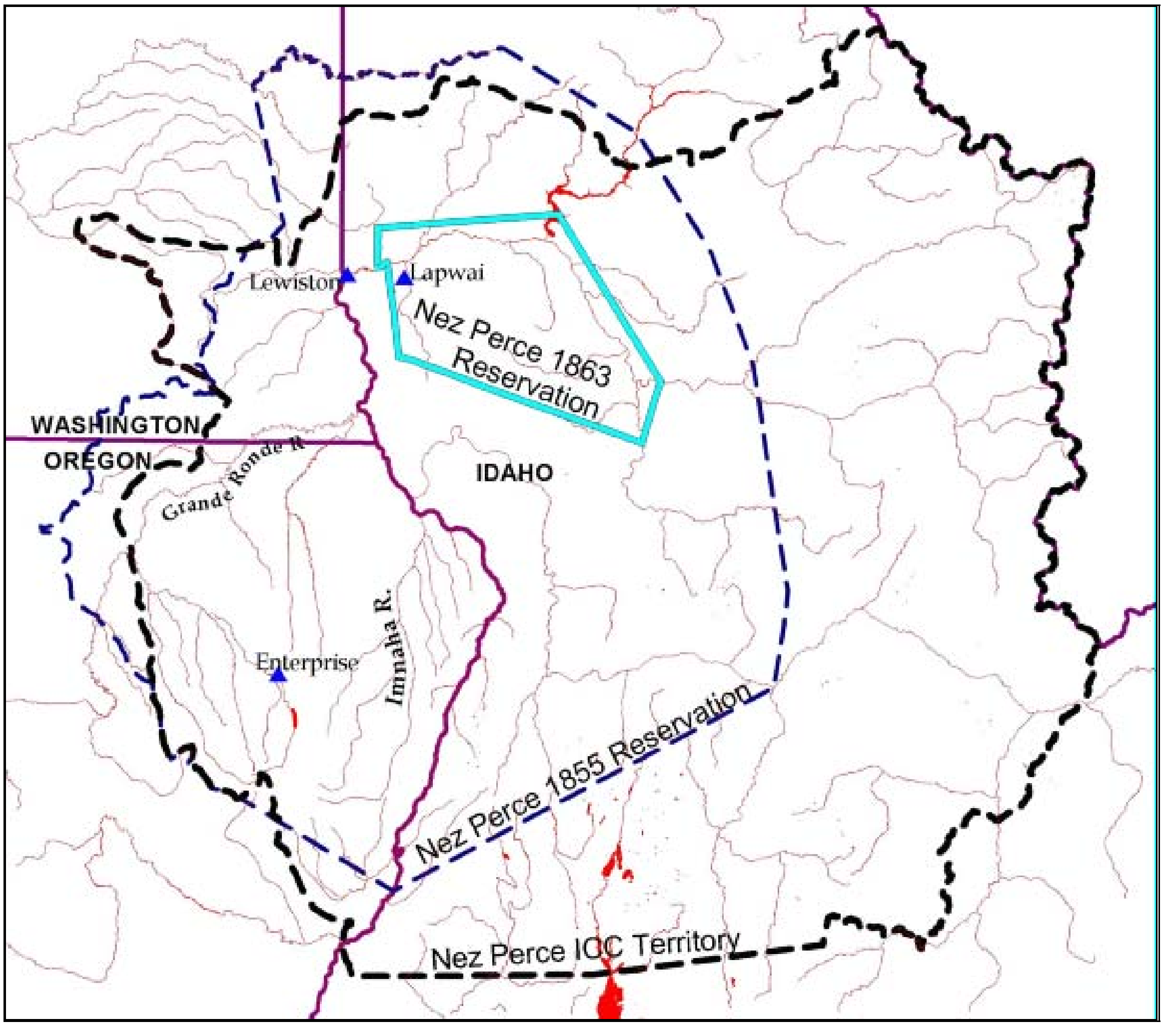

Figure 1.1. Nez Perce Tribe Territory, 1855 Reservation Boundary, and 1863 Reservation Boundary.

Traditionally, the Tribe harvested Snake River white sturgeon for subsistence purposes. Tribal elders confirm the historical presence of white sturgeon throughout the Snake River, mainstem Salmon River, the Clearwater River from its mouth to above Orofino, ID, as well as seasonal migrations into the Grande Ronde River (Elmer Crow, Nez Perce Tribe Department of Fisheries Resources Management, Personal Communication). In addition to being an important food source, white sturgeon served many purposes in the culture of the Tribe. White sturgeon blood was used to make glue; the hides were used for bow cases and quivers, and for water proofing footware. However, subsistence fishing has been severely limited as a result of low white sturgeon numbers between Hells Canyon and Lower Granite dams. There is a potential for a significant subsistence fishery for white sturgeon if populations warrant. There has been an increased emphasis for subsistence white sturgeon harvest due to drastically reduced salmon populations and associated Endangered Species Act (ESA) considerations.

Historically, white sturgeon were abundant in the Snake River. The species supported a commercial harvest beginning in the mid-1890's and lasting nearly 50 years. Local newspapers documented several large specimens being harvested in the upper Snake River. In 1943, the Idaho Department of Fish and Game (IDFG) imposed regulations to end commercial harvest. A series of harvest restrictions followed, and in 1970, the IDFG implemented a no-kill, catch-and-release recreational fishery. Limited harvest was allowed by the state of Washington until 1994, when the Washington Department of Fish and Wildlife (WDFW) imposed a no-kill, catch-and-release regulation upstream of Lower Granite Dam.

The development of the Columbia River Basin hydroelectric system has furthered the decline of white sturgeon. The hydro-system has created impoundments throughout the basin, degraded or destroyed white sturgeon spawning and rearing habitat, severely restricted movements of white sturgeon and their principal food resources. As a result, white sturgeon populations are not as abundant or productive as they were before the hydro-system. Populations may face extinction in some upper Columbia River Basin segments, including portions of the Snake River Basin, where cumulative impacts due to dam blockage and impoundment are particularly acute.

The degree to which the Tribe is culturally coupled to fish was recognized in treaties signed between the Tribe and the United States Government. The same treaties that confined the Tribe to a fraction of their former territory also guaranteed their access to fishery resources. Article three of the treaty of 1855 guarantees to the Tribe:

> "The exclusive right of taking fish in all the streams running through or bordering said reservation … as also the right of taking fish at all usual and accustomed places in common with citizens of the Territory."

No subsequent treaty or agreement between the Tribe and the United States altered this treaty-reserved right. Treaty fishing rights are now the legal basis for the Tribe's involvement, as co-managers, in fishery resource restoration, reintroduction and management activities throughout their former range.

While there has been many changes in the way of life for Tribe, maintaining and restoring fisheries is imperative to their present life styles. The Tribe has reserved the right to harvest fish in a manner that allows them to maintain this way of life. The rights to take fish and regulate fishery resources have been challenged in court, but courts have upheld these rights (American Indian Resource Institute 1988). However, rights to fish and manage fish are meaningless if there are no fish to be harvested or resources to be managed (CRITFC 1995). Thus, the Tribe believes that rebuilding the white sturgeon population through a comprehensive and adaptive approach is warranted culturally, ecologically and legally.

This document presents the Nez Perce Tribe's comprehensive and adaptive white sturgeon management plan. Adaptive management will be used to convert knowledge gained from research and monitoring into a well-informed and properly guided management program. This plan describes implementation tactics designed to rebuild the white sturgeon population in the Hells Canyon reach of the Snake River (Figure 1.2). An integral part of this plan is monitoring and evaluation to assess the effects of management actions on the population and to evaluate progress toward achieving the identified objectives. Therefore, the purpose of this plan is to provide information to regional co-managers and others in order to make sound decisions, and to present a strategy to ensure the persistence of white sturgeon and ultimately a sustainable fishery.

1.2 MANAGEMENT DECISION PROCESS

Applied adaptive management of fisheries resources is inherently a dynamic process. The management process supported by this white sturgeon management plan follows eight core steps[1] in a balance of program content, management process, and relationships (between co-managers, resources users, and policy). Pre-labeling core management decision points and the basic information used to guide those decisions is central in maintaining transparent and efficient management of resources. Establishing a predetermined decision tree where management recommendations are hard-wired is not readily embraced by managers or functionally possible given a complex environment and adaptive management framework. The following list of core decision items, predetermined thresholds, and guiding information will be considered on an annual basis with full consideration for change in program scope and direction applied every five years.

1) Annual harvest recommendation (5 kg/ha goal).

- Current population estimate relative to viability threshold (80% confidence that current population abundance is above minimum thresholds[2]).
- 5 year and 15 year description of population status and trend (greater than 80% confidence that the population status is actually above viability thresholds).
- Level of annual harvest considered acceptable and sustainable.

2) Acceptable time frame for achieving management goals.

- Ability for significant level of harvest (below goal) by 2015.

[1] The NPT Department of Fisheries Resources Management applies an eight-step approach to management process (CRITFC 1995). The steps include: 1) define desired resource condition, 2) determine resource status, 3) identify limiting factor (s), 4) develop management options, 5) apply selected manage action(s), 6) monitor and evaluate results, 7) modify/adjust manage action or goals, and 8) monitor and evaluate results.

[2] Viability and minimum thresholds for abundance and population growth rates specific to HCR or CRB sturgeon populations have not been developed to date. A general conservation biology recommendation for sturgeon is 2,500 and being used as interim threshold. Assessment of population estimates to thresholds must consider data precision bounds.

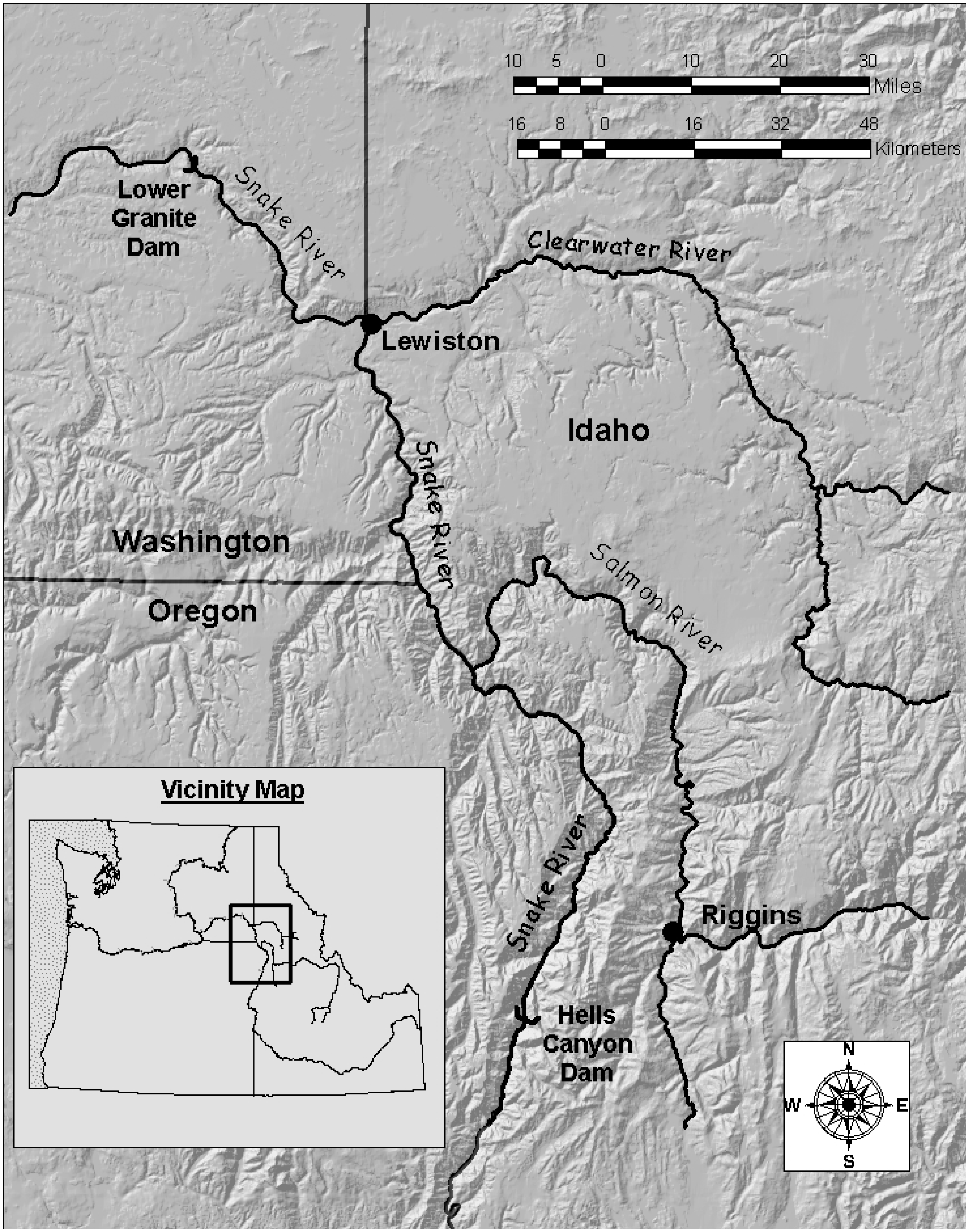

Figure 1.2. Map of the Snake River study area.

3) Scope of management actions to be implemented to achieve management goals.

- Limiting factors.
- Risk and benefits of potential management actions.
- Feasibility/reality check for management action implementation (funding, permitting, co-manager support/approval, cost/benefit assessment, fidelity to management action implementation).

4) Acceptable risk and uncertainty in achieving management goals.

- Greater than 80% probability that management action will achieve anticipated affect (must establish and address both type I and type II error).
- Greater that 95% probability of population persistence over 100 yrs.
- Small-scale study implementation (assumes results are transferable to larger or different locations).

5) Recommendation for continuation, expansion, and/or termination of management actions.

- Review of management action results relative to predicted/expected (80% confidence that results actually reflect reality).

6) Recommendation for off-site mitigation.

- Review of progress towards goals. If unacceptable, develop off-site harvest opportunities of white sturgeon, and resident trout or other species substitution.

7) Revision of management goal (increase, reduce, maintain).

- Requires policy consideration of technical assessment of current population productivity potential relative to existing goals.

1.3 GOALS AND OBJECTIVES

The overall goal of the management plan is to maintain a viable, persistent population of white sturgeon in the HCR of the Snake River that can support an annual sustainable harvest. This management goal is further identified by the following objectives which may be used to measure the progressive response of the population to implemented management actions:

- A natural, stable age structure comprising both juveniles and a broad spectrum of spawning age-classes;

- Stable or increasing numbers of both juveniles and adults;

- Consistent levels of average recruitment to ensure future contribution to reproductive potential;

- Stable genetic diversity comparable to current levels;

- A minimum level of abundance of 2,500 adults to minimize extinction risk; and

- Provide an annual sustainable harvest of 5 kg/ha.

A proactive management approach is thus essential to identify and implement feasible measures that will restore and rebuild the white sturgeon population in the HCR to a level that sustains viability and can support an annual harvest. Implicit in this approach will be the recognition that the integrity of the stock, the habitat features essential to recruitment, and the current beneficial uses will be restored and preserved. This implies that natural reproduction can not be replaced but may be complemented by artificial measures of production to recover stock levels, that genetic identity (e.g., haplotype diversity) of the stock will not be eroded, and that fishing opportunities currently available to recreational anglers will not be eliminated but possibly enhanced.

A minimum viable population size has yet to be quantified for the HCR white sturgeon population despite the development of population viability analysis (PVA) models to examine potential limiting factors (Jager et al. 2001; Jager et al. 2002). However, a benchmark level of 2,500 adults has been established as a level of concern for sturgeon populations by the World Conservation Union (IUCN 1994). This number is also consistent with viability benchmarks used in U.S. Endangered Species Act assessments. A minimum effective population size of 500 adults, and a census population of several times the effective size, is suggested to prevent bottlenecks that rapidly reduce adaptive genetic diversity (Thompson 1991). Because of the high variability in reproductive success and the consequent likelihood that only a small percentage of adults contributes to the genome of any given cohort (Hedgecock 1994), effective population size is probably much lower than census population size in sturgeon populations. Thus, a census adult population size of 2,500, a level five times the recommended effective size, is not an unreasonable minimum benchmark level for the HCR white sturgeon population.

Consistent with the proactive approach is the need to define a reasonable, provisional harvest objective, given the productive potential of the HCR, by which to assess the attainability of the harvest objective of 5 kg/ha/yr. Because the number of harvestable white sturgeon that could be supported in the management area is unknown due to uncertainty in the reach's current carrying capacity, estimates from population surveys conducted in Lower Columbia River reservoirs were used as surrogates (Beamesderfer et al. 1995). In surveys conducted in Bonneville Reservoir (8,400 ha) from 1989 to 1999, estimated abundances of white sturgeon within a slot limit of 120-180 cm ranged between 1,200 and 3,640 fish, calculated densities ranging between 0.14 and 0.43 fish/ha. In surveys conducted in The Dalles Reservoir (4500 ha) from 1987 to 1997, estimated abundances of white sturgeon within the slot limit ranged between 800 and 8,300 fish, calculated densities ranging between 0.18 and 1.85 fish/ha.

A sustainable annual subsistence harvest of 5 kg/ha was identified consistent with the estimated production potential for white sturgeon in impounded reaches of the Columbia River system (CBFWA 1997). Providing that the management area encompasses the Snake River from Hells Canyon Dam (Rkm 398) to Lower Granite Dam (Rkm 174), the Clearwater River upriver to Orofino, ID (Rkm 66), and the Salmon River upriver to Riggins, ID (Rkm 132), this harvest goal equates to the annual removal of a total of 1,575 white sturgeon within a given slot limit of 120-180 cm (Table 1). However, this desired harvest level is incompatible with current levels of white sturgeon production in the management area. Recent surveys have estimated a population size of approximately 3,700 fish, with the number of fish greater than the minimum harvestable size constituting less than half of this estimate (Everett et al. 2003). Not only is the adult census below the stated minimum threshold level but the desired level of harvest would essentially remove half of the population including all of its reproductive potential. Furthermore, given that this population has not measurably increased in numbers during the last 30 years (Everett et al. 2003), any additional substantial mortality applied by an increase in fishing pressure may drive the population to precariously low levels of abundance.

The upper estimate of 1.85 fish/ha is probably not an unreasonable provisional short or mid-term objective for harvestable numbers in the management area given that exploitation rates are much higher in Lower Columbia reservoirs than in the HCR. Applying this density to the total estimated available white sturgeon habitat in the management area (i.e., Snake, Clearwater, and Salmon Rivers) yielded an estimate of 9,036 white sturgeon of harvestable size (Table 1). At an exploitation rate of 0.10, this equates to an annual harvest of 904 fish. Assuming that the ages of the harvested fish are distributed within the slot limit according to a stable-age distribution, the biomass that can be harvested from these 904 fish equates to an extraction level of 2.8 kg/ha. The estimated annual yield of 2.8 kg/ha is somewhat higher than the sustainable annual yields estimated by Beamesderfer et al. (1995) for Bonneville Reservoir (1.9 kg/ha) and The Dalles Reservoir (1.29 kg/ha), but is substantially lower than the estimate generated for the unimpounded reach below Bonneville Dam (19.6 kg/ha; DeVore et al. 1995).

The provisional target objective of 1,110 for harvestable numbers in the free-flowing Snake River (Table 1.1) is also compatible with the objectives set forth in white sturgeon management plans drafted by Idaho Department of Fish and Game (IDFG 2003) and Idaho Power Company (IPC 2003). Benchmark targets for these management entities include a population density of 32 sturgeon/km and a stock structure consisting of 30% of individuals between the sizes of 90 and 180 cm TL. Assuming 173 km of habitat in the free-flowing section of the Snake River, this equates to a population size of 5,530 individual white sturgeon. If fish within the slot limit of 120-180 cm constitute 67% of the individuals in the 90-180 length range, then the number of harvestable fish is calculated as 1,111 (i.e., 5,530 x 30% x 67%), a number quite comparable to that estimated for this plan.

1.4 Project History

In 1995, the Tribe initiated a white sturgeon research project to address measure 10.4A.4 of the Northwest Power and Conservation Council (NPCC; formerly the Northwest Power Planning Council – NWPPC) 1994 Fish and Wildlife Program. During the first phase of this project a Biological Risk Assessment Team (BRAT) was assembled to develop a risk assessment for white sturgeon in the Upper Snake River between Hells Canyon and Lower Granite dams. The BRAT participants included a wide range of professionals from a variety of federal, state, private, and tribal agencies that were knowledgeable and concerned about white sturgeon ecology, the Snake River system, and regional ecological issues. The resultant *Upper Snake River White Sturgeon Biological Assessment* (Carmichael et al. 1997) identified: 1) regional white sturgeon resource objectives, and 2) potential mitigative actions that could be used to achieve regional objectives.

Table 1.1. Estimated biomass and number of harvestable white sturgeon (slot limit of 120-180 cm) from various reaches of the management area under given target objectives.

	Management reach				
	Lower Granite Reservoir	Free-flowing Snake River	Clearwater River	Salmon River	Total
Reach length (km)	51	173	66	132	422
Estimated available sturgeon habitat (ha)[a]	3,600	600	228	456	4,884
	Annual harvest of 5 kg/ha				
Biomass harvested (kg)	18,000	3,000	1,140	2,280	24,420
Equivalent number of fish harvested[b]	1,160	200	70	145	1,575
	Density of 29 harvestable kg/ha				
Harvestable numbers	6,660	1,110	422	844	9,036
Harvestable biomass (kg)	103,300	17,200	6,700	13,000	140,200
Harvested numbers					
10% Exploitation	666	111	42	84	904
20% Exploitation	1,332	222	84	168	1,808

[a] Estimated sturgeon habitat in the free-flowing reach of the Snake River was obtained from an instream flow assessment conducted by Idaho Power (Chandler et al. 2003). The proportional amount of habitat relative to river kilometers from Chandler et al. (2003) was used to estimate usable habitat in the Clearwater and Salmon Rivers.
[b] Numbers of fish were assumed to be distributed within the slot limit according to the stable age distribution derived from a life-cycle model for HCR sturgeon

The risks associated with the implementation of these potential management actions, as well as a no action alternative, were also analyzed in Carmichael et al. (1997) using the risk assessment process described by Lestelle et al. (1996). However, the BRAT was not able to fully assess the risks and effectiveness of individual mitigative actions because of lack of basic information concerning the white sturgeon in the Snake River between Hells Canyon and Lower Granite dams.

In 1996, a multi-year research study (Hoefs 1997) was designed and implemented to collect specific biological and environmental data needed to assess the health and status of the population, as well as characterize habitat used for spawning and rearing. The study design was based on a broad array of information needs identified by the risk assessment as fundamental to evaluating the effectiveness of the alternative mitigative actions.

From 1996 to 2002, life history data was collected on the population in the Hells Canyon reach of the Snake River. Equipped with this recently collected data, the BRAT reconvened in 2003 and reviewed and modified the list of potential mitigative actions. A new risk assessment

(Heppell et al. 2004) was conducted using this information to assess the mitigative actions and to help develop this adaptative management plan.

1.5 Relationship to Other Programs and Projects

The white sturgeon management plan must be consistent with other on-going studies in the basin. In order to avoid both contradiction and redundancy in our efforts, we have considered several white sturgeon research and management projects while developing the plan. Many of these projects are funded by Bonneville Power Administration (BPA) to implement and achieve the NPCC Fish and Wildlife Program (FWP) objectives in other reaches of the Columbia River Basin to mitigate for impacts of the hydrosystem. Other projects include efforts by state agencies, local public utility districts (PUD) and universities. Outlined below are a few of these programs and projects.

1.5.1 Fish and Wildlife Program and Subbasin Amendments

White sturgeon between Lower Granite Dam and Hells Canyon Dam are specifically addressed in the NPCC 2000 FWP. The FWP described four objectives related to resident fish:

- complete assessments of resident fish losses throughout the basin resulting from the hydrosystem,
- maintain and restore healthy ecosystems and watersheds, which preserve functional links among ecosystem elements to ensure continued persistence,
- protect and expand habitat and ecosystem functions as the means to significantly increase abundance, productivity, and life history diversity of resident fish,
- achieve population characteristics of these species within 100 years that, while fluctuating due to natural variability, represent on average full mitigation for losses of resident fish.

This plan addresses objectives 2, 3 and 4 above. In achieving these objectives, the NPPC acknowledged that activities such as altering the hydropower system operations, supplementation, and harvest manipulations might be required.

This plan also addresses measure 10.4A.4 of the NPCC 1994 FWP that calls for the BPA to "...fund an evaluation, including a biological risk assessment (see Section 7.3B.1), of potential means of rebuilding white sturgeon populations in the Snake River between Lower Granite and Hells Canyon dams (NPPC 1995). The NPCC encouraged studies to be undertaken and completed quickly and on-the-ground projects identified and implemented as soon as possible to address the needs of this species.

The spatial coverage of this white sturgeon management plan encompasses portions of four NPCC FWP subbasin amendments and the mainstem amendment. The subbasin plans include: Snake Hells Canyon, Salmon, Clearwater, and Lower Snake. White sturgeon are a focal species in the Hells Canyon subbasin plan, and a species of special interest in the Salmon subbasin plans. The lower Snake subbasin plan defers to any assessment or management objectives/strategies for the Snake River proper contained in that subbasin to the mainstem amendment.

Each subbasin plan has a vision statement or guiding principle that target a healthy ecosystem, with abundant, productive, and diverse aquatic and terrestrial species and habitats. This includes enhancement of species populations to a level of healthy and harvestable abundance to support tribal treaty and public harvest goals. These types of statements include white sturgeon as a part of a fully functioning ecosystem that maintains historic biological linkages and meets current social-economic expectations.

The NPCC's FWP Hells Canyon Subbasin Management Plan amendment contains multiple objectives and strategies for white sturgeon. Objective 1A strategies 1A2 and 1A3 aim to address "the major impacts of upstream hydroelectric development on those species that primarily use the mainstem Snake River for much of their life history, particularly fall chinook and white sturgeon. Limited connectivity due to dams may limit persistence or productivity of these species within the Snake Hells Canyon subbasin. In addition, the influence of upstream impoundments on flows, thermal regimes, and nutrient levels may limit spawning and incubation success of white sturgeon. Hydroelectric projects have also isolated white sturgeon and bull trout populations within the Snake Hells Canyon subbasin by restricting their movements into or out of the reach." Objective 2A strategies 2A7 and 2A8 deal with downstream factors constraining productivity. This objective focuses on spring and fall chinook, steelhead, and Pacific lamprey. It failed to mention white sturgeon specifically, but should have given the anadromous life history strategies used by white sturgeon. These strategies looked to "maximize natural and artificial production effectiveness in the subbasin— continue existing and/or implement innovative production strategies in appropriate areas to support fisheries, natural production augmentation rebuilding and recovery, reintroduction, and research." Other components identified include "monitor and evaluate effectiveness of implementation of artificial and natural production strategies including environmental strategies outlined in problem statements 8 through 15, and develop hatchery fish stocking and marking guidelines for all life stages to optimize the use of hatchery fish." Objective 3A looks to "increase migratory fish productivity and production, as well as life stage specific survival, through in-subbasin habitat improvement." Strategy 3A2 is specific to white sturgeon and the other strategies are generally "aimed at addressing aquatic biological concerns through in-subbasin measures specifically. Although upstream (problem statement 1) and downstream (problem statement 2) out-of-subbasin factors substantially limit aquatic populations within the subbasin, addressing in-subbasin concerns will also be necessary to achieve biological goals established for the Snake Hells Canyon subbasin. Naturally occurring spring and fall chinook, Pacific lamprey, steelhead, and white sturgeon (local migration only) are migratory species that exhibit reduced or declining populations and productivity in the Snake Hells Canyon subbasin. A combination of out-of-subbasin and in-subbasin strategies is required to achieve stabilization and/or recovery of these populations." Objectives 8A and 8B and associated strategies 8A1- 8A5 work to restore natural flow regime that supports and meets the life history needs of aquatic species (includes white sturgeon) in the subbasin.

The NPCC FWP 2003 mainstem amendment has a general objective to "provide conditions that support the needs of resident fish species in upstream reservoirs and river reaches, as well as the needs of anadromous and resident species in the lower parts of the mainstem." A specific objective for white sturgeon is also described: "enhance the abundance and productivity of white sturgeon in the mainstem in order to rebuild and sustain naturally produced populations of white sturgeon and sustain an annual harvest of white sturgeon. Operate the hydropower system to maximize spawning and rearing success of white sturgeon while operating in concert with the needs of salmon." Table 1 displays other program and initiatives and their relationship to the white sturgeon management plan.

Table 1.2. Relationship of the white sturgeon management plan to legal and other initiatives.

Program or Initiative	Description of Program or Initiative	Relationship to the Management Plan
Treaty of 1855	The Nez Perce Tribe reserved "The exclusive right of taking fish in all the streams running through or bordering said reservation ...and… taking fish at all usual and accustomed places …"	Restoration of white sturgeon productivity would assist in meeting federal obligations to the Nez Perce Tribe.
U.S. v. Oregon	Treaty fishing rights litigation addressing Columbia Basin salmon and steelhead harvest and enhancement goals.	The proposed program would assist in meeting obligations and agreements under the lawsuit.
Pacific Northwest Power Planning and Conservation Act of 1980	This Act established the Northwest Power Planning Council for the purpose of mitigating for the development and operation of hydroelectric projects within the basin. The Council implements the Fish and Wildlife Program to protect, mitigate, and enhance fish and wildlife in the Columbia River basin.	The proposed program would be funded through the Fish and Wildlife Program.
Wy-kan-ush-mi Wa-kish-wit: Spirit of the Salmon Tribal Recovery Plan (NPT *et al.* 1995).	Plan developed by the four Columbia River Treaty Tribes to restore fish runs.	The proposed program is recommended by the Tribal Recovery Plan. The plan sets a goal to increase lamprey and sturgeon to naturally sustaining levels within 25 years in a manner that supports tribal harvests.

1.5.2 Regional White Sturgeon Research and Management Projects

Lower Columbia River Projects

In the Lower Columbia River, BPA funds project 198605000, which began in 1986 with the title *Status and Habitat Requirements of White Sturgeon Populations in the Columbia River Downstream from McNary Dam*. This project was designed as a cooperative effort among the agencies involved in restoration and enhancement of white sturgeon populations in the Columbia and Snake River basins. The project's title, scope and contributing agencies have changed, but its project number has not. As part of this project ODFW, in cooperation with other management, research and tribal agencies, has been gathering data on white sturgeon. Research has focused on determining the status of white sturgeon within Bonneville, The Dalles, and John Day Reservoirs. Certain agencies have taken the lead in different geographical areas and in different areas of research. Investigators have studied a host of population characteristics including abundance, spawning and rearing habitat requirements, feeding needs, movement and distribution, as well as developed white sturgeon sampling techniques.

In addition to research, this project has been implementing a strategy to enhance production of white sturgeon in those reservoirs between Bonneville and McNary dam. Juvenile white sturgeon are trapped below Bonneville Reservoir and transplanted into The Dalles and John Day Reservoirs to provide harvest opportunities. This is an on-going project with periodic stock assessment monitoring in each Lower Columbia River reservoir.

Another component of this project was the development of artificial propagation techniques for white sturgeon. CRITFC and WDFW collected broodstock from below Bonneville Dam and from McNary Reservoir and transported them to the white sturgeon holding facility below the McNary Dam Juvenile Fish Facility. Fish were spawned and eggs were transferred and reared at the USFWS Abernathy Fish Technology Center (AFTC). Juvenile fish were outplanted as part of an experimental release to supplement selected Columbia River white sturgeon populations. This project has since been discontinued by BPA, but preliminary results have been used to guide subsequent programs in the middle Columbia River (see below).

Middle Columbia River Projects

In the Middle Columbia River, BPA Project 198605000 has conducted white sturgeon stock assessments in McNary, Rock Island, Chief Joseph (Lake Rufus Woods) Reservoirs, and the Hanford Reach. This is an on-going project with periodic stock assessment monitoring in select Middle Columbia River reservoirs.

The Chelan County PUD (CCPUD), which operates Rock Island and Rocky Reach Dams, funded white sturgeon sampling in both reservoirs. In 2003, CRITFC and WDFW conducted an experimental release of white sturgeon juveniles into Rocky Reach Reservoir to assess distribution and survival. These fish were progeny of Lower Columbia River broodstock reared at AFTC. Furthermore, as part of their relicensing application, CCPUD has recommended a long-term white sturgeon supplementation program. CCPUD has developed a white sturgeon management plan (CCPUD 2005), and has drafted an approach for enhancing white sturgeon in Rock Reach Reservoir.

The Grant County Public Utility District (GCPUD), which operates Priest Rapids and Wanapum Dams, funded sampling in both reservoirs. As part of their Federal Energy Regulatory Commission (FERC) relicensing application, GCPUD has also recommended an experimental white sturgeon conservation aquaculture program in order to support harvest (GCPUD 2003). Douglas County PUD, which operates Wells Dam, has also conducted white sturgeon field studies.

Upper Columbia River Projects

Studies in the 1990's of white sturgeon in the upper Columbia River between Grand Coulee Dam (USA) and Hugh L. Keenleyside (B.C.) indicated a population with few juveniles and poor recruitment. In 1993, the population in British Columbia was designed as a Red List species by the BC Conservation Data Centre. That designation identifies a species as critically imperiled. In 1996, the Canadian government began to develop a recovery plan. The Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) was formed in 2000 to address the recruitment failures of white sturgeon within the upper Columbia River. By 2002, the plan, which was drafted by both Canadian and US agencies, was finalized. Early emphasis has been placed on producing juvenile white sturgeon for immediate release as a stop-gap method to overcome the recent recruitment failure. A white sturgeon conservation hatchery was established Hill Creek hatchery and later moved to the Freshwater Fisheries Society of B.C.'s Kootenay Trout Hatchery. Similar to the KTOIH program, broodstock are captured from the Columbia River, spawned and released. The production goal is 12,000 white sturgeon released yearly until natural recruitment is restored.

In 2005, Malaspina University in Nanaimo, B.C. received funding commitments to pursue white sturgeon aquaculture research. Research would focus on conservation and protection of sturgeon species through responsible aquaculture techniques. In the past, Malaspina's International Centre for Sturgeon Studies has provided eggs and fry to B.C.'s commercial white sturgeon aquaculture program.

In 1991, BPA funded a pilot hatchery program for the Kootenai River white sturgeon. The hatchery is managed by the Kootenai Tribe of Idaho (KTOI) in cooperation with IDFG and USFWS. Also in 1991, flows from Libby Dam were manipulated to mitigate for white sturgeon spawning and rearing habitat degradation. In 1994, Kootenai River white sturgeon were list as endangered under the Endangered Species Act (ESA), and the Kootenai hatchery (KTOIH) was expanded to address ESA concerns. The Kootenai River White Sturgeon Recovery Plan (USFW 1999) established a yearly production goal of 9,000 to 12,000 fish. White sturgeon broodstock are collected from the Kootenai River, held and spawned at KTOIH, then later released. In order to offset any catastrophic loss at the KTOIH, one-half of the resultant eggs are transferred to the Kootenay Trout Hatchery (KTH) in British Columbia, Canada. Breeding protocols, developed by Kincaid (1993), are used to maximize genetic diversity of hatchery produced fish.

Lower Snake River Projects

In the Lower Snake River, BPA Project 198605000 has conducted white sturgeon stock assessments in Ice Harbor, Lower Monumental, and Little Goose Reservoirs. This is an on-going project with periodic stock assessment monitoring in each Lower Snake River reservoir.

Middle and Upper Snake River Projects

For white sturgeon management purposes, IDFG has identified eight reaches in the Snake River above Hells Canyon Dam (IDFG 2003). Most reaches incorporate one or two mainstem dams and their reservoirs. During the late 1980's to early 2000's minimal white sturgeon hatchery releases were conducted above Hells Canyon Dam. Most outplants were for research and sport fishery supplementation purposes. The releases were conducted as a cooperative effort by IDFG, the College of Southern Idaho and private fish hatcheries. IDFG has proposed actions that continue white sturgeon population research and monitoring for the majority of these reaches, as well as implementing measures to improve water quality. IDFG recognizes the possibility of hatchery intervention or white sturgeon translocation; however, these actions have been given lower priority until further research is completed (IDFG 2003).

In 2000, as part of a pilot research project, BPA funded the Nez Perce Tribe to release 50 white sturgeon into Hells Canyon Reservoir. The goal of the project was to develop and implement a fishery augmentation program to restore subsistence harvest of white sturgeon in Hells Canyon and Oxbow Reservoirs in order to partially mitigate for losses of white sturgeon in these and other reaches of the Snake River. Funding was not renewed, and the project was abandoned in 2001.

As part of their FERC relicensing process, IPC has conducted white sturgeon stock assessments in each reach of the Snake River above the mouth of the Salmon River to Shoshone Falls. From the results of these assessments, IPC has produced a white sturgeon management plan which recommends several actions to mitigate for negative impacts to white sturgeon (IPC 2003). In select reaches above Hells Canyon Dam, IPC has suggested conservation aquaculture programs, translocation of white sturgeon from more productive reaches, and improvements in water quality.

Systemwide Projects

Genetic samples have been collected from white sturgeon throughout the Columbia River Basin. These samples have been analyzed as part of BPA Project 199902200, *Assessing Genetic Variation Among Columbia Basin White Sturgeon Populations*. Results from this project could help direct activities such as transferring white sturgeon between populations, developing hatchery breeding plans and subsequence release strategies.

Oregon State University (under BPA Project 198605000) has developed a reproductive maturation status model for white sturgeon. The discriminant function analysis uses blood plasma indicators, sex steroids, calcium, and fork length to predict sex and stage of maturity. This model may provide additional information on potential factors limiting recruitment.

CHAPTER 2: STATUS OF HELLS CANYON REACH WHITE STURGEON

2.1 ABUNDANCE

Population surveys have been periodically conducted in the HCR over the last 30 years (Table 2.1). Before closure of Lower Granite Dam, a survey conducted from 1972 to 1975 estimated population size in the management area to be between 8,000 and 12,000 individuals (Coon et al. 1977). A second survey conducted during 1982-1984 sampled a more restricted section of the HCR (Lukens 1985). Extrapolation of the survey estimate to the entire free-flowing reach of the Snake River provided an estimate of approximately 4,000 fish. During 1990-1991, another survey was conducted in Lower Granite reservoir and yielded an estimate of around 1,500 fish (Lepla 1994). A final joint survey was concurrently conducted by the Nez Perce Tribe (Everett et al. 2003) and IPC (Lepla et al. 2001) from 1997 to 2001. Combining numbers from their surveys generated a point estimate of approximately 3700-4000 fish from Hells Canyon Dam to Lower Granite Dam. Despite the different sampling methods employed by the various researchers and the different reaches in which surveys were conducted, estimates over the last 20 years suggest that the white sturgeon population in the HCR management area, though relatively stable, has not measurably increased in size.

Table 2.1. Population abundance estimates reported for white sturgeon between Lower Granite Dam (Rkm 174) and Hells Canyon Dam (Rkm 398) (Source: Everett et al. 2003).

Location	Abundance (estimator)	Sample Years	Source
Lower Granite Dam site to Hells Canyon Dam	8,000-12,000 (Schnabel)	1972-75	Coon et al. 1977
Clearwater River to Hells Canyon Dam (Rkm 224-398)	3,955 (Schnabel)	1982-84	Lukens 1985
Lower Granite Reservoir (Rkm 174-240)	1,524 (Schnabel) 1,372 (Jolly-Seber)	1990-91	Lepla 1994
Salmon River to below Hells Canyon Dam (Rkm 303-383)	1,312 (Schnabel) 1,600 (Jolly-Seber)	1997-2000	Lepla et al. 2001
Lower Granite Dam to Salmon River (Rkm 174-303)	2,859 (Schnabel) 2,140 (Jolly-Seber)	1997-2001	Everett et al. 2003

2.2 SIZE STRUCTURE

While abundance may not have significantly changed during the last 20 years, trends in the size structure of the population have been detected (Figure 2.1). Surveys conducted before 1985

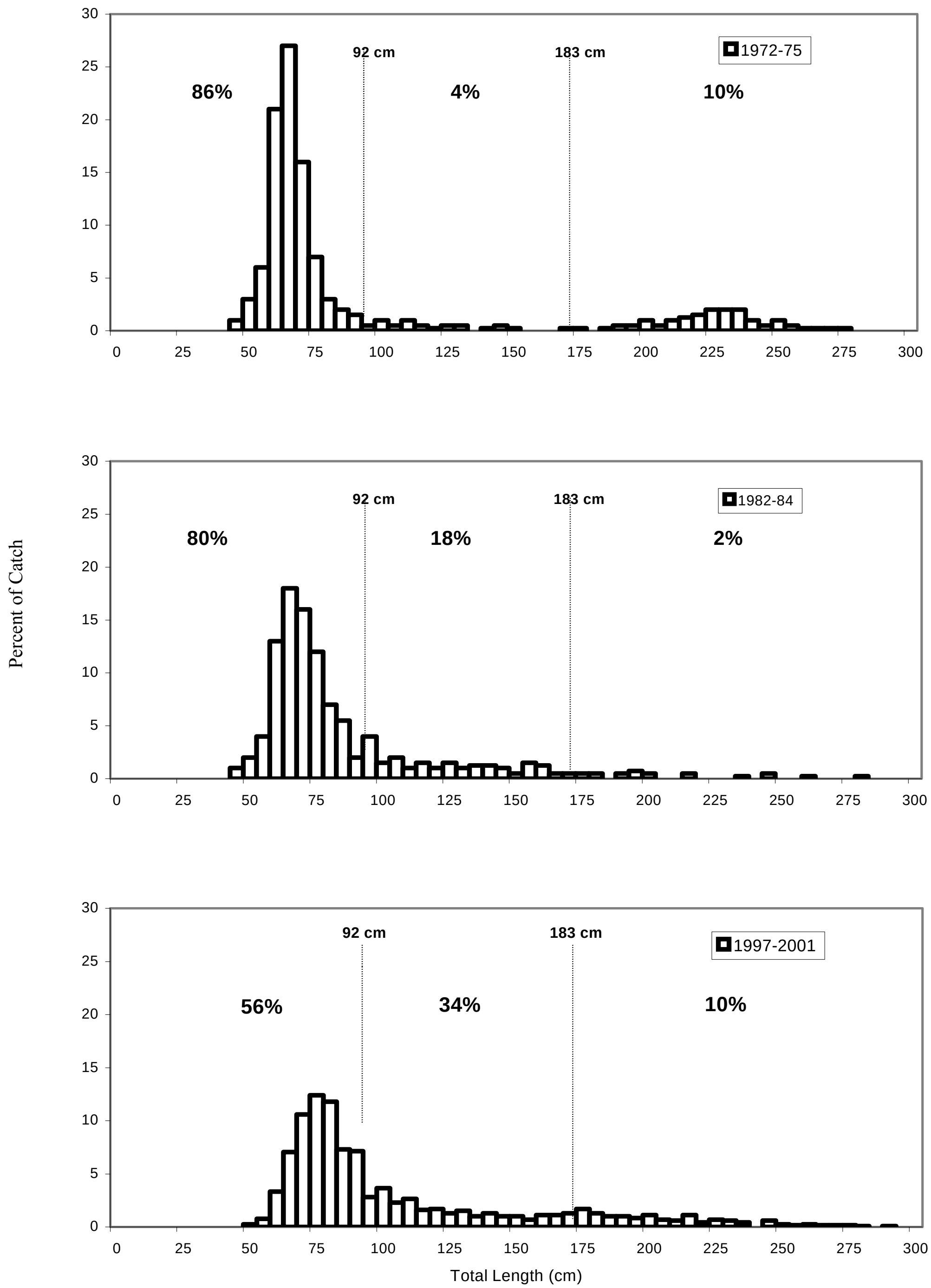

Figure 2.1. Total length (TL) frequency distributions of white sturgeon sampled from the Hells Canyon reaches of the Snake River in 1997-2001 (Lukens et al. 2001; Everett et al. 2003), 1982-84 (Lukens 1985), and 1972-75 (Coon et al. 1977) (Source: Everett et al. 2003).

revealed a high percentage of small fish in the white sturgeon population (Coon et al. 1977; Lukens 1985). Eighty-six and eighty percent of sampled fish were smaller than 92 cm in surveys conducted in 1972-75 and in 1982-84, respectively. Furthermore, less than 18 percent of the sampled fish in both surveys ranged between 92 and 183 cm in length, a size class which was heavily harvested until 1970. In contrast to these studies, the joint survey conducted during 1997-2001 indicated that 34 percent of sampled white sturgeon ranged between 92 and 183 cm in length, while 56 percent were smaller than 92 cm. Apparently, larger size classes in the HCR white sturgeon population have benefited from the elimination of the state of Idaho's consumptive fishery in 1972.

Spatial differences in size structure also were observed during surveys conducted from 1997 to 2001. A higher percentage of small white sturgeon were sampled in the free-flowing reaches than in the reservoir. The median size of white sturgeon collected in the free-flowing segment of the Snake River was 88 cm, whereas the median size of fish captured in Lower Granite reservoir was 117 cm (Figures 2.2 and 2.3). Relative weights of white sturgeon were also significantly greater for fish collected in Lower Granite reservoir (W_r, mean of 90.5) than for fish sampled in free flowing reaches of the Snake River (W_r, mean of 84.6) during 1997-2001. This difference may suggest that there may be either a greater abundance of food or a lower expenditure of energy per caloric intake in the slow-moving reaches of the reservoir than in the free-flowing reaches upriver. Seasonal dietary studies may help elucidate the factors contributing to this discrepancy.

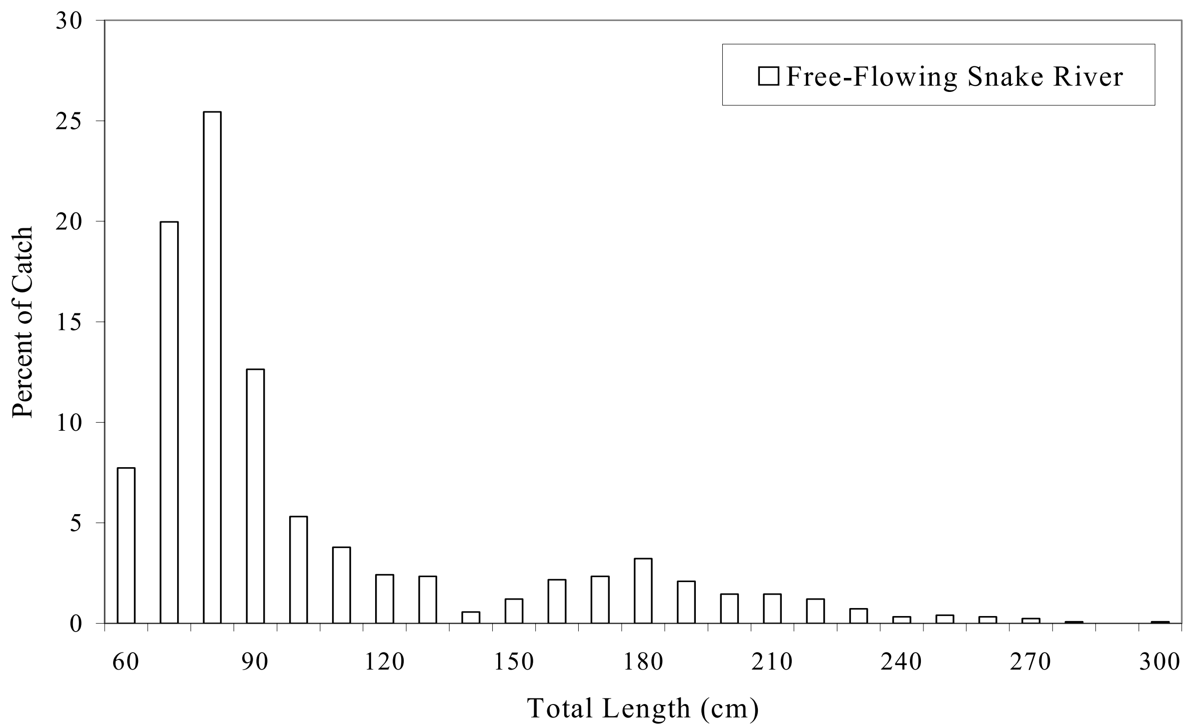

Figure 2.2. Length frequency distribution of white sturgeon captured in the free-flowing Snake River during 1997-2001 (Source: Everett et al. 2003).

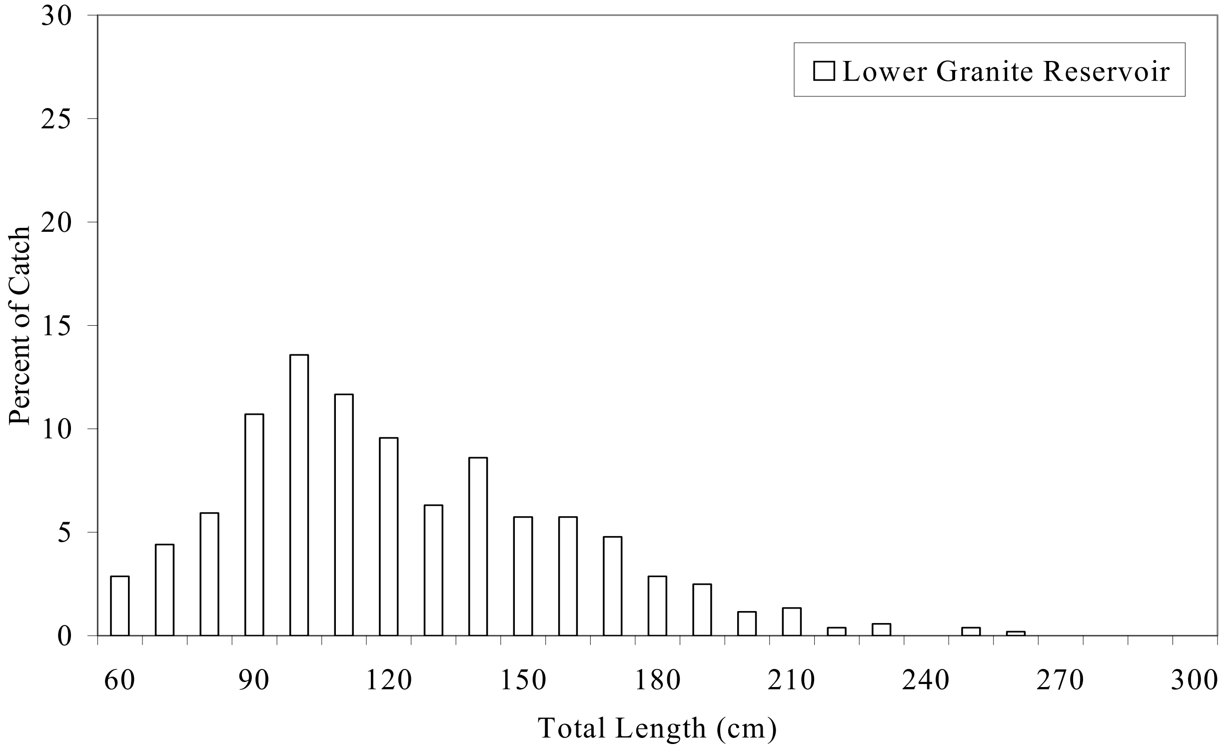

Figure 2.3. Length frequency distribution of white sturgeon captured in Lower Granite Reservoir during 1997-2001 (Source: Everett et al. 2003).

Relative weights of HCR white sturgeon sampled during the most recent survey were much smaller than those estimated for white sturgeon in lower Columbia River reaches. Mean relative weights of white sturgeon in Bonneville, The Dalles, and John Day reservoirs ranged between 97 and 100 (Beamesderfer et al. 1995), while the mean relative weight of fish collected below Bonneville Dam exceeded 110 (Devore el al. 1995). However, von Bertalanffy growth equations derived from white sturgeon captured in the HCR during 1999-2001 implied that HCR fish were growing faster in length than fish sampled in other Columbia River Basin reservoirs (Figure 2.4). Due to the apparent incongruity in the relative weight and length-at-age data, it is difficult to assess the capacity for white sturgeon growth and production in the HCR.

2.3 DISTRIBUTION AND MOVEMENT

Though white sturgeon were captured throughout the Snake and Salmon Rivers during the 1997-2001 HCR survey, catch rates differed among sample reaches. Average catch per unit effort (CPUE) was more than three times higher in the free-flowing reach of the Snake River (i.e., the Salmon River confluence to the Grande Ronde confluence; Rkm 270-302) than in the downriver reservoir reaches (Figure 2.5). In addition, relatively few white sturgeon were collected in the transitional zone between Lower Granite Reservoir and the free-flowing habitat of the Snake River (Rkm 235-255; Figure 2.5).

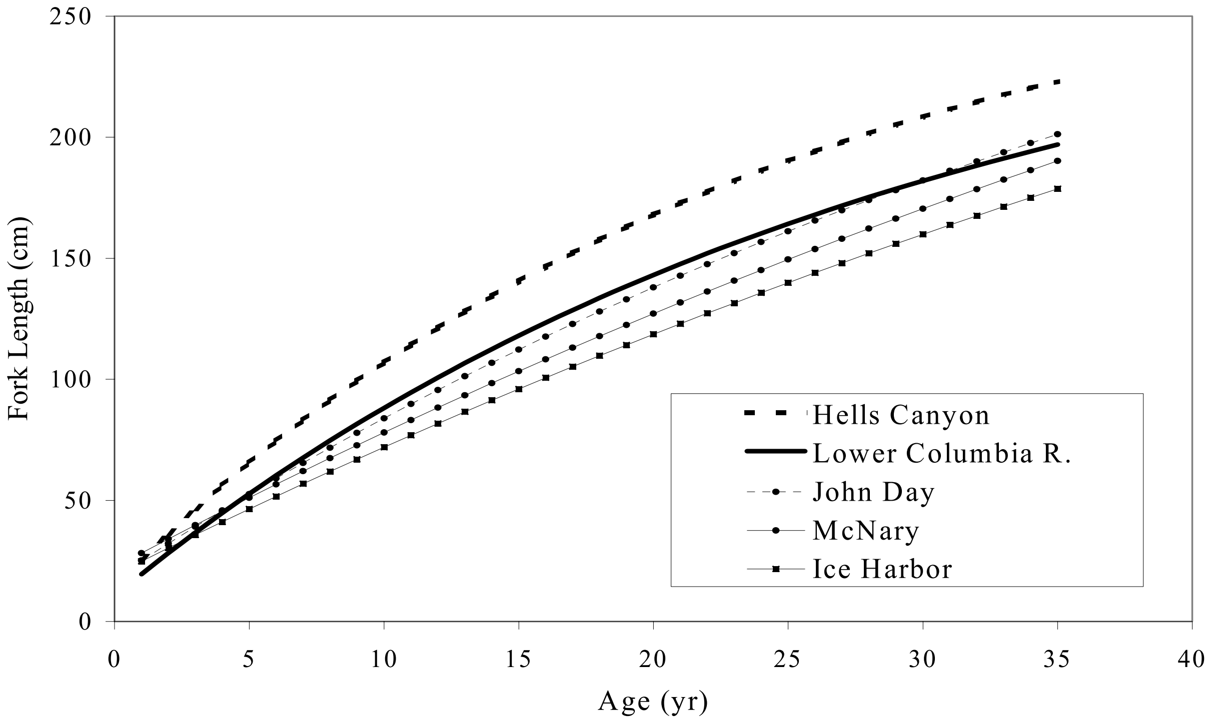

Figure 2.4. Comparison of von Bertalanffy growth curves generated from white sturgeon sampled from the Hells Canyon reach (Lepla et al. 2001; Everett et al. 2003), the Lower Columbia River (DeVore et al. 1995), John Day Reservoir (Beamesderfer et al. 1995), McNary Reservoir (Rien et al. 1997), and Ice Harbor (DeVore et al. 1998).

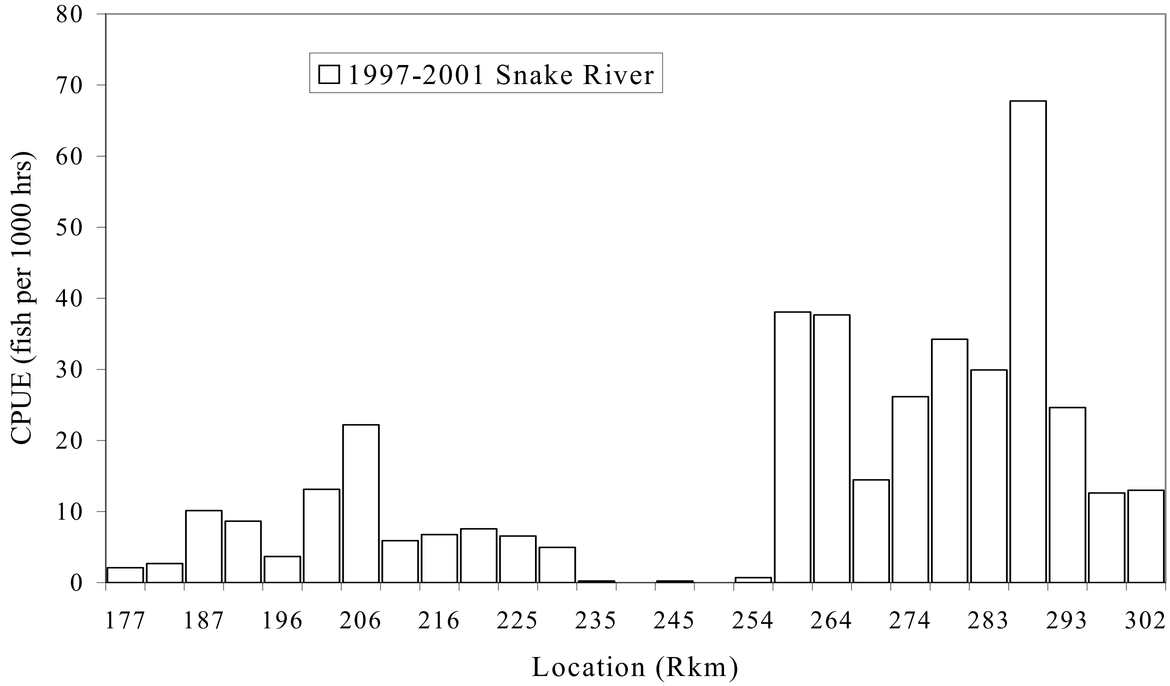

Figure 2.5. Distribution of CPUE (fish/1000 hours) per five km segments in the Snake River, from 1997 to 2001 (Source: Everett et al. 2003).

Results from mark-recapture and telemetry data indicate that movement was rather limited in the HCR during survey periods (Lepla et al. 2001; Everett et al. 2003). Roughly half of the PIT/Floy tagged white sturgeon (n=527) moved less than 0.9 km compared with 16% that traveled more than 16 km. Movements were less extensive for fish tagged in free-flowing reaches of the Snake River (mean of 7.1 km) than for those tagged in the reservoir (mean of 19.0 km). In addition, only 6% of the recaptures moved between the two river segments. Telemetered fish also exhibited little movement. Distances between contacts averaged only 1.4 km and 6.8 km for white sturgeon radio-tagged in the free-flowing reaches of the Snake River and in the reservoir, respectively.

Survey results suggest greater numbers of white sturgeon populating the free-flowing reaches than the reservoir reaches of the HCR. In addition, while tagging results indicated exchange between the two segments, the limited movement displayed by white sturgeon in the HCR suggests potential site-fidelity in this system. Site-fidelity may also partially explain the noted difference in the age structure between the two segments of the Snake River.

2.4 Reproduction and Early Life Stage Survival

Indices of reproduction were detected in the segment of the HCR downriver of the Salmon River confluence in every year of a spawning survey conducted from 1999 to 2001 (Everett et al.

2003). However, sampling for white sturgeon eggs proved inefficient in determining the spatial distribution of spawning activity. Despite a total of 129,408 hours of sampling effort using artificial egg mats, only forty-nine eggs were collected on recovered mats. Time periods in which eggs were collected suggested a protracted spawning period for white sturgeon in the HCR. Eggs were found on mats between May 10 and June 27 in 2000 and between May 11 and July 2 in 2001. The range of temperatures, near-bed velocities, and depths at sites where eggs were collected were consistent with other egg incubation studies conducted along the Columbia River (Parsley et al. 1993; McCabe and Tracy 1994; Parsley and Kappenman 2000). However, 36 of the 38 mats that had collected eggs were deployed at sites dominated by sand, a substrate not considered optimal for egg survival. These results could partially be attributed to the reaches that were sampled and not to the prevailing substrate type in the HCR. Sampling for other early life-stages proved even more difficult than identifying egg incubation sites. In 2001, no YOY white sturgeon were collected in the Snake river in approximately 6500 h of setline effort (Everett et al. 2003).

Reproductive success does not seem to be a problem in the HCR white sturgeon population. The prevalence of juvenile fish in stock assessments periodically conducted between 1972 and 2002 suggests consistent levels of recruitment. However, reliable, efficient techniques need to be developed for sampling eggs, larvae and YOY white sturgeon so that relationships between year-class strength and seasonal river conditions can be better understood.

2.5 EXPLOITATION

Idaho Fish and Game has prohibited the harvesting of white sturgeon from the HCR since 1972, permitting only a catch and release fishery. Exploitation rates from Washington, Oregon, and Nez Perce fishermen in the recent past have yet to be assessed. Anecdotal evidences suggests that tribal fishermen frequent the lower reaches of the HCR more often than the upper free-flowing reaches (Elmer Crow, Nez Perce Tribe Department of Fisheries Resources Management, Personal Communication). Because white sturgeon are harvested for ceremonial and subsistence purposes, the implementation of a monitoring program would aid in determining reach-specific estimates of fishing mortality.

CHAPTER 3: PROPOSED MANAGEMENT ACTIONS

3.1 Impacts to Hells Canyon Reach White Sturgeon: Justification for Mitigation
3.2 Development of Alternative Management Actions
3.3 Alternative Action Assessment
3.4 Where to Find More Information

3.1 Impacts to Hells Canyon Reach White Sturgeon: Justification for Mitigation

Restorative measures outlined in this management plan are intended to mitigate for the loss of the opportunity to annually harvest sufficient numbers of white sturgeon from the HCR of the Snake River. Prior to the anthropogenic modification of the Columbia River system, mobile white sturgeon likely immigrated into the HCR from other reaches of the river system to seasonally access favorable habitats. During these seasonal migrations, white sturgeon would have been available to tribal fishermen for ceremonial and subsistence purposes. However, dam construction along the Columbia and Snake Rivers has effectively eliminated the seasonal influx of harvestable white sturgeon. In addition, habitat alterations due to dam construction have probably limited white sturgeon productivity in the HCR. Similar conclusions have been drawn for the reductions in potential production of white sturgeon populations in Lower Columbia River reservoirs (Beamesderfer et al. 1995).

Historical overexploitation initially contributed to the collapse of white sturgeon populations in the Columbia River basin. Catch rates of lower Columbia River fisheries peaked in the late 1800's and precipitously declined thereafter (Craig and Hacker 1940). Although historical harvest records are not available for the Snake River, trends in catch rates were believed to be similar to those recorded in the Columbia River (US EPA 2002a). In addition, overfishing in the lower Columbia River may have removed individuals that would have seasonally migrated into the upper reaches of the Snake River Basin. The enactment of restrictive regulations to protect spawners in the mid 1900's allowed white sturgeon populations to recover in the lower basin (DeVore et al. 1995). However, ongoing hydroelectric development in the Columbia River Basin has inhibited the conveyance of these benefits to upriver reaches of the river system.

In the unmodified Columbia River system, white sturgeon likely engaged in long-distance feeding and reproductive migrations to access widely-separated foraging and reproductive habitats. However, dam construction along the Columbia and Snake rivers has functionally isolated white sturgeon populations preventing their adaptive ranging behavior. Though downriver transfer may occur passively in early life stages through entrainment at dams, larger individuals rarely actively move among fragmented reaches of the river system (North et al. 1993). Thus, Snake River reaches did not benefit from the rebuilding of white sturgeon populations in the Lower Columbia River. In addition, each impounded reach may no longer provide the full spectrum of optimal habitats for all life-stages of white sturgeon. Restricted access to favorable foraging and spawning habitats has likely reduced the overall productivity of white sturgeon in different reaches of the Columbia River Basin (Beamesderfer et al. 1995) . The inability to freely access more productive reaches in the Lower Columbia River likely inhibits

growth rates of different life stages of white sturgeon in the HCR. Suitable spawning habitat is still available in the HCR as evinced by the consistent levels of recruitment detected in periodic population surveys (Coon et al. 1977; Lukens 1985; Everett et al. 2003). However, dams have likely limited the reproductive potential in this reach by impeding the upriver movement of spawners from downriver reaches.
Depressed populations of lamprey and salmon are also partially attributed to hydroelectric development along the Columbia and Snake Rivers. Prior to dam construction, anadromous fish likely contributed to the forage base of white sturgeon as direct prey items and as a source of marine-derived nutrients that supported productivity at higher trophic levels. The decline in numbers of anadromous fish in the HCR has thus decreased feeding opportunities and limited the availability of energetic resources to white sturgeon.

River regulation has also changed the physical characteristics of rearing habitats for white sturgeon by increasing water temperatures in the slow-moving impounded reaches and by trapping sediments behind dams. The effects of elevated, summer temperatures in the reservoir reaches upriver of Lower Granite Reservoir on white sturgeon physiology have yet to be studied. During low flow years, seasonally high water temperatures may impact growth and survival rates of early-life stages. Depositional zones in the impounded reach above Lower Granite Reservoir have also likely reduced the suitability of rearing habitats for early-life stages. The prevalence of fine sediments in these reaches eliminates the interstitial spaces that serve as temporary refugia for yolk-sac larvae before exogenous feeding commences (Brannon et al. 1995). In addition, early-life stages of white sturgeon are extremely sensitive to environmental pollutants as a result of their benthic orientation (Detlaff et al. 1993). Contaminants may readily accumulate in depositional zones behind dams, and have recently been a topic of concern in the Columbia River system (Foster et al. 2001b; US EPA 2002b; Feist et al. 2005). Although the principal mechanisms that influence survival rates of early life-stages have not been identified in the HCR, white sturgeon larvae that drift into reservoir reaches may be extremely vulnerable to high rates of mortality.

Dams along the Snake River have also altered the natural variability in seasonal and daily flow regimes. Flow regulation during the spawning season can suppress the high levels of discharge that are considered important for white sturgeon recruitment (Kolhorst et al. 1991; Anders and Beckman 1993; Nilo et al. 1997). High discharge may promote reproductive success by (1) increasing the quantity of available spawning habitat; (2) ensuring that fine sediments are flushed from egg incubation sites; (3) dispersing eggs to reduce the mortality associated with clumping; (4) dispersing emerging larvae to both facilitate downriver transport to suitable rearing areas and minimize competitive interactions once exogenous feeding begins; and (5) creating a high-velocity environment that disrupts foraging activity of potential predators (Parsley and Beckman 1994; Parsley et al. 2002). Daily water level fluctuations resulting from power peaking operations at dams can also adversely affect reproduction in white sturgeon by disrupting spawning cues and dewatering egg incubation reaches (Auer 1996). Although the effects of flow regulation and load-following operations on white sturgeon year-class strength in the HCR have yet to be studied, the consistent levels of recruitment detected in population surveys suggest that impacts may be minimal. Instream flow analyses conducted by IPC have indicated that the quality of potential spawning, egg incubation, and larval habitat below Hells Canyon Dam may be reduced only in low flow years (Chandler et al. 2002).

3.2 Development of Alternative Management Actions

The BRAT used the Patient Template Analysis (PTA) to compare existing conditions in the HCR to plausible historical conditions prior to anthropogenic impacts (Lichatowich et al. 1995). From this comparison, the team underscored several problematic factors that are likely constraining the productivity potential of the white sturgeon population (Carmichael et al. 1997). The first three factors are mainly attributed to basin-wide, structural changes to the CRB, whereas the last factor is determined by seasonal impacts specific to the HCR:

- Reductions in lamprey and salmonid populations have depressed the food resources available to white sturgeon and have consequently limited the capacity for growth;
- Optimal habitats for growth and survival of all life-stages may no longer be immediately available within the confines of the management area;
- Depositional, low-velocity areas near Lower Granite Dam have reduced habitat suitability for early-life stages (e.g., egg and larval stages); and
- Additive mortality may be imposed by the catch and release fishery, especially during periods when high water temperatures exacerbate the stress incurred during retrieval.

The BRAT addressed these problems using a multifaceted approach. The strategies identified by the BRAT included increasing survival rates during the early-life stages, reducing mortality at juvenile and adult life stages, improving growth rates at various life stages to increase fecundity and thus spawning potential, and augmenting the numbers of fish in the management area. Consistent with the strategies for recovery, twelve actions were chosen for potential implementation (Carmichael et al. 1997). Each action is described below and summarized in Table 3.1.

Action A: Enhance and restore anadromous salmonid and lamprey populations in the management area.

This action targets improvement of the food resource value for white sturgeon throughout the system and would influence all feeding life stages. This action may improve reproductive success of white sturgeon through increased gonadal development. Long-term fitness would increase because of increased life time fecundity and increased effective breeding population size. There is limited risk of predators and competitors. There would likely be benefits to other aquatic and terrestrial species with this action. The feasibility of accomplishing this objective for salmonids within and around the reach is high. Many efforts are underway to enhance and resort salmonids in the Snake River basin downstream from Hells Canyon Dam. The feasibility of restoring lamprey is unknown as is the feasibility of restoring anadromous fish above Hells Canyon Dam. To provide benefits to white sturgeon there would have to be a direct or indirect transfer through the food chain to white sturgeon which appears likely.

Action B: Reduce power peaking generation at Hells Canyon Dam to maintain flow stability and eliminate water level fluctuations.

This action is designed to improve primary and secondary productivity and could benefit spawning during low water years. This action will influence reproductive success, long-term fitness, and ecological interactions in a manner similar to other food enhancement strategies. There is considerable uncertainty regarding the magnitude of increase in secondary production that could be achieved and the transfer of benefits to white sturgeon. Because of the river channel morphology it is likely this action would provide only small benefits to white sturgeon. This action would require substantial shifts in power generation profiles and would be very costly in terms of lost power revenue.

Action C: Restore river flow pattern to natural hydrograph while maintaining Lower Granite pool at present level.

This action proposes to restore a peak into the hydrograph at the time of spawning and egg dispersal. The primary effect would be to increase reproductive success by improving egg dispersal and survival. This action may also provide small benefits through improvement of the food resource base. It may also decrease exotic competitor interactions by creating a less favorable environment for exotic species. This action will have implication to irrigation needs upstream and to power generation demands.

Action D: Restore white sturgeon passage upriver and downriver at Lower Snake and Idaho Power dams.

This action would provide the opportunity for white sturgeon to utilize other areas for rearing throughout their life. In addition, it would increase gene flow from adult spawners that live below Lower Granite Dam and would allow juveniles that are entrained to return to this river section. This action would improve long-term fitness by increasing gene flow and diversity. There would not be any negative ecological interactions associated with this action. There is a limited amount of knowledge and technology regarding effective means for providing white sturgeon passage. There is a need for technology development, and the cost for providing passage would likely be high.

Action E: Reduce the impact of the catch and release fishery, particularly at times in the summer when water temperature is high.

This action targets reduction of the impact of the catch and release fishery, particularly at times when water temperatures are at peak during the summer months. This action would reduce mortality and increase long-term fitness of the population. In addition, it may reduce stress on adults and improve reproductive success by reducing egg restoration. This action has the potential for substantial improvement in productivity and to increase effective population size.

There would be no change in ecological interactions as a result of this treatment. The action would have a negative influence on a portion of the guide and tourism industry. It would be difficult to eliminate the incidental catch on white sturgeon because of all other types of fisheries occurring that incidentally catch white sturgeon.

Action F: Collect adult fish from other populations in the Snake and/or Columbia rivers and release into the management area.

This action could mitigate productivity reductions by increasing adult/spawner abundance and mitigating adult mortality associated with the catch and release fishery. It could increase long-term fitness by increasing effective population size and potentially increase genetic diversity. For this action to be effective we must assume that density dependent effects on growth and survival are minimal and that survival of transplanted adults would be high and they would have to contribute to the fishery or spawn successfully. Genetic issues of donor and recipient stocks must be considered with this action and may pose significant risk to long-term fitness. Because of the potential for competitive interactions between the natural population and released fish there is risk of negative ecological interactions. It is reasonable to collect a substantial number of adult from other locations in the lower Snake and Columbia rivers. Transport technology and cost effectiveness are uncertain and need further evaluation.

Action G: Collect juvenile white sturgeon from other populations in the Snake or Columbia rivers and release them into the management area.

This action could increase effective population size and genetic diversity and therefore increase long-term fitness. For this action to be effective we must assume that density dependent effects are minimal and that survival of released juveniles to the adult stage would be high. If juvenile fish do not survive to adult stage and reproduce or contribute to fisheries, this action could reduce long-term fitness. A negative ecological interaction could occur if transplanted juveniles compete with natural fish but do not reproduce effectively or contribute to harvest. It is feasible to collect large numbers of juveniles form other location and hauling is feasible. Genetic issues associated with the donor stock must be considered with this action.

Action H: Produce adult white surgeon in a hatchery and release into the management area.

This action could increase productivity be increasing adult/spawner abundance and mitigate adult mortality associated with the catch and release fishery. It could increase long-term fitness by increasing effective population size and potentially increase or decrease genetic diversity depending on stock source and production plans. For success, we must assume density dependent factors are minimal and survival after release would be high. There is a high degree of uncertainty regarding how well fish reared in captivity would adapt and perform in nature. The technology to produce mature fish in a hatchery environment is presently available; however the costs would likely be high. As is the case with any supplementation program, genetic issues of donor and recipient socks are a major concern.

Action I: Produce juvenile white sturgeon in a hatchery and release into the management area.

This action could increase long-term fitness by increasing adult/spawner abundance if juveniles survive to the adult stage. To contribute to long-term fitness we would have to assume adequate post release survival to the adult stage and reproductive success of hatchery fish in nature. We assume that density dependent factors re minimal. There is a risk that if juveniles lived for some period of time but did not survive to spawn or contribute to fisheries there would be a negative interaction with the existing natural populations. Genetic risks must be considered with this treatment action. Costs of operating and maintaining a production facility could be high depending on the level of production.

Action J: No action.

If no action is taken to improve the performance of white sturgeon it is unlikely that any of the goals and objectives for white sturgeon in the study area will be met.

Action K: Implement reservoir drawdown to natural river levels that may occur for salmon restoration efforts.

A reservoir drawdown will influence habitat quality for white sturgeon in the river reaches that are presently impounded. This action could improve reproductive success by improving egg incubation survival and spawning in the reservoir reaches. There is considerable uncertainty whether any adults would spawn in this reach or if eggs would drift to this reach from existing spawning locations. This action could decrease abundance of existing competitors and reduce predation. Substantial sediment scouring would have to occur to expose gravel and cobbles suitable for spawning and egg incubation.

Action L: Reduce chemical and other contaminants in Lower Granite Reservoir.

There is little information available to assess the magnitude of this problem, and therefore no assessment was completed for this action. The evaluation of chemical contaminants as a problem was identified as a high priority information need.

Table 3.1. Actions proposed by BRAT for management of the white sturgeon population in the Snake River system between Hells Canyon and Lower Granite dams. Actions K and L were not evaluated due to unknown or similarity of proposed effects on the population.

Action	Description
A	Enhance and restore anadromous salmonid and lamprey populations in management area
B	Reduce power peaking generation at Hells Canyon Dam to maintain flow stability and eliminate drastic water level fluctuations
C	Restore river flow patterns to a natural hydrograph while maintaining Lower Granite reservoir at the present level
D	Restore white sturgeon passage upriver and downriver of Lower Snake River and Idaho Power dams
E	Reduce the impact of the catch and release fishery, particularly at times in the summer when water temperature is high
F	Collect adult white sturgeon from other populations in the Snake and Columbia rivers and release into the management area
G	Collect juvenile white sturgeon from other populations in the Snake and Columbia rivers and release into the management area
H	Produce adult white sturgeon in a hatchery and release into the management area
I	Produce juvenile white sturgeon in a hatchery and release into the management area
J	No action
K	Implement a reservoir drawdown to natural river levels that may occur for salmon restoration efforts
L	Reduce chemical and other contaminants in Lower Granite Reservoir

3.3 Alternative Action Assessment

The management actions proposed by the BRAT were evaluated by (1) assessing the relative potential for each action to affect population growth rate (λ) and thus harvest opportunities; and (2) determining the feasibility of execution, including the implementation timeframe, for each action.

3.3.1 Description of the Criteria Used to Evaluate Actions

Potential changes to the population's growth rate (λ) were evaluated using a matrix-based life-cycle model (Heppell et al. 2004). Elements of the matrix model included age-specific survival and fertility rates which were derived from empirical data obtained from white sturgeon field studies (Table 3.2). Age-specific fertility rates were calculated as the spawning potential (parameter P_e) of a female of a given age multiplied by the survival rate from egg to the young-of-the-year (YOY) developmental stage. Because empirical data on first year survival rates were unavailable, YOY survival was estimated to provide an approximately stable population growth rate (i.e., $\lambda \approx 1$). Hereinafter, fertility rate will be used to describe age-specific fertilities and YOY productivity rate will be defined as the sum of the fertilities across all ages.

Table 3.2. Parameter values used to construct the white sturgeon life-cycle model.

Parameter	Parameter definition	Value or equation		Reference
L_∞	Von Bertalanffy length at infinity	311		Everett et al. 2003
k	Von Bertalanffy slope	0.045		Everett et al. 2003
t_o	Von Bertalanffy intercept	-1.34		Everett et al. 2003
b_w	Length-weight equation exponent	3.25		Everett et al. 2003
a_w	Length-weight equation coefficient	0.00000159		Everett et al. 2003
b_f	Length-fecundity equation exponent	2.94		DeVore et al. 1995
a_f	Length-fecundity equation coefficient	0.072		DeVore et al. 1995
μ_l	Mean length at maturity	168		Beamesderfer et al. 1995
σ_l	Standard deviation about mean length at maturity	53		Beamesderfer et al. 1995
C_∞	Maximum proportion of spawning females	0.20		Beamesderfer et al. 1995
p_s	Probability of spawning	0-0.20[a]		
P_e	Spawning potential	(fecundity)(p_s)		
S_0	Age-0 survival	0.00015		see text
F_x	Age specific fertility	(P_e)(S_0)		
S_x	Survival of age classes >0	Ages 1-2:	0.67	Heppell et al. 2004
		Ages 3-13:	0.77	Heppell et al. 2004
		Ages >13:	0.91	Heppell et al. 2004

[a] Probability is determined from a cumulative normal distribution function that contains the parameters μ_l, σ_l, C_∞ (see Beamesderfer et al. 1995 for details).

Each alternative management action was hypothesized by the BRAT to enhance either YOY productivity rates, stage-specific (e.g., juveniles, adults) survival rates, or both (an increase in individual growth rate was hypothesized to increase age-specific spawning potential and thus YOY productivity; Table 3.2). Elasticity analysis, a type of sensitivity analysis commonly used in life-cycle modeling, was used to assess how prospective changes in these vital rates would differentially affect population growth (Caswell 2001). The elasticity value of a given parameter indicates the percent change to λ induced by a percent change in the parameter's vital rate. For example, a 10% increase in a given survival rate with an elasticity value of 5% would increase λ by 0.5% (10% x 5%). In addition, elasticities can be summed across broad life stages to determine the overall influence of a life stage's vital rate on λ. For example, the combined elasticity of juvenile survival rates (ages 2-6), each with a given elasticity of 5%, would be 25% (5 years x 5%). A 10% increase in this group's survival rate would result in a 2.5% increase in λ. Elasticities thus allow vital rates to be standardized and compared across ages or age-groups to determine their proportional influence on λ (Caswell 2001).

Alternative management actions were assigned a qualitative score that represented the potential for the action to increase population growth rate. Scores were based on interpretations derived from the elasticity analysis in combination with the putative changes to vital rates implicit in a proposed action's implementation. Scoring proceeded as follows: (1) the action would not increase population growth; (2) the action would slightly increase population growth; (3) the action would moderately increase population growth; and (4) the action would significantly increase population growth.

Although an additional management goal for this population is to provide an annual sustainable harvest, it was assumed that the action displaying the greatest potential for population growth would also provide the greatest potential for harvestable fish. Only actions A-I and L were evaluated in the modeling analysis because data were unavailable for the potential effects of contaminants on λ (action J) and effects were judged to be similar between action K and proposed actions that restored a natural hydrograph. Finally, as a result of the uncertainty inherent in parameter estimation and of other model assumptions that most likely violated population processes (e.g., density-dependence was not incorporated into the model structure), caution should be exercised when interpreting results from the analysis.

An evaluation of implementation feasibility was also conducted for the proposed management actions. A feasibility assessment considered the uncertainties inherent in the realization of a given action's objectives, encompassing both the biological mechanisms by which the action would increase the population's vital rates and the likelihood that an appreciable change in vital rates could be detected. The feasibility assessment also considered the potential impediments to implementation, including logistical and operational constraints and user conflicts. Many of the impediments and uncertainties associated with the proposed actions have been previously stated in BRAT documents (Carmichael et al. 1997) and will be repeated here for emphasis. For this assessment, the uncertainties and impediments dictated the time horizon in which a given action's objectives could be feasibly monitored and realized: (1) Short-term, less than 10 years; (2) Mid-term, between 10 and 25 years; (3) Long-term, greater than 25 years; or (4) Not feasible due to prohibitive constraints.

3.3.2 Life-Cycle Model Results

Estimated age-specific elasticities from the white sturgeon life-cycle model were greatest and similar for survival rates during the juvenile stages before the onset of maturity (Figure 3.1). This equality of elasticity at immature life stages is a common property to elasticity analyses and indicates that population growth will be equally affected by tantamount changes to any given age-specific survival rate at this stage (Heppell et al. 2000). In contrast, elasticities continually declined as age advanced after the onset of maturity (Figure 3.1). Thus, the growth rate of the population will respond less to management actions that improve survival of older adults than actions taken to increase survival of early maturing fish. Compared with the survival rates, the elasticities of age-specific fertility rates were relatively low (Figure 3.1). This indicates that a percent change in age-specific fertility would have a relatively small effect on the population's growth rate compared with similar percent changes in survival rates.

Table 3.2. Vital rates hypothesized to be affected by actions proposed by BRAT to manage the white white sturgeon population in the Snake River system between Hells Canyon and Lower Granite dams.

Alternative action	Effect on population	Vital rates affected
A	Provides food resources that enhance juvenile growth and female condition	YOY productivity, individual growth rate
B	Improves spawning habitat enhancing egg and larval survival	YOY productivity
C	Improves habitat enhancing egg and larval survival, juvenile growth rate, and female condition	YOY productivity, individual growth rate
D	Improves habitat enhancing young-of-the-year and small juvenile survival, and increases number of spawning females	YOY productivity, small juvenile survival
E	Reduces current catch and release mortality for large juveniles and adults	Large juvenile and adult survival
F	Introduces adults from other populations	Adult survival[a]
G	Introduces juveniles from other populations	Early life stage survival[a]
H	Releases hatchery-reared adults	Adult survival[a]
I	Releases hatchery-reared juveniles	Early life stage survival[a]
J	No action	

[a] Supplementation artificially inflates survival rates at stage of supplementation

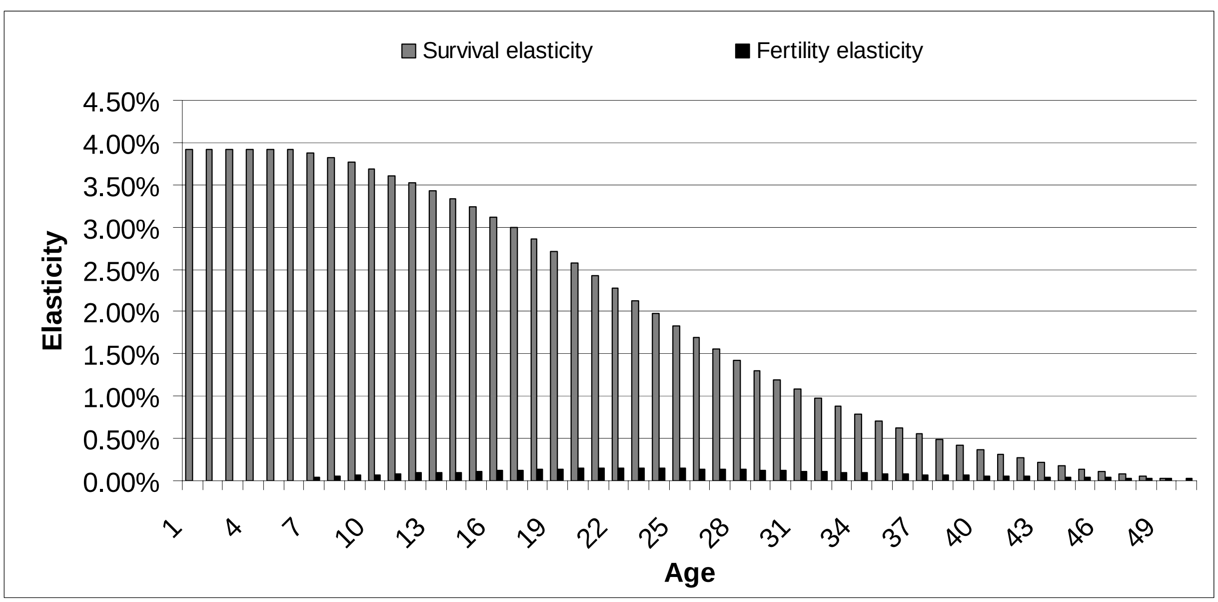

Figure 3.1. Age-specific survival and fertility rate elasticities derived from the white sturgeon life-cycle model.

Elasticities were then summed across ages for each specified life-stage to examine the relative influence of each given life-stage on population growth rate. The elasticity for YOY productivity was defined as the sum of the fertility elasticities across all ages. The summation of survival elasticities across age groups 1-3, 4-10, 11-21, and >21 were classified as elasticities for small juveniles, large juveniles, maturing adults, and mature adults, respectively. Although the age demarcation of life stages could be considered arbitrary, it permitted a comparison of elasticities across various life stages. According to the analysis, percent changes in YOY productivity would have the least influence on population growth rate (Figure 3.2). It should be noted that the elasticity value for YOY productivity (3.9%) was the same as the elasticity values for age-specific survival rates of immature fish. Thus, population growth would be equally affected by a percent change in YOY productivity, accomplished through actions that either affect spawning potential or first year survival, as an equivalent percent change in the survival rate of an immature age class. Elasticities were greatest for the maturing adult group (34%) and were lower but similar for the large juvenile (27%) and mature adult groups (24%)(Figure 3.2). However, the apparent differences in life-stage elasticities were partially attributed to differences in the number of age-classes included in each life-stage. Thus, the low elasticity value for small juveniles (12%) was due to this life-stage comprising elasticities for only three age-specific survival rates. Although the mature adult group consisted of survival elasticities summed across 30 age classes, the relatively moderate elasticity value for this stage was due to the declining elasticities in aging adults. As previously mentioned, actions taken to increase survival rates of older adults will likely be less effective toward promoting population growth than actions taken to increase survival of juveniles and maturing fish.

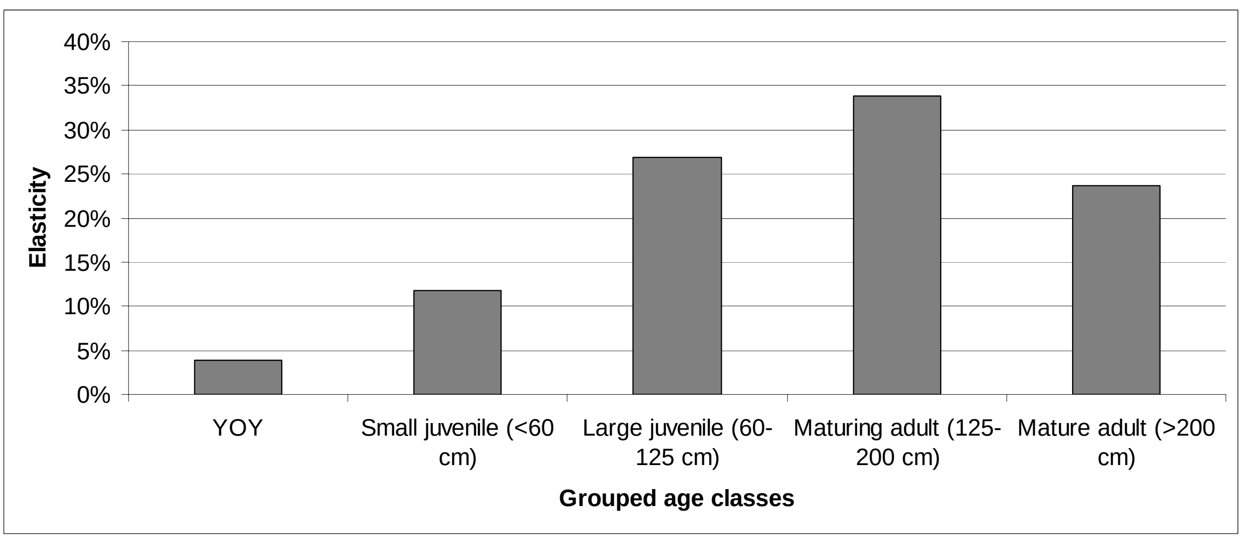

Figure 3.2. Life-stage elasticity estimates derived from the white sturgeon life-cycle model. Displayed elasticities include YOY productivity (summed elasticities of age-specific fertilities) and size classes representing summed elasticities of survival rates across specified ages.

Life-stage elasticities were also used to examine the compensatory changes in survival or YOY productivity rates that were required to maintain a stable population growth rate under a harvest regime. An additive fishing mortality rate of 0.10 was applied to fish within a length slot limit ranging from 110 to 150 cm (ages 8-14). Under this scenario, YOY productivity would need to increase by 60% to offset the reduced survival rates of fish within the slot limit (Figure 3.3). In comparison, compensatory percent increases were smaller for other life-stages. Small juvenile survival rates would need to increase by 20%, and survival of older age groups would only need to increase by approximately 10% (Figure 3.3). Therefore, management actions that increase YOY productivity must be more effective than actions taken to increase survival rates of other life-stages when fish are being removed from the population.

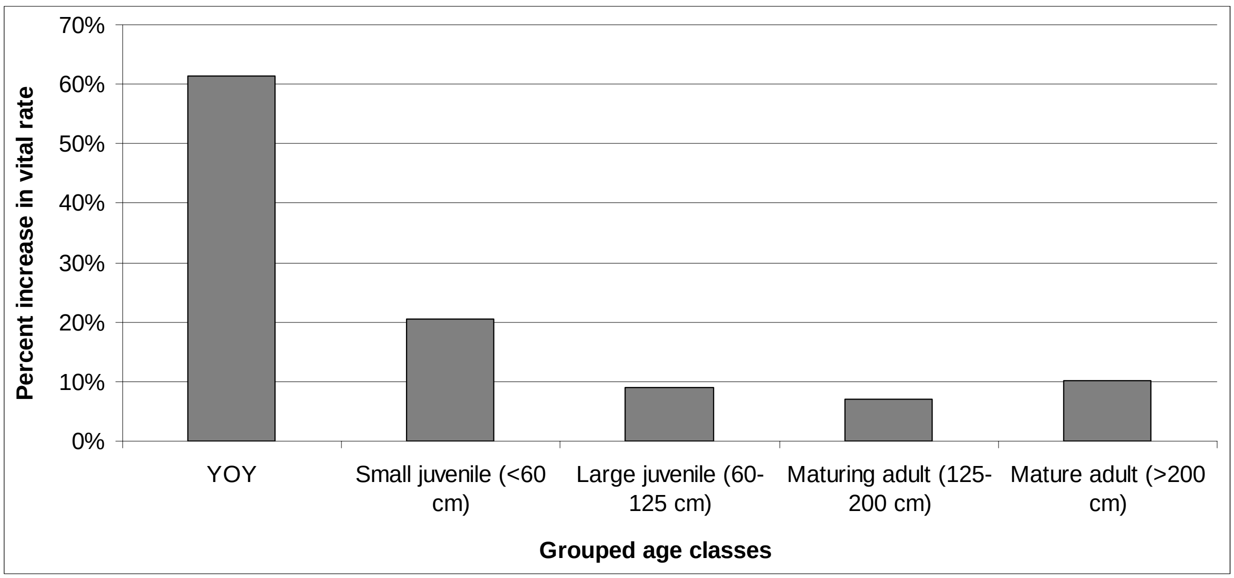

Figure 3.3. Percent increase in vital rate required to maintain a stable population growth rate under a harvest regime (F = 0.1, slot limit between 110 and 150 cm). Displayed vital rates include YOY productivity (summed fertilities) and survival rates for various size classes.

Although elasticities provided an assessment of the relative contribution of YOY productivity and survival rates to population growth rate, the potential for augmentation in these vital rates provided additional information as to their relative importance in affecting changes in λ. Survival rate estimates of maturing and mature adults were relatively high (0.91). As a result, the potential increase in survival is limited to 9.8% ((1-0.91)/0.91). Despite the combined high elasticity value of 54% for these life-stages, the maximum possible increase to λ resulting from increasing survival rates is only 5.3% (9.8% x 54%). In contrast, the potential for increase is greatest for YOY productivity as a consequence of the estimated low YOY survival rate (0.00015). For example, increasing the YOY survival rate to 0.0005 would result in a 233% increase in YOY productivity and increase λ by 9.4% (233% x 4%). Therefore, even though YOY productivity had the lowest elasticity value of all life-stages, it has the greatest opportunity for survival gains and consequently the greatest potential for increasing population growth rate (Gross et al. 2002).

3.3.3 Evaluation of Management Actions Using Established Criteria

This section summarizes the anticipated changes to vital rates associated with implementation of each alternative management action, the scores assigned to each action representing its potential to increase population growth, and the time horizon in which each action could be feasibly realized.

Action A: Enhance and restore anadromous salmonid and lamprey populations in the management area.

This action intends to increase the availability of food resources to all life-history stages, and thus targets the improvement of growth rates for individual white sturgeon. A concomitant increase in age-specific fecundity may be expected as somatic growth indices increase and additional energetic resources are allocated to gonadal growth. An increase in fecundity would thus increase spawning potential and consequently YOY productivity assuming that compensatory changes in first year survival rate do not occur (Table 3.2).

According to the elasticity analysis, the percent increase must be significantly higher in YOY productivity than in the survival rates of other life-stages to attain similar increases in population growth. Under this management action, this translates into achieving a significant, proportional increase in age-specific fecundity. Although there is no theoretical ceiling for age-specific fecundity as there is for survival rate, physiological constraints likely impose limits to the number of eggs that a highly-fecund white sturgeon of any given age can further produce. Given the uncertainties regarding the capacity by which spawning potential could proportionately be increased, this action's potential to increase population growth only received a score of 2.

Assumptions implicit in action implementation are that enhanced food resources will be both utilized and translated into increased growth rates of individual white sturgeon. However, uncertainty exists as to the trophic pathways by which enhancement will increase growth rates of different life-history stages (Carmichael et al. 1997). Lampreys and salmonids may confer direct benefits to larger white sturgeon as prey items, or they may augment productivity at lower trophic levels through carcass-derived nutrient additions. In addition, the level of salmonid and lamprey restoration required to achieve a measurable increase in white sturgeon growth rates is unknown.

Evaluation of the efficacy of action implementation would require monitoring of individual performance indices including growth rate, relative weight, spawning frequency, and fecundity. Trends in performance indices could then be related to trends in indices of reach productivity including lamprey and salmonid numbers and invertebrate densities. In addition, monitoring the diet of white sturgeon would indicate if shifts in food preference correspond with changes in anadromous fish runs. Recovery measures are currently being implemented for salmonid populations and have recently been addressed for lamprey. However, anadromous restoration involves basinwide coordination and is affected by a suite of interacting ecological and anthropogenic factors that operate at large spatial and temporal scales. Several decades of recovery strategies have yet to substantially elevate annual numbers of returning salmonids. As such, it is likely that an effective evaluation of this management action would only be feasible in the long term.

Action B: Reduce power peaking generation at Hells Canyon Dam to maintain flow stability and eliminate water level fluctuations.

This action intends to increase the quality and quantity of reproductive habitat by maintaining steady levels of discharge during the spawning and incubation period. As previously mentioned in section 2.3, fluctuating water levels may disrupt spawning activity, temporarily dewater egg incubation sites, and affect larval transport to suitable nursery grounds. Thus, this action intends to increase YOY productivity by increasing both spawning intensity (i.e., the number of eggs released by mature females) and an early life-stage component of first-year survival (Table 3.2).

As indicated by the elasticity analysis, significant proportional increases in YOY productivity must occur to increase population growth. On the other hand, there is tremendous potential for increasing YOY productivity if the management action targets the extremely low survival rates during early-life stages. However, the proposed action intends to increase survival only during the egg and yolk-sac larval stages; other components of first-year survival, including the exogenous feeding stages, may not be similarly affected. High mortality rates during these latter developmental stages may offset the benefits conferred upon the earlier stages. As a result of these uncertainties, this action's potential to increase population growth received a score of 2.

Action implementation would necessitate advancing our understanding of how fluctuating flows influence spawner behavior, the quality and quantity of incubation habitat, and the mechanisms influencing emerging larvae. Gravid females could be monitored during the spawning season to determine if unstable flows prolong residence times on spawning grounds or affect the ovulation or release of eggs. Spawning mats could be deployed in marginal egg incubation habitat downriver of the dam to determine if changes in water levels expose deposited eggs. In addition, sampling techniques for larval and post-larval fish would need to be improved to monitor the changes in the spatial and temporal distribution of early life stages associated with fluctuating flows. These sampling techniques could be developed in the short term.

The feasibility of action implementation would undoubtedly necessitate consultation and coordination with IPC to discuss the potential for modifications to daily dam operations. Experimental flow manipulation studies could be designed concurrent with spawner, egg, and larval fish monitoring efforts to determine the potential benefits to white sturgeon resulting from flow stabilization. Consultation with IPC would proceed in the short-term as the sampling methods briefly outlined in the previous paragraph are developed. If modifications are implemented, it would take several years before the year-classes that benefited from the action are recruited to a harvestable size. Therefore, effective evaluation of the management action would likely be feasible in the mid-term.

Action C: Restore river flow pattern to natural hydrograph while

maintaining Lower Granite pool at present level.

This action proposes to restore a peak in discharge at the time of spawning, improving the survival rates of egg and larval stages. Higher flows have been suggested to flush sediment from incubation habitat; disperse both eggs and larvae, thus minimizing competitive interactions; and reduce predation rates on early life stages by creating an unfavorable high-velocity environment for exotics (Parsley et al. 2002). Thus, this action intends to increase YOY productivity by improving survival rates of early-life stages.

An assessment of the proposed action's potential to increase population growth is similar to that described for 'Action B'. Even though there is immense potential for increasing first-year survival, this action targets survival only at the egg and yolk sac stages. Currently, it is unknown if mortality during these stages is a bottleneck to YOY productivity in this system. Other sources of mortality during the first year may limit the effectiveness of this action. In addition, manipulating flow levels to increase current velocity during the larval drift stage may only distribute larvae into unfavorable rearing areas further downriver (e.g., Lower Granite reservoir). Consequently, this action's potential to increase population growth only received a score of 2.

To evaluate the effectiveness of this action, a better understanding of the present relationship between year-class strength and the annual flow regime in this section of the Snake River is needed. A lack of information exists as to which components of the flow regime, including the magnitude, duration, and timing of increasing flows, is important to reproductive success in white sturgeon. Although peak flows in the Snake River have been suppressed, the profile of seasonal discharge along the HCR may not be too dissimilar from pre-impoundment conditions. Reliable techniques to measure reproductive success, including methods to estimate larval and YOY densities, will need to be further developed in the short term.

Similar to 'Action B', implementation will require coordination with IPC to develop feasible strategies to test the efficacy of seasonal modifications to the flow regime. Releasing water to simulate the pre-impoundment hydrograph will affect upriver irrigation demands and power-generating capabilities. Because of the costs to other users, it is imperative that the sampling techniques to measure appreciable changes in reproductive success be established before experimental modifications are initiated. As mentioned for 'Action B', because the action is targeting early life stages, it would take several years before the year-classes that benefited from the action are recruited to a harvestable size. As a result, effective evaluation of this action would most likely proceed in the mid-term.

Action D: Restore white sturgeon passage upriver and downriver at Lower Snake and Idaho Power dams.

This action proposes to allow white sturgeon access to favorable rearing habitats that may be otherwise unavailable in the reach. In addition, restoring connectivity among impounded river reaches may allow adults from outside the reach to access suitable spawning habitats that are currently available within the reach. This action thus has the capability of increasing the capacity of optimal habitat essential to the growth and survival of all life stages. In addition, seasonally augmenting the numbers of spawners in the management area will effectively increase the overall spawning potential and consequently YOY productivity.

The elasticity analysis indicates that actions that improve survival rates of immature and young adult life stages are more likely to be effective than actions that target YOY productivity or survival rates of older adults. This action purports to positively affect vital rates at all life stages, including survival rates and YOY productivity. Consequently, this action's potential to increase population growth received a score of 3.

To evaluate the effectiveness of this action, movement and performance indices would need to be assessed to determine if fish are using and benefiting from the expanded habitat. Immigration and emigration rates could be monitored to identify the life-stages that are moving among the reservoirs. Monitoring adults during the spawning season could determine if uniquely-marked individuals from other management units in the CRB are using spawning habitat in the HCR and contributing to reproductive potential. Trends in growth and survival could also be coupled with the movement data to determine if productivity is higher in wide-ranging than in sedentary individuals originating from the HCR.

Facilitating white sturgeon movement among the reservoirs would require a comprehensive and concerted effort among management entities in the CRB. The technology to effectively pass white sturgeon at dams has yet to be developed and would likely require years of planning and testing to evaluate the effectiveness of passage design. In addition, it is not known how many dams would require passage facilities to achieve the action's objectives. Quality rearing habitats may not be available in conterminous Snake River reaches; productivity objectives may only be realized by permitting access to lower Columbia River reaches. Due to the technological difficulties inherent in implementation, effective evaluation of this action would most likely proceed in the long term.

Action E: Reduce the impact of the catch and release fishery, particularly at times in the summer when water temperature is high.

This action intends to reduce the mortality rates of juvenile and adult fish associated with post-release injury or stress by regulating the time periods in which fish can be targeted by the catch-and-release fishery. According to the elasticity analysis, increasing survival rates at these life-stages would have a significant effect on population growth. However, estimates of survival rates for juvenile and adult life-stages are currently high, and thus the capacity for further increase is limited. In addition, estimates of additive mortality associated with the catch-and-release fishery are currently unavailable; negligible mortality would limit the effectiveness of this action. Because of the uncertainty in the degree that survival rates could be increased, this action's potential to increase population growth received a score of 2.

A study could be implemented that would assess the potential affects of the catch and release fishery on white sturgeon physiology and survival. Stress indices (e.g., plasma cortisol) could be measured from blood samples collected from fish that are caught using hook and line techniques. In addition, recapture rates could be analyzed during different time periods to assess potential changes in mortality associated with seasonal changes in water quality. Because sampling could be conducted during standardized population surveys that are scheduled to be completed every 3-5 years, evaluation of this action's potential would likely be feasible in the short-term.

Action F: Collect adult fish from other populations in the Snake and/or Columbia rivers and release into the management area.

This action intends to increase the number of adults in the management area, and thus 'artificially' augments the adult survival rates at the ages of supplementation. According to the elasticity analysis, actions that increase adult survival rates can significantly increase population size. Furthermore, translocation circumvents the constraints imposed on naturally high adult survival rates. Although supplementing adult age classes with transplants can induce an apparent elevation of survival rates, population growth may only be realized if the number of translocated adults is considerably large relative to the number of adults present in the recipient population. In other words, the influence of adult survival rate on population growth is dependent on the proportion of the adults affected by the action (Gross et al. 2002). This action received a score of 3 because of its potential to achieve a substantial increase in population growth.

Although it is feasible to collect a substantial numbers of fish from other reservoirs for release (Kern et al. 2001), it may be difficult to continue adult translocation efforts over an extended time frame. Productivity may not be sufficient in nearby reservoirs to sustain adult removals. In addition, the removal of adults from distant reservoirs may be opposed by other parties involved in white sturgeon management along the CRB. Collection efforts would probably be targeted toward the population below Bonneville Dam. Currently, there is a high demand for these adults by lower Columbia River fisheries. In addition, the potential mortality and costs associated with a long-distance translocation program may be prohibitively high. This action was not considered feasible if its intent is to provide an annual supply of adult fish to the HCR population.

Action G: Collect juvenile white sturgeon from other populations in the Snake or Columbia rivers and release them into the management area.

This action intends to increase the number of juveniles in the management area, and thus 'artificially' augments juvenile survival rates at ages of supplementation. The relatively high elasticity value for large juvenile survival indicates that actions that target this life stage can effectively increase population size. Similar to 'Action F', translocation can ostensibly increase survival rates beyond that which could naturally occur given that the released fish constitute a significant portion of the juveniles in the population. Therefore, this action's potential to increase population growth received a score of 3.

Because one of the goals of this management plan is to maintain the integrity of the current population, performance indices of both the transplanted individuals and the recipient population should be monitored to determine if supplementation is increasing competitive interactions. Growth rates and relative weight could be periodically measured during population surveys to assess potential density-dependent effects. In addition, periodic surveys would provide insight into the level of post-release mortality associated with long-distance transportation.

Due to the aforementioned likely opposition to fish removal from lower Columbia River reservoirs, a supplementation program based on annual releases of transplanted juvenile fish was not considered feasible. However, it may be feasible to conduct a small number of test releases in the HCR through a cooperative effort with lower Columbia River management agencies. These test releases could provide insight into the potential for a supplementation program based on releases of hatchery-reared fish. Small juveniles (e.g. 2-3 year olds) would be targeted for translocation because they would likely be comparable to the size at which hatchery fish would be released. Unlike adults, transplanted juveniles would not immediately contribute to the fishery given that their size at release is likely to be smaller than the harvestable slot limit. In addition, there would be an extended waiting period before released fish contributed to the spawning potential of the population. Thus, evaluation of the effectiveness of the test releases would likely proceed in the mid-term.

Action H: Produce adult white surgeon in a hatchery and release into the management area.

This action intends to increase the number of adults in the management area, and thus 'artificially' augments the adult survival rates at the ages of supplementation. According to the elasticity analysis, actions that increase adult survival rates can significantly increase population size. Furthermore, supplementation through hatchery releases circumvents the constraints imposed on naturally high adult survival rates. Although supplementing adult age classes with hatchery fish can induce an apparent elevation of survival rates, increases in population growth may only be realized if the number of annually supplemented adults is relatively high in relation to the number of adults present in the recipient population. The level of supplementation will undoubtedly be limited by the rearing capacity of the facility. Because of the constraints imposed on the number of adults that could be feasibly reared in an artificial environment, the action's potential to increase population growth received a score of 2.

The pace at which reliable techniques could be developed for successfully rearing adult white sturgeon in a hatchery environment would ultimately dictate the time frame in which this action could be feasibly evaluated. However, a juvenile hatchery supplementation program is also being considered and proposed in this management plan. Because the techniques for rearing white sturgeon are more established for juveniles than adults, the adult supplementation program was not considered a feasible option at this time.

Action I: Produce juvenile white sturgeon in a hatchery and release into the management area.

This action intends to increase the number of small juveniles in the management area, and thus augments YOY productivity through artificial increases in YOY survival rates. The elasticity analysis indicated that the greatest potential for increasing population growth rate could be realized through significant increases in YOY survival. This could be accomplished under controlled rearing conditions and by releasing age-1 or age-2 fish at levels that are relatively high in proportion to the number of small juveniles present in the population. Because of the tremendous potential for increasing population growth, this action received a score of 4.

Post-release survival would need to be adequate and comparable to estimates for wild fish to contribute to the reproductive potential of the population and to the fishery. Survival rates of released hatchery-reared juveniles (15-24 mo) in recovery efforts for the Kootenai River white sturgeon population were similar to or higher than survival rates estimated for wild juveniles (Ireland et al. 2002). Performance indices would need to be periodically monitored to determine if supplementation is adversely affecting the growth or survival rates of naturally produced fish. In addition, released fish would be uniquely marked to allow an estimate of their percent contribution to the spawning population during intermittent population surveys. Genetic concerns would need to be addressed especially when the numbers of released fish constitute a high proportion of the juveniles in the population.

Action implementation will require developing a master plan for construction and operation of the hatchery, and outlining broodstock collection techniques and mating strategies to promote genetic diversity. Techniques to sample small juvenile life stages should be well established before hatchery fish are initially released to effectively monitor their survival. In addition, a harvest monitoring program should be in place by the time liberated fish reach the legal size so that exploitation rates could be reliably estimated. An initial evaluation of the effectiveness of this action would likely proceed in the mid-term.

Action J: No action.

Population surveys conducted over the last 25 years suggest that the white sturgeon numbers in the HCR are relatively stable. Despite insufficient data to provide an accurate estimate of the current population growth rate, significant increases to population size may not occur without restoration efforts. Therefore, this action's potential to increase population growth received a score of 1.

Provided below is a table which summarizes the assessment that was conducted in section 3.2.3. Each management action proposed by the BRAT received a qualitative score that represented the action's potential to increase population growth in the HCR: the lower end of the range, '1', indicated that the action would not increase population growth, whereas the upper end of the range, '4', indicated that the action would significantly increase population growth. The score could be interpreted as a gauge that projects the success expected from action implementation. An action that receives a high score but doesn't yield the expected results in the allotted time frame should be reevaluated to determine if the assumptions implicit in the action are flawed. A time frame for feasible monitoring and evaluation was also assigned to each action: (1) Short-term, less than 10 years; (2) Mid-term, between 10 and 25 years; (3) Long-term, greater than 25 years; or (4) Not feasible due to prohibitive constraints, consistent with when a management action is expected to be realized.

Table 3.3. Summary of the analysis for assessing an action's potential to effect population growth and the timeframe in which an action could be feasibly realized.

Alternative management action	Potential for population growth	Time frame for feasible action effectiveness
Action A: Restore anadromous populations	2	Long term
Action B: Reduce power peaking at Hells Canyon Dam	2	Mid term
Action C: Restore flow patterns to simulate a natural hydrograph	2	Mid term
Action D: Restore passage among reservoirs	3	Long term
Action E: Reduce mortality associated with catch and release fishery	2	Short term
Action F: Translocate adults from other populations in the CRB	3	Not feasible
Action G: Translocate juveniles from other populations in the CRB	3	Mid term
Action H: Supplement with hatchery-reared adults	2	Not feasible
Action I: Supplement with hatchery-reared juveniles	4	Mid term
Action J: No action	1	---

3.4 Management Action Implementation

This plan is intended to undergo further review by the BRAT, management agencies and other technical experts. We recommend implementing a multiple management action approach to achieve the goals set forth in this plan. Priority management actions are those identified in Table 3.3 with the highest "potential for population growth" and shortest time frame for realizing action effectiveness. Implementation strategies should be pursued for all feasible management actions, with priority given to actions I, G and D. Application of the strategies will follow the decision process outlined in section 1.2. Much potential exists for proposal development and submission through BPA's 2007-2009 project selection cycle. Actions addressing basin-wide impacts of the Columbia River Hydrosystem will require proposals that seek funding to actively participate in regional management coordination. Forums that focus on issues related to mainstem anadromous productivity and mainstem passage should be specifically identified for involvement. Actions requiring new or modifications to existing production facilities will require proposals that direct immediate funding toward the development of a master plan and follow the NPCC adopted 3-Step Review Process for new production initiatives: step 1) conceptual planning, primarily in the form of a Master Plan; step 2) preliminary design and cost estimation, National Environmental Policy Act (NEPA), and Endangered Species Act (ESA) review; and step 3) final design review prior to new facility construction. Actions addressing improved flow conditions will require coordination with both IPC and BPA. This may involve experimental flow manipulations that would require funding to evaluate. Regardless of the management actions implemented, status monitoring of this white sturgeon population should be continued (see Chapter 4 and Appendix A). Finally, actions addressing remaining critical uncertainties (Appendix B) will require proposals that fund the necessary data collection.

3.5 WHERE TO FIND MORE INFORMATION

This plan contains general and technical information relevant to the proposed management actions. In addition to this information, several supporting documents have been completed during the development of the plan:

- Heppell, S., M. Webb, R. Sharma, S. Narum and K. Kappenman. 2004. Benefit-Risk Analysis of White Sturgeon in the Lower Snake River. Draft. Report to the Nez Perce Tribe.

- Everett, S. R., M. A. Tuell, and J. A. Hesse. 2003. Evaluation of potential means of rebuilding sturgeon populations in the Snake River between Lower Granite and Hells Canyon dams. 2002 Annual Report. Project 199700900. Bonneville Power Administration, Portland, OR.

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CHAPTER 4: MONITORING AND EVALUATION

4.1 ADAPTIVE MANAGEMENT APPROACH

The Tribe believes that rebuilding the white sturgeon population using an adaptive management approach. Pursuant to this approach, data collection and analysis for the monitoring and evaluation component of the program endeavors to: 1) provide science-based recommendations for management and policy consideration, 2) demonstrate when the program meets its recovery, restoration and mitigation goals and 3) assist in the re-establishment of tribal and recreational fisheries. The monitoring and evaluation (M&E) plan is divided into three sections: status monitoring, small-scale studies and monitoring and evaluating the implemented actions (effectiveness monitoring).

4.2 STATUS MONITORING

The status monitoring section of the plan has two primary objectives: 1) monitor abundance, distribution and life history characteristics of the Snake River white sturgeon population between Hells Canyon and Lower Granite Dams, including the major tributaries (Clearwater and Salmon Rivers) and 2) monitor the spatial and temporal distribution of the white sturgeon population between Hells Canyon and Lower Granite Dams, including the major tributaries (Clearwater and Salmon Rivers). Many of the elements of both the small-scale studies and the effectiveness monitoring will coincide with tasks outlined in the status monitoring section (see Appendix A).

4.3 SMALL-SCALE STUDIES

Four small-scale research studies have been proposed as part of the M&E plan to address remaining critical uncertainties (see Appendix B). The first study proposes to assess contaminant levels in Snake River white sturgeon between Lower Granite and Hells Canyon Dams, including the major tributaries (Clearwater and Salmon Rivers). The second study proposes to assess the impact of the catch-and-release fishery on Snake River white sturgeon between Lower Granite and Hells Canyon Dams, including the major tributaries. The third study proposes to develop techniques to capture young-of-the-year (YOY) white sturgeon between Lower Granite and Hells Canyon Dams, including the major tributaries. Finally, the forth study proposes to determine tribal harvest of Snake River white sturgeon between Lower Granite and Hells Canyon Dams, including the major tributaries.

4.4 MONITORING AND EVALUATION OF IMPLEMENTED ACTIONS

The majority of the effectiveness monitoring will be based on data collected from the status monitoring component of the M&E plan. Specific evaluation objectives and tasks will need to be further developed. Analysis will focus on two areas: 1) evaluating the success of the action and 2) evaluating the impact on the current population. In order to evaluate the success of an action, targets for various parameters will be identified. These parameters will most likely include; survival, abundance and spawning success. To evaluate the impacts to the current population, before and after comparisons of various parameters will be conducted. These parameters will most likely include: survival, growth, abundance, distribution, movement and spawning success. Determining significance levels, especially for detrimental impacts due to an action, will need to be identified. Table 4.1 outlines the feasible action categories and summarizes the projected time period required for planning, implementation and evaluation. Darkened circles for each timeline indicate when an action would likely be implemented. Arrows on timelines indicate that some actions would be monitored and evaluated indefinitely through an adaptive approach.

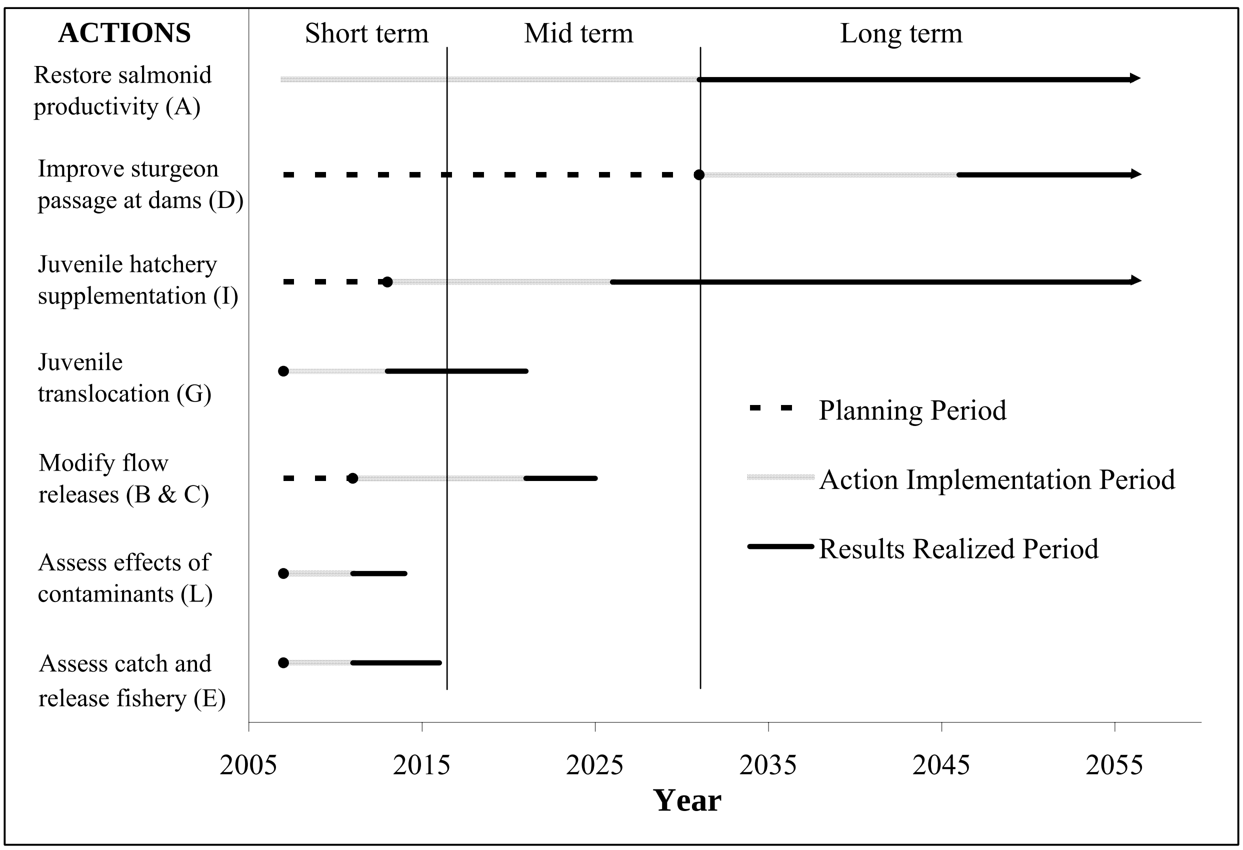

Figure 4.1. Evaluative time frames for the proposed management actions that were selected for implementation to recover white sturgeon in the management area.

4.4.1 Ameliorate Basin-Wide Impacts of Columbia River Hydrosystem

Targeted Proposed Management Actions:

> **Action A: Enhance and restore anadromous salmonid and lamprey populations in management area to increase growth rates of all life stages of white sturgeon.**
>
> **Action D: Restore white sturgeon passage upriver and downriver of Lower Snake River and Idaho Power dams to allow access to optimal habitats that would increase growth and survival rates of various life stages.**

Feasible Evaluative Time Period: Long-term

Short/Mid Term Tactics

Initially, this action would necessitate engaging in basin-wide cooperative efforts to discuss and implement feasible alternatives to improve migratory corridors and increase passage opportunities for both anadromous fish (i.e., salmonids and lamprey) and white sturgeon. Recovery measures to increase anadromous fish runs are currently being implemented for salmonids, and have recently been addressed for lamprey. Structural modifications at dams would need to be designed, implemented, and tested to address passage facilitation for white sturgeon.

Long Term Monitoring and Evaluation

To evaluate the effectiveness of implemented measures in achieving the management plan's objectives, white sturgeon would need to be monitored to determine favorable population responses. Levels of inter-basin transfer would need to be assessed either through telemetry or other unique marking techniques to determine seasonal changes in the numbers of fish in the HCR from inception of passage facilitation. The detection of an excess of emigration versus immigration of harvestable fish would not be consistent with plan objectives. Performance indices would also be monitored in fish that access habitats outside the HCR to determine if mobile fish are growing and surviving at higher rates than sedentary fish. Growth indices in combination with dietary studies could also be used to determine if white sturgeon are benefiting from changes in anadromous fish production in the HCR.

4.4.2 Introduce Fish to Supplement Natural Production

Targeted Proposed Management Actions:

> **Action G: Collect juvenile white sturgeon from other populations in the Snake and Columbia rivers and release into the management area.**
>
> **Action I: Produce juvenile white sturgeon in a hatchery and release into the**

management area.

<u>Feasible Evaluative Time Period:</u> Mid and long-term

<u>Short/Mid Term Tactics</u>

Collecting juveniles from other populations would require identifying a donor source with sufficient productivity to withstand significant juvenile removals. Given the current status of white sturgeon in Snake and Columbia River reservoirs, the population below Bonneville Dam may be the only source at this time. Thus, this action would necessitate collaboration among Columbia River management agencies in order to carefully partition the resource. Techniques for transporting juvenile white sturgeon long distances would need to be established. To reduce the impact to the donor source, test releases could occur on a smaller scale. These test releases could serve to measure both the survival of transplanted fish and the potential effects of hatchery produced juveniles. This action could be implemented in the short-term.

Producing hatchery juvenile white sturgeon would require a new facility or significant modifications to an existing facility. Hatchery production space is scarce in the local area. Given ESA considerations and the high priority on salmonid production, many hatcheries have been pushed to their maximum capacities. Few hatcheries have available space or water, and any excesses that do exist are only temporary and would not serve the annual rearing needs of a white sturgeon production program. Preferably, the facility would be located near a broodstock source, and be served by both surface and well water. If a new facility is required, then several planning documents would be developed beginning with a master plan. The process would include a site development analysis and preliminary construction design. An operating plan would be drafted which would outline broodstock collection and holding, spawning and mating strategies, incubation and early rearing techniques, outplants, and fish health monitoring. This action could be initiated in the short-term, with action implementation occurring in the mid-term. If only modifications to an existing hatchery are required, then the planning process would be similar; however, action implementation could be moved up to the short-term.

<u>Long Term Monitoring and Evaluation</u>

The M&E plan would be organized to address predetermined management objectives. This requires identifying target levels for those quantifiable measures that describe structural and functional attributes of interest. In order to evaluate progress toward meeting the objectives, the specific tasks within the plan would be structured to measure those relevant population attributes serving as performance indices.

To evaluate the effectiveness of transferring juvenile white sturgeon from other populations, an elaborate monitoring plan would be developed. The plan would be designed to evaluate the impact to the donor source, the transplanted fish and the recipient population. Several quantifiable population attributes such as abundance, growth, survival, and distribution would serve as performance indices. An initial evaluation of the effectiveness of this action would likely proceed in the mid-term.

To evaluate the effectiveness of producing hatchery juvenile white sturgeon, a monitoring plan would be developed to guide operations to optimize hatchery and natural production, and minimize deleterious ecological impacts. Again, attributes such as abundance, growth, survival and distribution, would serve as population performance indices. These indices evaluated against hatchery production attributes such as size-at-release, amount released, release location, and fish health would provide managers the necessary feedback to adaptively modify operations to meet objectives. Any hatchery M&E plan would need to be consistent and coordinated with other regional monitoring and evaluation plans and subbasin planning recommendations. As noted early, techniques to sample small juvenile life stages should be well established, and a harvest monitoring program should be in place prior to the released fish recruiting to the fishery.

4.4.3 Modify Hells Canyon Dam Operations to Improve Flow Conditions

Targeted Proposed Management Actions:

> **Action B: Reduce power peaking generation at Hells Canyon Dam to maintain flow stability and eliminate drastic water level fluctuations during the spawning period to reduce mortality rates of egg and larval life stages.**
>
> **Action C: Restore river flow patterns to a natural hydrograph while maintaining Lower Granite reservoir at the present level to increase survival rates of early life stages.**

Feasible Evaluative Time Scale: Mid-term

Short Term Tactics

Consult and coordinate with IPC to discuss the feasibility for flow modification studies and the design of field experiments that would test hypotheses regarding the effects of regulated flows on indices of reproduction. Flow manipulation experiments would assess how daily flow fluctuations affect the behavior and reproductive readiness of spawning white sturgeon, and the quantity and quality of egg incubation habitat. Flow augmentation experiments would assess how early-life stages are affected by the suppression of peak discharge during the spawning season. Effective monitoring and evaluation of these studies necessitates the development of reliable techniques to measure appreciable changes in the abundance of early-life stages of white sturgeon. For example, index sites could be established using egg mats to monitor changes in spawning intensity. Sampling methodologies for larval and YOY white sturgeon would also need to be improved.

Mid Term Monitoring and Evaluation

To assess the effect of daily flow fluctuations on reproductive success, gravid females could be monitored during the spawning season to determine if unstable flows prolong residence times on spawning grounds or affect the ovulation or release of eggs. Spawning mats could also be deployed in marginal egg incubation habitat downriver of the dam to determine if changes in water levels expose deposited eggs. Larval fish would be sampled during the spring and summer at index stations to relate changes in density and spatial and temporal distribution to the degree of flow stability. Annual differences in the distribution and abundance of larval and YOY white sturgeon at index stations would also be monitored during augmentation studies to determine the influence of the spring flow regime on year-class strength. Population surveys conducted ~10 years after implementation of the experimental studies should indicate if year-classes benefited from purported improvements to flow conditions at early-life stages.

4.4.4 Assess Levels of Contamination in HCR White Sturgeon

Targeted Proposed Management Action:

> **Action L: Reduce chemical and other contaminants in Lower Granite Reservoir that may impair survival of early life stages.**

Feasible Evaluative Time Period: Short term

Short Term Monitoring and Evaluation

Tissue samples (e.g., gonadal and muscle) will be collected using non-lethal sampling techniques from juvenile and adult white sturgeon in the HCR of the Snake River. External gross abnormalities, such as excessive fin erosion, cutaneous ulcers, or visible tumors, will be noted during collection procedures. Tissue samples will be stored and sent to a lab where they will be analyzed for the presence of environmental contaminants including heavy metals and organochlorines. The selection of contaminants that will be assayed will likely be based on those that have been primarily detected in fish tissues in the Columbia River Basin.

Contaminant concentrations in tissue samples collected from HCR white sturgeon will be compared to concentrations that have been reported to have detrimental effects on the physiology of fish, particularly white sturgeon. Concentrations comparable to or excessive of levels that have demonstrable lethal or sublethal effects will prompt and refine priorities for additional research. Additional research will most likely require laboratory and field studies that assess the effects of contaminants on white sturgeon histopathology, biochemistry (e.g. endocrinal responses), and indices of reproductive potential (e.g., hatching success, larval survival). This would undoubtedly entail coordinating and collaborating with research entities studying the effects of toxicants on the reproductive physiology of fish.

4.4.5 Assess the Impact of the Catch-and-Release Fishery on White Sturgeon

Targeted Proposed Management Action:

> **Action E: Reduce incidental mortality in juvenile and adult life stages associated with the catch and release fishery, particularly at times in the summer when water temperature is high.**

Feasible Evaluative Time Period: Short term

Short Term Monitoring and Evaluation

First, catch records from the states of Idaho, Washington and Oregon will be compiled and analyzed to describe recent levels of harvest and angling pressure on white sturgeon in the management area. Second, a mark-recapture study will be conducted to examine the potential effects of the catch and release fishery on white sturgeon physiology and survival. Fish will be caught throughout the year using standard recreational angling gear. Blood samples will be collected from fish to assess the level of stress (e.g., plasma cortisol) associated with prolonged retrieval. Fish will also be uniquely marked before their release to assess seasonal difference in recapture rates associated with water conditions at time of initial capture.

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APPENDIX A: STATUS MONITORING

Objective 1: Monitor abundance, distribution and life history characteristics of the Snake River white sturgeon population between Hells Canyon and Lower Granite Dams, including the major tributaries (Clearwater and Salmon Rivers).

Task 1.1: Monitor white sturgeon abundance throughout entire study area.

To estimate the size of the population mark-recapture estimators will be used. In order to better evaluate changes in abundance, both a closed population and open population model will be used (Tuell and Everett 2003, Everett and Tuell 2003a, Everett and Tuell 2003b). In most cases, it is difficult to measure or verify whether basic model assumptions are met. Thus, sampling will be randomized by reach and designed so data collected can be used to test whether white sturgeon are emigrating or migrating between reaches within the Snake River and/or it's tributaries (the Salmon and Clearwater Rivers) defining populations of interest. The white sturgeon population will be estimated (95 percent confidence intervals) throughout the study area. Sampling intervals, where marked fish will not be counted as recaptures in the population estimate, will be determined using recapture rates.

Accessible sampling reaches throughout the Snake and Salmon Rivers will be randomized and one or two reaches will be sampled per week during the sampling period. Reaches will be divided into 0.8 km (0.5 mile) sampling segments, each segment is considered a potential sampling site, and 20 sampling sites will be randomly chosen within a reach. Sampling sites are not stratified by habitat characteristics (depth, velocity or substrate type), thus catches were unbiased by habitat conditions to which white sturgeon may or may not be responding. Care will be taken not to confuse seasonal changes in densities throughout the study area with areas where densities may be limited due to lack of habitat.

Two primary sampling methods will be used to capture white sturgeon: 1) setlines, and 2) hook-and-line. Set-lines appear to be the most efficient per unit effort at sampling white sturgeon (Elliott and Beamesderfer 1990). Setlines consist of 100 feet of an anchored bottom-line with a series of gangen lines attached using snaps. Gangen are rigged with circle hooks attached approximately every ten feet (as described by Lepla 1994, Apperson and Anders 1990). A mixture of ten 10/0, 12/0, 14/0, and 16/0 galvanized barbed circle hook will be used on each line. Pickled squid, lamprey, and other available fish will be used to bait lines. Catch bias associated with hook size and bait type will be assessed. Setlines will be checked twice a day. As with nets, setlines in Lower Granite Reservoir will be set perpendicular to the channel and marked by a buoy only near the shore out of the shipping lane.

Hook-and-line sampling will be conducted where multiple passes by boat are not possible or to supplement net or setline fishing. Sixty pound or greater test Dacron line with either barbless 'J' hooks and barbless circle hooks of varying size will be used. Again a variety of baits will be used and bias associated with individual fishers, bait type, and hook sizes will be tested.

Captured white sturgeon will be processed aboard the collection boat or at the site of collection on the shore. If more than one fish is removed from a net or setline, or hooked white sturgeon are less than 100 cm in length, they will be placed in a holding tank replenished periodically with river water to maintain temperatures and oxygen levels consistent with the river. White sturgeon greater than 100 cm in length will be held in the river and secured to the boat with a tail strap. Captured white sturgeon brought aboard the boat will be placed in a vinyl stretcher being fed by river water while being processed. White sturgeon research in the Lower Columbia and Kootenai Rivers has shown that if the fish and gills are kept moist the effects of handling are minimized and no anesthetic is needed during processing. After fish are processed they will be released at location of capture.

Captured white sturgeon will be examined for previous marks and tags (tag scars, fin clipping, scute removals). New captures will be tagged using a Floy tag and a 15 mm Passive Integrated Transponder (PIT) tag injected near the armor of the head on the left side (North et al. 1996). PIT tags have been shown to be highly retentive (Clugston 1996) and are easily detectable using portable handheld scanners. Total and fork length (cm), girth (cm), and weight (0.1 kg) of the fish were measured and recorded. External gross abnormalities, such as excessive fin erosion, cutaneous ulcers, or visible tumors, will also be noted.

Habitat data will be collected throughout the study area and at most sampling sites, including: water depth, velocity, substrate, water temperature and discharge. Water column depth will be measured to the nearest 0.3 m using boat mounted, commercially available depth finders. Various models and brands depth finders will be used on the research vessels. Near substrate velocity was measured using a March-McBirney® Model 2000 flow meter fitted with a 45 m sensor cable. The velocity sensor will be attached to 11.3 kg sounding weight and stainless steel retrieval cable. Substrate type will be determined through visual inspection and sample dredging. An underwater camera will be used to conduct a substrate survey of the study area. Substrate type will be defined by particle size. Each 0.8 km will be assigned a substrate type based on the dominant substrate observed during the survey. Water temperature and discharge data will be gathered by the United State Geological Survey (USGS) at the Anatone and White Bird gauging stations, and Idaho Power Company at the mouth of the Salmon River. Site specific water temperature will be measured using hand held mercury thermometer.

Task 1.2: Monitor white sturgeon age, maturity, growth and mortality throughout the study area.

White sturgeon captured under Task 1.1 above will be used to collect information on the age/size structure of the population. Fifty to one-hundred of the white sturgeon from a variety of size classes will be aged by clipping a section of the pectoral fin and counting annual ring formations (Cuerrier 1951, Nigro 1989, Rien and Beamesderfer 1993, Tracy and Wall 1993). The lead ray of the left pectoral fin will be clipped near the point of attachment and distally about 2.5 cm from this point (Wilson 1987, Devore et al. 1995, Beamesderfer et al. 1995). Each ray will be cleaned and cut using a procedure similar to that outlined by Brennan and Cailliet (1989). This method has been validated for both lake sturgeon (Rossiter et al. 1995) and white sturgeon (Brennan and Cailliet 1991, Tracy and Wall 1994). Each fin ray will be analyzed using the procedure described in Everett et al. (2003). Lengths-at-age will be used to create a von Bertalanffy growth curve (Misra 1980; Moreau 1987).

White sturgeon captured under Task 1.1 above will also be used to determine sexual maturity. Fish > 150 cm will be sexed by making a small incision (1.5 -2 cm) along the side of the abdomen. Gonad tissue will be removed through this incision and examined to determine sex and maturity (Conte *et al.* 1988). The incision will be closed using sutures.

Relative weights (W_r) will be calculated for the reservoir and free-flowing segments of the Snake River, the Salmon River and the Clearwater River using the standard weight equation given by developed by Beamesdrfer (1993). Mortality will be estimated from a catch curve (Ricker 1975). Length-at-age data will be applied to the length frequency distribution of captured white sturgeon to calculate the proportion in each age class.

Task 1.3: Monitor spawning activities, timing, and locations.

Artificial substrate mats (McCabe and Beckman 1990) will be used to document white sturgeon spawning. The substrate mats are modified by Parley and Kappenman (2000), and will be deployed and checked using the method outlined in Tuell and Everett (2003). Sampling time will correspond with the peak spawning temperatures, approximately 10 to 18° C (Parley and Kappenman 2000). Mats will be retrieved every 48-72 hours (Marchant and Shutters 1996) and examined for eggs and larvae. Eggs and larvae will be preserved in formalin for later identification. Temperature, depth, near substrate velocity and substrate will be recorded at sampling sites.

Objective 2. Monitor the spatial and temporal distribution of the white sturgeon population between Hells Canyon and Lower Granite Dams, including the major tributaries (Clearwater and Salmon Rivers).

Task 2.1: Tag 20 to 25 white sturgeon with transmitters.

Fish will be fitted with both sonic and radio transmitters to ensure that they can be tracked between deep pools in the reservoir and rapids in the upper sections of the Snake River and the Salmon River. Tagging will be conducted in conjunction with task 1.2 above across the entire study area. Radio tagged fish will be selected based on capture location, fish size and gender. An attempt will be made to tag at least 5 spawning females (late vitellogenic egg stage; Beer 1981) and males with transmitters. Spawning behavior and habitat will be monitored between April and July to identify spawning habitat use by white sturgeon. Transmitters will be mounted on the dorsal fin using stainless steel wire (Apperson and Andres 1990).

Task 2.2: Monitor movements of radio tagged white sturgeon.

Tagged white sturgeon will be located once a week. The frequency of locations may be increased depending on the variability and patterns of habitat use and movement. Tracking will be conducted using a boat, truck or aircraft. Four or six-element antennas will be used to receive radio signals. A directional hydrophone deployed from a boat with a receiver adapted to receive sonic signals will be used to receive acoustic signals. Habitat data will be recorded at sites where fish were detected by boat. Recaptured PIT tagged white sturgeon will be used to supplement the movement analysis.

Task 2.3: Establish fixed monitoring sites.

The potential exists for a great deal of cost sharing through coordination of effort with existing research in the Snake, Salmon and Clearwater Rivers. Coordinate with USGS, the US Army Corps of Engineers, the USFWS, the University of Idaho and other agencies with existing telemetry studies for additional radio tracking assistance and data sharing from fixed monitoring sites.

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APPENDIX B: SMALL SCALE STUDIES

STUDY A: ASSESS CONTAMINANT LEVELS IN SNAKE RIVER WHITE STURGEON BETWEEN LOWER GRANITE AND HELLS CANYON DAMS, INCLUDING THE MAJOR TRIBUTARIES (CLEARWATER AND SALMON RIVERS).

INTRODUCTION

Hydroelectric development and other anthropogenic activities along the Columbia River Basin have altered spawning and rearing habitats and fragmented populations of white sturgeon (*Acipenser transmontanus*). In addition, white sturgeon numbers and productivity have been reduced from historic levels in various impounded reaches of the river system. Specifically, depressed numbers of white sturgeon in the reach of the Snake River between Hells Canyon and Lower Granite Dams (hereafter referred to as the Hells Canyon Reach (HCR)) have severely inhibited sustainable subsistence fishing by the Nez Perce people.

Pursuant to measure 10.4A.4 of the Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1994), a multi-year research effort was initiated by the Nez Perce tribe to evaluate the potential to rebuild white sturgeon populations along the HCR capable of supporting a sustainable annual harvest. In 1997, a Biological Risk Assessment Team (BRAT) comprising regional fisheries professionals completed a risk assessment for this population and identified potential mitigative actions for restoring white sturgeon numbers (Carmichael et al. 1997). One of the mitigative strategies identified by BRAT consisted of reducing contaminant loads in Lower Granite reservoir. This action addressed the potential for contaminants to adversely affect the survival and reproductive success of white sturgeon in the HCR. Currently, little information exists regarding levels of bioaccumulated environmental toxicants present in white sturgeon inhabiting the HCR. Furthermore, though the biological effects of contaminants on white sturgeon physiology have received considerable attention recently (Foster et al. 2001a; Foster et al. 2001b; Kruse and Scarnecchia 2002a; Kruse and Scarnecchia 2002b; Feist et al. 2005), the contaminant levels required to induce a significant effect on reproductive potential remain relatively unknown. Thus, more information is needed to better assess the effects of toxicants on the white sturgeon population inhabiting the HCR (Carmichael et al. 1997).

The objective of this study is to collect information on the types and concentrations of toxic contaminants, such as organochlorines and metals, present in white sturgeon inhabiting the HCR. Because one of the goals of tribal white sturgeon management in the HCR is to provide an annual sustainable harvest, it is critical to understand potential human health risks associated with white sturgeon consumption. This study would provide baseline information that could be used to assess risks and issue consumptive advisories if measured tissue concentrations exceeded established standards. In addition, measured levels of contaminants in reproductive tissues could be evaluated relative to levels that have been shown to have detrimental effects on the survival and growth of early life stages of white sturgeon and other fishes. This would undoubtedly entail coordinating and collaborating with regional fish biologists who are currently investigating the lethal and sublethal effects of toxicants on the reproductive physiology of white sturgeon.

PROBLEM AND JUSTIFICATION

Although habitat changes and overfishing are implicated as primary causes for declining white sturgeon populations, environmental contamination may also be a potential threat. High levels of toxic pollutants have been recently reported in various white sturgeon populations (MacDonald et al. 1997; Kajiwara et al. 2003). Pollutants are introduced into watersheds from various point and non-point sources including effluent from bleached-kraft pulp mills, aluminum smelters, sewage treatment plants, and runoff from agricultural and industrial areas. Riverbed sediments act as a major sink for introduced environmental toxicants and consequently may serve as a source for eventual uptake and bioaccumulation by aquatic organisms. Impounded reaches of river systems may be particularly vulnerable to toxicant loading as high levels of contaminants have been measured in reaches behind dams (Feist et al. 2005). Furthermore, many of the contaminants are environmentally persistent and may remain bioavailable for periods long after the activities contributing to their introduction have ceased. Several studies have detected persistent bioaccumulative compounds, including chlorinated dioxins, furans, pesticides, and polychlorinated biphenyls (PCBs), in sediment samples and fish tissues from the Columbia River system (US EPA 1992, 2002; Foster et al. 1999).

Fish may be exposed to contaminants through several pathways including uptake across gills or integument from contaminated environmental media (e.g. water or sediment), ingestion of contaminated prey, or maternal transfer. Benthic fish may be especially susceptible to chronic exposure because they maintain prolonged contact with the river bottom, may incidentally ingest sediment during feeding, and likely consume predominantly benthic food items (Cossa and Gobeil 2000). Organic contaminants (e.g. organochlorines) are generally lipophilic and resistant to metabolism, and thus tend to bioaccumulate in the lipid-rich body tissues of fish including muscle, adipose tissue, and gonads. Toxicants that accumulate in the gonadal tissue of adult females can be additionally transferred to progeny as lipids are incorporated into developing eggs during oogenesis (Niimi 1983; Heath 1995). The early life stages of fish are also extremely sensitive to high levels of contaminants in the environment as extruded eggs and larvae readily accumulate chemical residues over a short period of time (Birge et al. 1987; Peterson and Kristensen 1998)).

The benthic lifestyle and reproductive strategy of white sturgeon render them extremely susceptible to pollutant bioaccumulation. Their primarily benthic diet coupled with the incidental ingestion of sediment during suction feeding provides several pathways by which white sturgeon may be exposed to high levels of contamination. The long life span and late age of maturation also increases the period of time in which toxicants can bioaccumulate in somatic and reproductive tissues. Furthermore, a protracted period of gonadal recrudescence permits an accumulation of toxicants in developing oocytes between spawns. Broadcast eggs, as a result of their highly adhesive nature, also may absorb toxicants through contact with suspended sediment or bottom substrates during the incubation period (Kruse and Scarnecchia 2002a). Survival studies indicate that white sturgeon are highly sensitive to low levels of environmental contaminants during the embryonic and larval stages (Tikhonova and Shekhonova 1982; Detlaff et al. 1993)

Although lethal effects from acute exposure can be readily observable, the sublethal effects of contaminants on fish may not be as easily discernible or measurable. However, environmental pollutants have been shown to have significant sublethal effects on fish physiology (Heath 1995; Kime 1995; Arcand-Hoy and Benson 1998). The association between environmental contamination and the incidence of gross abnormalities (e.g., lesions, tumors, or developmental malformation) and immunological responses (e.g., macrophage aggregates) in laboratory and field studies suggest increased stress levels or pathological disorders in fish resulting from chronic exposure (Wolke 1992; Adams et al. 1996; Fournie et al. 1996; Holladay et al. 1996; Patino et al. 2003). Endocrine disrupting chemicals (EDCs), such as the organochlorine compounds DDT and PCBs, may also adversely affect reproductive potential in adult fish by altering the levels of circulating reproductive hormones. Depressed levels of estradiol and the prevalence of inhibited ovarian development have been found in adult fish at sites with high levels of contamination (Johnson et al. 1988). Toxicants have also been shown to reduce fertility, or the percentage of viable eggs in the ovary, and hatching success in fish (Monod 1985; Giesy et al. 2002). In some cases, toxic effects from maternally-derived contaminants may not be detectable until the early stages of larval development when absorption of the lipid-rich yolk sac is occurring (Hall et al. 1989; Walker et al. 1991; Gundersen et al. 1998).

Although published studies are less numerous, toxicants have been shown to have potential detrimental effects on reproductive physiology in white sturgeon. Kruse and Scarnecchia (2002b) found evidence suggesting an association between the level of metals and organochlorines in ovarian tissue and endocrine disruption in Kootenai River white sturgeon. Similarly, studies conducted along lower Columbia River reservoirs found a negative correlation between the toxic load measured in gonadal and liver tissues and the level of circulating androgens and gonad size (Foster et al. 2001a; Feist et al. 2005). However, the authors from these latter studies acknowledged that it was difficult to assess the potential effects of depressed androgen levels on maturation and reproductive success because only immature fish were sampled. Furthermore, little information is available as to how contaminant loads change as white sturgeon age. Kruse (2000) found higher contaminant concentrations in tissues of older fish; on the other hand, a negative correlation between age and toxic burden may be detected if bioaccumulated toxicants are gradually eliminated through subsequent spawns (Gundersen et al. 1998).

Recently, numerous studies have found high concentrations of contaminants in white sturgeon collected from the Columbia River watershed (Foster et al. 2001a; Foster et al. 2001b; US EPA 2002; Feist et al. 2005). Although risks to the white sturgeon's reproductive potential was not assessed in the US EPA (2002) study, the detected levels of metals and organochlorine compounds in white sturgeon tissues were considered to pose a serious human health risk for consumption. For example, tribal adults with white sturgeon consumption rates of ~400g/d had calculated cancer risks of 2 in 100 at some sites. High health risks were predominantly due to the high contaminant levels measured in white sturgeon collected from the Hanford reach. Although contaminant concentrations were lower in tissue samples from Snake River white sturgeon, only three fish were collected from Snake River reaches for the bio-contaminant survey conducted by the US EPA (2002). More information is thus needed to assess the level of environmental toxicants present in white sturgeon from Snake River reaches.

APPROACH AND COLLECTION METHODS

Objective A1. Determine the concentration of various environmental toxicants in tissues of Snake River white sturgeon between Hells Canyon and Lower Granite Dams, including the major tributaries (Clearwater and Salmon Rivers).

White sturgeon from which tissue samples will be collected will likely be sampled during the abundance surveys that are currently scheduled to be conducted every 3-5 years (see Everett et al. 2003 for fish collection methodology). Initially, tissue samples will be collected from ~100 fish from the HCR. Because toxic contaminants may be more prevalent in depositional reaches of Lower Granite reservoir than in upriver free-flowing reaches of the Snake River (Feist et al. 2005), tissue concentrations may differ between fish that primarily reside in the reservoir and those found in upriver reaches. Movement studies have suggested potential site-fidelity in white sturgeon inhabiting different reaches of the HCR (Everett et al. 2003). To ascertain the potential range of tissue concentrations present in the study area, samples will be collected from 50 fish in each of the reservoir and free-flowing river segments. From each river segment, tissue samples will be collected from white sturgeon of different sizes to assess the potential relationship between age and contaminant concentration. The number of fish to be sampled in each size class will be apportioned according to length frequency estimates generated for this population (Everett et al. 2003). Even though non-lethal tissue sampling techniques will be employed, samples will not be collected from fish smaller than 100 cm to minimize the potential adverse effects of the invasive procedures. Lengths, weights, and pectoral fin rays for age determination will be collected from sampled fish. External gross abnormalities, such as excessive fin erosion, cutaneous ulcers, or visible tumors, will also be noted.

Fish tissues typically sampled for contaminants include the liver, kidney, muscle, and gonad. Because white sturgeon sampled during survey procedures will not be sacrificed, only samples of muscle and gonadal tissue will be extracted from live white sturgeon. First, a small plug of muscle tissue will be removed from the area below the dorsal fin using the technique described by Quintal et al. (2003). The authors indicated that this technique provided sufficient muscle mass to analyze contaminant concentrations when using standardized procedures, and had no discernible effect on the post-release survival of white sturgeon. A small amount (5-10 g) of ovarian or testicular tissue will also be biopsied following the surgical procedures described in Everett et al. (2003) that were used to assess gender in their study. Muscle and gonadal samples will then be stored frozen until they are sent to a lab for contaminant analysis. The selection of contaminants that will be assayed will likely be based on those that have been primarily detected in fish tissues in the Columbia River basin. Results from the US EPA (2002) survey highlighted PCB's, chlorinated dioxins and furans, DDT (specifically the metabolite DDE), arsenic, and mercury as contaminants present in white sturgeon and most likely to pose potential threats to human health.

In addition to the tissue samples collected during standardized population surveys, attempts will be made to collect samples from fish harvested by tribal fishermen. A brief description of the purpose of the study will be disseminated to the community, and notices will be posted regarding the information that will be desired from harvested white sturgeon. Harvest biologists engaged in creel surveys will collect the appropriate data and tissue samples (e.g., liver and gonads) from harvested fish, and keep samples frozen in individually marked storage bags.

Objective A2. Assess the potential effects of contaminants on the productivity of the Snake River white sturgeon population between Hells Canyon and Lower Granite Dams, including the major tributaries (Clearwater and Salmon Rivers).

Contaminant concentrations in tissue samples collected from HCR white sturgeon will be compared to concentrations that have been reported to have detrimental effects on the physiology of fish, particularly white sturgeon. Concentrations comparable to or excessive of levels that have demonstrable lethal or sublethal effects will prompt and refine priorities for additional research. Additional research will most likely require laboratory and field studies that assess the effects of contaminants on white sturgeon histopathology, biochemistry (e.g. endocrinal responses), and indices of reproductive potential (e.g., hatching success, larval survival). Collaboration with research entities studying the effects of toxicants on reproductive physiology will certainly be pursued, as multifaceted contamination studies are not operationally feasible under the purview of tribal fisheries research.

STUDY B: ASSESS IMPACT OF CATCH-AND-RELEASE FISHERY ON SNAKE RIVER WHITE STURGEON BETWEEN LOWER GRANITE AND HELLS CANYON DAMS, INCLUDING THE MAJOR TRIBUTARIES (CLEARWATER AND SALMON RIVERS).

Objective B1. Describe current and recent harvest levels and angler pressure on Snake River white sturgeon between Lower Granite and Hells Canyon Dams, including the major tributaries (Clearwater and Salmon Rivers).

Task B1.1: Gather and analyze white sturgeon catch records from the states of Idaho, Washington and Oregon.

Analysis will be conducted to determine harvest rates (for Washington prior to 1994), and catch rates. White sturgeon size and location data, if available, will be used to augment status monitoring.

Task B1.2: Describe impacts of capture and handling affecting both growth and reproductive physiology of white sturgeon.

Plasma cortisol is used to indicate stress in white sturgeon. Increases in cortisol concentrations have been correlated to handling stress. We intend to determine the impact of increased cortisol concentrations on white sturgeon physiology following protocols established by UCWSRI (2002). White sturgeon will be collected using standard hook and line sampling. Fish will be sampled throughout the year, across the entire study area using a variety of hook sizes and baits. Captured white sturgeon will be processed, gear type will be noted and play time recorded. For fish > 150 cm gender and maturity will be determined.

STUDY C: DEVELOP TECHNIQUES TO CAPTURE YOUNG-OF-THE-YEAR (YOY) WHITE STURGEON BETWEEN LOWER GRANITE AND HELLS CANYON DAMS, INCLUDING THE MAJOR TRIBUTARIES (CLEARWATER AND SALMON RIVERS).

YOY white sturgeon have been successfully captured in reservoir habitats using gill nets, trawls and minnow nets. Techniques need to be developed to collect YOY white sturgeon in free-flowing more turbulent habitats. Determining YOY survival will be an important parameter to both status and effectiveness monitoring.

Objective C1. Capture YOY white sturgeon between Lower Granite and Hells Canyon Dams, including the major tributaries (Clearwater and Salmon Rivers).

Initial attempts to capture YOY white sturgeon in the Snake River focused on setlines with smaller (down to size 6) hooks will no success (Everett et al. 2003). Because white sturgeon do not fully recruit to setline sampling until they reach 50-60 cm, the abundance and size distribution of these smaller fish is currently unknown. Sampling using small mesh gill nets, set in selected locations may provide the greatest capture success. However, other researchers using gill nets have captured very few YOY white sturgeon. Furthermore, nets will need to be carefully monitored to avoid ESA salmonids within the sampling area. Other sampling methods, including trawling, minnow nets and underwater video observations will be tested.

STUDY D: DETERMINE TRIBAL HARVEST OF SNAKE RIVER WHITE STURGEON BETWEEN LOWER GRANITE AND HELLS CANYON DAMS, INCLUDING THE MAJOR TRIBUTARIES (CLEARWATER AND SALMON RIVERS).

The Nez Perce Tribe's harvest monitoring activities are on-going, encompassing fishing conducted year-round from the mainstem Columbia River (Zone 6) up to the headwaters of the Clearwater River on the Montana/Idaho border. The Tribe's monitoring program is currently focused on salmon and steelhead. The Tribe engages in developing the plans necessary to insure that proposed harvest is biologically and legally sound and that it occurs (i.e. take numbers, locations, dates and gear types) in the manner designed. Activities under this monitoring proposal will be conducted in conjunction with the Nez Perce Tribe's harvest monitoring program.

Objective D1. Monitor tribal harvest of Snake River white sturgeon.

Task D1.1: Conduct surveys in the Snake River between Lower Granite and Hells Canyon Dams, including the major tributaries (Clearwater and Salmon Rivers).

Two types of surveys will be conducted: direct interview and in-season. For the direct interview survey, data will be collected by direct observation and through interviews. The monitors will survey specific fishing periods and locations. The in-season interview will be conducted to compensate for our inability to conduct a complete creel survey to derive a ratio harvest estimate. The harvest monitors will routinely conduct interviews with the tribal fishers and submit the data collection sheets. This can be facilitated through direct contact with tribal fishers by harvest monitors assigned to specific creel survey duties. The interview survey data will be documented on a weekly basis to avoid counting the same fish over in subsequent interviews.

Task D1.1: Gather and analyze historic white sturgeon catch records from the tribal harvest program.

Current tribal regulations require white sturgeon catch cards to be completed at the end of the season. Data on the cards include fish size and capture location. Analysis will be conducted to determine previous and current harvest and catch rates. White sturgeon size and location data, if available, will be used to augment status monitoring.

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