

# FY 2008-2009 F&W Program Accords (MOA) Proposal Review

## Narrative

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Table 1. Proposal Metadata

<b>Project Number</b>	2007-155-00	
<b>Proposer</b>	Columbia River Inter-Tribal Fish Commission	
<b>Short Description</b>	Sturgeon Strategic and Hatchery Master Plan	
<b>Province(s)</b>	Columbia Cascade	
<b>Subbasin(s)</b>	Columbia Upper Middle	
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### ***Information transfer:***

#### **A. Abstract**

The long-term goal of this project is to facilitate restoration of productive, viable sturgeon populations and fishery opportunities in Federal Columbia River Power System portions of the mid-Columbia and lower Snake River reservoirs (Figure 1). Objectives include:

1. Complete, in conjunction with regional, tribal, state, and Federal management entities, a collaborative and comprehensive strategic plan for sturgeon conservation, restoration and management to include specific objectives, strategies, actions, milestones and schedules for habitat protection and restoration, natural production, hatchery production, fishery management, research, monitoring, and evaluation.
2. Complete a sturgeon hatchery review process to implement hatchery-related actions (if any) identified in the comprehensive strategic plan and consistent with directions provided by the Northwest Power and Conservation Council's three-step review process.
3. Facilitate, monitor and evaluate implementation of appropriate hatchery actions in collaboration with other regional sturgeon conservation, management, and restoration projects.

Over 20 years of dedicated research and management has failed to date to restore natural productivity or increase opportunities for harvest of mid-Columbia River sturgeon that have been impacted by the hydropower system. This project will provide guidance for the next phase of sturgeon conservation, management, and restoration in the mid-Columbia and lower Snake river reservoirs based on past research, monitoring, and evaluation completed by regional fish managers and partners. This includes a determination if use of hatchery fish is appropriate and outline specific directions for use that are consistent with a detailed analysis of objectives and risks. This work directly addresses the objective of the 2004 NPCC Subbasin Plan to increase sturgeon abundance in the lower mid-Columbia mainstem by: 1) continuing to develop hatchery technology and methodologies, 2) considering use hatchery fish for supplementation. The three objectives are conditional phases of the project with initiation of each phase contingent on decisions in the preceding phase.

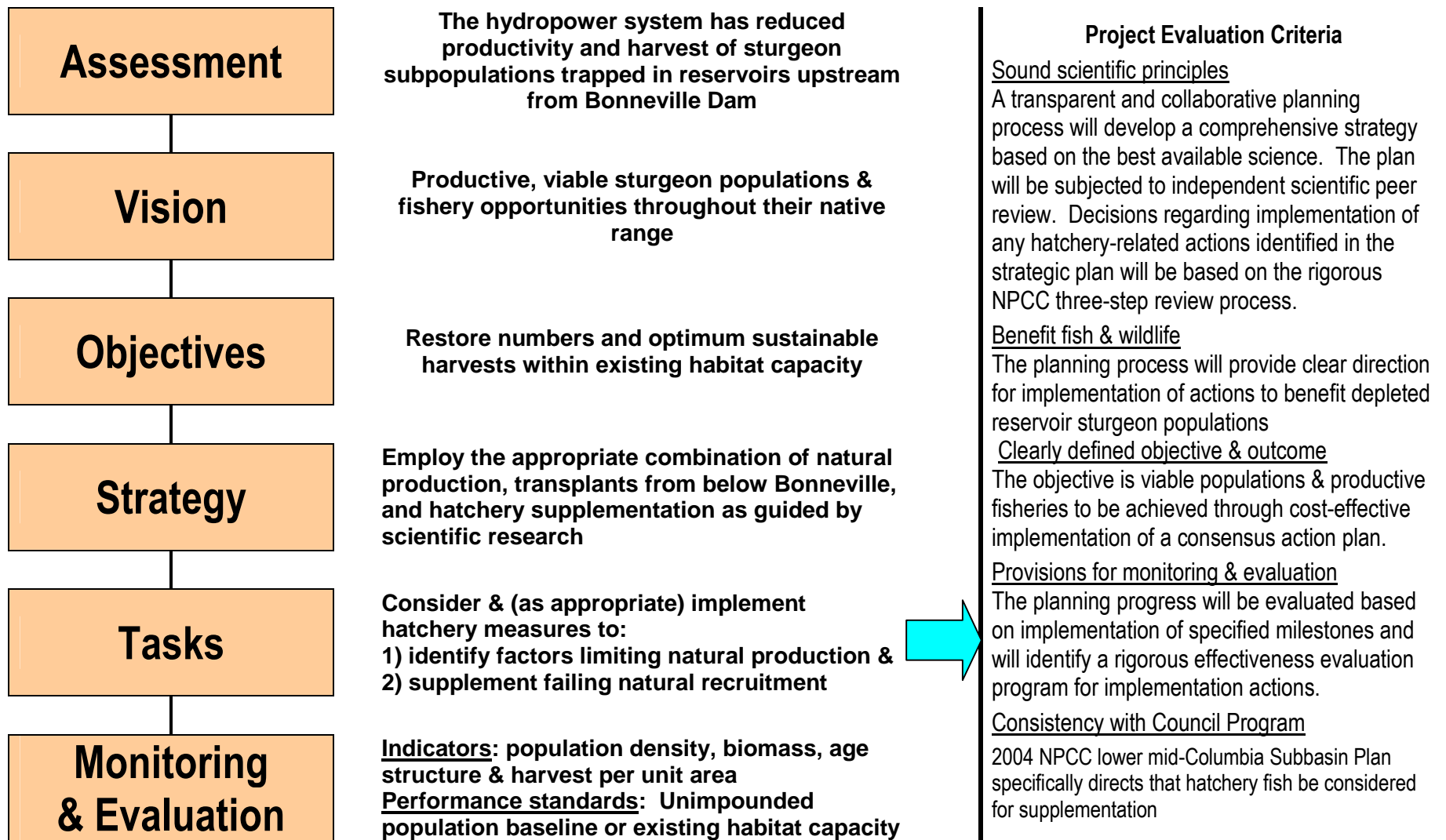


Figure 1. Logic path and evaluation criteria for sturgeon strategic and hatchery planning project within the context of regional sturgeon conservation, management, and restoration efforts.

## **B. Problem statement: technical and/or scientific background**

Construction and operation of the hydropower system has drastically reduced the biological viability and harvest opportunity for white sturgeon throughout the Columbia and Snake river systems (Beamesderfer et al. 1995; UCWSRI 2002; NPCC 2004). The river downstream from Bonneville Dam continues to support a large diadromous population and excellent fisheries (DeVore et al. 1995; ODFW and WDFW 2008). However, dams are significant passage barriers to white sturgeon which do not consistently use fish ladders designed for salmon (North et al. 1993; Warren and Beckman 1993; Parsley et al. 2007). The population below Bonneville no longer has access to thousands of miles of spawning and juvenile rearing habitat which has greatly reduced natural reproduction. The populations above Bonneville, trapped in a series of mid-Columbia and lower Snake River<sup>1</sup> mainstem reservoirs, are relatively small and unproductive, when compared to the population downstream of Bonneville Dam. Resident subpopulations have access to spawning and rearing habitat within each local river reach between dams, but since they are cut off from the rich resources of the Columbia River estuaries and the open ocean, production is limited to the resources available within each closed system between dams. Potential yield from impounded populations has been reduced by dams which restrict fish to river segments that may not include conditions optimal for all life stages (Beamesderfer et al. 1995).

The loss of significant sturgeon production upstream from Bonneville Dam has clearly impacted population attributes related to biological viability. McElhany et al. (2000) related biological viability of salmonid populations to abundance, productivity, spatial structure, and diversity. The most obvious impact among sturgeon is the loss of spatial structure due to the reduction or elimination of significant production from large areas of the system (Figure 2). While overall species viability is sustained by the strong population downstream from Bonneville Dam, the loss of upstream production areas has also substantially reduced abundance and productivity from historical levels (Beamesderfer et al. 1995). Genetic diversity of impounded populations is threatened by small effective population sizes due to low abundance, the periodic sturgeon maturation cycle, and environmental patterns that present only opportunities for successful reproduction.

Low numbers and productivity of impounded sturgeon subpopulations have severely reduced opportunities for harvest in tribal subsistence and commercial fisheries and non-tribal recreational fisheries upstream from Bonneville Dam (Figure 3). The impact has been particularly onerous on tribal fisheries which do not currently have access to the large sturgeon population downstream from Bonneville Dam. Tribal fisheries for sturgeon are largely restricted to the area between Bonneville and McNary Dams which still support some sturgeon production<sup>2</sup>. These reservoirs historically supported significant populations but were rapidly

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<sup>1</sup> For the purposes of this narrative, the mid-Columbia River mainstem is defined to include the area from The Dalles Dam to the Grand Coulee Dam. We refer to the lower mid-Columbia as that portion between The Dalles Dam and Priest Rapids Dam (including The Dalles, John Day, and McNary reservoirs of the Federal Columbia River Power System). We refer to the upper mid-Columbia as that portion between Priest Rapids Dam and Grand Coulee Dam (including Priest Rapids, Wanapum, Rock Island, Rocky Reach, Wells, and Chief Joseph reservoirs, which are largely operated by the Public Utility Districts). The lower Snake river is defined to include the area from the mouth upstream to Lower Granite Dam.

<sup>2</sup> Harvest of salmon and sturgeon upstream from Bonneville Dam is shared between tribal and non-tribal fisheries according to requirements and agreements administered under the continuing jurisdiction of the Federal Court under U.S. v. Oregon.

depleted following the expansion of sturgeon fisheries during the 1980s when it became apparent that impounded and unimpounded populations could not support the same level of harvest (Rieman and Beamesderfer. 1990; Beamesderfer et al. 1995; Macy et al. 1997).

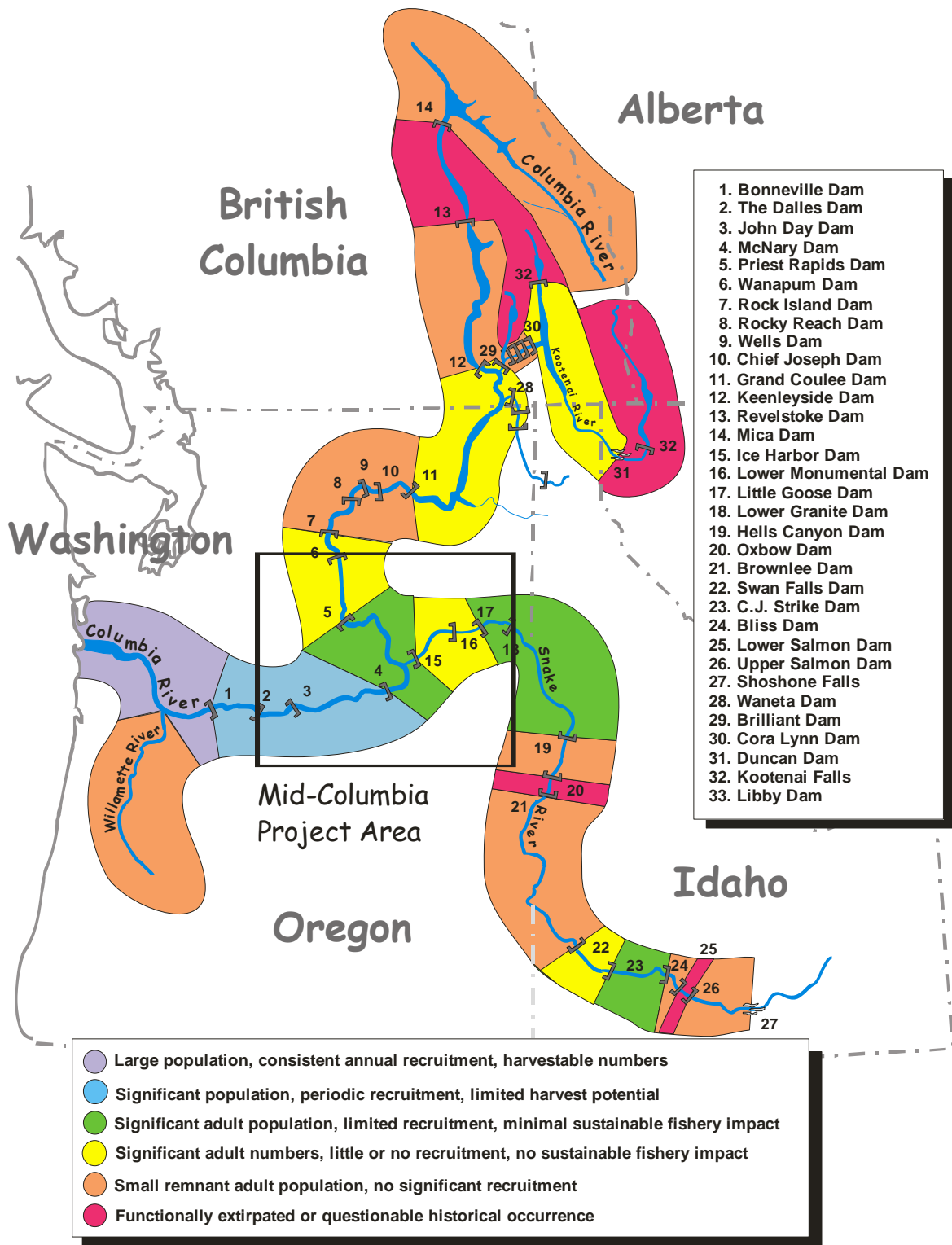


Figure 2. Status of white sturgeon subpopulations throughout the Columbia and Snake river system (adapted from UCWSRI 2002).

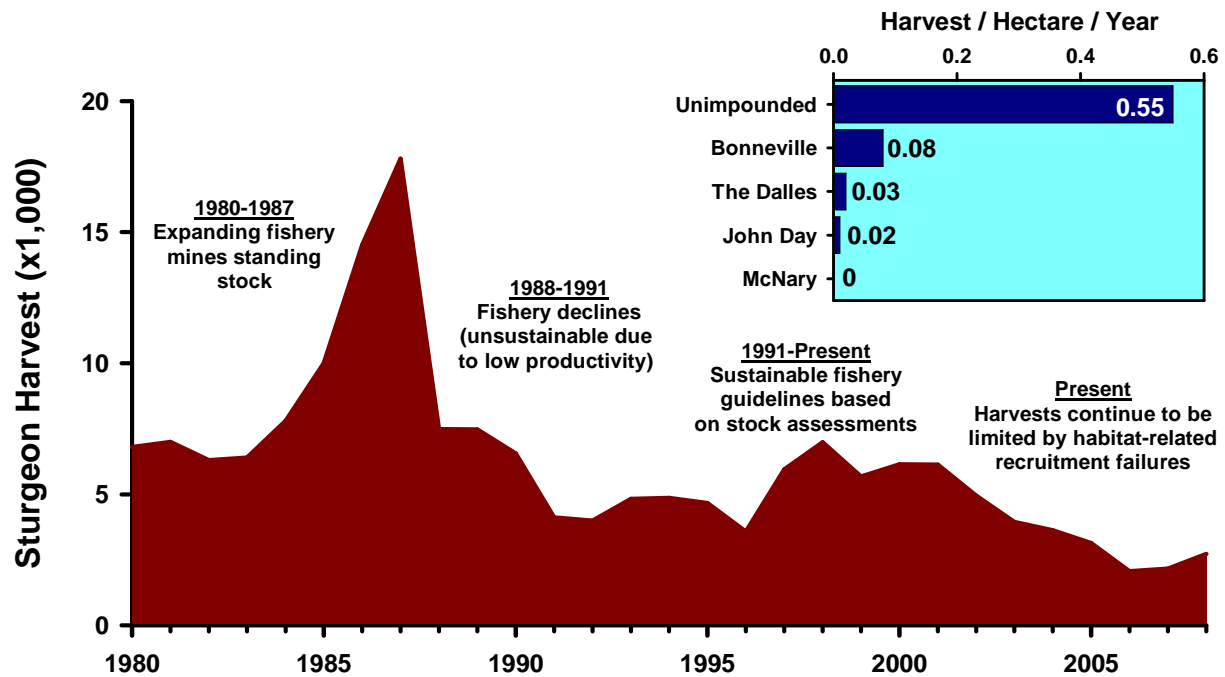


Figure 3. Annual harvest of white sturgeon from mid-Columbia impoundments upstream from Bonneville Dam and relative productivity based on 2008 harvest guidelines which are derived from sustainable harvest rates at current population levels (data from NPCC 2004; ODFW & WDFW 2008; Mallette 2008).

Most impounded populations are recruitment-limited due to a lack of suitable spawning habitat or flow conditions suitable to produce significant recruitment in the available habitat (Parsley and Beckman 1994; Counihan et al. 1999; Parsley and Kappenman 2000; NPCC 2004). Spawning is typically limited to tailrace areas immediately downstream of dams. Past research has determined that habitat suitability for spawning is determined by the physical characteristics of the tailrace and has documented the characteristics of tailraces that support sturgeon spawning (Parsley and Beckman 1994). Greater flows typically improve suitability but flow thresholds for successful spawning vary from reservoir to reservoir. Passage barriers posed by dams limit the dispersal of sturgeon from reservoirs with good spawning habitat into other areas of favorable rearing or foraging habitat.

Impoundments provide large areas of habitat suitable for juvenile, subadult, and adult sturgeon (Parsley et al. 1993; Parsley and Beckman 1994). Stock assessments of impounded populations have found good survival, growth, and condition of resident sturgeon (Beamesderfer et al. 1995; Rien 2007; Mallette 2008). This information suggests that the available habitat for juveniles and adults is not currently being utilized to capacity and could support greater sturgeon numbers if recruitment and passage were not limiting.

Previous research on status and limiting factors has led to an ongoing program in Bonneville, The Dalles, and John Day reservoirs of: 1) indexing of annual recruitment, 2) periodic stock assessment, 3) fishery monitoring, and 4) trap and transplant of juveniles from below Bonneville (NPCC 2004; Rien 2007; Mallette 2008). This program was designed to: A) identify flows needed to provide significant recruitment, B) maintain viable natural spawning populations in each reservoir, C) optimize fisheries within the constraints of existing production, and D) rebuild populations and fisheries.

Attempts to date to manage and rebuild impounded sturgeon populations have failed to restore significant levels of natural recruitment or opportunities for harvest (NPCC 2004; Mallette 2008; ODFW and WDFW 2008). Impounded populations remain at low or very low levels and in areas upstream from McNary Dam have been reduced to the point of nonviability (Ward 1999, 2000; Golder Associates 2003a, 2003b; Mallette 2008). Fishing opportunities on impounded populations remain very limited (ODFW and WDFW 2008).

No flow measures have been implemented to date for the specific benefit of impounded sturgeon populations in the mid-Columbia and lower Snake. Research has identified flow conditions that produce significant sturgeon recruitment in most dam tailraces but sturgeon spawning needs must compete with other needs for water including power generation, irrigation, and measures for the benefit of ESA-listed salmon and steelhead. Nor has consistent recruitment of sturgeon been restored by flow or other operational measures implemented for salmon (Mallette 2008). One significant impediment to the consideration of potential passage measures for sturgeon has been their potentially confounding impacts on salmon. Adult passage systems are constructed, calibrated and maintained at each dam to optimize salmonid passage and changes in these systems to attract and pass sturgeon are likely to reduce salmon passage success.

The “trawl and haul” program sought to transplant up to 10,000 juvenile sturgeon per year to The Dalles and John Day reservoirs. A total of 42,098 fish (30-90 cm FL, 1-6 years old) were transplanted from 1994-2005 (Rien 2006, 2007). High survival rates of fish transplanted into The Dalles and John Day reservoirs was promising (Rien and North 2002) but the program was suspended after 2005 due to funding constraints, difficulties in capturing adequate numbers of fish below Bonneville and concerns for impacts on the unimpounded population (Rien 2007).

Hatchery supplementation has been identified as a potential alternative for restoration of depleted sturgeon populations and fisheries in the mid-Columbia Reservoirs (Fickeisen 1985a, 1985b; NPCC 2004). Supplementation is a viable alternative for sturgeon restoration in the absence of effective implementation of other beneficial measures including spawning flow increases, passage improvements, or transplants (Beamesderfer and Farr 1997; Munro et al. 2007). Effective hatchery methods have only relatively recently been adapted and applied to North America sturgeons (Conte et al. 1988; Munro et al. 2007). Successful conservation hatchery programs have been developed for unique headwater populations of white sturgeon to bridge chronic habitat-related recruitment failures in the Kootenai River (Duke et al. 1999; Ireland et al. 2002a, 2002b; Paragamian and Beamesderfer 2004; Paragamian et al. 2005; KTOI 2007) and the transboundary upper Columbia River (Hildebrand et al. 1999; UCWSRI 2002; NRTWS 2006; Irvine et al. 2007). Kootenai and upper Columbia sturgeon recovery programs have demonstrated the feasibility of using hatchery-spawned sturgeon from wild parents to preserve native genetic diversity, supplement failed natural recruitment, and increase abundance in certain situations. Use of wild broodstock in these conservation hatchery programs has been key to their objective of maintaining the natural genetic diversity of the population and avoiding potential detrimental impacts of hatchery selection or domestication.

Hatchery-produced sturgeon are also a very useful experimental tool for applied research to determine limiting factors, habitat capacity, broodstock limitations, population parameters, and immigration/entrainment in natural populations (Box 1). Many questions on the basic life history of these fish, fundamental to successful management, will be most effectively answered with an experimental approach involving controlled testing of potential management alternatives. A large body of inferential research on existing populations has answered many questions but

system manipulations are necessary to address other critical unknowns, including the life-stage specific carrying capacity of impounded reaches of the river. Monitoring of hatchery sturgeon released in the Kootenai and Upper Columbia has provided critical information on factors limiting natural production, system capacity, and life history bottlenecks (Ireland et al. 2002b; Golder 2007; Justice et al. 2009). Under current conditions of low recruitment, critical information often cannot be obtained by monitoring of natural populations alone because of low numbers and sampling power. Use of marked hatchery fish provides a known subject population and structured releases allow for the design of systematic statistical experiments.

**Box 1. Potential test hypotheses that can be effectively addressed by research and monitoring using experimental releases of juvenile sturgeon spawned and reared in a hatchery. Priorities for evaluation of hypotheses and appropriate methodologies for examination will be developed in the strategic and master planning processes.**

- H1: Existing reservoir habitat is suitable for feeding, growth, survival and maturation of juvenile and subadult sturgeon.
- H2: Juvenile and subadult sturgeon utilize a wide range of the available reservoir habitats.
- H3: Habitat capacity of each reservoir is sufficient to support significant numbers and biomass.
- H4: Density dependent habitat constraints do not significantly affect population productivity.
- H5: Natural recruitment can be effectively estimated based on marked-unmarked ratios and recaptures of marked hatchery fish.
- H6: Habitat bottlenecks that currently limit recruitment occur at the spawning and/or early life history stages.
- H7: Downstream passage/entrainment does not significantly affect abundance and survival in source and downstream populations.
- H8: Behavior, distribution, movements, growth, survival, and condition of hatchery fish are similar to wild fish.
- H9: Hatchery supplementation can significantly increase harvestable numbers in reservoir populations.
- H10: Hatchery supplementation is a cost effective alternative for increasing harvestable numbers in reservoir populations.
- H11: Size and time of release determines the potential effectiveness and cost of hatchery supplementation.
- H12: Survival, growth, emigration and production capacity is reservoir specific and optimum hatchery supplementation levels are effectively estimated based on monitoring of population performance relative to fish number.
- H13: Natural recruitment in specific reservoirs is limited by low numbers of adult spawners.
- H14: Supplemented populations can be harvested with protection and recruitment of adults adequate to provide significant natural recruitment when suitable conditions occur.
- H15: Hatchery supplementation of impounded populations does not reduce genetic and life history diversity in target or adjacent populations through artificial selection or domestication.
- H16: Hatchery supplementation of impounded populations can occur without significant impact to the unimpounded anadromous population downstream from Bonneville Dam.
- H17: Adult numbers in reservoir populations can be stabilized over time with the use of hatchery supplementation.

Any consideration of the potential benefits of hatchery sturgeon must be tempered with careful calculation of the related conservation risks and costs (Anders 1998; Secor et al. 2002). While hatchery production can provide fish for research and fisheries, and have been a conservation tool of last-resort in cases like the Kootenai sturgeon, they can also pose considerable risks to the viability and sustainability of wild natural populations. Significant risks can include mining or direct mortality of wild broodstock, increased incidence of disease, domestication, behavioral

and genetic impacts, mixed hatchery-wild stock fishery effects, competition, density-dependent impacts due to habitat carrying capacity limitations, and ecosystem effects. Hatchery supplementation may be helpful to boost production of fisheries in impounded areas where natural reproduction is limited. However, it may be unrealistic to expect production of catchable-sized fish in those sections to ever achieve historical levels due to the lack of access to anadromous resources. In this case, hatchery augmentation may simply increase intraspecific competition and provide little benefit for local fisheries. The role of genetics in the relative success of anadromous versus ‘landlocked’ populations must also be considered. Considering the long lifespan of white sturgeon and the relatively brief period of selection imposed on these populations recently ‘landlocked’ by the series of Columbia and Snake River dams, it is possible that these populations are currently undergoing intense selection for genotypes that are better-adapted for their new environment. In this case, hatchery supplementation might interfere with this natural process. Prudence dictates that any contemplation of hatchery augmentation must be undertaken in conjunction with intensive genetic and life-history studies to try to document and track any changes that may be occurring in supplemented populations.

Sturgeon conservation, management, and restoration efforts in the mid-Columbia and lower Snake Rivers have now progressed to the point where the current objectives and strategies warrant a careful review. Significant course corrections may be required in order to achieve the overarching goal of restoring productive, viable sturgeon populations and fishery opportunities in Federal Columbia River Power System portions of the mid-Columbia and lower Snake river reservoirs. This project will provide guidance for the next phase of sturgeon conservation, management, and restoration in the mid-Columbia and lower Snake river reservoirs based on past research, monitoring, and evaluation completed by regional fish managers and partners. This includes a determination if use of hatchery fish is appropriate and specific direction for use consistent with an exhaustive analysis of objectives and risks.

Specific project objectives include:

1. Complete, in conjunction with regional, tribal, and state management entities, a collaborative and comprehensive strategic plan for sturgeon conservation, restoration and management to include specific objectives, strategies, actions, milestones and schedules for habitat protection and restoration, natural production, hatchery production, fishery management, research, monitoring, and evaluation.
2. Complete a sturgeon hatchery review process to implement hatchery-related actions (if any) identified in the comprehensive strategic plan and consistent with direction the Northwest Power and Conservation Council three-step review process.
3. Facilitate, monitor and evaluate implementation of appropriate hatchery actions in collaboration with other regional sturgeon conservation, management, and restoration projects.

## **C. Rationale and significance to regional programs**

### ***Columbia Basin Fish Accords***

This project is consistent with objectives to deliver specific, scientifically valid biological results for the region's fish identified in the 2008 Fish Accord agreements signed by four Northwest tribes with the federal action agencies.

### ***2000 Fish and Wildlife Program***

This project specifically addresses overarching biological objectives, resident and resident fish substitution objectives and artificial production strategies identified by the 2000 Fish and Wildlife Program (NPCC 2000). Every Fish and Wildlife Program since 1984 has recognized the need for research to determine the impacts of development and operation of the hydroelectric power system on sturgeon and evaluations of the potential for artificial propagation of white sturgeon (NPPC 1984; NPCC 2000).

The 2000 program identifies four overarching biological objectives for the fish and wildlife program: 1) a diverse sustainable ecosystem, 2) mitigation for adverse effects of the hydrosystem, 3) sufficient opportunities for tribal trust, treaty right, and non-tribal harvest, and 4) recovery of ESA-listed species (NPPC 2000). The CRITFC Sturgeon Strategic and Hatchery Master Plan Project will: 1) help sustain ecosystem diversity by restoring abundance and spatial structure of native white sturgeon in key portions of their range, 2) identify and provide an effective means of mitigating for adverse effects of the hydrosystem, and 3) improve opportunities for harvest of sturgeon, particularly including tribal trust and treaty rights.

For resident fish, objectives include 1) loss assessments, 2) protection and restoration of healthy ecosystems and watersheds, 3) an ecosystem approach to resident fish restoration, and 4) a 100-year target for full mitigation. The program also identifies additional objectives for blocked areas where resident fish substitutions are unable to mitigate for large anadromous losses. These include: 1) restoration of resident fish abundance, 2) reintroductions where feasible, and 3) administration and improvement of fishery opportunities for native, introduced, wild and hatchery-reared stocks that are compatible with native resident species. Both resident and blocked-area objectives are pertinent to sturgeon in the mid-Columbia River reservoirs. Sturgeon were historically diadromous which provided a very large and important resource to tribal fisheries upstream from Bonneville Dam. However, diadromous sturgeon no longer pass Bonneville Dam and production of resident sturgeon is not adequate to offset the loss of access to anadromous sturgeon resources. Habitat protection and restoration efforts are not adequate to restore significant production of resident sturgeon. Hatchery-reared stocks appear to be the only realistic alternative for meeting these objectives when the bottleneck is reproduction.

The 2000 program directed that artificial production can be used, under proper conditions, to 1) complement habitat improvements by supplementing native populations up to the sustainable carrying capacity of the habitat<sup>3</sup> with fish that are as similar as possible, in genetics and behavior, to wild native fish, and 2) replace lost salmon and steelhead in blocked areas. The CRITFC Sturgeon Project will assist in the development and implementation of an appropriate strategy for

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<sup>3</sup> The current carrying capacity of the habitat has not been determined. Results of Kootenai and upper Columbia River sturgeon work have demonstrated that the most effect means of determining capacity is an adaptive experimental approach of monitoring the individual and population response to increasing densities of hatchery-produced sturgeon.

supplementing native populations within the carrying capacity of the habitat while also ensuring protection of the native wild populations.

### ***2004 Subbasin Plan***

This project explicitly addresses objectives and strategies identified for sturgeon in the 2004 NPCC Subbasin Plan for the lower mid-Columbia mainstem. White sturgeon were selected as a focal species for this subbasin based on their management, ecological, and cultural significance. Objectives for white sturgeon include increasing abundance in the lower mid-Columbia mainstem (especially in reservoirs where the population is likely dying out). Corresponding strategies include: 1) continuing to develop hatchery technology and methodologies, 2) supplementing the sturgeon population in Priest Rapids Pool with hatchery fish, and 3) considering use hatchery fish to supplement The Dalles and John Day populations.

The subbasin plan noted that hatchery technology has now progressed to the point where it may now be possible to supplement white sturgeon populations in the lower mid-Columbia:

*In recent years the development of more successful hatchery technology has resulted in a growing commercial aquaculture industry in California and the potential for further commercial and enhancement hatcheries in the Columbia River Basin. (NPCC 2004)*

Only this sturgeon strategic and master planning project and the complementary Yakama Nation Sturgeon Management project are currently in development to address hatchery strategies identified for the FCRPS portion of the mid-Columbia River. No other hatchery evaluation efforts are included in ongoing projects funded under the Fish and Wildlife Program for the mid-Columbia.

### ***ESA***

Neither lower or mid-Columbia sturgeon are currently listed under the Endangered Species Act or subject to any current plans or petitions for listing. Hence, neither are specifically subject to Biological Opinions, recovery plans, Habitat Conservation Plans, or other plans. The unique headwater population of Kootenai River white sturgeon was listed as endangered in 1994 in response to population declines caused by near-total recruitment failure (Duke et al. 1999). Upper Columbia River white sturgeon in the Canadian portion of the transboundary population upstream from Grand Coulee Dam were listed under the Canadian Species at Risk Act in 2003 (Wood et al. 2007).

### ***NMFS Biological Opinion***

Columbia River white sturgeon were not considered in the 2008 FCRPS Biop because they are not listed under the Endangered Species Act. Kootenai River sturgeon are listed but subject of a separate biological opinion for Libby Dam. Green sturgeon are addressed by the 2008 FCRPS Biop but their Columbia River distribution is limited to the estuary. Green sturgeon originate outside the Columbia River system and do not occur in the Columbia River upstream from Bonneville Dam. Actions affecting mainstem flow and habitat conditions identified in the Biop for the benefit of listed salmonids have the potential to indirectly affect mid-Columbia River sturgeon but implemented or planned salmon alternatives have not and are not expected to significantly improve production of mid-Columbia River sturgeon populations.

## **D. Relationships to other projects**

### ***Historical background***

While this is a new project, it is a critical next step in long term sturgeon conservation, management, assessment, and research efforts currently underway in the Columbia River. To clearly understand the context and the need for a sturgeon hatchery assessment, it is helpful to take a long-term perspective matching the long life span of these fish. Because sturgeon can live to 100 years or more, current status and problems reflect current limitations and lingering effects of historical impacts and activities.

Prior to development, the white sturgeon ranged freely throughout the Columbia and Snake River systems as far upstream as Windermere Lake in Canada and Shoshone Falls in Idaho. The unexploited population included large numbers of very large adults. This population and fishery collapsed in the late 1800s due to unregulated commercial fishing for the cannery industry (Craig and Hacker 1940; Galbreath 1985). Sturgeon are notoriously susceptible to overfishing due to their longevity and late maturation (25-30 years) (Rieman and Beamesderfer 1990).

While dam construction was not responsible for the historical decline of white sturgeon, impoundment has been the primary impediment to rebuilding of inland populations (Beamesderfer et al. 1995). Columbia River sturgeon remained at very low numbers until the 1950s when a 6-foot maximum size limit was enacted to protect spawning adults (Bajkov 1951; ODFW and WDFW 2002). Numbers and fisheries steadily increased over the next several decades, particularly downstream from Bonneville Dam where fish continue to have access to the estuary and ocean. Fish ladders have been largely unsuccessful for passing sturgeon (Warren and Beckman 1993). Following completion of Bonneville Dam in 1938, initial passage efforts with fish elevators were somewhat effective for sturgeon. About 4,500 subadult sturgeon were passed upstream by fish elevators through 1956. However, use of elevators was discontinued as ladders proved to be much more efficient for upstream passage of salmonids. Further, one-way passage of adults into areas of limited spawning habitat is not a particularly fruitful restoration strategy.

Interest in sturgeon gradually built after 1950 as numbers improved following protection of spawners and salmon numbers continued to decline. By the 1970s, increasing fishery participation and harvest led to questions regarding the sustainability of sturgeon populations and fisheries. Washington and Oregon Departments of Fish and Wildlife and the U.S. Fish and Wildlife Service initiated limited population assessments in the late 1970s and early 1980s which highlighted concern over impounded populations (Malm 1978; King 1981; Stockley 1981; Macy et al. 1997). However, basic information was lacking on sturgeon biology, limiting factors, habitat requirements, status, and population dynamics.

In 1983, concern for sturgeon trends and the lack of information led the Columbia Basin Fish and Wildlife Council's Resident Fish Technical Committee and the Bonneville Power Administration to organize a regional workshop on research needs. This was the first sturgeon work under the newly-formed Northwest Power Planning Council's developing fish and wildlife program. Proceedings were published in 1984 (Fickeisen et al. 1984). The need for research to determine the impacts of development and operation of the hydroelectric power system on sturgeon was recognized in the 1984 Fish and Wildlife Program. White sturgeon work and research program implementation plans were completed in 1985 (Fickeisen 1985a, 1985b). Objectives included: 1) assessment of current status, 2) evaluation of the need for protection,

mitigation, and enhancement, 3) evaluation of potential methods for protection, mitigation, and enhancement, and development of tools to assess the effectiveness of efforts.

In 1986, BPA funded a study to determine the status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam BPA (Project 1986-50). The study was implemented cooperatively by the Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, U. S. Fish and Wildlife Service, and National Marine Fisheries Service (ODFW et al. 1987). A formal sturgeon stock assessment program was also initiated in 1986 downstream from Bonneville Dam by ODFW and WDFW using agency funds (ODFW and WDFW 2008). Results and conclusions of Phase I of the BPA-funded project were summarized in a 1993 final report (Beamesderfer and Nigro 1993a, 1993b) and have been widely published in the scientific literature (Elliot and Beamesderfer 1990; McCabe and Beckman 1990; Rien et al. 1994; Rien and Beamesderfer 1994; Beamesderfer 1993; North et al. 1993; McCabe et al. 1993; McCabe 1993; McCabe and Tracy 1994; Parsley et al. 1993; Parsley and Beckman 1994; Rieman and Beamesderfer 1990; Devore et al. 1995; Beamesderfer et al. 1995; Beamesderfer and Farr 1994).

A regional white sturgeon management framework plan was completed in 1992 by the Pacific States Marine Fisheries Commission (PSMFC 1992). Planning involved a wide range of policy and technical staff from State, Federal and Tribal fishery agencies from California, Oregon, Washington, and Idaho. This framework plan summarized the biological knowledge and management of white sturgeon throughout the Pacific States and provided guidance for further research and management. Goals included establishing and/or maintaining viable populations throughout the historic range, sustaining optimum benefits for diverse consumptive and non-consumptive uses, protection and enhancement of critical habitat, promotion of public awareness, and protection of the genetic integrity of local populations.

Phase II of the BPA-funded sturgeon project in the mid-Columbia began in 1992 based on based on recommendations of Phase I research (Beamesderfer and Nigro 1993c) and direction in the regional white sturgeon management framework plan (PSMFC 1992). Phase II included evaluations of: 1) effects of mitigation measures on productivity of populations downstream from McNary Dam and 2) status and habitat requirements in the mid-Columbia River upstream from McNary Dam and in the lower Snake River. Key mitigation actions in the area between Bonneville and McNary Dams included: A) continuing evaluations of flow requirements for sturgeon recruitment based on annual indexing of year class strength; B) implementation of an intensive fishery management plan based on catch monitoring and periodic stock assessment; and C) experimental evaluation of fish transplants from below Bonneville Dam as an alternative to passage. Phase II of this project is ongoing (Mallete 2008).

### ***Sturgeon Hatchery Projects***

Hatchery-evaluation projects for Columbia River sturgeon were also initiated during the early 1980s concurrent with Phase I of the 86-50 research project. The first NPPC Fish and Wildlife program included a measure to determine the potential for artificial propagation of white sturgeon (NPPC 1984). Initial efforts focused on laboratory work describing early life history and population genetics (Brannon et al. 1985a, 1985b, 1986, 1988; Setter 1989; Setter and Brannon 1992). Early genetic studies found less diversity in impounded populations relative to the population downstream from Bonneville Dam (Setter and Brannon 1992; Brown et al. 1992).

Sturgeon culture techniques were relatively unknown in North America prior to 1980 when Dr. Serge Doroshov established a research program at the University of California-Davis building on sturgeon hatchery practices he had learned in the Soviet Union prior to emigration to the United States. Dr. Doroshov demonstrated that white sturgeon could be produced by catching adults in the wild, hormonally inducing ovulation and sperm production, artificially spawning eggs harvested by cesarean section, and rearing fry in fingerlings on artificial feed (Doroshov et al. 1983; Doroshov and Lutes 1984; Anderson 1988; Conte et al. 1988). Commercial white sturgeon aquaculture programs began in California and Idaho during the early 1980s using broodstock captured from the Columbia River below Bonneville Dam. These operations have been successfully spawning and rearing fish for 20 years. Agreements with state agencies created opportunities for private growers by allowing them to collect wild broodstock and provide mitigation fish to the state for stocking or research efforts. A private aquaculture facility was operated on the lower Columbia River from 1981-2008 for broodstock collection, spawning and rearing under permit by Oregon. Mitigation fish provided by the hatchery were primarily stocked by Oregon in the Willamette River upstream from Willamette Falls but 1,019 of these mitigation juveniles were marked and released into John Day Reservoir near Irrigon, Oregon in May 2005 (B. Parker CRITFC 1/5/06 memo).

Development of effective conservation hatchery programs for white sturgeon in the Columbia Basin began in 1990 with an experimental program for Kootenai sturgeon (Apperson and Anders 1991; KTOI 2007). Kootenai sturgeon are a unique isolated headwater population that were listed as endangered in 1994 in response to population declines caused by recruitment failure. This work was led by the Kootenai Tribe of Idaho and the Idaho Department of Fish and Game. The first artificial spawning of wild Kootenai white sturgeon occurred in 1990, initial hatchery experimental construction was completed in 1991, the first hatchery releases occurred in 1992, a genetic breeding plan was established in 1993, disease management strategies were formalized in 1999 and the program was subsequently expanded as other efforts to restore natural recruitment have failed (Kincaid 1993; LaPatra et al. 1999; KTOI 2007; Ireland et al. 2002a, 2002b; Paragamian and Beamesderfer 2004; Paragamian et al. 2005). A similar hatchery conservation program was established in the Canadian upper Columbia in 2001 (Golder 2007) to address measures identified in an upper Columbia white sturgeon recovery plan (UCWSRI 2002) and the listing of upper Columbia River white sturgeon under the Canadian Species at Risk Act in 2003 (Wood et al. 2007). The program was expanded to the U.S. portion of the transboundary reach by the WDFW beginning in 2006 (Beamesderfer and Justice 2008).

Research efforts to determine the efficacy of using supplementation as an enhancement tool in mid-Columbia reservoirs were conducted under Phase II of the BPA-funded 85-50 sturgeon project from 1999 to 2003 by the Columbia River Intertribal Fish Commission and the U. S. Fish and Wildlife Service. Research focused on developing protocols for capture and maturation of pre-spawn adults, culture and rearing technology, and evaluating release size strategies. Wild broodstock were collected primarily from Bonneville and McNary reservoirs. Spawning and rearing occurred at a temporary facility at McNary Dam and at the Abernathy Fish Technology Center near Longview WA. A total of 93 adults were collected for broodstock and 8 were successfully spawned (Table 2). A total of 20,600 juveniles were released in 2003 into Rock Island Reservoir near Wenatchee WA (Kappenman and Parker 2005). Rock Island were hatchery-reared juveniles were released primarily focus of this experimental effort because the local population had been practically extirpated. An additional 739 juveniles were released into John Day reservoir (450 in fall 2002 and 289 in 2005). Budget constraints in 2003 forced an

early termination of this effort and resulted in the release of 48,000 unmarked young-of-the-year into the upper Willamette River (Kappenman and Parker 2005).

Subsequent monitoring documented significant survival and growth in of the hatchery juveniles released in Rock Island Reservoir but also recaptured significant numbers of these fish in downstream reservoirs including Wanapum, Priest Rapids, McNary, and John Day (B. Parker CRITFC 1/5/06 memo). Hatchery fish dominated the catch of juvenile sturgeon in Rock Island, Wanapum, and Priest Rapids reservoirs which highlights the utility of using a known population of marked hatchery fish to assess wild fish numbers.

The CRITFC research effort substantially improved the basis for application of spawning and culture methods to mid-Columbia sturgeon. Significant findings included: 1) sturgeon hatchery supplementation is a promising strategy for experimentation, restoration or supplementation; 2) objectives and risks need to be clearly articulated and carefully evaluated, 3) spawning and rearing success in the hatchery will depend on the availability of adequate amounts of water and the ability to regulate water temperatures, 4) use of fish collected during spawning will be more successful than collection and extended holding of fish prior to spawning, and 5) low numbers of adults in reservoirs make it a problem to collect adequate numbers of ripe males and females (Kappenman and Parker 2004).

The CRITFC hatchery research effort also highlighted the pitfalls of attempting to implement a project with minimal facilities and staff. It is clear that development of an effective sturgeon hatchery program will require significant multi-year investments (Kappenman and Parker 2004). Success will depend on the availability of both adequate facilities and sturgeon culture expertise. Effective culture methods developed for sturgeon elsewhere will need to be refined and adapted by trial and error to the specific facility and application (Kappenman and Parker 2004). Coordination of hatchery development efforts and sharing of information and expertise among areas in the basin will expedite efforts and may also promote economies of scale.

**Table 2. Summary of experimental sturgeon hatchery evaluation activities for mid-Columbia River conducted under Phase II of the 86-50 project funded by Bonneville Power Administration (Kappenman and Parker 2001, 2002, 2003, 2004, 2005).**

Year	Activity
1999	<ul style="list-style-type: none"> <li>• 9 broodstock were collected (1♀ from Wanapum Reservoir, 2♀ &amp; 6♂ from McNary Reservoir)</li> <li>• A temporary facility was built at Abernathy Hatchery to hold broodstock</li> <li>• 1♀ &amp; 1♂ subsequently matured but at different times. No fish were produced</li> <li>• All McNary broodstock were released in McNary, the Wanapum fish was held over for 2000</li> </ul>
2000	<ul style="list-style-type: none"> <li>• 16 broodstock were collected (2♀ &amp; 14♂ from McNary Reservoir)</li> <li>• One ♀ captured at Wanapum Reservoir in 1999 was held for spawning in 2000</li> <li>• Maturation of broodstock held at Abernathy Hatchery was not successful - constant cold temperature of the well water at that facility was subsequently determined to be the cause</li> <li>• All broodstock were released in the area of origin</li> </ul>
2001	<ul style="list-style-type: none"> <li>• 27 broodstock were collected (4♀ &amp; 23♂ from McNary Reservoir)</li> <li>• A facility was developed at McNary Dam to hold and spawn fish at ambient river temperatures</li> <li>• the 1<sup>st</sup> successful spawning for this project, a 1x2 mating produced 104,000 eggs &amp; 32,000 larvae</li> <li>• Only 900 subyearlings were reared by Abernathy Hatchery due to disease &amp; bird predation losses</li> <li>• All broodstock were released in the area of origin</li> </ul>
2002	<ul style="list-style-type: none"> <li>• 21 broodstock were collected (1♀ &amp; 19♂ from McNary Reservoir &amp; 1♀ from below Bonneville Dam)</li> <li>• Spawning occurred at the McNary Dam temporary facility</li> <li>• one 1x4 mating produced 84,700 eggs &amp; 22,640 fry</li> <li>• 50,000 larvae were also obtained in June 2002 from 1x1 mating of broodstock collected by the Pelfry sturgeon hatchery below Bonneville Dam</li> <li>• 21,700 subyearlings were reared at Abernathy Hatchery</li> <li>• 450 BY 2001 yearlings released into John Day Reservoir in fall</li> <li>• All broodstock were released in the area of origin</li> </ul>
2003	<ul style="list-style-type: none"> <li>• 20 broodstock were collected from McNary (2 ♀, 17♂) &amp; Bonneville (1 ♀) reservoirs</li> <li>• Spawning occurred at the McNary Dam temporary facility</li> <li>• One 1x1 mating produced only 4 larvae due to poor egg quality</li> <li>• 20,600 BY 2002 juveniles released into Rock Island Reservoir (12,000 @ 9 mo. in April 2003, 8,600 @ 13 mo. in Sept.)</li> <li>• Water system problems resulted in mortality of 2 ♂ broodstock</li> <li>• Budget constraints result in termination fish spawning and rearing activities</li> <li>• 48,000 remaining BY 2002 juveniles released into the Willamette River</li> </ul>
2005	<ul style="list-style-type: none"> <li>• 289 age 1, 2, 3, and 4 year olds were released into John Day Reservoir (BY 2000-2003)</li> </ul>
2006	<ul style="list-style-type: none"> <li>• Winter gill net sampling was conducted in Wanapum, Rock Island, and Priest Rapids reservoirs to monitor growth, survival, condition, distribution, and downstream migration of Rock Island releases.</li> </ul>
2008	<ul style="list-style-type: none"> <li>• 26 remaining subadults transferred from Abernathy Hatchery to the Yakama tribal hatchery</li> </ul>

### ***Basin-wide Sturgeon Activities***

Sturgeon assessment, planning, and restoration activities have been extended throughout the Columbia and Snake river basins since 1990. Kootenai River sturgeon assessment and conservation efforts under the NPCC Fish and Wildlife Program began in 1989 and are ongoing (Apperson and Anders 1990; KTOI 2007; Paragamian et al. 2005). Canadian assessments of the transboundary population above Lake Roosevelt began around 1990 and are ongoing (RL&L 1994; Hildebrand et al. 1999; UCWSRI 2002; Irvine et al. 2007). A sturgeon recovery project was initiated in the U.S. portion of the transboundary reach under the NPCC program in 2003 (Howell and McLellan 2005). Extensive sturgeon assessments have been completed in the Snake River upstream Lower Granite by the Idaho Department of Fish and Game, Idaho Power, and the Nez Perce Tribe (Cochner et al. 1985; Hoefs 1997; Lepla et al. 2001). Plans for conservation, management, and restoration of sturgeon in the Snake River upstream from Lower Granite Dam have been completed by all three parties (IPC 2005; NPT 2005; IDFG 2008).

Sturgeon population status in Snake and mid-Columbia reservoirs upstream from McNary and lower Snake reservoirs downstream from Lower Granite was assessed from 1995-2002. Phase II of the Bonneville 86-50 project sampled in McNary Reservoir and Hanford Reach in 1995 (Rien and Beiningen 1997), Ice Harbor Reservoir in 1996 (Ward 1998), Lower Monumental and Little Goose reservoirs in 1997 (Ward 1999), and Lake Roosevelt, Lake Rufus Woods, and Rock Island Reservoir in 1998 (Ward 2000). Status assessments in the mid Columbia PUD reservoirs were completed as part of Relicensing efforts in Priest Rapids and Wanapum reservoirs in 2000-2002 (Golder 2003), Rocky Reach in 2001-2002 (Golder 2002), and Wells in 2001-2002 (Jerald 2007).

Sturgeon mitigation issues in upper mid-Columbia River reservoirs operated by the Public Utility Districts (PUDs) fall under the purview of FERC license requirements of Grant County PUD (Priest Rapids, Wanapum), Chelan County PUD (Rock Island, Rocky Reach), and Douglas County PUD (Wells). Under the expected terms of their new license agreements, sturgeon conservation and mitigation responsibilities in portions of the upper mid-Columbia will be implemented by the responsible PUDs. Progress towards White Sturgeon Management Plans, as a part of these new License conditions is summarized below:

- A draft White Sturgeon Management Plan has been developed by the Grant County PUD for the Priest Rapids Project (Priest Rapids and Wanapum reservoirs) (GCPUD 2008) and is currently being reviewed by tribal, state and federal fisheries managers. The goal of the management plan is to promote growth of the population in the project area to a level that is commensurate with the available habitat by year 30 of the new license. To meet this goal, Grant County PUD is proposing a supplementation program to increase the population through use of hatchery-reared fish, fish that have been captured in the lower Columbia River for direct release into the reservoir or other methods recommended through a collaborative effort with relicensing stakeholders represented in a Priest Rapids Fish Forum established as part of the license.
- A Final White Sturgeon Management Plan has been developed by Chelan County PUD for the Rocky Reach Project. The overall goal of this Rocky Reach White Sturgeon Management Plan is to promote white sturgeon population growth in the [Rocky Reach] Reservoir to a level commensurate with the available habitat based on monitoring results. This is to be accomplished by meeting the following objectives: 1) increasing the population of white sturgeon in the Reservoir through implementing a supplementation

program; 2) determining the effectiveness of the supplementation program; 3) determining the carrying capacity of available habitat in the Reservoir; and 4) determining potential for natural reproduction in the Reservoir, then adjusting the supplementation program accordingly. FERC is currently reviewing proposed License conditions and is expected to issue a new License in spring, 2009.

- A Final White Sturgeon Management Plan has been developed by Douglas County PUD for the Wells Project. The goal of the WSMP is to increase the white sturgeon population in the Wells Reservoir to a level that can be supported by the available habitat consistent with its carrying capacity based upon a program involving supplementation activities, monitoring of results, and adjustment to the supplementation program as warranted by the monitoring results. Consistent with the other Mid-Columbia PUDs, Wells is seeking Settlement Agreements with tribal, state and federal resource managers to be included as a part of their new FERC License. These discussions are ongoing, with the new License scheduled to be issued in 2013.

### ***Related Mid-Columbia Projects***

The comprehensive strategic and master planning initiated under the MOA by the Columbia River Inter-Tribal Fisheries Commission (described in this narrative) is designed to address sturgeon management, conservation, and restoration in Federal Columbia River Power System (FCRPS) reservoirs of the mid-Columbia River between Bonneville and Grand Coulee dams. This effort is closely affiliated and complementary to the ongoing sturgeon mitigation and restoration project in Columbia and Snake River reservoirs upstream from Bonneville Dam and the Yakama sturgeon management project (Table 3, Table 4). Restoration needs and alternatives were identified in Phases I and II of the joint agency and tribal Columbia River sturgeon project (BPA #1986-050). Phase I of the CRITFC strategic and master planning project (BPA #2007-155) will involve all management partners in a planning process to provide guidance for further restoration and monitoring actions in the FCRPS portion of the mid-Columbia and lower Snake rivers, including guidance for appropriate usage of hatcheries for sturgeon research or supplementation. Phase I of the Yakama sturgeon management project will provide critical input into the strategic and hatchery master planning process, help determine the potential suitability of tribal hatchery facilities for sturgeon, and facilitate implementation of appropriate hatchery-related measures identified in the strategic and master planning process. Guidance in the strategic and master plans will be incorporated into Phase III of the joint Columbia River sturgeon project and further work by the Yakama sturgeon management project.

**E. Project history (for ongoing projects)**

This project is being treated as a new project. However, this project essentially restores funding to continue and expand upon the hatchery evaluation work initiated under BPA project 1986-050. Previous hatchery evaluation efforts under BPA project 1986-50 were suspended in 2003 due to funding limitations.

**Table 3. Relationship to existing projects**

<b>Funding Source</b>	<b>Project #</b>	<b>Project Title</b>	<b>Relationship (brief)</b>
BPA	1986-050-00	White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam	<ul style="list-style-type: none"> <li>• Research and monitoring in this long-term effort is the basis for identification of the need for further hatchery evaluations</li> <li>• The next phase of this project is expected to incorporate research, monitoring and evaluation components as appropriate for any future hatchery experiments or supplementation actions</li> </ul>
BPA	2007-155-00	Comprehensive strategic and master plan for conservation, management and restoration of impounded sturgeon in the mid-Columbia and lower Snake Rivers	<ul style="list-style-type: none"> <li>• This project will clarify the suitability and role of hatchery sturgeon, and develop detailed master and implementation plans for hatchery actions and evaluations as appropriate.</li> <li>• This work will guide Phase II of the YIN sturgeon management project and Phase III of the White sturgeon mitigation and restoration project.</li> </ul>
Yakama Nation	--	Cost sharing with revenue from the Grant County Relicensing agreement	<ul style="list-style-type: none"> <li>• Discretionary tribal funds will be used to support a portion of this work</li> </ul>
Mid-Columbia PUDs	--	White Management Plan for the Priest Rapids Project (Implementation)	<ul style="list-style-type: none"> <li>• Hatchery development and evaluation activities for will be coordinated between FCRPS and PUD portions of the system</li> </ul>

**Table 4. Phasing of implementation schedule for related mid-Columbia River sturgeon research, monitoring, and restoration projects.**

Columbia River Sturgeon ODFW, WDFW, CRITFC, USGS (BPA #1986-050)		Strategic & Master Planning CRITFC (BPA 2007-155)	Sturgeon Management Project Yakama Nation (BPA 2008-455-00)
1986-1991	<u>Phase I</u> Research tools & methods Status in lower mid-Columbia Habitat requirements & limitations Loss assessment Restoration alternatives		
1991-2008	<u>Phase II</u> Status in upper mid-Columbia & lower Snake Monitor lower mid-Columbia populations Optimize fishery management Evaluate flow requirements Evaluate transplants Pilot hatchery feasibility research		
2009-2010	Strategic planning to refine Phase III approach	<u>Phase I</u> Comprehensive Strategic Plan Master Planning Process (Step I) Policy review, production objectives, genetics management plan, evaluate site & operation alternatives, conceptual design, coordinated implementation & evaluation schedule	<u>Phase I</u> <sup>a</sup> Strategic Planning Refine expertise & methodology Identify facility requirements & costs Implementation plan for production (as appropriate) Development of research/monitoring/evaluation
2011-2018	<u>Phase III</u> To be determined based on outcome of Phase I & comprehensive strategic planning process	<u>Phase II</u> Master Planning Steps 2 (preliminary design) & 3 (final design & review) if appropriate <u>Phase III</u> Implementation monitoring and evaluation	<u>Phase II</u> <sup>a</sup> To be determined based on outcome of Phase I & comprehensive strategic planning process

<sup>a</sup> May also involve cooperative efforts with mid-Columbia Public Utility Districts.

**F. Proposal biological/physical objectives, work elements, methods, and metrics**

The long-term goal of this project is to facilitate restoration of productive, viable sturgeon populations and fishery opportunities in Federal Columbia River Power System portions of the mid-Columbia and lower Snake river reservoirs.

***Related to all Objectives (1-5):***

Work Element 119: Manage and Administer Projects - Task 0.1

This will include project administration, internal coordination, and contract development. Annual work statements, budgets, and property inventories will be submitted to the BPA COTR.

*Methods:* NA

*M&E:* Implementation/Compliance (metrics: milestones met, yes or no)

Milestone	Start date	End date	Description
A. Funding package – internal review	8/15/2009	9/30/2009	30 day internal review period
B. Accrual – BPA submission		9/10/2009	Estimate of contract work that will occur prior to Sept but will not be billed until Oct 1 or later
C. Funding package – BPA submission		10/1/2009	Delivered to the COTR

Work Element 185: Produce Pisces Status Report - Task 0.2

The Contractor will report on the status of milestones and deliverables in Pisces. Reports will be completed either monthly or quarterly as determined by the BPA COTR. Additionally, when indicating a deliverable milestone as COMPLETE, the contractor will provide metrics and the final location (latitude and longitude) prior to submitting the report to the BPA COTR.

*Methods:* NA

*M&E:* Implementation/Compliance (metrics: milestones met, yes or no)

Milestone	Start date	End date	Description
A. Jan-Mar 2009		4/15/2009	
B. Apr-Jun 2009		7/15/2009	
C. Jul-Sep 2009		10/15/2009	
D. Oct-Dec 2009		12/31/2009	

Work Element 132: Produce (Annual) Progress Report - Task 0.3

The progress report will summarize the project objectives, hypotheses, completed and uncompleted deliverables, problems encountered, lessons learned, and long term planning. Examples of long-term planning include future improvements, new directions, or level of effort for contract implementation, including any ramping up or ramping down of contract components or of the project as a whole. Date range will be agreed upon by the COTR and the contractor and may or may not coincide with the contract period.

*Methods:* NA

*M&E:* Implementation/Compliance (metrics: milestones met, yes or no)

Milestone	Start date	End date	Description
A. Draft report for internal review		11/1/2009	Progress and results through Oct of contract year
B. Final report		12/31/2009	

***Objective 1. Complete a collaborative and comprehensive strategic plan for sturgeon conservation, restoration and management to include specific objectives, strategies, actions, milestones and schedules for habitat protection and restoration, natural production, hatchery production, fishery management, research, monitoring, and evaluation.***

A strategic planning process for mid-Columbia and lower Snake River sturgeon will be organized and facilitated by the CRITFC. This process will include a 2009 workshop of regional fish management tribes and agencies to refine objectives, strategies, measures, and near-term (10-year) implementation schedules and responsibilities for sturgeon conservation, management, and restoration in the mid-Columbia and lower Snake Rivers. This work will include a thorough risk assessment for potential future use of sturgeon including elements identified in **Table 5**. The product of this effort will be a written strategic plan that represents a consensus of the regional sturgeon managers.

Work Element 189: Regional coordination – Task 1.1. Strategic Planning Workshop

A comprehensive strategic and master planning process including attendance at a 2-day planning workshop. Our initial intent is to undertake this workshop under the auspices of the Columbia Basin Fish and Wildlife Authority and to conduct an inclusive process. Part 1 of the workshop would include a series of presentations of a brief oral (Powerpoint) summaries of past and planned project work. Presenters would provide brief written summaries for inclusion in the workshop proceedings and electronic copies of pertinent references. Part 2 of the workshop would involve a facilitated planning process to identify and discuss potential alternative conservation, restoration and management objectives, strategies, etc. These discussions would form the basis for development of an initial draft of a strategic plan for further review and consideration. The workshop would also review pending results of a prior CBFWA regional workshop on sturgeon research needs, identify priorities for additional research developed from the CBFWA research needs workshop, and incorporate research priorities into the strategic plan.

*Methods: A small organizational team would be convened to guide work shop development. Invitations to the organizational team be include representatives from the Inter-Tribal Fish Commission, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, U.S. Geological Survey Biological Resources Division, Bonneville Power Administration, and the Columbia Basin Fish and Wildlife Authority with a background and interest in mid-Columbia sturgeon issues. This group would further define the scope, format, and participation of the workshop and would subsequently be expected to participate on a larger strategic planning team.*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. Meeting of Organizational Team		February 2009	Schedule to be finalized
B. Engage facilitator		March 2009	
C. Format & schedule		March 2009	
D. Conduct Workshop		April 2009	
E. Draft proceedings		April 2009	Documents presentation & notes for future use
F. Participant review of draft		May 2009	
G. Final proceedings		May 2009	

**Table 5. Example performance standards and indicators to be considered in a formal risk analysis of any potential future sturgeon hatchery programs.**

<i>Performance Standard</i>	<i>Type</i>	<i>Performance Indicator</i>
<b>1. Maintain natural production potential of adult sturgeon population</b>	<b>Benefit</b>	Gradual increase in population size and age composition as a result of recruitment of hatchery fish: <i>Proportion of the size/age cohort contributed by hatchery</i> <i>Number of hatchery-reared fish by life stage including maturity</i> <i>Individual growth rates &amp; condition factors</i> <i>Size &amp; age specific survival rates</i> <i>Relative distribution and habitat use patterns of wild &amp; hatchery fish</i>
<b>2. Conserve genetic &amp; life history diversity</b>	<b>Benefit</b>	Retention of wild sturgeon life history characteristics and genetics by the hatchery reared population <i>Spawning matrices to maximize diversity</i> <i>Minimum effective population size</i> <i>Haplotype and genotype frequencies in hatchery broodstock &amp; progeny</i> <i>Balanced contributions of family groups</i> <i>Individual and population attributes as in #1 above.</i>
<b>3. Research natural production limitations</b>	<b>Benefit</b>	Understanding of the life history characteristics and factors limiting natural recruitment <i>Estimated natural cohort size relative to known hatchery release number</i> <i>Rearing bottlenecks between YOY and adult</i> <i>Effects of contaminants on development, survival, &amp; growth</i> <i>Habitat capacity</i>
<b>4. Increase effectiveness &amp; reduce costs</b>	<b>Benefit</b>	Adaptive approach to achieve results while reducing process, administrative overhead, & operation costs <i>Complete planning and review processes and move to multi-year funding schedule with check points</i> <i>Adapt size and time of release for maximum benefits and minimum risks</i> <i>Marking methods to distinguish hatchery and natural fish</i> <i>Larval release experiments if appropriate</i>
<b>5. Avoid broodstock mortality</b>	<b>Risk</b>	Additional mortality does not speed population decline <i>Mortality rate of broodstock in hatchery &amp; after release</i> <i>Sustainable recruitment of natural broodstock through fisheries</i>
<b>6. Do not exceed carrying capacity</b>	<b>Risk</b>	No significant density-dependent trend in growth, condition, or behavior of wild or hatchery sturgeon <i>Individual and population characteristics as in #1 above</i>
<b>7. Avoid disease transfer</b>	<b>Risk</b>	Minimal incidence of disease in the facility <i>Appropriate spawning &amp; rearing practices &amp; densities</i> <i>Rigorous disease testing protocols</i> <i>Rear disease-free trout for bait and broodstock feeding</i>
<b>8. Minimize behavioral or genetic impacts</b>	<b>Risk</b>	Avoidance of selective hatchery practices <i>Effective spawner population sizes</i> <i>Non-selective mating &amp; grading protocols</i> <i>Limited behavioral changes that could cause differential post-release mortality</i>

Work Element 174: Produce Plan – Task 1.2. Draft Strategic Plan Review & Comment

A strategic plan will be developed based on direction from a Strategic Planning Team that includes representatives from all tribes and agencies with management authority or a related responsibility or interest. The make-up of this team has not been determined at this time but will be initiated by the workshop organizational team. Involvement of the public and other stakeholders also remains to be determined. The Strategic Planning Team will implement an iterative plan development process involving preparation, review, and revision of a draft plans culminating in the preparation of a final version intended to guide mid-Columbia sturgeon activities over at least the next 10-year period. The scope and depth of the plan will be determined as part of the outcome of the process.

*Methods: This project will provide the resources to facilitate the completion of the strategic plan including a technical write*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. Strategic Planning Team kickoff meeting		May 2009	Involves plan development team
B. Plan outline & guidance		May 2009	
C. Prepare draft plan			
D. Co-manager Review		Sep 2009	repeat as needed
E. Revisions as directed		Oct 2009	Repeat as needed
F. Final review meeting		Nov 2009	
G. Final Strategic Plan		Dec 2009	

Work Element 183: Produce Journal Article – Task 1.3. Symposium Article

A summary of the strategic plan including the history of activities and the technical basis for proposed actions is targeted for publication in the scientific literature as a case history. This publication will be prepared for inclusion in the proceedings of the 2009 International Sturgeon Symposium to be held in Wuhan China.

*Methods: The CRITFC administrator will make a presentation to the symposium and prepare a publication for the proceedings.*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. ISS Meeting		Oct 2009	
B. Draft Publication		Dec 2009	
C. Final Version for Publication		Mar 2010	

**Objective 2. Complete a sturgeon hatchery review process to implement hatchery-related actions (if any) identified in the comprehensive strategic plan and consistent with direction the Northwest Power and Conservation Council three-step review process.**

The Mid-Columbia Sturgeon Strategic Plan completed under objective 1 will clarify hatchery needs and objectives based on a comprehensive analysis of tradeoffs between potential benefits and risks. As appropriate based on this guidance, CRITFC will develop a hatchery master plan consistent with the Northwest Power and Conservation Council 3-step process. This process will guide consideration, definition, drafting and review of hatchery development plans from specification of production objectives through consideration of production alternatives to completion of a detailed final plan. Stages in this process are used by decision makers to ensure scope, intent, and accuracy of cost.

As the project develops from conceptual to final design, more detail and understanding is generated for analysis. A variety of alternative programs, facilities, and sites might be considered. At this point, no specific sturgeon hatchery facility concepts or plans have been identified. The hatchery master planning process will involve a detailed review of hatchery alternatives and programs that are consistent with the strategic needs and objectives. Alternative might include adaptation of existing an existing facility, expansion of an existing facility, or construction of a new facility. A plan will be distilled from these alternatives based on real world considerations of feasibility, efficacy, and cost guided by the experience of other successful sturgeon conservation hatchery programs in the basin.

Work Element 168: Council 3-step Process: Step 1 – Task 2.1. Conceptual Plan Coordination

Step 1 is the conceptual/preliminary phase of the master planning process. This step will involve policy review, development of specific production objectives, completion of genetics management plan, evaluations of site and operational alternatives, conceptual design, layout and cost estimate based on a feasibility/concept design, and development of a coordinated implementation & evaluation schedule. The key products needed for a Council Decision are: 1) a program master plan and 2) an initial facility layout and cost estimate. This work element is a planning/coordination function that is broken out under a discrete work category because it is a unique feature of the F&W Program and needs to be tracked separately. This work element captures the labor and materials associated with coordinating the Step 2 process. It does not include any work associated with creating or revising any of the required documents.

*Methods:* Included are coordination activities required for submission of documents, responding to Council/ISRP questions, developing and providing additional materials, attending meetings with Council/ISRP, and making appropriate revisions, etc.

*M&E:* Implementation/Compliance (metrics: milestones met, yes or no)

Milestone	Start date	End date	Description
A. Initial kick-off meeting	1/1/2010	1/30/2010	involving stakeholders
B. Engage design consultant	1/1/2010	1/30/2010	
C. Master plan completed	1/1/2010	10/30/2010	from WE #174, Produce Plan
D. Cost Estimate prepared	1/1/2010	7/30/2010	from WE #175, Design and/or Specifications
E. Submittal package delivered to Council	TBD		
F. Council/ISRP comments received	TBD		
G. Revision/edits/additional planning	TBD		

work completed			
H. Revised package submitted to Council	TBD		
I. Council approves/rejects	TBD		proceeding to Step 2

**Work Element 174: Produce Plan – Task 2.2 Master Plan Development**

Preparation of the Hatchery Master Plan suitable for Council Step 1 review. The master plan will include descriptions of: 1) relationship and consistencies of the proposed project to the scientific principles identified in the 2000 Columbia River Basin Fish and Wildlife Program; 2) linkage to other projects and activities in the subbasin and the desired end-state condition for the target subbasin; 3) biological objectives; 4) expected project benefits; 5) implementation strategies; 6) relationship to basin-wide habitat strategies; 7) alternative measures that were considered for resolving the resource problem including relative cost effectiveness; 8) historical and current status of the species; 9) current and planned management of the species; 10) consistency of the proposed project with NMFS recovery plans and other fishery management and watershed plans; 11) status of the comprehensive environmental assessment; 12) monitoring and evaluation plan; 13) specific items and cost estimates for ten Fiscal years for planning and design (conceptual, preliminary, final), construction, operation, maintenance, monitoring, and evaluation; 14) the relation and link to Council Program artificial production policies and strategies; 15) a completed Hatchery and Genetic Management Plan; 16) a harvest plan; and 17) a conceptual design of the proposed strategies and/or facilities, including an assessment of the availability and utility of existing facilities.

*Methods: This work element includes actual preparation of the required documents for submitted in the Step 1 Review. Document contents will follow the NPCC's requirements under their 2001 Step Document, Section V., Elements A&B (<http://www.nwcouncil.org/LIBRARY/2001/2001-29.pdf>).*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
D. Initial scoping meeting	1/1/2010	1/30/2010	Involves plan development team
E. Prepare draft Master Plan	2/1/2010	5/30/2010	
F. Co-manager Review meeting	6/1/2010	6/30/2010	
G. Revisions as directed	7/1/2010	7/30/2010	
H. Final review meeting	8/1/2010	8/30/2010	
I. Final Master Plan		10/30/2010	

**Work Element 175: Produce Design and/or Specifications – Task 2.3. Conceptual/Preliminary Design**

Preparation of conceptual design elements of the Hatchery Master Plan suitable for Council Step 1 review. Step I is the feasibility stage which identifies all major components and elements and includes initial attempts at laying out the components on the chosen site or proposal. This work element covers all work associated with the preparation of engineering or technical drawings, specifications and/or budgets required for the construction/installation of structures or facilities. Identification and evaluation of alternative facility proposals is an important part of this step, including an assessment of the availability and utility of existing facilities. The Conceptual/Preliminary design phase completed under Step 1 is expected to produce estimates within a variance of plus or minus 35-50%.

*Methods: Approximate structure size and layouts are presented, with rough plans and elevations, general electrical and piping layouts are identified, but with little*

*detail. Cost estimates are general and often based on costs from previous projects and comparable construction costs.*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. Initial scoping meeting	1/1/2010	1/30/2010	Involves plan development team
B. Identify critical facility elements	2/1/2010	2/30/2010	Common to sturgeon facility need
C. Identify facility alternatives	3/1/2010	3/30/2010	Options for adapting existing or developing new facilities
D. Alternative review & selection	4/1/2010	4/30/2010	Concept approval by plan development team
E. Draft Conceptual design	5/1/2010	5/30/2010	Descriptions, diagrams & drawings
F. Concept review	6/1/2010	6/30/2010	Involves plan development team
G. Final Conceptual design	7/1/2010	7/30/2010	
H. Example specifications	7/1/2010	7/30/2010	
I. Example cost estimates	7/1/2010	7/30/2010	Including cultural surveys, permitting, construction, and M&E

**Work Element 169: Council 3-step Process: Step 2 – Task 2.4. Progress Review Coordination**

Step 2 is the progress review phase of the master planning process. This step will identify any major difficulties in the design and proposal. At this point, the proposal provides the detail and specifics to meet the intent and scope of the previous decision and ensure financial responsibility. For step 2, the key documents needed for a council decision are: 1) NEPA and ESA review, and 2) preliminary design leading to a more refined facility plan and cost estimate. This work element is a planning/coordination function that is broken out under a discrete work category because it is a unique feature of the F&W Program and needs to be tracked separately. This work element captures the labor and materials associated with coordinating the Step 2 process. It does not include any work associated with creating or revising any of the required documents.

*Methods: Includes activities necessary to coordinate the progress review include submitting required documents, responding to Council/ISRP questions, developing and providing additional materials, attending meetings with Council/ISRP, and making appropriate revisions, etc.*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. Initial kick-off meeting	1/1/2011	1/30/2011	involving stakeholders
B. NEPA/ESA documentation completed	1/1/2010	4/30/2011	from WE #165, Produce Plan
C. Cost Estimate prepared	1/1/2010	4/30/2011	from WE #175, Design and/or Specifications
D. Submittal package delivered to Council	TBD		
E. Council/ISRP comments received	TBD		
F. Revision/edits/additional planning work completed	TBD		
G. Revised package submitted to Council	TBD		
H. Council approves/rejects	TBD		proceeding to Step 3

**Work Element 175: Produce Design and/or Specifications – Task 2.5. Preliminary design**

This work element covers all work associated with the preparation of a preliminary design including engineering or technical drawings, specifications and/or budgets required for the construction/installation of structures or facilities based on the results of step I review of the

conceptual design. The design phase completed under Step 2 is expected to produce estimates within a variance of plus or minus 25-35%.

*Methods: Detailed structure size and layouts are presented, with plans and elevations, general electrical and piping layouts are identified, etc. Cost estimates are developed from the conceptual design. May include ancillary work such as land surveying, photogrammetric surveys, field surveys, etc.*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. Initial scoping meeting	1/1/2011	1/30/2011	Involves plan development team
B. Draft preliminary design	2/1/2011	2/30/2011	Descriptions, diagrams & drawings
C. Design review	3/1/2011	3/30/2011	Involves plan development team
D. Complete preliminary design	4/1/2011	4/30/2011	
E. Preliminary specifications	4/1/2011	4/30/2011	
F. Preliminary cost estimates	4/1/2011	4/30/2011	Including cultural surveys, permitting, construction, and M&E

#### Work Element 165: Produce Environmental Compliance Documentation – Task 2.6. Preliminary Design Phase

Covers any work by the Contractor to assemble, gather, acquire, or prepare documents in support of obtaining environmental compliance from BPA, providing maps, drafting a Biological Assessment, obtaining permits, conducting public involvement activities, completing an archaeological survey, etc.). Needs specific to this project will be identified by BPA's Environmental Compliance Lead. National Environmental Policy Act (NEPA) coverage for this work element will be identified by BPA's Environmental Compliance Lead. Endangered Species Act (ESA) consultation is typically not required for at the master plan development and conceptual design phase of this work element. National Historic Preservation Act (NHPA) Section 106 consultation is typically not required for this work element. Public involvement is typically not required for this work element.

*Methods: Documentation and assistance will be provide to support BPA's Environmental Compliance Group (such as maps, design drawings, survey reports, permit applications, ESA documents, etc.) as directed.*

*M&E: Implementation/Compliance (metrics: milestones met, yes or no)*

Milestone	Start date	End date	Description
A. Identify needs	1/1/2011	1/30/2011	from BPA's Environmental Compliance Lead
B. Provide compliance documents	1/1/2011	4/30/2011	as directed
C. Verify completion of EC requirements		4/30/2011	

#### Work Element 170: Council 3-step Process: Step 3 – Task 2.7. Final Design Coordination

Step 3 of the NPCC's 3-step process is the 'final design' phase of the process. These activities include submitting required documents, responding to Council/ISRP questions, developing and providing additional materials, attending meetings with Council/ISRP, and making appropriate revisions, etc. For step 3, the key documents needed for a Council decision are: 1) 100% design plans and specifications and 2) a 100% cost estimate, with a 10-15% contingency. This work element is a planning/coordination function that is broken out under a discrete work category because it is a unique feature of the F&W Program and needs to be tracked separately. This work element captures the labor and materials associated with coordinating the Step 3 process. It does

not include any work associated with creating or revising any of the required documents. See Related Work Elements section, on the work element background page.

*Methods:* Includes activities necessary to coordinate the progress review include submitting required documents, responding to Council/ISRP questions, developing and providing additional materials, attending meetings with Council/ISRP, and making appropriate revisions, etc.

*M&E:* Implementation/Compliance (metrics: milestones met, yes or no)

Milestone	Start date	End date	Description
A. Initial kick-off meeting	TBD		involving stakeholders
B. NEPA/ESA documentation completed	TBD		from WE #165, Produce Plan
C. Final Design completed	TBD		from WE #175, Design and/or Specifications
D. Submittal package delivered to Council	TBD		
E. Council/ISRP comments received	TBD		
F. Revision/edits/additional planning work completed	TBD		
G. Revised package submitted to Council	TBD		
H. Council approves/rejects	TBD		proceeding to construction

#### Work Element 175: Produce Design and/or Specifications – Task 2.8. Final Design

This work element covers all work associated with the preparation of a final design including engineering or technical drawings, specifications and/or budgets required for the construction/installation of structures or facilities based on the results of step I review of the conceptual design.

*Methods:* Detailed structure size and layouts are presented, with plans and elevations, general electrical and piping layouts are identified, etc. Cost estimates are developed from the preliminary design. May include ancillary work such as land surveying, photogrammetric surveys, field surveys, etc.

*M&E:* Implementation/Compliance (metrics: milestones met, yes or no)

Milestone	Start date	End date	Description
A. Initial scoping meeting	TBD		Involves plan development team
B. Draft final design	TBD		Descriptions, diagrams & drawings
C. Final internal review	TBD		Involves plan development team
D. Complete final design	TBD		
E. Complete final specifications	TBD		
F. Complete final estimates	TBD		Including cultural surveys, permitting, construction, and M&E

***Objective 3. Facilitate, monitor and evaluate implementation of appropriate hatchery actions in collaboration with other regional sturgeon conservation, management, and restoration projects.***

At such time as any sturgeon hatchery development efforts transition to through the construction and implementation phases, this MOA project will transition to the research, monitoring and evaluation activities for the restoration program. Details of this monitoring effort will be developed in the strategic and master plans completed under objectives 1 and 2. Methods and milestones will be further developed in work plans prior to initiation of this phase of the project.

Work Element 156: RM&E and Data Management – Task 3.1. Develop RM&E Methods and Designs

Work to identify and/or develop monitoring methods, designs, or tools based on the RM&E plan identified in the Hatchery Master Plan. Includes statistical and sampling designs; standard sampling protocols and data definitions; conceptual or simulation models; software development; tagging and other monitoring equipment; and generally any other work that prepares for the implementation of actual data collection/generation.

Work Element 157: RM&E and Data Management – Task 3.2. Collect/Generate/Validate Field and Lab Data

Work to collect, create, generate, or capture source data. Includes developing field manuals of sampling and data collection procedures; collecting new empirical data; entering data into a computer spreadsheet/database; developing automated data capture programs/routines and related hardware/software (e.g., PDAs, data loggers, thermographs); preparing metadata; and quality assurance/quality control processes. Includes any preparations for collecting data if not covered by another work element. This work element covers both the collection of field samples/specimens (e.g., tissue, macroinvertebrate, or water quality samples) and the subsequent laboratory analyses of field samples/specimens.

Work Element 162: RM&E and Data Management – Task 3.3. Analyze/Interpret Data

These activities apply analytical tools to render meaning from data for making better management decisions. They go beyond data summaries. Often involving tests of statistical significance, this work element also may include modeling, indices, and synthesis. Typically culminates in resource management recommendations presented in a report of research/evaluation findings or analyses presented as formal publications.

Work Element 132: Reporting – Task 3.4. Produce (Annual) Progress Report

This work element covers written reports of results that typically are submitted to BPA at the end of a contract period for dissemination to the public. These progress reports may cover less than a year or multiple years. They are not required or appropriate for all contracts in all years, but are particularly important when useful results are not captured by standard Pisces metrics or status reports. "Technical" reports will be used to describe RM&E Methods and Designs (WE# 156), analysis and interpretation of data (WE#1 56), and collection, generation and validation of substantial amounts of data when it is important also to report the data collection methods. Technical progress reports will use a scientific format.

## **G. Facilities and equipment**

This is fundamentally a planning project, will be conducted in an office setting, and will require no specialized facilities or equipment. The project could potentially identify the need for development of sturgeon a production facility as part of the strategic planning process. Step One of the Hatchery Master Planning Process initiated by the CRITFC will consider alternatives and provide guidance for facility development as appropriate.

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## I. Key personnel

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Project Leader	<p>Blaine Parker</p> <p>Columbia River Inter-Tribal Fish Commission 729 NE Oregon, Suite 200 Portland OR 97232 (503) 238-0667 <a href="mailto:PARB@critfc.org">PARB@critfc.org</a></p>
FTE:	<p>Initially set at 0.08 (1month) FTE for 2009, with anticipated increases in successive out years.</p>
Qualifications:	<p><u>Education</u> <i>B.S. in Fish and Wildlife Management, 1985, Montana State University</i> <i>M.S. in Zoology 1990, Idaho State University</i></p> <p><u>Employment</u> <i>United States Forest Service, Mt. Hood National Forest, 1989-1991</i> <i>Columbia River Inter-Tribal Fish Commission, March , 1991-Present.</i> <i>White Sturgeon Project Manager 1993-Present</i> Multifaceted management and research responsibilities on white sturgeon for the Commission, including but not limited to; stock assessments, fishery monitoring, research, and management, supplementation research, disease investigations, ghost net removals, as well as planning and restoration efforts</p>
Duties	<p>Commission Lead with regard to White Sturgeon Management /Research efforts in Zone 6 since 1994. Additional past primary duties/activities also research/management efforts with Pacific lamprey, ghost nets, and invasive species.</p>
Related projects & publications	<p>Author/Co-author on numerous project reports including mid-Columbia sturgeon research and mitigation project (BPA #1986-50) since 1994</p> <p>Participation on regional forums for white sturgeon (Sturgeon Management Task Force), invasive species prevention and management (Oregon Invasive Species Council Member 2002-04)</p> <p>Numerous presentations at state and regional AFS meetings on white sturgeon, Pacific lamprey, and invasive species.</p> <p>Kappenman, K.M. and B.L. Parker. 2007. Ghost nets in the Columbia River: Methods for locating and removing derelict gill nets in a large river and an assessment of impact to white sturgeon. <i>North American Journal of Fisheries Management</i> 27:804-809.</p>

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Consulting Scientist	<p>Ray Beamesderfer</p> <p>Cramer Fish Sciences 600 NW Fariss Road Gresham OR 97030 503.491.9577 PHONE <a href="mailto:beamesderfer@fishsciences.net">beamesderfer@fishsciences.net</a></p>
FTE:	0.25
Qualifications:	<p><u>Education</u> <i>B.S. in Wildlife &amp; Fisheries Biology 1979, University of California, Davis.</i> <i>M.S. in Fishery Resources 1983, University of Idaho</i></p> <p><u>Employment</u> <i>Cramer Fish Sciences, Senior Fish Scientist, 2000-Present.</i> Completion of a wide variety of fishery management, biological assessment, and conservation or recovery planning projects for State and Federal Agencies, Indian Tribes, Private Industry, and Non-Governmental Organizations.</p> <p><i>Oregon Department of Fish and Wildlife, Fish Biologist, 1983-2000.</i> Management biologist for Columbia River salmon and sturgeon fisheries; staff analyst and agency representative for inter-jurisdictional Columbia River salmon, resident fish, and hydropower issues; and program and project leader for research including mid-Columbia sturgeon.</p>
Duties	Master planning team leader & lead writer
Related projects & publications	<p>Upper Columbia River white sturgeon recovery plan. 2002. Spokane Tribe of Indians, British Columbia Ministry of Water, Land and Air Protection, and BC Hydro Corporation. Chief writer.</p> <p>Upper Columbia sturgeon hatchery release strategy. 2008. British Columbia Ministry of Environment and BC Hydropower. Analysis &amp; recommendations.</p> <p>Kootenai River white sturgeon conservation aquaculture program monitoring, evaluation, and reporting. 2000-present. Kootenai Tribe of Idaho.</p> <p>Hatchery genetic management plans for the Oregon Department of Fish and Wildlife Sandy and Clackamas River Hatcheries (2005) and for the Kootenai Tribal Sturgeon Hatchery. Writer.</p> <p>Lower Columbia salmon and steelhead recovery plan. 2002-2004. Washington Lower Columbia River Fish Recovery Board. Chief Scientist, Lead writer.</p> <p>Kootenai River Burbot conservation plan. 2004. Kootenai Tribe of Idaho. Chief writer.</p> <p>Author or co-author of 14 scientific articles on sturgeon biology, status management, and hatchery evaluations.</p>

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