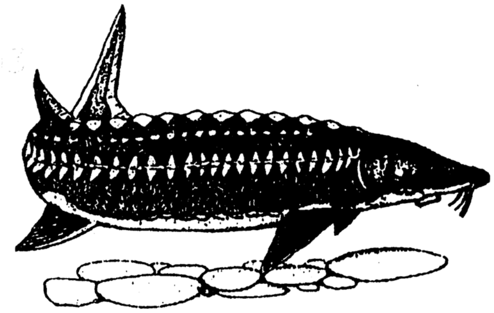


HATCHERY AND GENETIC MANAGEMENT PLAN

Hatchery Program:
White Sturgeon Conservation Aquaculture

Species or Hatchery Population/Strain:
Kootenai River White Sturgeon

Agency Operator:
Kootenai Tribe of Idaho

Watershed and Region:
Kootenai / Mountain Columbia

Date Submitted: 12/15/2000

Date Last Updated: 12/15/2000

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.
Kootenai Tribe of Idaho White Sturgeon Conservation Hatchery

1.2) Species and population (or strain) under propagation, ESA/population status.
White sturgeon (*Acipenser transmontanus*) ESA endangered (9/6/94)

1.3) Responsible organization and individuals

Name (and title):	***Susan Ireland Biologist/Administrator (lead contact)***
	John Siple Hatchery Manager (on-site operations lead)
Agency or Tribe:	***Kootenai Tribe of Idaho***
Address:	***P.O. Box 1269, Bonners Ferry, Idaho 83805***
Telephone:	***(208) 267-3620***
Fax:	***(208) 267-1131***
Email:	***ireland@kootenai.org***

Other agencies, Tribes, co-operators, or organizations involved, including contractors, and extent of involvement in the program:

The Kootenai Tribe of Idaho (KTOI) administers and operates the hatchery program and conducts monitoring and evaluation studies. Hatchery monitoring and evaluation is closely integrated with other investigations of Kootenai River fisheries and the ecosystem by the Idaho Department of Fish and Game (IDFG), Montana Department of Fish Wildlife and Parks (MFWP), and the KTOI. The KTOI also subcontracts to the University of Idaho (U of I), College of Southern Idaho (CSI), Idaho Department of Fish and Game, U. S. Fish and Wildlife Service (USFWS), U. S. Geological Survey (USGS), and British Columbia Ministry of Fisheries (BCMF) for technical services including disease and genetic monitoring, cryopreservation research, database management, and facility support.

The Kootenai Sturgeon Hatchery is part of a cooperative sturgeon conservation and recovery program being implemented and coordinated through a white sturgeon recovery team that includes members from the U. S. Fish and Wildlife Service, Kootenai Tribe of Idaho, Idaho Department of Fish and Game, Montana Fish, Wildlife, and Parks, University of Idaho, Army Corps of Engineers (ACOE), British Columbia Ministry of Environment, Land, and Parks (BCMELP), and Canada Department of Fisheries and Oceans (CDFO).

1.4) Funding source, staffing level, and annual hatchery program operational costs.

The Bonneville Power Administration under the Resident Fish Portion of the Northwest Power Planning Council's Fish and Wildlife Program funds hatchery construction, operations, administration, research, and monitoring. Cost sharing is also provided by the Upper Columbia United Tribes, U. S. Fish and Wildlife Service, British Columbia Ministry of Fisheries, U.S. Geological Survey, and Clear Springs Foods in the form of cash or in-kind facilities and services.

Current staff includes the biologist/administrator, the hatchery manager, and five hatchery technicians.

Table 1 summarizes program operational costs. Operation and maintenance costs including personnel and facilities typically average $600,000 to $700,000 per year. The program also includes significant planning and monitoring components, which comprise about 2-4% and 10-25% of the annual budget, respectively. Development of the hatchery program has been implemented in phases with the next scheduled capital construction phase scheduled for 2003-2004. Table 2 contains summary of program development and investments.

Table 1. Projected Fiscal Year 2001 – 2005 budgets.

	FY 2001	FY 2002	FY03	FY04	FY05
Planning and design	50,000	95,000	35,000		
Construction/implementation	164,000	184,000	2,000,000	640,000	400,000
Operations and maintenance	622,375	635,000	650,000	650,000	900,000
Monitoring and evaluation	292,193	316,000	314,000	314,000	314,000
Total	1,128,568	1,230,000	2,999,000	1,604,000	1,614,000

Table 2. Past program investments, milestones, and plans.

Year	Budget	Milestones
1988	$117,653	Program initiated
1989	$156,104	Cooperative sampling with IDFG to capture wild white sturgeon adults
1990	$236,430	Experimental breeding program initiated- Artificial spawning of wild broodstock demonstrated gamete viability
1991	$150,000	Experimental hatchery completed
1992	$179,723	First releases of hatchery-spawned juveniles (from 1991 brood year)
1993	$649,573	Genetic breeding criteria completed, hand stripping of eggs proved successful Monitoring program initiated in wild
1994	$378,553	Second experimental release of hatchery-spawned juveniles
1995	$952,387	Recaptures of hatchery-reared juveniles in river provided initial information about habitat use, movement, and growth of white sturgeon juveniles in the Kootenai River.
1996	$67,356	Disease testing protocols initiated
1997	$566,650	Non-lethal iridovirus test and field collection method for sperm developed Loss of 1997 brood from equipment failure reinforced need for improvements; release of 1995 brood year
1998	$750,000	Began Phase I of facility and water supply upgrades
1999	$1,263,692	"Fail-safe" rearing program initiated at BCMF Kootenay Hatchery
2000	$880,193	Phase I facility and water upgrades completed
2001	$1,128,568	
2002	$1,230,000	
2003	$2,999,000	Phase II upgrades to provide for adequate rearing and alternate water source
2004	$1,604,000	Phase II upgrades to be completed
2005	$1,614,000	
⋮	⋮	⋮
2022		Projected completion date*

** USFWS recovery plan calls for conservation aquaculture program to continue until evidence is available to show that natural reproduction is yielding adequate recruits to sustain the genetic variability of the population.*

Unlike most hatchery programs for salmon and trout, which are based on known techniques and practices developed over many years, the Kootenai sturgeon program is an evolving program that must develop new methods of culture and conservation hatchery practices consistent with its focus on sturgeon preservation. Kootenai River white sturgeon studies by the KTOI were initiated in 1988 and the conservation aquaculture program began in 1991 in response to questions concerning water quality, white sturgeon gamete viability and the feasibility of aquaculture as a component to population recovery. Initial investments were relatively small and the program was expanded, as initial efforts were successful.

Progeny from wild broodstock were successfully produced and reared in the Kootenai Tribal Hatchery in 1991, 1992, 1993, 1995, 1998, 1999, and 2000. The Kootenai River white sturgeon was listed as endangered in 1994 and no broodstock capture or spawning occurred. No sturgeon from the 1996 year class were produced due capture and broodstock quality difficulties related to high spring runoff, cold water temperatures, and take limitations on timing of broodstock collection. This problem was rectified through coordination with USFWS and IDFG, which provided the capability to collect broodstock at more appropriate times and locations. The 1997-year class suffered catastrophic mortality in the hatchery due to unforeseen equipment failure. This problem has been rectified by approval and implementation of a hatchery upgrade that brought the facility up to standard and provided for increased water quality, quantity, and equipment redundancy and the addition of a "fail-safe" facility located within the Kootenay drainage in British Columbia, Canada. There is still a need for increased rearing capacity to provide adequate rearing space for up to 12 families per year as the project becomes fully implemented. Each family group must be reared separate from other family groups to ensure proper identification at outplanting and also must be reared at low densities to prevent disease outbreak (LaPatra et al. 1994). Master plan development was planned for initiation in 1999 for another facility within the Kootenai River drainage to provide adequate rearing space and a separate, reliable water source.

Experimental releases of hatchery-produced white sturgeon occurred in 1992 and 1994 and totaled 305 fish from 1990, 1991, and 1992 year classes. During 1995, 25 hatchery-reared white sturgeon were captured using gill-nets (Paragamian et al. 1995). During 1996, 45 hatchery-reared juveniles were captured in the Kootenai River (Paragamian et al. 1996). The experimental releases provided the first habitat use, movement, survival, and growth information for juvenile white sturgeon in the Kootenai River. Since then, the program has received approval from the USFWS White Sturgeon Recovery Team to become fully implemented and approximately 4,879 white sturgeon juveniles representing 36 family groups have been released into the Kootenai River. Data indicates that sturgeon released at age 1+ are surviving in the Kootenai River. Regular annual releases are now a component of the sturgeon recovery plan.

1.5) Location(s) of hatchery and associated facilities.

The KTOI hatchery is located on the Kootenai River mainstem at River Kilometer 241 near Bonners Ferry, Idaho (Figure 1). The British Columbia Kootenay Sturgeon Hatchery at Fort Steele, B.C. is also used to rear five family groups (from fertilized eggs taken from wild broodstock at the KTOI hatchery) to ensure no catastrophic losses of future year classes. The British Columbia Kootenay Sturgeon Hatchery is located at the confluence of the Bull River and Kootenay River, approximately 44 kilometers southeast of Cranbrook, British Columbia and approximately 136 kilometers upstream of Libby Dam. Both hatcheries are located in the Kootenai River basin (HUC 17010101).

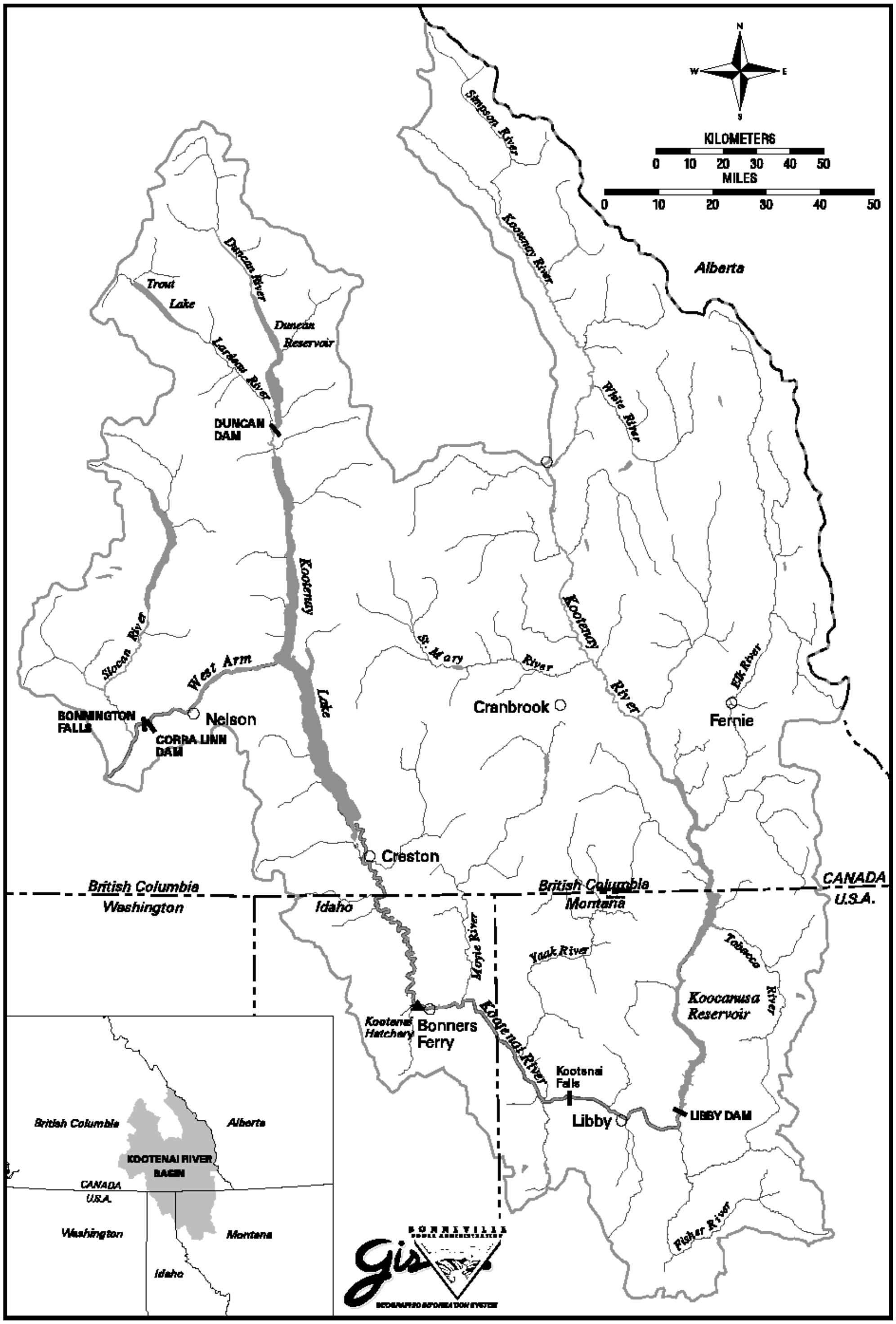


Figure 1. Map of the Kootenai/y drainage.

1.6) Type of program(s).

The KTOI white sturgeon hatchery is an Integrated Recovery Program as defined by criteria prescribed by this template. (*An integrated recovery program is primarily designed to aid in the recovery, conservation or reintroduction of a particular natural population, and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population).* This definition for Kootenai River white sturgeon presupposes that natural spawning conditions for the wild population will be restored by habitat measures.

1.7) Purpose (Goal) of program(s).

The goal of the KTOI white sturgeon hatchery program is to prevent extinction, preserve the existing gene pool, and begin rebuilding healthy age classes of the endangered white sturgeon in the Kootenai River using conservation aquaculture techniques with wild broodstock.

This goal is consistent with the Preservation/Conservation purpose identified in Northwest Power Planning Council Document 99-15. The NPPC defined preservation/conservation based on the need to conserve genetic resources of a very small population at a critical late stage in its decline pending future rebuilding. Populations that require preservation/conservation face imminent demise or extirpation and, in most cases, are listed under the federal Endangered Species Act. The NPPC notes the need for immediate intervention in these emergency situations concurrent with the development of a plan for recovery. The NPPC also cautioned that the duration of the preservation/conservation purpose should be minimized because the longer a population is maintained in the hatchery, the less it will resemble the original naturally producing population in regard to genetics and behavior.

The NPPC suggests that a preservation/conservation purpose requires an explicit recovery plan with a compressed time-frame for return of the fish to the wild and an effective plan for dealing with the underlying habitat or management problem so that the preservation hatchery does not become a museum to preserve fish with uncertain connections to the natural population structure. The U. S. Fish and Wildlife Service published a recovery plan for Kootenai white sturgeon in 1999. This plan recognizes the need to restore critical sturgeon habitat in the Kootenai River and the uncertainty in what habitat measures will be necessary. The recovery plan also includes the KTOI conservation aquaculture program as a critical component of recovery actions.

In addition to preservation/conservation purposes, the KTOI white sturgeon hatchery program also serves a research purpose and could evolve toward restoration, mitigation, or augmentation purposes depending on the success of habitat restoration efforts. Research components involve continued evaluations of hatchery practices consistent with the natural biological system within a strict experimental design. The hatchery program also provides fish for experimental use in estimating natural production rates and in identifying limiting factors. The KTOI hatchery is the pioneer hatchery for producing white sturgeon for use in the wild. Lessons and methods developed in the Kootenai will form the basis for consideration and development of other white sturgeon conservation aquaculture programs in the basin.

Potential use of the KTOI hatchery for restoration or augmentation purposes might feasibly be considered if habitat restoration measures are successful. The NPPC defined restoration as the use of artificial production to speed or "jump-start" recovery of natural populations, especially in order to achieve a harvestable population size. A restoration program assumes a population is reduced or eliminated by habitat degradation or other effects (e.g. overharvest), but that the problem has or is being corrected and the existing biological system is now or will soon be capable of sustaining natural production. The NPPC defines an augmentation program as one, which provides fish in numbers beyond the capability of the natural system, to address a social motivation, such as the desire for harvest greater than the existing natural system, can sustain. It operates within an intact natural system that is functioning at or near its natural capacity in the freshwater juvenile life stage, with excess capacity available at other life stages. It augments natural productivity. If habitat restoration measures do not provide suitable spawning and rearing conditions for white sturgeon in the Kootenai River system, a mitigation or compensation purpose of the hatchery may become appropriate.

1.8) Justification for the program.

The KTOI white sturgeon conservation aquaculture program currently provides the only significant source of recruitment by a unique wild population that has been in decline since the 1960's and has not recruited significant numbers of naturally produced fish since 1974. The naturally produced population now consists almost entirely of mature, older individuals and is gradually declining as fish age and die without replacement. Nearly a decade of augmented river discharge experiments intended to stimulate natural spawning and recruitment have successfully stimulated spawning but have failed to produce natural recruitment (Duke et al. 1999; USFWS 1999; Anders et al. 2000).

The Kootenai River white sturgeon is one of several land-locked populations found in the Pacific Northwest. Their distribution extends from Kootenai Falls, Montana, located 50 river kilometers below Libby Dam, downstream through Kootenay Lake to Cora Linn Dam on the lower west arm of Kootenay Lake, B. C. A natural barrier at Bonnington Falls downstream of Kootenay Lake has isolated the white sturgeon in the Kootenai River from other white sturgeon in the Columbia River since the last glacial age approximately 10,000 years ago (Northcote 1973). This population is believed to have been isolated from other white sturgeon populations in the Columbia River Basin following post-Pleistocene recolonization approximately 10,000 years ago (Northcote 1973, Alden 1953).

The population adapted to natural pre-development conditions of the Kootenai system, which was characterized by frequently large spring freshets, an extensive large-river-floodplain, and delta marshland habitats in the downstream portions of the river upstream from Kootenay Lake. The flood-pulse model of large river-floodplain ecosystems (Junk et al. 1989) suggests that the mosaic of such habitats, as historically present in the Kootenai River, were valuable sources of nutrients required for system productivity. Modification of the Kootenai River by human activities including industrial and residential development, extractive land use practices, floodplain isolation by diking, and construction and operation of a hydropower dam drastically changed the river's natural thermograph and hydrograph (Anders 1991; Anders and Richards 1996; Anders et al. 2000; USFWS 1999; Duke et al. 1999; Apperson and Anders 1991; Partridge 1983). These changes altered white sturgeon spawning, incubation and rearing habitats, changed community structure and species composition across trophic levels, and resulted in depressed biological system productivity (Anders et al. 2000, Anders and Richards 1996; Paragamian 1994; Snyder and Minshall 1996).

The Kootenai River white sturgeon population has been in decline since the mid-1960's (Duke et al. 1999; USFWS 1999). Population size was first estimated to be 4,000 to 6,000 individuals (Graham 1981). Partridge (1983) estimated population size to be 1,148 fish (50-224 cm TL; 95 %CI 907-1503) using tag recovery data from 1979 through 1981,. In 1990, the population was estimated to include 880 individuals (88-274 cm TL; 95% CI 638-1,211; Apperson and Anders 1991). The 1990 estimate was not statistically different from the previous estimate of 1,148, although different sampling areas and protocols confounded interpretation (Giorgi 1993). Most recently, in 1997, the population was estimated to contain 1,468 individuals (95% CI 740-2197, Paragamian et al. 1997).

Natural recruitment failure in this population was first reported in the early 1980's (Partridge 1983). Reconstruction of year-class strength from sturgeon age composition has confirmed that the last substantial year-class was produced in 1974, which was the year prior to operation of Libby Dam. The dam impounds the Kootenai River near Libby, Montana, forming Lake Koocanusa. Construction and operation of Libby Dam has drastically altered the hydrograph, thermograph, and downstream nutrient loading rates in the Kootenai River. Hypothesized causes of natural reproduction and recruitment failure have included post-impoundment thermal and physical habitat alterations, limited gamete viability due to exposure to contaminants in the river, egg and fry mortality due to suffocation, predation and food limitation, and over winter mortality due to habitat loss or food limitation (Anders 1991, Apperson and Anders 1991; Anders 2000; USFWS 1999; Kruse 2000).

Research since 1991 has confirmed natural spawning in eight of the past nine years but juvenile survival has been extremely limited. Hundreds of fertilized and developing eggs have been collected from the Kootenai River under a range of post-impoundment hydrograph and thermograph conditions in all years except 1992 (USFWS 1999). However, nine years of sampling found only 16 naturally recruited white sturgeon (or about 1% of the population) that were 21 years of age or less (Paragamian et al. 1995). Because white sturgeon do not begin reproducing until approximately age 20, this means that the equivalent of one full generation in the white sturgeon life cycle has been lost.

The white sturgeon population in the Kootenai River was listed as endangered on September 6, 1994 (59 FR 45989) under the U. S. Endangered Species Act and a recovery plan was completed in 1999. Recovery will be contingent upon re-establishing natural recruitment, minimizing additional loss of genetic variability to the population, and successfully mitigating biological and physical habitat changes caused by the construction and operation of Libby Dam. The overall recovery strategy for the white sturgeon in the Kootenai River takes a three-pronged approach (USFWS 1998). Priority 1 actions for immediate implementation include: 1) flow augmentation to enhance natural reproduction; 2) the conservation aquaculture program to prevent extinction; and 3) restoration of suitable habitat conditions to increase the chances of white sturgeon survival past the egg/larval stage.

We do not know why white sturgeon recruitment continues to fail or what habitat changes are required to solve this problem. Flow augmentation has not yet created favorable survival conditions, and other habitat bottlenecks may also exist. Barring some unforeseen habitat miracle, the hatchery provides the only means to conserve the native genetic material, begin rebuilding a healthy age class structure, and prevent extinction. If future measures fail to re-establish suitable habitat conditions, the hatchery program may be the only long-term recourse for preserving a segment of this population.

The recovery plan for white sturgeon takes an ecosystem approach by including measures to benefit other resident fish species such as kokanee and burbot. The Kootenai sturgeon hatchery program has contributed the use of its facilities and expertise to these efforts where compatible and consistent with sturgeon activities. These resident fish measures are very small scale and are a value-added benefit of the program rather than a component of the program. For instance, native kokanee are considered an important prey item for white sturgeon and also provided an important fishery in the tributaries of the lower Kootenai River. Native kokanee populations have declined dramatically in the past two decades. Kokanee runs into north Idaho tributaries of the Kootenai River numbering thousands of fish as recently as the early 1980's (Partridge 1983) have now become "functionally extinct". Redd counts from 1993-1999 indicate the South Arm stock of kokanee from Kootenay Lake that migrates into the tributaries of north Idaho has been extirpated (Anders 1995; Ireland 1997; KTOI unpublished data). Program staff used information and expertise from B.C. Ministry of Environment staff to develop instream incubation techniques with eyed eggs in lieu of use or development of a hatchery program while a separate project (Kootenai River Ecosystem Improvement, BPA 94-49) is implementing habitat protection and restoration measures on degraded streams by identifying areas where streams can be restored and working with private landowners. Kokanee restoration activities are more appropriately reviewed in the context of the other projects specific to their restoration.

Similarly, native burbot in the Idaho and Canadian portion of the Kootenai River drainage are at risk of becoming extinct (Paragamian 1996; Paragamian et al. 2000). IDFG has been monitoring the movement, habitat use, and spawning behavior of burbot since 1993 and has not found evidence of successful spawning or recruitment. As with the white sturgeon, conservation aquaculture may play a role in the recovery of this species, as efforts to restore habitat conditions necessary for the survival of burbot continue. Sturgeon aquaculture staff is available to contribute expertise to these efforts but any burbot plans and activities are more appropriately reviewed as an independent effort.

1.9) List of program "Performance Standards."

In their Artificial Production Review, the Production Review Committee of the NPPC defined "Performance Standards" as a set of specific criteria by which progress in achieving the program goal/purpose can be measured.

The goal of the KTOI white sturgeon hatchery program is to prevent extinction, preserve the existing gene pool, and begin rebuilding healthy age classes of the endangered white sturgeon in the Kootenai River using conservation aquaculture techniques with wild broodstock. The performance standards corresponding to this goal as defined in NPPC (1999) are to:

1. Maintain, augment, and restore a viable naturally spawning population using artificial production strategies to reduce the threat of population extinction by providing annual or near-annual year-class production from native broodstock.
2. Conserve genetic and life history diversity of the endangered Kootenai white sturgeon population for a 20 year duration (approximate age at maturity) using wild broodstock to maintain the inherent diversity and mimic the wild population haplotype or genotype frequencies in hatchery broodstock and progeny.
3. Use hatchery-reared fish and facilities to conduct research on factors limiting natural production.
4. Conduct research to improve the performance and cost effectiveness of artificial propagation efforts and to minimize risks.
5. Avoid mortality risks to wild broodstock at capture and spawning.
6. Minimize the detrimental genetic or behavioral impacts of artificial propagation by outplanting fish at the earliest point consistent with survival and evaluation.
7. Avoid disease introduction or increase in disease incidence in the wild population.
8. Avoid risk to the natural population by monitoring parameters that estimate biological condition and related population dynamics as a surrogate for estimating carrying capacity of the natural habitat.

1.10) List of program "Performance Indicators", designated by "benefits" and "risks."

Performance indicators are specific operational measures of fish or hatchery attributes that address each performance standard. They determine the degree to which program standards have been achieved, indicate the specific parameters to be monitored and evaluated, and are used to detect and evaluate the success of the hatchery program and any risks to or impairment of recovery of affected, listed fish populations. Performance indicators must be are measurable, realistic, feasible, understandable, affordable, and time specific. Table 3 lists the specific performance indicators corresponding to each performance standard and indicators are discussed in more detail below.

Table 3. Performance standards and indicators for Kootenai sturgeon hatchery program.		
Performance Standard	***Type***	***Performance Indicator***
1. Maintain natural population	**Benefit**	Gradual increase in population size and age composition as a result of recruitment of hatchery fish: *Proportion of the size/age cohort contributed by hatchery* *Number of hatchery-reared fish by life stage including maturity* *Individual growth rates & condition factors* *Size & age specific survival rates* *Relative distribution and habitat use patterns of wild & hatchery fish based on CPUE & sonic telemetry*
2. Conserve genetic & life history diversity	**Benefit**	Retention of wild sturgeon life history characteristics and genetics by the hatchery reared population *Haplotype and genotype frequencies in hatchery broodstock and progeny* *Separate rearing of family groups* *Fail-safe rearing of each family in separate facilities* *Experimental population established outside current range* *Cryopreservation of sperm if feasible* *Individual and population attributes as in #1 above.*
3. Research natural production limitations	**Benefit**	Understanding of the life history characteristics and factors limiting natural recruitment *Estimated natural cohort size relative to known hatchery release number* *Rearing bottlenecks between YOY and adult* *Effects of contaminants on development, survival, & growth* *Evaluation of sediment transport and pre and post dam conditions in the spawning area*
4. Increase effectiveness & reduce costs	**Benefit**	Adaptive approach to achieve results while reducing process, administrative overhead, & operation costs *Complete planning and review processes and move to multi-year funding schedule with check points* *Adapt size and time of release for maximum benefits and minimum risks* *Marking methods to allow release as subyearlings* *Larval release experiments if appropriate* *Cryopreservation techniques*
5. Avoid broodstock mortality	**Risk**	Additional mortality does not speed population decline *Mortality rate of broodstock in hatchery & after release*
6. Do not exceed carrying capacity	**Risk**	No significant density-dependent trend in growth, condition, or behavior of wild or hatchery sturgeon *Individual and population characteristics as in #1 above*
7. Avoid disease transfer	**Risk**	Minimal incidence of disease in the facility *Appropriate spawning & rearing practices & densities* *Rigorous disease testing protocols* *Rear disease-free trout for bait and broodstock feeding*
8. Minimize behavioral or genetic impacts	**Risk**	See #2 above

1.10.1) "Performance Indicators" addressing benefits.

Benefits of the sturgeon hatchery program include maintaining the natural population through replacement of a lost generation of recruits, conserving genetic and life history diversity, and providing critical information on factors currently precluding significant natural production. The adaptive experimental approach this project has been taken and the involvement of a broad spectrum of tribal, governmental, University, and private participants should also ensure that the program continues to evolve toward a more effective and less costly end.

These performance standards will be addressed by a comprehensive monitoring and evaluation program of fish in the hatchery and in the wild following release. Numbers and mortality of eggs, larvae, and juveniles are tracked throughout the spawning and rearing process. An annual field-sampling program has also been implemented cooperatively with IDFG to recapture and evaluate hatchery-reared fish and any wild-produced fish. Data on numbers, lengths, weights, and marks are used to estimate survival and growth rates. Comparison of wild numbers, if any, with known hatchery release numbers also provide empirical estimates of natural recruitment rate. Growth and condition factors will also provide an index of density dependent effects that could affect productivity of the wild population. An extensive genetic testing program has also been implemented to identify haplotype and genotype frequencies in hatchery broodstock and progeny for comparison with similar data on the wild population. Excess eggs and hatchery-reared fish also provide a source of experimental fish for contaminant assessments, animal health research, in situ hatching experiments, and other research that might provide insight into factors limiting the wild population.

The conserved population will be considered healthy when: 1) a combination of natural and hatchery production has restored a length and age frequency distribution in which all size and ages are represented, 2) numbers of adult spawners are sufficient to produce recruitment which maintains the population size and age distribution at a stable level, 3) habitat improvements are sufficient to allow natural spawning to maintain the population in the absence of hatchery supplementation, 4) population size is sufficient to maintain genetic and life history diversity.

1.10.2) "Performance Indicators" addressing risks.

Risks of the sturgeon hatchery program include accelerating the decline of the wild population if significant mortality of adults resulted from handling, reducing the success of natural spawning and recruitment if hatchery fish over-seed the habitat capacity, increasing mortality or reducing productivity of wild fish if hatchery practices introduced new diseases or increased the incidence of endemic diseases, and reduced genetic or life history diversity if hatchery practices failed to maintain as intended.

These risk performance standards are also addressed by many of the same monitoring and evaluation program indicators used to address benefits. Fish numbers and condition are monitored in the hatchery and in the wild following release. Broodstock capture and spawning methods have been developed and refined to minimize stress and improve artificial spawning success. An intensive genetic and animal health-monitoring program has been implemented. Adjustments have been made throughout the development of this program and will continue to be made based on monitoring and evaluation results consistent with the adaptive management principles recommended by the Artificial Production Review Committee of the ISRP.

1.11) Expected size of program.

The intent of the conservation hatchery program is to approximate a "normal expanding" natural population without exaggerating the contribution of a small fraction of the parent population, as occurs in typical supplementation programs (Kincaid 1993). We estimate that this goal will require an annual production equivalent to 4-10 breeding adults per family for 4-12 families. Theoretically, implementation of this breeding plan each year for the next 20 years using 5 different mating pairs per year would yield an effective population size of 200. About 1,000 age 1 juveniles per family produce target numbers of approximately 8 progeny per family or about 4 breeding pairs per family at age 20, assuming annual survival rates of 50% for years 2 and 3, and 85% for years 4-20 of all fish planted. Natural survival in the river environment during the 18+ years from planting to maturity would result in variability in genetic contribution of families to the next broodstock generation. Number of fish released per family will be adjusted in future years when actual survival rate is known.

Conservation hatchery production numbers were initially developed with an end goal of 10-20 adults per family surviving to female age at first maturity (20 yr.) for two reasons: 1) To represent progeny of Kootenai River wild population genetics; and 2) to avoid over or under-representation of any particular haplotypes or genotypes as a result of the hatchery program. Initial target numbers are the result of Federal Recovery Team negotiations, based on theoretical annual mortality rates presented by Kincaid (1993) in his breeding strategy for this population. The numbers are "loose" because insufficient juvenile white sturgeon (< age 25) exist in the Kootenai River to calculate annual or cumulative survival rates to age at first maturity (approx. 20 yr. for females, males age 12-15). Recaptured juveniles from the conservation aquaculture program, given several years of post-release survival, will allow calculation of empirically based annual and cumulative mortality rates for Kootenai River white sturgeon. These rates in turn will allow calculation of more accurate release numbers to meet target goals and the realistic modeling of the effects of alternative strategies to identify the optimum approach.

1.11.1) Proposed annual broodstock need (maximum number of fish).

The captive breeding program will use 2-8 females and 4-16 males captured from the Kootenai River each spring. Fish are spawned in pairs or in diallel mating designs to produce up to 12 individual families that are reared separately to maintain family identity.

Note that sturgeon are iteroparous spawners. Spawning frequency is estimated at 5 years for females and 2-3 years for males in the Kootenai River system (Paragamian et al.

1996). Males are currently spawned at capture in the field and immediately released at the capture site. Females are transported to the hatchery and released alive after spawning. Typical practice in the sturgeon aquaculture industry is to spawn females by caesarian section. A hand-stripping method of spawning has been developed and used since 1993 in this hatchery program to considerably reduce stress and injury associated with spawning. Hand stripping also reduces the time that broodstock are held in the facility after spawning. Release of broodstock back into the river now generally occurs one week after spawning, while fish spawned by caesarian section were generally held 2-3 months post spawn to ensure adequate recovery time. Since 1991, 19 wild adult sturgeon used for conservation breeding purposes have been subsequently recaptured. One female was spawned by caesarian section on 6/22/1991 and released at Rkm 241 (hatchery location) with a sonic tag on 8/12/1991. She spent the next 31 days swimming downstream to Kootenay Lake, British Columbia. She was tracked for three years in the lake and recaptured at the north end of Kootenay Lake 5 years after the spawning event and original capture. Her health seemed good and although no increase in length was measured, she weighed 7 kg more than at original capture.

Proposed annual fish release levels (maximum number) by life stage and location.

Fish will be marked to identify family and year class before release. Number of fish released will be equalized at up to 1,000 per family for 4-12 families. Releases are made at age 1+ in the fall when fish are large enough to mark. Fish too small to mark are retained in the hatchery and released in the spring or fall as two-year-old fish. Annual releases may average 1,000-12,000 fish per year depending primarily on the availability of maturing females and the number of families produced (and incorporation of survival data to further evaluate stocking goals).

Life Stage	Release Location	Annual Release Level
Eyed Eggs	NA	0
Unfed Fry	Kootenai River	Up to 150,000 may be experimentally released in 2001 (White Sturgeon Recovery Team decision)
Fry	NA	0
Fingerling	NA	0
Yearling/2 year old	Kootenai River	1,000 – 12,000 (up to 1,000 fish per family)

1.12) Current program performance, including estimated survival rates, adult production levels, and escapement levels. Indicate the source of these data.

The Kootenai Tribal conservation program has released 4,879 juvenile white sturgeon into the Kootenai River between 1992 and 2000 (age 1-2 years old) (IDFG database and annual reports; KTOI annual reports; Ireland et al. 2000) and approximately 139,000 larvae (age 3-12 days) in 2000 as an experiment to help determine the bottleneck to survival (KTOI and IDFG progress reports 2000). Through monitoring and evaluation of the hatchery releases, gillnetting for juvenile white sturgeon in the Kootenai River has captured a total of 669 juveniles since 1995 through the 2000 sampling season (includes multiple recapture events) in the Kootenai River in Idaho (IDGF database; IDFG and KTOI reports 1996-1999). A total of 14 juvenile white sturgeon have been captured in Kootenay Lake, British Columbia between 1999 and 2000 (BC. Ministry of Environment, Land, and Parks Progress Reports). Total fork length growth of hatchery reared- reared juvenile white sturgeon released into the river and subsequently recaptured averaged 5.27 cm annually (IDFG reports). Relative weight, W_r, (Beamesderfer 1993) was calculated for 664 hatchery raised white sturgeon juveniles released into the Kootenai River between 1991-1999 and subsequently recaptured between 1995 and October 2000. Mean relative weight, Wr, was 90.638 (S.D. 27.131) (IDFG unpublished data). With five years of recapture data now available, we will be able to estimate survival rates for hatchery-released juveniles this year. Survival estimates will be used to adjust stocking numbers in the future, although we will not have survival to maturity estimates because white sturgeon in the Kootenai River do not become reproductively mature until the age of 22 for females and age 16 for males (Paragamian 1997). We recognize that normal year-to-year environmental variation in precipitation, flooding, flow rates, temperature, predator populations, and food supply can create wide variation in annual and long-term survival. Information gained from monitoring and evaluating biological condition and related population dynamics of white sturgeon in the Kootenai River, as well as information gained about ecosystem productivity (KTOI Project 19944900 – Improve the Kootenai River Ecosystem) will also be incorporated into future decisions concerning stocking rates.

1.13) Date program started (years in operation), or is expected to start.

The current program has developed from an experimental program initiated in 1990 to a Priority 1 Action listed in the Recovery Plan for white sturgeon in the Kootenai River (USFWS 1999). The initial efforts were geared toward research of gamete viability and possible negative effects of exposure to water- and sediment-borne contaminants. Experimental breeding of wild Kootenai River white sturgeon broodstock in 1990 resulted in the first successful artificial propagation of wild Kootenai River white sturgeon (Apperson and Anders 1991). A low cost hatchery facility was built in Bonners Ferry to explore the feasibility of sturgeon aquaculture as a component to recovery, which was then in a developmental stage in North America. Progeny from wild broodstock were successfully produced in 1991, 1992, 1993, 1995, 1998, 1999, and 2000. A significant facility upgrade was completed in 1998-2000 to address hatchery needs consistent with use as prescribed in the ESA recovery plan. A second upgrade is also planned to provide space necessary to rear separate family groups consistent with genetic concerns and to provide a second water source for increased rearing capacity. In 1998, the KTOI entered into a cooperative agreement with BC Ministry of Environment to provide KTOI with a fail-safe facility located in Fort Steele, B.C. in order to have a backup in case of catastrophic loss at the Tribal facility.

1.14) Expected duration of program.

The initial intent of the program was to begin replacing lost sturgeon recruitment. There has not been any measurable recruitment since 1974. This equates to 26 years of missing year classes. The USFWS Recovery Plan calls for conservation aquaculture program to continue until evidence is available to show that natural reproduction is yielding adequate recruits to sustain the genetic variability of the population. The current intent is for continued refinement, implementation, and monitoring of the Kootenai River Conservation Aquaculture Program for a minimum of the equivalent of one generation (20 years), or until repeatable, natural recruitment and subsequent natural production are reestablished.

1.15) Watersheds targeted by program.

Upper Kootenai River basin from Kootenay Lake, British Columbia to Kootenai Falls, Montana (HUC 17010101)

1.16) Indicate alternative actions considered for attaining program goals, and reasons why those actions are not being proposed.

Alternative actions include: 1) no action; 2) more aggressive habitat restoration efforts; and 3) adaptation of other hatchery facilities rather than development of a new facility.

1) No action would probably mean the extinction of this sturgeon population. The longevity of white sturgeon (up to 100 years), delayed maturation (approximately age 20 in females), and spawning periodicity (5 or more years in females in the Kootenai population) suggests that sturgeon populations can persist through extended periods of unsuitable spawning conditions. This adaptation is particularly well suited to large, dynamic river systems where suitable conditions may depend on the right combinations of habitat, temperature, and flow which do not occur every year (Beamesderfer and Farr 1997). However, a lapse in spawning of over 25 years is unprecedented in a sustainable natural white sturgeon population. The robust white sturgeon population in the Columbia River downstream from Bonneville Dam spawns successfully every year (McCabe and Tracy 1992, DeVore et al. 1995). Sturgeon populations, which have been able to persist in Columbia and Snake River reaches isolated by dam construction, typically recruit at least some juveniles during many or most years with periodic big year classes when conditions are optimum. Healthy sturgeon populations are characterized by age-frequency distributions that include large numbers and percentages of juvenile and subadult fish. Age and length distributions are stable and are skewed toward young fish. The lower Columbia River white sturgeon population (downstream from Bonneville Dam) is composed of > 95% sexually immature fish and this population also sustains an annual harvest of 50,000 fish (DeVore et al. 1999). The age and length distributions of the Kootenai population are heavily skewed toward older fish and have been shifting to the right over time. Approximately 90% are age 25 and older fish (Paragamian et al. 1995; BPA 1997). Thus, the key to successful management of threatened and endangered populations must be to apply appropriate conservation measures that minimize risk and maximize benefit before their potential for success is overly compromised by small population size or reduced population viability (Anders 1998).

2) More aggressive habitat actions might result in resumed natural recruitment if the appropriate actions could be identified and implemented but would not replace the 25 years of failed recruitment. The adult population would continue to decline and restored recruitment would lapse as the adult population died before their progeny mature. Significant genetic diversity could be lost in this potentially small population bottleneck even presuming the unidentified habitat measures succeeded immediately. Simultaneous implementation of habitat restoration and conservation culture appears to offer the highest probability of protection and preservation of the Kootenai River white sturgeon.

3) No other hatchery facilities provide a suitable alternative for the sturgeon aquaculture program. Animal health concerns have constrained interbasin movements of fish and hatchery facilities in the Kootenai basin are limited. Sturgeon spawning and rearing requirements are unique to this species and adaptation of trout or salmon facilities would be a poor substitute for a facility designed specifically for sturgeon. A site on the Kootenai mainstem near fish spawning or staging areas also facilitates the capture and transport of wild broodstock to hatchery in a condition suitable for spawning. The need to capture several mature females with ripe eggs during the spawning season is a critical component of a successful hatchery program.

SECTION 2. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

2.2) List all existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates.

Kootenai White Sturgeon Recovery Plan: The KTOI hatchery program is a crucial element of the Recovery Plan adopted in 1999 by the U. S. Fish and Wildlife Service for this ESA endangered species. Recovery actions include "Develop and implement a conservation aquaculture program to prevent the extinction of Kootenai River white sturgeon. The conservation aquaculture program will include protocols on broodstock collection, gene pool preservation, propagation, juvenile rearing, fish health, and preservation stocking." The recovery strategy was to implement the conservation aquaculture program for at least the next 10 years. Specific actions related to this objective include:

21. The conservation aquaculture program will follow policies and procedures of the Northwest Power Planning Council's Columbia Basin Fish and Wildlife program and the service's artificial propagation policy.
    211. Obtain necessary local State, Tribe, Federal, and Canadian approval and permits for all conservation aquaculture activities.
22. Develop performance standards for KTOI hatchery facilities.
    221. Determine water quality standards for KTOI hatchery.
    222. Upgrade KTOI hatchery facility to meet aquaculture objectives.
    223. Maintain Kootenai Sturgeon Hatchery as secondary rearing facility.
    224. Implement the conservation aquaculture program.
23. Implement genetic preservation guidelines for broodstock collection and mating designs.
    231. Use adopted white sturgeon broodstock protocol.

232. Collect adequate numbers of male and female broodstock to maintain the genetic variability.
233. Annually evaluate the conservation aquaculture program.

24. Develop a release plan for Kootenai River white sturgeon.
241. Evaluate appropriate production goals.
242. Develop a fish health plan for hatcheries rearing white sturgeon.
243. Develop tagging protocol for hatchery reared white sturgeon.
244. Develop a policy for hatchery white sturgeon in excess of beneficial uses identified in recovery.
245. Evaluate the feasibility of establishing an experimental white sturgeon population outside of its current occupied range.

25. Release hatchery-reared white sturgeon into the Kootenai River basin.
251. Adjust white sturgeon releases as necessary, to meet objectives of the Kincaid breeding plan.

26. Monitor ecological interactions between hatchery reared and wild white sturgeon.
261. Determine factors limiting production (natural or hatchery) and habitat use patterns for each life history stage.

This HGMP is consistent with the recovery plan in all respects.

USFWS Draft Biological Opinion for white sturgeon in the Kootenai River (July 27, 2000). This project is listed as "necessary and appropriate" (in terms and conditions) to implement the reasonable and prudent measures #1 and #3 in the draft Biological Opinion consultation conducted by USFWS Regions 1 and 6 on July 27, 2000. Specifically:

1g. The action agencies shall design and conduct those studies necessary to determine the effects of Libby dam operations and other threats on sturgeon life history, and the causes of sturgeon mortality.

3a. The action agencies shall continue to maintain the preservation stocking program operated by the Kootenai Tribe of Idaho, and associated rearing facilities operated by BC Ministry of Environment, Land, and Parks. This program is described in the 1999 Sturgeon Recovery Plan and shall be operated until deemed unnecessary by the Service.

3b. The action agencies shall maintain the current level of monitoring associated with all stages of natural recruitment and the preservation stocking program.

This HGMP is consistent with the USFWS Draft Biological Opinion in all respects.

U.S. Fish and Wildlife Service Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act (October 20, 2000): This project meets the USFWS policy and intent regarding propagation of endangered species. This HGMP is consistent with the policy in all respects.

Northwest Power Planning Council Fish and Wildlife Program (1994): This project specifically addresses the following measures in the program adopted in 1995:

- 10.3B.11: "In consultation with the Confederated Salish and Kootenai Tribes, the Montana Department of Fish, Wildlife, and Parks, the Kootenai Tribe of Idaho and other appropriate entities, fund the design, operation, and maintenance of mitigation projects in the Kootenai River system and Lake Koocanusa to supplement natural propagation of fish…"
- 10.4B.1: "Operate and maintain a low-capital sturgeon hatchery on the Kootenai Indian Reservation. With Bonneville, explore alternate way to make effective use of the hatchery facility year-round."
- 10.4B.2: "Survey the Kootenai River downstream from Bonners Ferry, Idaho, to the Canadian border to: 1) evaluate the effectiveness of the hatchery, and 2) assess the impact of water-level fluctuations caused by Libby Dam on hatchery operations for outplanting of sturgeon in the Idaho portion of the Kootenai River."
- 10.4B.5: "As part of the Kootenai sturgeon recovery strategy the Kootenai Tribe of Idaho is to: 1) operate the Kootenai Tribal sturgeon hatchery and develop propagation methods to ensure healthy sturgeon are outplanted into the Kootenai River, 2) participate on the water budget team, and 3) conduct monitoring and evaluation to assess the effectiveness of these measures…"
- 2.2G.1: "The Council calls for the development, funding, and implementation of agreements between fish and wildlife managers on both sides of the U.S./Canada border that recognize the mutual benefit of protection mitigation and enhancement for transboundary species…"

This HGMP is consistent with the Fish and Wildlife Program direction in all respects.

Columbia Basin Fish and Wildlife Authority Multi-Year Implementation Plan (1997): The goal of this plan is to promote the long-term viability of native fish in native habitats where possible. The decline of native fish species in the Kootenai River drainage has been attributed to the construction and operation of Libby Dam (USFWS 1998). The following objectives have been listed in the RFM-MYIP for white sturgeon in the Kootenai River drainage: 1) Mitigate and compensate for the decline of white sturgeon in the Kootenai River drainage caused by the construction and operation of Libby Dam; 2) Preserve existing gene pool and re-establish natural age class structure of the population; 3) Restore recruitment produced by naturally-spawning adult sturgeon; 4) Restore this stock of sturgeon to a sufficient abundance and age distribution to allow for ceremonial, subsistence, and recreational harvest by tribal members and recreational harvest by sport anglers; 5) Restore viable native fish populations in historic spawning and rearing areas. This HGMP is consistent with the MYIP plan in all respects.

Genetic Breeding Plan: A plan to preserve the genetic variability of the wild stock (Kincaid 1993) regulates hatchery practices. The breeding plan guides management in the systematic collection and spawning of wild adults before they are lost from the breeding population and includes measures to minimize potential detrimental effects of conventional stocking programs. Details of this plan are described in subsequent sections. This HGMP is consistent with the Genetic Breeding plan in all respects.

Subbasin Summary for the Kootenai Basin prepared for the Northwest Power Planning Council (2000): The summary describes the status of fish and wildlife populations in the

Kootenai Basin (including limiting factors) and provides a detailed listing of remedial actions necessary for fish, wildlife, and habitat rehabilitation. This HGMP is consistent with the Subbasin Summary for the Kootenai Basin in all respects.

Cooperative Rearing Agreement with Canada: Kootenai River white sturgeon are a transboundary fish that ranges freely across the international border with Canada. The KTOI, as directed by USFWS and in accordance with Council Measure 2.2G.1, has forged a relationship with Canada concerning the recovery of sturgeon. Beginning in 1999, British Columbia Ministry of Fisheries has provided a "fail-safe" facility for the Kootenai River white sturgeon at the Kootenay Sturgeon Hatchery (KSH) near Fort Steele, B.C. for a relatively low cost. A contract that outlines the terms and conditions of the agreement (spawning, egg incubation, transfers, rearing, fish health management, marking, liberation, and general fish culture) is signed annually by both parties. This HGMP is consistent with the agreement in all respects.

Cooperative Management Agreement with Idaho Department of Fish and Wildlife, Montana Department of Fish, Wildlife, and Parks, and British Columbia Ministry of Environment, Land, and Parks: The KTOI and the State of Idaho operate in close collaboration to manage Kootenai River fishes including white sturgeon, monitor and evaluate the sturgeon hatchery program, monitor the wild white sturgeon population and research limiting factors, and to conduct other Kootenai River investigations. For instance, the IDFG is conducting an evaluation of natural spawning of white sturgeon. IDFG assists is broodstock collection each spring, as it coincides with the sampling to collect adults for sonic monitoring. Monitoring of hatchery fish by the IDFG is augmented by KTOI by using different gear types, sampling in areas not previously sampled, and sharing information. B.C. MELP collects information and data about white sturgeon in Kootenay Lake. The KTOI, IDFG, BC MELP and MDFWP have a data sharing agreeement. All field data collected on white sturgeon is compiled in a single database coordinated by IDFG. Data is compiled to provide the most accurate and up to date information concerning broodstock collection, capture of wild sturgeon for sonic tracking, and locations of fish fitted with transmitters, etc. Monitoring and evaluation efforts are described in further detail in subsequent sections.

2.3) Relationship to harvest objectives.

There are currently no fisheries for this endangered Kootenai white sturgeon population.

2.3.1) Describe fisheries benefiting from the program, and indicate harvest levels and rates for program-origin fish for the last 12 years (1988-99), if available.

Fishing for white sturgeon in Kootenai River fisheries is prohibited and no plans anticipate resumed fishing in the foreseeable future. Fishing has been prohibited on this population since 1979 in Montana, and since 1994 in Idaho and British Columbia. Known fishery harvest or incidental impact rates are zero. Incidental catch of white sturgeon in current fisheries is insignificant because other fisheries occur in times, areas, and with methods and gear to which sturgeon are not vulnerable. Small fisheries for white sturgeon existed prior to closure although effort and catch in these fisheries declined to very low levels concurrent with the decline in the wild population. Fisheries prior to closure were regulated with a combination of bag, possession, size, and gear restrictions (Apperson and Wakkinen 1992). System habitat limitations and productivity are such that the sturgeon fishery will probably not resume in the near future, but an appropriate long term recovery standard should restore population productivity so that target sturgeon fisheries could be contemplated.

2.4) Relationship to habitat protection and purposes of artificial production.

The sturgeon conservation aquaculture program is an interim measure for preventing extinction and maintaining the genetic variability of the existing wild population while habitat restoration measures are identified and implemented. The complete failure of natural production, difficulties in identifying effective habitat measures and the long-term time scale needed to restore habitat in a large river system like the Kootenai result in the need for this interim measure. Habitat recovery measures are identified as a crucial component of the Kootenai River White Sturgeon Recovery Plan and are subject to an extensive evaluation and experimental implementation program currently being implemented by the KTOI, the States of Idaho and Montana, the Federal government, British Columbia Ministry of Environment, Land, and Parks, the Bonneville Power Administration, and others.

2.5) Ecological interactions.

The Kootenai River ecosystem includes a variety of species including bull trout, interior redband trout, westslope cutthroat, rainbow trout, native kokanee, and burbot. Sturgeon generally occupy a benthic habitat niche and do not interact with most of these species in any significant fashion. Where interactions may occur, they are subtle and beyond our ability to project, measure, or distinguish from interactions with other features of the system. Some species such as spawned-out kokanee were likely a historical food source but are no longer present in significant numbers. Interactions with other sensitive species are minimal or non-existent.

The greatest potential for program impacts is between hatchery and wild sturgeon. Wild sturgeon might negatively impact the program by introducing endemic diseases into the hatchery environment. Disease transfer, genetic effects, or competition effects of a poorly conceived program might negatively impact wild sturgeon. Wild sturgeon positively impact the program by contributing source broodstock. Wild sturgeon will benefit positively from the program addition of fish to the population to prevent extinction until successful habitat recovery measures are implemented.

One of the key interaction concerns related to the hatchery program is the potential for competition between hatchery-reared and naturally spawned sturgeon juveniles. Production of large numbers of hatchery juveniles might swamp natural production and might reduce growth, condition, and survival of the wild fish. For this reason, hatchery releases are carefully limited and a field-sampling program is monitoring the population for indicators of compensatory effects.

Adding hatchery fish to a system that is nutrient limited could increase pressure on wild fish, however, adding naturally recruited wild fish to the same system will also theoretically increase “pressure” on wild fish. For the past 9 years, an attempt has been made to reestablish natural recruitment by using flow augmentation during the spawning season. To date, natural recruitment has not been reestablished. The white sturgeon recovery team has made the decision to use conservation aquaculture in the short term because they believe the risks associated with the "do nothing" approach far outweigh the risks associated with conservation aquaculture.

Interspecific competition of hatchery fish with other species of fish is not expected to be significant. By definition, competition occurs only with the condition of resource limitation. Given the highly speculative nature of potential unwanted side effects of interspecific competition, and the extremely low presence of juvenile white sturgeon in the Kootenai River (wild and hatchery), releasing fish is not rationally viewed as "adding fish to the system." Rather, the conservation aquaculture program is currently the only successful means of compensating for 20+ years of absent recruitment. Presently, the virtual absence of wild juvenile white sturgeon in the Kootenai system appears to present no threat of interspecific competition, based on presumed lack of resource limitation.

2.1) Describe alignment of the hatchery program with other hatchery plans and policies Explain any proposed deviations from the plan or policies.

The white sturgeon hatchery program is and will continue to be operated consistent with all extent plans and agreements including those identified in Section 2.2 and the NPPC annual production report.

Many hatchery reviews and policies were developed for application to anadromous salmon and steelhead programs which were historically geared toward a harvest objective. Specific activities and recommendations in those reviews and policies may not directly apply to the sturgeon conservation hatchery program but the general scientific framework and policies contained in reviews like the NPPC Artificial Production Review are applicable.

The NPPC recommended 10 policies to guide use of artificial production based on a scientific foundation for ecologically sound fish and wildlife management developed as a part of the Multi-Species Framework process, and on a scientific assessment by the Scientific Review Team of how artificial production might fit within that ecological framework. Policies include:

1. The purpose and use of artificial production must be considered in the context of the environment in which it is used.
2. Artificial production remains experimental. Adaptive management practices that evaluate benefits and address scientific uncertainties are critical.
3. Artificial production programs must recognize the regional and global environmental factors that constrain fish survival.
4. Species diversity must be maintained to sustain populations in the face of environmental variation.
5. Naturally spawning populations should be the model for artificially reared populations.
6. Fish managers must specify the purpose of each artificial production program in the basin.
7. Decisions about artificial production must be based on fish and wildlife goals, objectives and strategies at the subbasin and basin levels.

8. Because artificial production poses risks, risk management strategies must be implemented.
9. Production for harvest is a legitimate management objective of artificial production. But to minimize adverse impacts on naturally spawning populations, harvest rates and practices must be dictated by the need to sustain naturally spawning populations.
10. Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.

Policy #1 requires artificial production to be used consistent with an ecologically based scientific foundation for fish and wildlife recovery. The Kootenai program recognizes that the ultimate success of the artificial production program depends on restoration the environment in which the fish are released, reared, migrate and return. The program intercedes for the minimum portion (2 years or less) of the sturgeon life cycle needed to compensate for the bottleneck in the natural life cycle. Hatchery sturgeon will exist for almost all of their lives in a larger ecological system where they have access to the available range of riverine and lake habitats and are subjected to environmental factors and variation that we can only partially understand. The success of the program will be evaluated with regard to sustained benefits to the wild sturgeon population over the entire life cycle, rather than by the number of juveniles produced. Hatchery protocols have been specifically designed with the express purpose of avoiding domestication.

Policy #2 requires that artificial production be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate benefits and address scientific uncertainties. The Kootenai white sturgeon program includes an extensive monitoring and evaluation program, which is also included within a comprehensive research and monitoring program of the entire Kootenai ecosystem. The program has demonstrated a ready ability to recognize and integrate new information since it's inception (Table 2).

Policy #3 requires that hatcheries mirror the dynamics and behavior of the larger system. Management and expectations of the KTOI sturgeon program are flexible to reflect the dynamics of the natural environment and large variation in juvenile survival rates are anticipated. Program development and evaluation have been extensively coordinated at the watershed, subbasin, basin and regional levels and are closely integrated with habitat improvement efforts.

Policy #4 requires that a diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation. The entire KTOI program is geared to maintain this unique species and the maintenance of population diversity currently depends on a successful hatchery operation.

Policy #5 requires that artificially reared populations be modeled after naturally-selected populations in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics. The KTOI sturgeon program seeks to minimize hatchery involvement in the sturgeon life cycle so that natural processes prevail.

Policy #6 requires an explicit identification of whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed. The preservation and research goal of the KTOI program is clearly and explicitly defined in the Recovery Plan, the NPPC Fish and Wildlife Program, and this HGMP. The underlying habitat decline, which threatens extirpation, is currently being addressed through a series of experimental flow manipulations intended to identify appropriate conditions for natural spawning. Opportunities to restore natural floodplain function and habitat are also being investigated. The propagation program is intended to last until natural production is restored by habitat actions. The program will be evaluated based on the results and schedule of habitat restoration experiments. The hatchery purpose will be re-evaluated if appropriate habitat restoration efforts are deemed a failure or too expensive to implement. Conversely, facility withdrawal or conversion to another identified purpose will be considered in the context of the habitat results.

Policy #7 requires that decisions on the use of the artificial production tool be made in the context of deciding on fish and wildlife goals, objectives and strategies at the subbasin and province levels. The Kootenai sturgeon hatchery program is currently listed as an important component in the context of the basin wide planning process associated with revision of the NPPC Fish and Wildlife program.

Policy #8 requires that appropriate risk management needs to be maintained. The current monitoring and evaluation program is focused on key features that can be measured and program planning has anticipated the effects of factors beyond our capability to measure. For instance, a back-up rearing facility and establishment of an experimental non-essential Kootenai sturgeon population outside the current occupied range (within the subbasin) will provide protection for unforeseen risks.

Policy #9 refers to harvest and is not applicable to the KTOI program at this time.

Policy #10 refers to Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement, which are addressed in detail elsewhere in this plan. This plan anticipates that mandates and obligations can be altered by the appropriate authorities in response to new information or other events.

SECTION 3. WATER SOURCE

3.1) Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to production attributable to the water source.

One of the benefits of the current hatchery location is its proximity to the Kootenai River near the reach used by the wild sturgeon population. The hatchery is located at river kilometer 241 and the main spawning reaches are located between river kilometers 229-238. The primary hatchery water source is the same Kootenai River water used by the naturally spawning population. This is less an issue for Kootenai River sturgeon than it is for an anadromous species where homing and straying are affected by the water source. However, the female broodstock held in the hatchery between capture and spawning (usually between March or April through spawning in June) are exposed to ambient water temperature, enabling timing of gonad maturation to occur as it would in the wild. The wild female broodstock spawning events in the hatchery generally coincide with the timing of sturgeon spawning in the wild. Also, use of the ambient river water exposes the rearing sturgeon to similar conditions to those that would be encountered in the wild.

Since 1999, the source for incubation and hatching of sturgeon eggs at the Kootenai Tribal Hatchery is filtered Kootenai River water. Past attempts of incubation and hatching using ambient unfiltered river water resulted in high mortality rates due to siltation and fungus problems. Prior to the completion of Phase I of the hatchery upgrade in 1999, incubation and hatching used municipal water. The development of a river water filtration system was precipitated in part by the catastrophic mortality of an entire larval year class in July of 1997 when chlorine filtration equipment failed.

The current water intake system at the Kootenai Tribal Hatchery begins at the Kootenai River, where water is withdrawn through a pair of 12” intake pipes coupled to 24” diameter by 24” long stainless steel wedge wire intake screens. Through screen velocity is limited to 0.4 ft. per second. One intake screen is installed 5 feet above the river bottom and the second is installed 15 feet above the river bottom. The three river intake pumps (20 hp) are solids handling submersible type and are located in an on-shore wet well and operate on a active and stand-by mode. Under normal conditions, a single pump will operate to produce 250 gallons per minute, at approximately 125 feet of total dynamic head. Water is delivered to the treatment building through an 8” ductile iron underground pipe. The current system is designed to filter sediment from the river water using Amiad filters and seven 55-inch diameter pressure sand filters. All filtration equipment is designed to automatically backwash. Following the sand filters, the flow passes through a flow control valve to maintain the rearing head tank water level between selected depths. Three ultraviolet disinfection units follow the flow control valve and are piped in parallel, each with the capacity of 250 gallons per minute and a 50,000 microwatt per centimeter squared dosage rate, assuming a 90% ultraviolet transmission efficiency. Following the UV disinfections, a portion of the river water is then diverted through use of a manually adjusted ball valve at a rate of up to 50 gallons per minute to a head tank to feed egg incubation and hatching operations during the spring/summer months. The rest of the water goes directly to the hatchery to provide for rearing of fish from the prior year class. A separate duplex pump system passes the incubation and rearing water through a cooling heat exchanger and a propane fired boiler and heat exchange unit. It is the objective of the heat exchange system to temper river water for use during incubation and hatching, giving a regulated temperature of 12-13 degrees C. This is accomplished using heat exchange and cooling from a well water source. In no case is the tempering water source (well water) blended with the river water. After the eggs are hatched and the larvae have absorbed their yolk sacs and initiated feeding, they are gradually shifted to ambient river water for the duration of their time in the hatchery. Ambient water temperatures range from 1 degree C to 18 degrees C. The incubation and hatching system is in use between June and September.

The Kootenay Sturgeon Hatchery in British Columbia was constructed as an addition to the existing Kootenay Trout Hatchery to accommodate the need for a back-up facility. The water source for the Kootenay Sturgeon Hatchery is an abundant source of high quality groundwater that ranges from 6-9 degrees C. Water is pumped into the facility to a head tank and boilers and heat exchangers provide for heating of water for incubation, hatching, and early rearing. Currently, the hatchery has warmer water in the winter and cooler water in the summer than the Kootenai Tribal Hatchery. The warmer water temperatures have resulted in faster growth than the sturgeon at the Kootenai Tribal Hatchery that are reared on ambient river water. In general, it appears that fish from the Kootenay Sturgeon Hatchery will attain a size appropriate for marking by the age of 12-15 months. Effluent from the Kootenay Sturgeon Hatchery from egg incubation and rearing stages to 120 days post-hatch is sterilized with ozone and piped to ground. Effluent from rearing stages from 121 days to 360 days post-hatch is sterilized with ozone and discharged to surface.

3.2) Indicate any appropriate risk aversion measures that will be applied to minimize the likelihood for the take of listed species as a result of hatchery water withdrawal, screening, or effluent discharge.

Hatchery intake screens conform to NMFS and USFWS screening guidelines to minimize the risk of entrainment of fish species. Screening is described under Section 3.1. Although the USFWS does not have specific screening criteria for bull trout at this time, research is being conducted at the Abernathy facility that will result in criteria specific for bull trout. In the interim, most USFWS field offices are using NMFS criteria.

A National Pollutant Discharge Elimination System permit (NPDES) is not required for the facility because of low production levels. Minimum requirements for NPDES permits are production > 20,000 pounds of fish per year**.**

SECTION 4. FACILITIES

In response to the Council's 1987 Columbia River Basin Fish and Wildlife Program, BPA funded the construction of the KTOI Experimental White Sturgeon Facility, which began operations in the spring of 1991. The low-capital facility was originally constructed to determine whether artificial propagation was feasible based on existing water quality of the Kootenai River and whether gametes from wild sturgeon in the Kootenai River were viable. Initial culture efforts demonstrated that eggs could be successfully fertilized, incubated, and hatched.

The facility was considered experimental until 1996, when the draft recovery plan called for the full implementation of the conservation aquaculture program (USFWS 1996). The existing facility and equipment was inadequate to meet the new expectations of the conservation aquaculture program as stated in the draft and final recovery plans (USFWS 1996 and 1999) and the breeding plan to preserve genetic variability of the white sturgeon in the Kootenai River (Kincaid 1993). A 1997 funding request was presented to NPPC and CBFWA for approval to bring the facility up to standard in order to provide adequate reliability (Phase I System Improvements – J-U-B Engineering Report 1997). The funding request was approved in time to make the following improvements to the existing facility beginning in 1998: 1) Upgrade the water supply capacity; 2) Improve the water treatment system to assure acceptable water quality; 3) Improve reliability through equipment upgrades and redundancy; and 4) Improve facilities for maintenance and protection of equipment.

Current plans and budget requests include completion of a Phase II upgrade, which is described in further detail in section 4.6.2 below. In no instance, does operation of the hatchery facilities or planned new construction, result in adverse effects to habitat for listed species.

4.1) Broodstock collection, holding, and spawning facilities.

All broodstock used in the Kootenai River Conservation Aquaculture program are captured from the wild population by angling or set lining. Female broodstock are collected from the Kootenai River in areas containing pre-spawning aggregations confirmed by ten years of on-going telemetry (IDFG Annual Reports 1990-1999). Each fish collected is weighed and measured, checked for recapture, and if not recaptured, marked with an individually numbered Floy tag, injected with a PIT tag and biopsied to determine sex and gonad development (spawning periodicity for females is 5 years and 2-3 years for males). Females are captured between February and May and held in the Kootenai Tribal Hatchery during final gonad maturation. After transport to the hatchery (see Section 4.2), each female is held separately or with one other fish in covered, circular fiberglass tanks (3 m diameter x 1.2 m deep) located inside the main hatchery building. An external standpipe maintains water level at approximately 1.14 m inside the tank. Water exchange is provided at 10-15 volumes/day and O_2 is maintained at approximately 5.0 mg/L. The center drain is level with the tank bottom to reduce obstruction and provide for efficient waste removal. Broodstock are held in Kootenai River water pumped into the hatchery and are fed live juvenile rainbow trout that are produced at the hatchery specifically for this purpose.

From 1990-1996, all potential male broodstock were brought to the hatchery, where milt was extracted for use in spawning. From 1997 to the present, milt is collected from flowing males in the field just prior to spawning induction of the female, and held in plastic bags and refrigerated in ice-filled coolers. Oxygen is replaced every 12 hours. Viable sperm can be stored for up to one week using this method. Sperm is checked for viability and motility upon arrival at the hatchery and again before egg fertilization takes place. A minimum water activated motility period of 2 minutes, verified under the microscope, as well as a high ratio of activated to nonactivated sperm, is required to designate viable sperm samples (Conte 1988).

Sturgeon females generally do not ovulate spontaneously in captivity. To induce ovulation, lutenizing hormone (LHRHa) is administered. However, treatment is only effective if the female has reached the responsive stage of final ovarian maturation, which is manifested by the advanced stage of germinal vesicle migration and the oocyte response with germinal vesicle breakdown to a maturation-inducing hormone (Van Eenennaam et al. 1996). Prior to spawning induction, the female sturgeon is transferred by stretcher to a covered rectangular fiberglass spawning tank (2.1 meters long x 0.61 meters wide x 0.61 meters deep), allowing for underwater hormone injection (LHRHa) and observation of eggs once the female begins ovulation.

4.2) Fish transportation equipment (description of pen, tank truck, or container used).

Following sex determination and gonad development by biopsy in the field, potential female broodstock are directly transferred from the boat (in a water-filled stretcher) to a covered fiberglass tank mounted on a truck for immediate transfer to the hatchery. Oxygen is provided by a bottled oxygen system for the short trip to the hatchery. Water for the tank is obtained from the hatchery (Kootenai River) prior to transport. The truck is parked near the sampling area and transfer from the staging area to the hatchery generally takes approximately ½ hour.

The same truck and tank is used for transportation of juvenile white sturgeon for release. Release sites are located between river kilometer 171 and 259 (the hatchery is located at river kilometer 241). Sturgeon are netted out of the rearing tanks into the truck tank containing Kootenai River water. At the release site, fish are netted from the tank truck and released into the river. Some release sites require access by boat, in which case, sturgeon are loaded by net into a live well on the boat, netted out of the well at the release site, and released directly into the river.

Starting in 1999, approximately 5,000 to 20,000 fertilized, disinfected eggs from up to five families are shipped to the Kootenay Sturgeon Hatchery in British Columbia as a "fail-safe" measure to minimize the risk of catastrophic loss. Once the eggs are washed and disinfected, they are loaded into double plastic bags filled with 4-6 liters of water from the Kootenai Tribal Hatchery (ambient river water). The bags are then inflated with oxygen, sealed, and placed in a cooler. Some warming of eggs occurs during transport so that the temperature will be matched with the incubation temperature at the Kootenay Sturgeon Hatchery (15 degrees C). Temperature is monitored during the trip and ice is added if necessary (weather dependant). The coolers are transported to the Kootenay Hatchery by pick up truck, a trip that takes approximately 2 ½ hours.

For release of juvenile white sturgeon from the Kootenay Sturgeon Hatchery, standard trout transportation trucks with insulated, oxygenated 150 to 250 gallon tanks are used. Fish are netted from the rearing tanks into the trucks and then netted out of the tanks at the release site.

4.3) Incubation facilities.

Incubation occurs in modified MacDonald jars (13 liter capacity, round bottom cylinders, 50 cm tall, and 20 cm in diameter), which drain into rectangular fiberglass fry collection tanks (1.2 m x 0.56 m x 0.31m deep). The incubation jars are made of acrylic plastic that allows for direct observation of the eggs and flow pattern. Water enters the jars through water distribution pipes, each equipped with a control valve. The PVC pipe passes through a jar cap screen and is sleeved in a clear acrylic pipe that extends from the jar-cap to about 2.5 cm from the bottom of the jar. This design provides adequate control of water velocity and egg agitation (Conte et al. 1988). The water flows out of the jar, over a lip positioned under the cap, and directly to the fry collection tank. The hatchery uses up to 24 jars and up to 12 tanks to separate all families and half-sib families. The capacity of each jar is 5,000 to 25,000 eggs. Eggs are incubated with filtered water from the Kootenai River held at approximately 13 degrees C during incubation (refer to

Section 3.1 for a description of the incubation water system). Eggs begin hatching in approximately 10 days post-fertilization and the hatch is complete at approximately 14 days post-fertilization. As eggs hatch, the emerged fry tend to move vertically and the water flow carries them to the top of the jar and over the lip, directly into the fry collection tank. Eggshells are siphoned daily from the fry collection tanks. The incubation and hatching methodology is adapted from Conte et al. 1988.

As mentioned in Section 4.2, starting in 1999, approximately 5,000 to 20,000 fertilized, disinfected eggs from up to five families were shipped to the Kootenay Sturgeon Hatchery in British Columbia as a “fail-safe” measure to minimize the risk of catastrophic loss. The Kootenay Sturgeon Hatchery incubation and hatching facilities are configured similar to the above description (with capacity for five families rather than twelve and incubation temperatures a few degrees higher (15-16 degrees C rather than 13 degrees C).

4.4) Rearing facilities.

The hatchery piping and drain system is designed for flexibility regarding tank use for different life stages. River water is piped into the main hatchery facility from the treatment room and distributed through a 4” pipe system with valves located approximately every 3 feet so that different tanks can be set up depending upon life stage. Upon completion of hatching, all fry within a family are transferred from fry collection tanks to larger rectangular fiberglass rearing tanks for early larval feed initiation. Each tank is equipped with a PVC spraybar with an attached valve to control flow. A perforated stainless steel screen ($3/16^{th\ inch}$) fits into a slot at one end of the tank to separate the clean out standpipe from the larval rearing area. In addition, flexible small mesh fiberglass window screen is used to cover the perforated stainless steel screen to prevent escape of larval fish. Tanks are covered and lights are kept off when staff are not working in the hatchery, since larvae exhibit a slightly phototaxic behavior. The facility uses up to 32 tanks for this life stage, each 2.44 m length x 0.56 m wide x 0.31 m deep. Feed initiation occurs approximately 2-3 weeks post-hatch, after the yolk sac is absorbed. Larvae are fed by hand every 2 hours between 6 A.M. and 8 P.M. and automatic feeders are on 24 hours a day. The hand feeding enables fish that are less aggressive to initiate exogenous feeding. Fry are transferred to circular fiberglass tanks approximately 3 weeks after initiation of feeding. Circular tanks are preferred because they allow for circular water flow, providing current for fry to swim in. Circular tanks are also easier to clean (feces and excess feed collect around the center standpipe for easy removal). Fiberglass circular tank size ranges from 1.02 m diameter x 0.43 m deep to 1.42 m diameter x 0.76 m deep. Because all families and half-sib families are reared separately until release and fry are also separated according to size, up to 32 tanks can be set up and used during this life stage. Fish held beyond age one are transferred to large circular fiberglass tanks (3 to 4.5 m in diameter), and reared in densities below 225-g/cubic foot of water. The facility has two rearing sheds housing 6 - 4.5 m diameter circular tanks (Rearing Shed 1) and 12 – 3 m diameter tanks (Rearing Shed 2). Ambient river water is piped through the main hatchery and then to the rearing sheds. The Kootenay Sturgeon Hatchery rearing facilities are configured similar to the above description (with capacity for five families rather than twelve).

4.5) Acclimation/release facilities.

No specialized acclimation or release facilities are required for sturgeon.

4.6) Describe operational difficulties or disasters that led to significant fish mortality.

In 1997, the entire larval year class was lost as a result of an unfortunate chain of events: 1) In 1996, a proposal was presented to perform some of the necessary upgrades needed at the hatchery. The funding request was not approved; 2) In January 1997, KTOI presented another request for funding in order to upgrade the facility and provide funding for a back-up facility operated by IDFG in Sandpoint. The RFM approved partial funding of the request. The facility in Sandpoint was to be used for back-up but was not available because a broken main waterline had not been repaired. Because the facility was not operational, the KTOI did not have a portion of the 1997 year class in a fail-safe facility; and 3) The use of water from the Northside Water District (de-chlorinated through a charcoal filtration system) to incubate and rear white sturgeon to 3 weeks of age had been the only successful way to produce sturgeon in the past. Incubating in river water has caused fungus problems and egg suffocation because of silt and bacteria present in the flow-through river water system. During incubation in 1997, the North Side Water District replaced some main lines in the water system and flushed them with chlorine. The chlorine filtration system failed, resulting in the overnight loss of the entire 1997-year class. This event confirmed the need for improvements in the water supply system, which was subsequently completed during Phase I of hatchery improvement construction.

4.6.1) Indicate available back-up systems, and risk aversion measures that minimize the likelihood for the take of listed species that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality.

The KTOI White Sturgeon Hatchery has been constructed with numerous back-up and emergency scenarios in mind. From availability of trained staff seven days a week, 24 hours a day, to power supply, piping, equipment and water supply, operation in unusual or adverse conditions can be accomplished in a variety of ways.

First, the municipal electrical power supply has been improved from an old single-phase river crossing to a new and reliable 3-phase crossing. When the municipal power is interrupted, all of the critical water supply equipment and lighting is automatically switched over to the 100-kilowatt propane-fired generator. The propane generator is currently being converted to natural gas to provide more reliable fuel supply, especially in severe winter conditions when propane and diesel delivery can be difficult.

The new river water delivery system is also backed up through the use of the original river pump station. A 40-kilowatt diesel generator provides stand-by power to the back-up pump station. Multiple pumps are provided in each pump station to allow one unit out of service for maintenance or repair.

Municipal water can also be supplied to the hatchery and rearing facilities. Activated carbon filters are in-line to guard against chlorine in the municipal water. Compressed air and ceramic air diffusers are also available in the hatchery and rearing areas to maintain adequate oxygen content in the water if the river water supply is unavailable for an extended period of time.

The river water supply normally flows through the treatment equipment. However, it can be bypassed directly to the hatchery and rearing head tanks in case of piping or equipment failure in the treatment building. Similarly, each piece of equipment in the treatment building can be bypassed to accommodate maintenance and emergency operations.

An alarm system employs an automatic dialer, audible exterior horn, and interior strobe light to notify operators of an alarm condition. Alarm conditions include low and high incubation water temperatures, pump failure, low head tank water level, power failure, filter system failure, and ultraviolet disinfection system failure. The alarm system is routed through a programmable logic controller (PLC). The PLC receives the alarm signals and sends them on to the audible system, dialer, and light as well as logs them on the hatchery computer. The computer is equipped with PC Anywhere software and a modem to allow the PLC and all the alarm data to be accessed by a technician from a remote location. This interface facilitates rapid response to alarm conditions.

The water discharge system has also been connected with drain connections to the river as well as the Irrigation District drainage ditches. Both systems are designed to operate satisfactorily under the 100-year flood conditions predicted for the Kootenai River. A flood control dike that was designed for the 100-year flood also protects the KTOI site. The primary river pump station is designed to operate under 100-year flood conditions as well.

In the event of a train, roadway, or other accidental spill that may affect water quality, the KTOI hatchery is notified by the Boundary County Sheriff's dispatch. Since the hatchery staff live in the adjacent village or stay in the crew quarters while on duty, emergency actions can be instituted quickly 24-hours per day and seven days per week.

4.6.2) Indicate needed back-up systems and risk aversion measures that minimize the likelihood for the take of listed species that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality.

A significant facility upgrade was completed in FY2000 to address hatchery needs consistent with use prescribed by the USFWS recovery plan (1999). Phase I upgrades that have been completed to date at the existing Tribal facility include: 1) 3-phase power crossing and standby generation system; 2) new river intake piping system; 3) water treatment system with three submersible river intake pumps and two types of filtration followed by ultraviolet disinfection; 4) water temperature control system for incubation; 5) crew quarters and boat storage; 5) re-piping and concrete in the main hatchery; and 6) installation of a dock to carry wild broodstock from the boat to the hatchery.

These upgrades bring the existing facility up to standard but there is still be a need to provide adequate rearing space for up to 12 families per year as the project becomes fully implemented. Each family group must be reared separate from other family groups to ensure proper identification at outplanting (USFWS 1999) and also must be reared at low densities to prevent disease outbreak (LaPatra et al. 1994). Presently, the existing facility can house approximately 8 families per year class to the age of 2. The BCMF "back-up facility" in Canada provides space for up to five families per year class to the age of 2 (representing up to five female's progeny). The intention of the back-up facility is to provide replication of families represented in the Kootenai Tribal Facility in case of catastrophic loss at either facility. Although the BCMF "back-up facility" provides an important function (and will contribute fish to the stocking goal when necessary), it does not provide additional rearing space that is necessary to represent up to 12 families per year class, as called for in the USFWS recovery plan (USFWS 1999). For this reason, we have received funding in FY2000 to begin preparing a master plan for a second facility located on Tribal land in the Kootenai River drainage to provide adequate rearing space for white sturgeon.

SECTION 5. BROODSTOCK ORIGIN AND IDENTITY

5.1) Source.

All broodstock used in this program are wild Kootenai River fish which are captured, spawned, and released following spawning. Fish are collected in staging and spawning areas near Bonners Ferry between river km 200 and 245.

5.2) Supporting information.

5.2.1) History.

No broodstock other than wild Kootenai River white sturgeon have ever been used in the program. This ESA endangered stock fails to meet even the most optimistic critical and viable population thresholds (see section 10.2.2 for discussion of thresholds).

5.2.2) Annual size.

Up to 20 wild broodstock are spawned per year. Based on an approximate wild population size of 500 to 2,000 adults, broodstock would comprise 1-4% of the population. Use of wild broodstock does not affect population status relative to critical and viable thresholds because wild spawning is currently unsuccessful and broodstock are released alive after spawning.

5.2.3) Past and proposed level of natural fish in broodstock.

All (100%) of broodstock are wild fish.

5.2.4) Genetic or ecological differences.

Hatchery and natural stocks are identical except that the broodstock in any single year represent a subset of the available population.

5.2.5) Reasons for choosing Broodstock traits

No specific broodstock traits or characteristics are selected.

5.2.6) ESA-Listing status

Hatchery-reared sturgeon are listed as Endangered and are essential for recovery.

5.3) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects that may occur as a result of using the broodstock source.

The risk of among population genetic diversity loss will be reduced by selecting the indigenous white sturgeon population for use as broodstock in the supplementation program.

SECTION 6. BROODSTOCK COLLECTION

6.1) Life-history stage to be collected (eggs, juveniles, adults).

All broodstock are collected as mature adults immediately prior to spawning.

6.2) Collection or sampling design.

All broodstock used in the Kootenai River Conservation Aquaculture program are captured from the wild population by angling or set lining. Male and female broodstock are captured from February through May in areas containing pre-spawning aggregations confirmed by ten years of ongoing telemetry (IDFG Annual Reports 1990-1998). Annual collection of late vitellogenic females from these areas, and subsequent spawning of these fish in the hatchery suggested that fish spawning throughout the entire spawning season congregated simultaneously in the same areas. Thus, our broodstock sampling regime incorporated spawners from the duration of the spawning run.

To identify potential broodstock in the field, all captured fish are biopsied to determine sex and gonad maturation stage (Conte et al. 1988). Captured fish are placed ventral side up in a hooded water-filled stretcher suspended across the gunwales of the boat. Sex and reproductive development is determined by visual observation of gonadal tissues through a 2-3 cm midline incision on the ventral surface of the fish. Reproductive development of males and females is categorized according to criteria reported by Conte et al. (1988). Every fish collected is weighed and measured (mm, FL, TL), checked for recapture, and if not a recapture, marked with an individually numbered Floy tag and injected with a PIT tag. Once sex and reproductive status is determined, fish are either brought to the hatchery for subsequent spawning or released back into the river. Male and female broodstock recaptured in the wild are weighed, measured, and immediately released. Recaptured male and female broodstock that contributed to surviving progeny groups are not spawned more than once.

6.3) Identity.

Only one target population is present. Wild broodstock that have been captured before or have contributed to previous hatchery broods are distinguished with individually-numbered Floy and PIT tags and data regarding all captured fish is provided to field crews on an annual basis in a field notebook organized alphabetically and numerically by PIT tag number (IDFG database). Hatchery origin fish are identified by a PIT tag and a scute removal mark and are also included in the field notebook database.

6.4) Proposed number to be collected:

6.4.1) Program goal (assuming 1:1 sex ratio for adults):

A genetic breeding plan has been implemented to guide management in the systematic collection and spawning of wild adults before they are lost from the breeding population. The implementation of the breeding plan includes measures to minimize potential detrimental effects of conventional stocking programs. The objective of the conservation aquaculture program is to produce 4-12 separate families per year. This will generally require 2-6 females and 4-12 males per year. Actual numbers for any given year generally depends upon the annual number of females available in the spawning population and the success in capturing ripe females. The implementation plan incorporates the expectation that actual annual numbers will vary.

6.4.2) Broodstock collection levels for the last 12 years (e.g., 1988-99), or for most recent years available:

A total of 477 broodstock were captured from 1990 through 2000, of which 68 were spawned (23 females, 45 males), producing 44 families (see following table). For simplicity, all half-sibling families were included in this total of 44 families. Fertilization and hatching success rates ranged from 6 % to > 99% and 1% to 90% respectively among all years.

Year	Adult Males	Adult Females	Jacks	Eggs	Juveniles	No. families produced
1990	1	1	NA	0	0	1
1991	3[a]	1	NA	0	0	1
1992	3[b]	1	NA	0	0	3
1993	2	1	NA	0	0	2
1994	0	0	NA	0	0	0[c]
1995	4	2	NA	0	0	4
1996	2	1	NA	0	0	2[d]
1997	5	3	NA	0	0	6[e]
1998	6	3	NA	0	0	6
1999	8	4	NA	0	0	8
2000	11	6	NA			11
Total	**45**	**23**	**NA**	**0**	**0**	**44**

a: Sperm from 3 males pooled.
b: Eggs fertilized separately from each male.
c: No white sturgeon handled, due to ESA listing.
d: No survivors to age at release; hatching success 1% due to low broodstock (gamete) quality.
e: No survivors to age at release; hatching success > 80%; larvae died shortly after hatch due to equipment/facility failure.

6.5) Disposition of hatchery-origin fish collected in surplus of broodstock needs.

Unlike most salmon and steelhead hatcheries where hatchery broodstock enter the collection system, sturgeon must be caught one by one in the wild. Broodstock collection activities for sturgeon cease when adequate numbers of mature fish are in hand. In many years, collection activities may continue through the duration of the wild sturgeon spawning season.

6.6) Fish transportation and holding methods.

All broodstock used in the Kootenai River Conservation Aquaculture program are captured from the wild population by angling or set lining between February and June. Female broodstock are collected from the Kootenai River in areas containing pre-spawning aggregations confirmed by ten years of on-going telemetry (IDFG Annual Reports 1990-1999). White sturgeon broodstock are often large, weighing between 45 and 75 kg, and special handling is required to avoid injury to the fish. Each captured fish is placed in a hooded stretcher in the water, prior to placing them aboard the boat. The sturgeon's axial skeleton is cartilaginous, and the stretcher distributes the weight evenly and provides support, preventing injury to the internal organs when the fish is moved (Conte et al. 1988). The stretcher is constructed of smooth nonabrasive fiber-reinforced nylon sheeting attached to two 2.4-meter poles. It has a hood at one end to cover the fish's head, acting as a respiration chamber when water is added. The stretcher and fish are then hoisted into the boat, the stretcher is placed across the gunwales of the boat, the fish is turned on the dorsal side, and water is added to the stretcher. Each fish is measured, checked for recapture, and if not recaptured, marked with an individually numbered Floy tag and injected with a PIT tag, and biopsied to determine sex and gonad development (spawning periodicity for Kootenai River white sturgeon is 5 years for females and 2-3 years for males). Total time in the stretcher is less than 10 minutes.

Following sex determination and gonad development by biopsy in the field, potential female broodstock are directly transferred from the boat (in a water-filled stretcher) to a covered fiberglass tank mounted on a truck for immediate transfer to the hatchery. Oxygen is provided by a bottled oxygen system to provide aeration for the short trip to the hatchery. Water for the tank is obtained from the hatchery (Kootenai River) prior to transport. The truck is parked near the sampling area and transfer from the staging area to the hatchery generally takes approximately ½ hour.

After transport to the hatchery, each female is held separately or with one other fish during final gonad maturation in covered, circular fiberglass tanks (3 m diameter x 1.2 m deep) located inside the main hatchery building. Female broodstock are held in ambient Kootenai River water pumped into the hatchery and are fed live juvenile rainbow trout that are produced at the hatchery specifically for this purpose. An external standpipe maintains water level at approximately 1.14 m inside the tank. Water exchange is provided at approximately 10 to 15 volumes per day and O_2 is maintained at approximately 5.0 mg/L. The center drain is level with the tank bottom to reduce obstruction and provide for efficient waste removal. Female broodstock are generally held in the hatchery for 2 weeks to 4 months for final gonad maturation. Female broodstock are returned to the river approximately one week after the spawning event.

From 1990-1996, all potential male broodstock were brought to the hatchery, where milt was extracted for use in spawning. From 1997 to the present, milt has been collected from flowing males in the field just before spawning induction of the female. Field methodology described above for female broodstock is similar for males except that a surgical biopsy is not necessary during the natural spawning period to determine sex. Instead, flowing males are identified in the field by extraction of milt. Milt is extracted using surgical tygon tubing attached to a syringe and inserted into the vent, and held in plastic bags and refrigerated in ice-filled coolers. Oxygen is replaced every 12 hours. Viable sperm can be stored for up to one week using this method. Sperm is checked for viability and motility upon arrival at the hatchery and again before egg fertilization takes place. A minimum water activated motility period of 2 minutes, verified under the microscope, as well as a high ratio of activated to non-activated sperm, is required to designate viable sperm samples (Conte 1988).

6.7) Describe fish health maintenance and sanitation procedures applied.

Biopsies to assess sex and gonad maturation are completed with sterile surgical methods. Methodology is detailed in Conte el al. 1988. In preparation for surgery, the abdominal area anterior to the genital pore is treated with a 4 percent antibacterial solution of nitrofurazone, administered with a wash bottle. Using a scalpel with a size 10 blade, a 2-3 cm incision is made through the ventral midline, a distance of three to five ventral scutes anterior to the genital pore. The presence or absence of ripe oocytes or testes is then confirmed and the incision is closed and sutured using a cruciate or continuous suture pattern with resorbable sterile sutures. The surgical area is then washed with a 4 percent solution of nitrofurazone.

6.8) Disposition of carcasses.

Not applicable for sturgeon. Broodstock are released alive after spawning.

6.9) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed species resulting from the broodstock collection program.

Adverse genetic or ecological measures by use of wild broodstock are eliminated by the use of a small fraction of the population and the live release of all fish after spawning. Fish capture methods by angling or set lining minimize any size selectivity associated with other capture gears such as gillnets. The fish captured thus represent a random sample from the adult population of potential spawners. Disease amplification risks in capture and handling are eliminated by use of sterile techniques in field biopsies and the isolation of broodstock in the hatchery. Standard hatchery equipment and facility sanitation and fish health maintenance guidelines and procedures are followed.

SECTION 7. MATING

Sturgeon culture techniques differ from those used for salmonids because of inherent differences in gonad development, spawning frequency, and sperm and egg structure, physiology, and biochemistry. A complete description of broodstock evaluation, gamete processing, and incubation of eggs is outlined in the Hatchery Manual for White Sturgeon by Conte et al. (1988). This includes information concerning: 1) assay to determine spawnable females and final oocyte maturation; 2) spawning induction of females including injection schedule for LHRHa, injection procedures, and observation of response; 3) milt and egg extraction overview including checking sperm viability, sperm dilution, egg fertilization, and egg de-adhesion; and 4) incubation of eggs and early life stages.

Given the uniqueness of the species and the new concept of conservation aquaculture for a long-lived species, methodology has been adapted by networking with experts in the field, as well as using and refining techniques described in Conte et al. (1988). Techniques have been refined to suit the purposes of the conservation aquaculture program. For example, surgical removal of eggs was used for 2 years until hand-stripping of eggs proved to be a viable alternative. Hand-stripping of eggs greatly minimizes stress associated with Cesarean surgery and reduces the recovery period of post-spawning adult white sturgeon prior to release back into the wild. Also, we are in the process of refining techniques for field collection and storing of sperm to minimize the number of wild fish brought to the hatchery.

7.1) Selection method.

Breeding matrices and protocols were developed to maximize effective population number and to minimize chances of future post-stocking inbreeding in the wild (Kincaid 1993). The conservation-breeding program uses 2-6 females and 4-12 males captured from the Kootenai River each spring. Fish are spawned in pairs or in diallel mating designs to produce up to 12 individual families that are reared separately to maintain family identity. The field collection of broodstock results in a random selection process for spawners as described previously.

7.3) Fertilization.

Eggs from all potential female broodstock held in the hatchery are evaluated to estimate timing of final maturation. Germinal vesicle breakdown (GVDB, Conte et al. 1988) and Polarization index (PI) values (J. VanEenennaam et al. 1996) are calculated at least twice for at least 20 eggs from each female brood fish prior to spawning. Selection criteria for female broodstock included $\geq$ 80% GVDB and PI values of $\leq$ 0.10. All selected female broodstock receive two doses of synthetic ovulatory (releasing) hormone LHRHa at 0.1mg/kg body weight: 1) an initial dose (10% of total calculated dose), and 2) a resolving dose (90% of total calculated dose) (Conte et al. 1988). Males do not receive LHRHa injections, with the exception of two males that were experimentally injected during 1997. From 1990 through 1996, all male broodstock were removed from the river to the hatchery, where sperm was extracted. Since 1997 all sperm samples have been collected from flowing males in the field, up to several days before fertilization. A minimum water-activated motility period of 2 min, verified under a dissecting microscope, as well as a high ratio of activated to nonactivated sperm, is required to designate viable sperm samples (Conte 1988).

Initially, (1990-1992) eggs were removed by Caesarian surgery (Conte et al. 1988). Since 1993 eggs have been removed solely by hand stripping (Siple and Anders 1993) to minimize the stress experienced by the broodstock. Use of this hand-stripping technique also enables earlier release of post-spawned broodstock back into the river, and reduces the chance for disease or infection associated with complete post-surgery recovery, which took up to several months. Eggs are collected within 48 hours after the LHRHa resolving dose, after ovulation began, characterized by several hundred eggs visible on the bottom of the spawning tank. Eggs are fertilized, volumetrically quantified, de-adhesed with Fuller's Earth, and incubated in modified MacDonald hatching jars (Conte et al. 1988).

7.3) Cryopreserved gametes.

Cryopreservation of sturgeon gametes is not currently practiced. Research is being conducted at the University of Idaho as part of this program in an attempt to determine if cryopreservation is feasible for sturgeon. This method will be considered for incorporation into future activities if a feasible methodology can be identified.

7.4) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme.

A genetic monitoring program has been implemented to assess and potentially minimize genetic risks associated with this hatchery program. The success of the sturgeon hatchery program hinges on accurately representing the wild population's genetic diversity and variation in a subset of broodstock from that population. Failures of other conservation aquaculture programs to restore wild populations may have resulted from under- or over-representing a subset of a wild populations' specific genotypes or haplotypes or from other selection pressures (Hindar et al. 1991; Waples 1991; Waples and Teel 1990). Such failures may have occurred due to design oversight or logistical or economic constraints.

MtDNA and nuclear DNA are being analyzed, including but not limited to D-loop length variation screen (mtDNA) microsatellite analysis (mt and nuclear DNA), and direct sequencing of mtDNA regions. Samples of wild fish are being taken to monitor possible differences between hatchery and wild brood stocks. Genetic analyses of samples from wild broodstock, their progeny groups, and an ongoing but separate analysis of the wild population all address the issues of genetics accompanying this hatchery program. A sub-contract with the University of Idaho's (ARI) Fish Genetics Lab is currently in place to provide this work.

Nucleotide primer pairs for eight separate microsatellite loci are used to PCR amplify the intervening sequences between primers. All microsatellite primers have been used to previously amplify polymorphic loci in white sturgeon samples (May et al., 1997). An approximate 400 bp segment of the hypervariable, non-repetitive portion of the D-loop region will be sequenced from individuals from each family to assess the nucleotide divergence in this rapidly evolving portion of the mitochondrial genome. For methodologies using sturgeon see Brown et al. (1996), Stabile et al (1996), Miracle and Campton (1995), and Buroker et al. (1990). An automated DNA sequencer and nucleotide primers specific for this region will be used in this task. Geneticists include Dr. Madison Powell and consulting geneticist Dr. Don Campton. University of Idaho, ARI Fish Genetics Lab is subcontracted to perform the genetics portion of proposal.

White sturgeon possess a series of length variants in the control region of their mitochondrial genome that have been used to identify maternal lineage. This length variation arises as a consequence of a gain or loss of 1-5 perfectly repeated tandem 78-82 base-pair sequences (Brown et al., 1996, 1992; Buroker et al., 1990). Frequencies of these length variants were reported for 113 wild white sturgeon from the Kootenai system (Kootenai River n=66; Kootenay Lake n=47; Anders and Powell 1998). Length variant frequencies were subsequently determined for 54 wild broodstock brought to the Kootenai Hatchery from 1997 through 1999 (see Powell and Anders 1999 for DNA isolation and PCR protocols). A Monte Carlo simulation for chi-square tests that employed 1000 boot-strap resampling iterations (Roff and Bentzen 1989) was used to compare how length variant frequencies of the 113 wild fish differed from those of the 54 broodstock from the same wild (source) population. Genetic typing of progeny groups is ongoing but incomplete and not reported here. Five mitochondrial control region length variants have been observed among the 113 fish surveyed from the wild population in the Kootenai River and Kootenay Lake (see Table below). Preliminary results from the 54 wild Kootenai River broodstock suggest that all five length variants found in the wild population were represented by the 54 broodstock. Distribution of haplotype (length variant) frequencies were non-significant with standard chi-square analysis (x^2 = 1.64). However, 82.1% of 1,000 boot strap iterations (Roff and Bentzen 1989) exceeded the average chi-square value of 3.97.

mtDNA control region length variant frequency comparison between 113 wild Kootenai River white sturgeon and 54 Kootenai Hatchery broodstock from the same population. Percent of samples having each length variant is indicated parenthetically.

Length variant	Wild population	Broodstock sample group
LV-01	54 (47.8)	26 (48.1)
LV-02	35 (31.0)	14 (25.9)
LV-03	11 (9.7)	6 (11.1)
V-04	6 (5.3)	3 (5.6)
LV-05	7 (6.2)	5 (9.3)
Totals	113 (100)	54 (100)

The feasibility of pedigree analysis is being explored but it has not been implemented to date. Unlike other animal and fish breeding programs, the logistics of spawning wild endangered white sturgeon lacks many of the luxuries of design flexibility these other species possess. For instance, a desirability or dissimilarity matrix approach has been used for salmonids in the Pacific Northwest to reduce the probability of spawning closely related broodstock and associated deleterious effects. In some of these cases, dozens to hundreds of potential broodstock are simultaneously available, along with added flexibility from cryopreservation. All these conditions are unavailable to our sturgeon spawning program.

Although not a comprehensive population assessment, our genetic analysis (mtDNA control region length variant analysis) provided an efficient, low-cost technique to monitor genetic diversity and variation of native broodstock relative to that of the wild (source) population. The relative simplicity and low cost of this analysis makes it possible to genetically type wild broodstock prior to spawning. Provision of this genetic information can provide hatchery managers, biologists, and geneticists with the opportunity to develop spawning matrices to reduce or eliminate unintended mating of highly related broodstock. Implementation of this analytical technique can also help mimic natural within-population genetic diversity and variation, and theoretically improve fitness of progeny groups. Future genetic research should include the use of bi-parentally inherited nuclear markers (RFLP's and microsatellites) at population, broodstock, and progeny levels to further resolve relevant population genetic issues and to address responses of the wild population to continued operation of the Kootenai River Conservation Aquaculture Program.

SECTION 8. INCUBATION AND REARING

8.1) Incubation:

8.1.1) Number of eggs taken/received and survival rate at stages of egg development.

All fertilized eggs are subsequently incubated, hatched, and reared. Starting in 1999, approximately 5,000 to 20,000 fertilized, disinfected eggs from up to five families are shipped to the British Columbia Ministry of Fisheries Kootenay Hatchery in Fort Steele, British Columbia as a "fail-safe" measure to minimize the risk of catastrophic loss at either facility. Incubation and rearing methods at Fort Steele mirror those used at the KTOI facility

Year	Number of Females Spawned*	Number of Families	**Total** and Mean # Eggs Taken (Range)	Estimated Larvae Produced	Average Egg-Larval Survival Rate
1990	1 (1)	1	**60,000** a	1,100	1.8%
1991	1 (2)	1	**68,536** a	14,000	20%
1992	1 (2)	3	**141,984** a	22,700	16%
1993	1	2	**86,326** b	18,100	21%
1994	0 (0)	0	0	0	0
1995	2 (2)	4	**142,700** c Mean-71,350 (70,875-71,825)	39,800	28%
1996	1 (2)	2	**61,805** c	200	<1%
1997	3 (4)	5	**201,480** c Mean -67,160 (39,600-97,080)	60,600	30%
1998	3 (3)	6	**216,526** c Mean 72,175 (60,076-92450)	60,000	28%
1999	4 (5)	8	**277,050** cd Mean 69,262 (37,800-105,000)	174,500	63%
2000	6 (6)	11	**306,085** cd Mean-51, 014 (17,100-112,160)	223,500	73%

*(Number of females in hatchery in parentheses)
a: eggs taken by caesarian section
b: eggs taken by a combination of hand-stripping and caesarian section
c: eggs taken by hand-stripping
d: a portion of the eggs were incubated at the Kootenay Sturgeon Hatchery

8.1.2) Loading densities applied during incubation.

Fertilized eggs are approximately 3-4 mm in diameter. Each MacDonald jar generally receives 5,000 to 25,000 fertilized eggs and flow is adjusted to maintain a 30-40% exchange per minute.

8.1.3) Incubation conditions.

Water flow through the hatching jars provides a gentle rolling of the eggs, which allows oxygen to reach all eggs in each jar. Eggs typically hatch within 10 to 14 days at 13 degrees C. Upon hatching, fry swim up and exit the MacDonald jars with the effluent water and are deposited directly into rectangular fiberglass rearing tanks (1.2 m x 0.56 m x 0.31m deep). A full description of the UV treatment, water filtration system (to prevent silt from suffocating eggs), and incubation water system see Section 3.1 (Water Source).

8.1.4) Ponding.

Upon completion of hatching, all fry within a family are transferred to circular fiberglass rearing tanks for larval and fingerling grow-out. All families and half-sib families were reared separately until release. Sturgeon are reared in the Kootenai Tribal Hatchery for up to 2 years prior to release. Fish held beyond age one are transferred to larger circular fiberglass tanks (3 - 4.5 m in diameter). See Section 4.4 for further details regarding rearing facilities.

8.1.5) Fish health maintenance and monitoring.

Fungus is controlled during incubation by maintaining a water flow that gently rolls the eggs, as well as temporarily reducing the water flow and siphoning out dead eggs. Eggshells are also siphoned from the fry collection tank several daily during hatching.

8.1.6) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to fish during incubation.

Eggs are incubated using filtered river water (with UV treatment) to minimize the risk of catastrophic loss due to siltation or fungus problems caused by river water and potential filtration problems caused by using chlorinated municipal water. Egg densities in MacDonald hatching jars are kept low to minimize mortality risk from fungus and clumping. Additionally, eggs are incubated separately according to family so that parental contribution at stocking age can be identified and genetics can be monitored.

8.2) Rearing:

8.2.1) Provide survival rate data (*average program performance*) by hatchery life stage (fry to fingerling; fingerling to release) for the most recent twelve years (1988-99), or for years dependable data are available.

Survival data by hatchery life stage is generally not available because routine culling takes place during each life stage. Before 1999, rearing space and water availability was limited and culling was necessary to prevent overcrowding. With full implementation of the program, the number of fish spawned has increased in the past few years. Additionally, with the new upgrades to water quality and quantity, survival during incubation has increased. Rearing space is still a limiting factor and culling to prevent overcrowding is still necessary. High production rates per family are not the focus of this conservation program. Rather, a focus on the breeding plan and an attempt to provide genetic diversity are more important than producing as many fish as possible.

8.2.2) **Density and loading criteria (goals and actual levels).**

Larval, fingerling, and juvenile densities are maintained below 225 g of fish per cubic foot of water as a precaution against density-dependent, stress-induced disease outbreaks.

8.2.3) Fish rearing conditions

Water temperatures for rearing are ambient river water temperatures and range from 1-18^0 C. As part of an ongoing water quality-monitoring program at the KTOI hatchery, monthly water samples are collected at the hatchery inlet (before filtration) and the head tank (after filtration).

Lab analyses of conventional parameters include: Alkalinity, total dissolved solids, total suspended solids, N-Ammonia, NO3 + NO2, and ortho-phosphorus. Lab analyses for inorganics include: Calcium, copper, magnesium, manganese, and zinc. Other parameters monitored include temperature, dissolved oxygen, and bacteria. Quality control analyses are also included in the lab report.

8.2.4) Indicate biweekly or monthly fish growth information (*average program performance*), including length, weight, and condition factor data collected during rearing, if available.

N/A Routine fish growth information is not collected.

8.2.5) Indicate food type used, daily application schedule, feeding rate range (e.g. % B.W./day and lbs/gpm inflow), and estimates of total food conversion efficiency during rearing (*average program performance*).

When larvae are ready to initiate exogenous feeding (2-3 weeks of age), they are started on commercial grade trout starter (soft moist). As they grow, they are fed commercial grade trout food (soft-moist) throughout their time in the hatchery and food size is adjusted for fish size. Feeding rates are decreased as water temperature drops during the fall/winter months.

8.2.6) Fish health monitoring, disease treatment, and sanitation procedures.

A primary goal of any aquaculture program is to minimize introduction and transmission of pathogens in cultured and native populations. Available scientific information should be used to develop conservation and management strategies that minimize the transmission of disease from cultured fish to native populations and the potential severity of disease in the native population (LaPatra et al. 1999). Although asymptomatic infection may be widely distributed within and among wild populations, maintenance of optimal rearing conditions (e.g. optimal rearing densities, temperature regimes, water quality conditions) can reduce or prevent stress-mediated manifestation of disease in the hatchery setting. Development, refinement, and strict implementation of the Program's disease testing protocols for white sturgeon in the Kootenai Hatchery should minimize potential in-hatchery disease outbreak and disease transmission risks to the wild population.

Recent Kootenai Hatchery upgrades completed in 1999 (new water intake system, increased water temperature control for incubation and hatching, sediment filtration systems, pathogen control (UV sterilization), and added rearing capacity) have increased hatching success and survival of early life stages, and minimized disease outbreak and fish loss (Ireland 1999). High fertilization, development, and hatching rates in 1999 and 2000 may be indicative of future benefits to be provided from the extensive hatchery upgrades. The addition of a "fail-safe" facility in British Columbia also helps to ensure success of the program.

From 1992 through 1996, white sturgeon in the Kootenai River Conservation Aquaculture Program were periodically tested for the presence of white sturgeon iridovirus (WSIV), when disease mediated fish loss occurred in the hatchery. Since 1997, all broodstock and at least thirty progeny from each brood year are tested for the presence of pathogens. Disease testing includes parasitology, bacteriology, virology and histology examinations. Since 1997, ovarian fluid and male and female gametes are also sampled and tested for viral pathogens (e.g. WSIV and *Herpes* viruses 1 and 2).

8.2.7) Indicate the use of "natural" rearing methods as applied in the program.

"Natural" rearing methods are currently the subject of experimentation in salmon and steelhead hatcheries in an attempt to identify strategies that produce a fish better adapted for wild conditions they will encounter upon release. These methods include things like natural substrates and structures, cover, and feeding regimens. The unique life history and behavior of sturgeon requires different rearing strategies than for salmon. For instance, sturgeon are deep water, benthic feeders which are not as susceptible to predation by birds and mammals, hence would not benefit by a feeding regimen designed to foster predator avoidance. Current practice is to rear sturgeon in dark, covered circular tanks that provide similar light, water velocity, and water temperature conditions to the natural habitat. Also, the flow through water system in the hatchery provides ambient river water for rearing.

8.2.8) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to fish under propagation.

Fish are currently being reared for release at age 1 or 2. The need to mark all hatchery fish to distinguish from wild production precludes release at a smaller size or age (except for experimental releases of 3-12 day old larvae in 2000). The only suitable tag or mark that can be expected to persist over the life span of these long-lived fish is a PIT tag. In the effort to minimize the risk of domestication effects that may be imparted through rearing to age 1 or 2, we are continuing to research alternative marking methods for smaller fish.

SECTION 9. RELEASE

Describe fish release levels, and release practices applied through the hatchery program.

Prior to 1999, all releases of hatchery-reared Kootenai River white sturgeon were experimental, to assess growth, survival, and habitat use of juveniles in the wild. Annual release numbers are determined each year by the white sturgeon recovery team based on numbers of families, fish available, and the preservation stocking criteria in the breeding plan (Kincaid 1993).

Proposed fish release levels.

Age Class	Maximum Number	Size	Release Date	Location
Eggs				
Unfed Fry	Up to 150,000 (experimental release)		Summer	Kootenai
Fry				
Fingerling				
Yearling	Up to 12,000	> 20 g	Spring/Fall	Kootenai

9.2) Specific location(s) of proposed release(s).

Stream, river, or watercourse: Kootenai River (HUC 17010101)

Release points: Idaho (from downstream to upstream release sites): Porthill - rkm 170 (near Canadian border); Copeland - rkm 199.5; Ferry Island – rkm 205; Rock Creek confluence – rkm 215.5; Shorty's Island – rkm 231; Deep Creek confluence – rkm 240; Hatchery Dock – rkm 241; Ambush Rock – rkm 244.5 (near Bonners Ferry); and Moyie River confluence - rkm 258.5

Major watershed: Kootenai River

Basin or Region: Columbia River Basin/Mountain Columbia Province

9.3) Actual numbers and sizes of fish released by age class through the program.

The Kootenai Tribal conservation program has released 4,879 juvenile white sturgeon into the Kootenai River between 1992 and 2000 (age 1-2 years old) (IDFG database and annual reports; KTOI annual reports; Ireland et al. 2000) and approximately 139,000 larvae (age 3-12 days) in 2000 as an experiment to help determine the early life survival bottleneck (KTOI and IDFG progress reports 2000). Through monitoring and evaluation of the hatchery releases, gillnetting juvenile white sturgeon in the Kootenai River captured a total of 669 juveniles from 1995 through the 2000 sampling season (includes multiple recapture events) in the Kootenai River in Idaho (IDFG database; IDFG and KTOI reports 1996-1999). A total of 14 hatchery produced juvenile white sturgeon have been captured in Kootenay Lake, British Columbia between 1999 and 2000 (BC MELP Progress Reports). Annual growth of hatchery-reared juvenile white sturgeon released into the river and subsequently recaptured averaged 5.27 cm (FL) (IDFG reports). Relative weight, W_r, (Beamesderfer 1993) was calculated for 664 hatchery raised white sturgeon juveniles released into the Kootenai River between 1991-1999 and subsequently recaptured between 1995 and October 2000. Mean relative weight, Wr, was 90.638 (S.D. 27.131) (IDFG unpublished data). With five years of recapture data now collected, post-release survival rates for juveniles in the Kootenai River should be estimated during 2001.

Summary of numbers released and recapture rates of hatchery produced white sturgeon juveniles released into the Kootenai River in Idaho and Montana between 1992-1999. These numbers do not reflect the 173 juveniles recaptured during the 2000-sampling season or the 2,177 juvenile white sturgeon released into the Kootenai River in September – October of 2000 from the 1999-year class (length and weight data for the 1999 year class released in 2000, as well as recapture data from the 2000 sampling season have not been summarized yet). Also not included in the table are the 139,000 3-12 day old larvae released in 2000 as part of an experiment to help determine the bottleneck to survival.

Numbers and recapture rates of hatchery produced white sturgeon juveniles (progeny of wild broodstock) released into the Kootenai River in Idaho and Montana between 1992 and 1999

Year Class	Number Released	Mean Total Length (mm) (S.D.)	Mean Weight (g) (S.D.)	Release year	Percent (#) Recaptured [a]
1990	14	455	321	Summer 1992	25.2 (54) [b]
1991	200	255	64.4	Summer 1992	-
1992	91	-	-	Fall 1994	45 (41)
1995	1,076	229 (27)	47 (16)	Spring 1997	15 (295) [c]
1995	891	343 (43)	147 (61)	Fall 1997	-
1995	99	408 (70)	283.3 (136.8)	Summer 1998	6 (6)
1995	25	565 (71)	805.8 (276.4)	Summer 1999	<1 (2)
1998	306	261 (42)	79.5 (44.4)	Fall 1999	0
Total	2,702				14.7% (398)

a: Percent recaptured during 1993-1999 sampling period for each release year (Excluding multiple recapture events).
b: Includes 1990 and 1991 year class.
c: Includes 1997 spring and fall release.

Analysis of data for release of the 1999 year class and 2000 recapture events was not complete of this writing and is not included in this table.

9.4) Actual dates of release and description of release protocols.

See above table for season of release. See Section 4.2 for description of release protocols. Release dates are generally chosen to coincide with having a majority of any given year class at a size that can be marked. Also, some fish are retained to a larger size in order to attach sonic transmitters for habitat use and movement research.

9.5) Fish transportation procedures, if applicable.

Sturgeon are transported to the release site in an oxygenated covered fiberglass tank filled with ambient river water) mounted on a truck and released from shore or by boat.

9.6) Acclimation procedures.

No acclimation procedures are required for sturgeon. Sturgeon are reared on ambient river water and released into the Kootenai River.

9.7) Marks applied, and proportions of the total hatchery population marked, to identify hatchery component.

Before release, each fish is weighed, measured and marked. Hatchery-produced fish are marked with PIT tags and scute removals. Scutes are removed to denote year class in case of tag loss (e.g. the ninth left lateral and the eighth right lateral scutes were removed from juveniles from the 1998 year class). Due to current limitations of permanent tagging or marking technologies for juvenile white sturgeon, fish are PIT tagged and released at > 20g, since body mass appeared to be a better predictor of PIT tag retention than length or age. In order to determine future post-stocking survival and potential genetic contribution to the next generation, family identification, year class, and release site are included in data records for each fish.

9.8) Disposition plans for fish identified at the time of release as surplus to programmed or approved levels.

The USFWS ESA Section 10 Permit (PRT-798744) authorizes routine culling of hatchery reared fish to maintain low rearing densities (to preclude stress induced disease from overcrowding) and to fulfill the intent of the preservation stocking strategy outlined in the *Breeding Plan to preserve the Genetic Variability of the Kootenai River White Sturgeon* (Kincaid 1993).

9.9) Fish health certification procedures applied pre-release.

One month prior to release, animal health is evaluated using the protocol developed by USFWS, B.C. Ministry of Environment, Land, and Parks, IDFG, and MFWP pathologists and agreed upon by all agencies. Test results are provided to all agencies and a letter of request is written to USFWS from KTOI. After the USFWS concurrence letter is received, a transportation and release permit is obtained from IDFG at the request of KTOI and USFWS. Disease testing results are reviewed by relevant state, provincial, federal and tribal management agencies. Generally, fish with no diagnostic disease symptoms and ≤ 10% prevalence of endemic pathogens are approved for release.

9.10) Emergency release procedures in response to flooding or water system failure.

Refer to Section 4.6.1 for a description of the back-up and emergency system at the Kootenai Tribal Hatchery. Also, risks of system failure have been addressed by incubating eggs at the fail-safe facility. The KTOI program has made a formal international agreement with the British Columbia Ministry of Fisheries to provide off-site “fail-safe” rearing space at the Kootenay Trout Hatchery, Fort Steele, BC. The Kootenai Tribal Hatchery has recently completed exhaustive upgrades to minimize many risks associated with culture facilities. Emergency release procedures can be implemented in the event that all other back-up systems had failed. This would entail contacting USFWS recovery team representatives for an authorization for emergency release.

9.11) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed species resulting from fish releases.

The intent of the breeding plan and preservation stocking strategy outlined in the *Breeding Plan to preserve the Genetic Variability of the Kootenai River White Sturgeon*

(Kincaid 1993) is to minimize risk associated with conventional stocking programs. As stated by Kincaid (1993), "The standard concept of supplemental stocking is that large numbers of fish are reared to the fingerling or yearling stage, then planted on top a "natural" population to expand the production of that fishery. The goal of a supplemental stocking program is typically to expand the population or increase production of a fishery; little attention is given to preservation of the existing gene pool. The term "preservation stocking" is used here to indicate that preservation of genetic variability is the primary objective of the program' as "slow" expansion of population is a secondary goal. Undesirable effects commonly associated with supplemental stocking occur when the hatchery product (1) competes with wild fish for food and rearing space, resulting in reduced survival of the wild fish; (2) competes with wild fish for spawning habitat, resulting in reduced reproduction of wild fish; and (3) interbreeds with wild fish; resulting in the introduction of hatchery-adapted genes, which dilute the genetic attributes and gene complexes that enhance "wild" survival, growth, and reproductive performance. This plan differs from "conventional" supplemental stocking in several ways. First, because the current broodstock has not reproduced successfully since 1974, there is no reproducing population of white in the Kootenai River to compete and interbreed with fish planted under this plan. Second, the number of fish planted will be small compared with conventional supplemental stocking programs. The number of fish planted per family will be equalized at a level designed to produce only 2-5 times broodstock replacement numbers.

The objective of the breeding plan is to preserve the existing gene pool; therefore, number of fish planted will represent equal numbers from all available families and will be only enough to produce 4-10 adults per family at maturity. As individual fish will be used as parents only once every 5 years, the likelihood of inbreeding in future generations will be reduced. Effects of preservation stocking, as outlined under this plan, do not pose a threat to the genetic stocking of the existing gene pool. Conversely, this plan offers an approach for preserving the genetic variability remaining in this seriously threatened, declining white sturgeon population."

SECTION 10. PROGRAM EFFECTS ON ALL ESA-LISTED, PROPOSED, AND CANDIDATE SPECIES (FISH AND WILDLIFE)

10.1) List all ESA permits or authorizations in hand for the hatchery program.

Kootenai River White Sturgeon Biological Opinion (59 FR 45989)
ESA Section 10 Permit No. PRT-798744

All Kootenai Tribe of Idaho activities associated with the backup facility in British Columbia are permitted by a CITES permit issued by the USFWS Office of Management Authority (Permit number 00US011646/9). A USFWS wildlife inspector authorizes concurrent USFWS Form 3177 export/import permits at the time of shipment. Each release of white sturgeon (preservation stocking) into the Kootenai River is cleared by USFWS through written communication (and necessary state and provincial permits are also obtained before transport or stocking). IDFG fish transportation permits have been issued for all fish transport and releases. Disease testing protocols have been developed and implemented to the satisfaction of all agencies and entities involved.

10.2) Provide descriptions, status, and projected take actions and levels for ESA-listed natural populations in the target area.

10.2.1) Description of ESA-listed, proposed, and candidate species affected by the program.

Information concerning the Kootenai River white sturgeon conservation culture program is listed in the above sections. The Draft biological opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities of the program.

- Identify the ESA-listed population(s) that will be directly affected by the program.

The ESA-listed population directly affected by this program is the Kootenai River white sturgeon. Information concerning the Kootenai River white sturgeon conservation culture program is listed in the above sections. The Draft biological opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities of the program.

- Identify the ESA-listed population(s) that may be incidentally affected by the program.

Information concerning the Kootenai River white sturgeon conservation culture program is listed in the above sections. The Draft biological opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities of the program.

10.2.2) Status of ESA-listed species affected by the program.

- Describe the status of the listed natural population(s) relative to "critical" and "viable" population thresholds.

Empirical "critical" population sizes for white sturgeon remain undefined. However, the concept of minimum viable population size (MVP) has been a topic of great interest to conservation biologists (Meffe and Carroll 1994). MVP is defined as the smallest isolated population that has a specified percent chance of persisting for a specified period of time in the face of foreseeable demographic, genetic and environmental stochasticities, and natural catastrophes (Meffe and Carroll 1994). However, it's the unforeseen stochastic and catastrophic events that make accurate predictions difficult.

Nonetheless, Shaffer (1987) reported an MVP that included 500 breeding individuals. The estimated annual number of female breeders in the Kootenai River system (limited relative to males in this population) ranged from 26 to nearly 50 (USFWS, University of Idaho, unpublished data, 2000). Additional male breeders increase this estimate of annual spawners. Thus, relative to Shaffer's 1987 MVP, the viability of the Kootenai River white sturgeon population may be in question.

However, the fact that white sturgeon are iteroparous and possess inter-generational spawning suggests a more optimistic future for the demographics and genetic viability of this population. Proper attention to genotype and nuclear marker frequencies in the wild population, and the broodstock and progeny sample groups should account for maintenance of background variability and within-population diversity.

- Provide the most recent 12-year (e.g. 1988 - present) progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for the listed population. Indicate the source of these data.

During the last ten years of monitoring, only one hatching fry has been found and no free-swimming larvae or young of the year have been captured. Despite extensive monitoring, only 17 naturally recruited juvenile sturgeon associated with experimental augmentation flows between 1991 and 1999 have been captured to date.

- Provide the most recent 12-year (e.g. 1988 - 1999) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.

The effective breeding number (N_e) for a population is the number of individuals in a random breeding population with an equal sex ratio, which would yield the same rate of inbreeding or genetic drift as the population being studied (Falconer 1981). One important goal of the Kootenai River White Sturgeon Conservation Aquaculture Program is to maximize contribution of a large number of individual male and female broodstock over an initial 10-year period (Kincaid 1993; Duke et al. 1999). This practice will theoretically approach a desirable effective population number, or effective number of breeders. Although a linkage-disequilibrium method of N_e estimation for Kootenai River white sturgeon has not been performed, this program is currently investigating the feasibility of using microsatellite data for an assignment test to potentially estimate numbers of breeders contributing to hatchery-produced and wild-produced year classes.

In addition, based solely on probability theory, the estimated number of spawners to be used during this 10-year period (1999-2008) is predicted to reach or exceed the level needed to represent haplotype frequencies in the broodstock (and hence progeny groups) at levels equal to that of the wild population (P. Anders, University of Idaho, pers.comm). For example, the least common length variant in the D-loop of Kootenai River white sturgeon mtDNA is approximately 5% (University of Idaho, unpublished data, 2000). Thus, based on the probability of representing this least common haplotype, present at 5% in the population, approximately 60 different broodstock should be used. Based on current rates of broodstock collection and spawning in the Kootenai hatchery during the past 5 years (see Section 6.4 and 8.1), this goal is expected to be met, thus achieving the goal of matching the haplotype frequency distribution of the wild population within broodstock and progeny groups.

- Provide the most recent 12 year (e.g. 1988 - 1999) estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds, if known.

It will take up to 20 years for hatchery-produced fish to begin contributing to the breeding population.

10.2.3) Describe hatchery activities, including associated monitoring and evaluation and research programs, that may lead to the take of listed species in the target area, and provide estimated annual levels of take *(see "Attachment 1" for definition of "take")*. **Provide the rationale for deriving the estimate.**

The Draft 2000 Biological Opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities associated with this program. All activities are also reviewed and approved by the Kootenai River White Sturgeon Recovery Team.

- Describe hatchery activities that may lead to the take of listed species in the target area, including how, where, and when the takes may occur, the risk potential for their occurrence, and the likely effects of the take.

The Draft 2000 Biological Opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities associated with this program. All activities are also reviewed and approved by the Kootenai River White Sturgeon Recovery Team.

- **Provide information regarding past takes associated with the hatchery program, (if known) including numbers taken, and observed injury or mortality levels for listed fish**.

The Draft 2000 Biological Opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities associated with this program. All activities are also reviewed and approved by the Kootenai River White Sturgeon Recovery Team.

- **Provide projected annual take levels for listed species by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting from the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).**

The Draft 2000 Biological Opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities associated with this program. All activities are also reviewed and approved by the Kootenai River White Sturgeon Recovery Team.

- Indicate contingency plans for addressing situations where take levels within a given year have exceeded, or are projected to exceed, take levels described in this plan for the program.

The Draft 2000 Biological Opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities associated with this program. All activities are also reviewed and approved by the Kootenai River White Sturgeon Recovery Team.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1) Monitoring and evaluation of "Performance Indicators" presented in Section 1.10.

11.1.1) Describe the proposed plans and methods necessary to respond to the appropriate "Performance Indicators" that have been identified for the program.

Table 3. Performance standards and indicators for Kootenai sturgeon hatchery program.

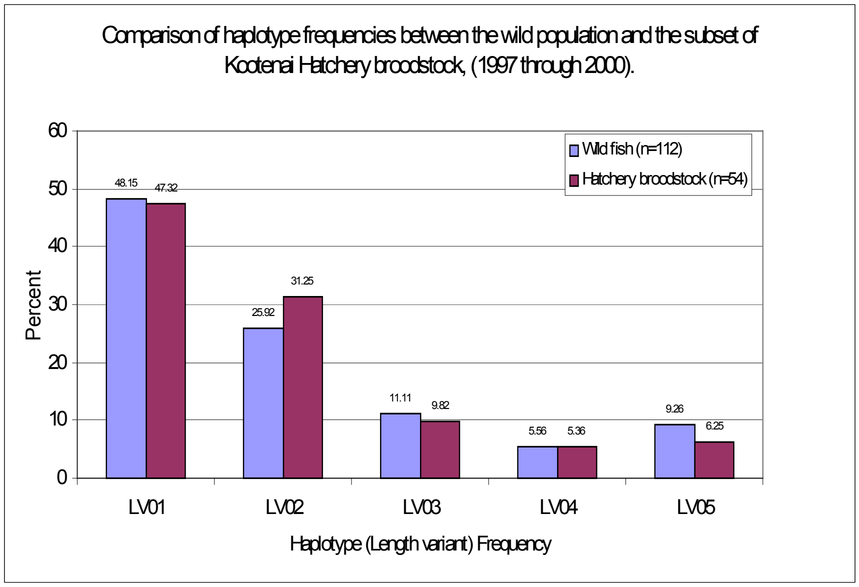
Performance Standard	*Type*	*Performance Indicator*
1. Maintain natural population	**Benefit**	Gradual increase in population size and age composition as a result of recruitment of hatchery fish: *Proportion of the size/age cohort contributed by hatchery* *Number of hatchery-reared fish by life stage including maturity* *Individual growth rates & condition factors* *Size & age specific survival rates* *Relative distribution and habitat use patterns of wild & hatchery fish based on CPUE & sonic telemetry*
2. Conserve genetic & life history diversity	**Benefit**	Retention of wild sturgeon life history characteristics and genetics by the hatchery reared population *Haplotype and genotype frequencies in hatchery broodstock and progeny* *Separate rearing of family groups* *Fail-safe rearing of each family in separate facilities* *Experimental population established outside current range* *Cryopreservation of sperm if feasible* *Individual and population attributes as in #1 above.*
3. Research natural production limitations	**Benefit**	Understanding of the life history characteristics and factors limiting natural recruitment *Estimated natural cohort size relative to known hatchery release number* *Rearing bottlenecks between YOY and adult* *Effects of contaminants on development, survival, & growth* *Evaluation of sediment transport and pre and post dam conditions in the spawning area*
4. Increase effectiveness & reduce costs	**Benefit**	Adaptive approach to achieve results while reducing process, administrative overhead, & operation costs *Complete planning and review processes and move to multi-year funding schedule with check points* *Adapt size and time of release for maximum benefits and minimum risks* *Marking methods to allow release as subyearlings*

		Larval release experiments if appropriate *Cryopreservation techniques*
5. Avoid broodstock mortality	**Risk**	Additional mortality does not speed population decline *Mortality rate of broodstock in hatchery & after release*
6. Do not exceed carrying capacity	**Risk**	No significant density-dependent trend in growth, condition, or behavior of wild or hatchery sturgeon *Individual and population characteristics as in #1 above*
7. Avoid disease transfer	**Risk**	Minimal incidence of disease in the facility *Appropriate spawning & rearing practices & densities* *Rigorous disease testing protocols* *Rear disease-free trout for bait and broodstock feeding*
8. Minimize behavioral or genetic impacts	**Risk**	See #2 above *Release fish at earliest life stage possible*

A comprehensive monitoring and evaluation program is in place to assess genetic variability, survival, growth, movement, and habitat use of juveniles released into the Kootenai River. The monitoring program was initiated in 1993 to annually recapture post-release hatchery-reared white sturgeon in the Kootenai River (Marcuson et al. 1995, IDFG Annual Reports 1996-1999, Kootenai Tribe of Idaho Annual Reports 1997-1999). Mark-and-recapture techniques using gillnets are used to estimate mean annual growth of post-release hatchery-reared white sturgeon in the Kootenai River, as well as provide data for analysis of individual and population characteristics. Ultrasonic telemetry is used to determine juvenile white sturgeon movement and habitat use in relation to depth, velocity, substrate and cover.

Data collection for monitoring and evaluating the adult population is performed by IDFG and BC MELP and is accomplished using setline and hook and line techniques, ultrasonic telemetry, artificial substrate mats (McCabe and Beckman 1990), D-ring plankton nets (Parsley et al. 1989), and other larval fish sampling gear. All data collected by the agencies are contributed to a database managed by IDFG. Analysis includes population attributes such as population size, sex ratio, spawning periodicity, occurrence of natural spawning and spawning behavior, growth and age composition.

Tissue samples (non-invasive pectoral fin clips) have been collected annually from all broodstock and from each progeny group produced in the Kootenai hatchery. These tissue samples are preserved immediately in tissue lysis buffer and sent to the lab (UI,ARI) for genetic analysis (Anders and Powell 1998). Archived genetic data from 113 wild fish from the Kootenai River and Kootenay Lake allow comparisons of haplotype and microsatellite marker frequencies between the wild population, the entire broodstock group, and all progeny groups (families) produced in the hatchery. The goal here is to produce cumulative genetic marker frequency distributions among the broodstock and progeny groups that most closely resemble those of the wild population. To date this goal is being successfully met (see figure below):



11.1.2) Indicate whether funding, staffing, and other support logistics are available or committed to allow implementation of the monitoring and evaluation program.

Funding and staff for monitoring and evaluation are an integral component of annual contracts with the Bonneville Power Administration.

11.2) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed species resulting from monitoring and evaluation activities.

Risks of monitoring activities are minimal. The proportion of wild fish handled is small and non-lethal sampling methods are employed.

SECTION 12. RESEARCH

The KTOI white sturgeon program has been extensively coordinated with ongoing sturgeon research and recovery. While other project sponsors have proposed supplementation, the KTOI white sturgeon conservation aquaculture project is the only project successfully producing white sturgeon juveniles from wild broodstock in the Upper Columbia Basin. The KTOI staff initially spent time with experts in this particular field (Serge Doroshov and Joel Van Eenennaam, UC Davis, and Terry Patterson, CSI) to learn the intricacies of the sturgeon culture process. With the increasing success of the project, other project managers in the region have spent time with the KTOI staff to learn the complexities of spawning and rearing this species.

While the aquaculture program is essential to the population recovery effort, recovery is also contingent upon re-establishing natural recruitment. Research to determine factors limiting recruitment is an important component of this program and is well coordinated with other research agencies (IDFG, BC Ministry of Environment, MDFWP, and USFWS). In order to determine potential risk associated with limiting factors, the effects of individual and concurrent multiple stressors in the Kootenai River ecosystem must be addressed (Foran and Ferenc 1999). This portion of the program attempts to qualify and quantify these multiple stressors in order to evaluate the total and secondary impacts on resources from anthropogenic disturbances.

12.1) Objective or purpose.

The following is a summary of limiting factors from the Kootenai River Subbasin Summary (2000):

The substantially unnatural change to the flows in the Kootenai River caused by at Libby Dam is considered to be a primary reason for the Kootenai River white sturgeon's continuing lack of recruitment and declining numbers. As a result of original Libby Dam operations (until the initiation of experimental flows in 1992), the natural, high, spring flows thought to be required by white sturgeon for reproduction rarely occurred during the May-to-July spawning season when suitable temperature, water velocity, and photoperiod conditions would normally exist. In addition, cessation of periodic flushing flows has allowed fine sediments to build up in Kootenai River bottom substrates. This sediment fills the spaces between riverbed cobbles, reducing fish egg survival, larval and juvenile fish security cover, and insect production. Acoustic Doppler profiles of the Kootenai River bottom have revealed large sand dunes located in the spawning reaches used by the white sturgeon (IDFG/USGS unpublished data). The effect of moving dunes is unknown but may contribute to egg suffocation and/or prolonged contact with contaminated sediments, further contributing to recruitment failure.

White sturgeon in the Kootenai River spawn within an 18 km reach of river downstream of Bonners Ferry, Idaho (river kilometers 228-246). This spawning reach is comprised of sand substrate, which is thought to be poor habitat for survival of eggs and larva when compared to white sturgeon spawning habitat in the Columbia River (Parsley and Beckman 1994; Paragamian et al., in press). More suitable substrates of cobble and gravel are upstream of Bonners Ferry (Apperson 1991, Paragamian et al., in press). Improved flows for spawning in recent years appears to have resulted in increased spawning as evidenced by the collection of more sturgeon eggs (Paragamian et al., in press). Despite improved spawning, the success for recovery of Kootenai River white sturgeon remains a serious concern. Few wild juvenile white sturgeon have been captured that were produced during flow test years.

Lake spring maximum elevations also appear to be contributing to the decline of white sturgeon. Concomitant to Libby Dam construction, the elevation of Kootenay Lake was lowered 2 m. Although Kootenay Lake is 108 km downstream of the spawning reach, higher lake elevations have a backwater effect on the sturgeon spawning reach. As the lake elevation rose during any given spawning season, sturgeon spawned progressively further upstream (Paragamian et al., in progress). Fifty-nine percent of the variation in spawning location was attributable to Kootenay Lake elevation. A linear regression model indicated higher lake elevations might promote spawning further upstream over cobble substrate.

As a consequence of altered flow patterns, average water temperatures in the Kootenai River are typically warmer (by 3 degrees Celsius) during the winter and colder (by 1 - 2 degrees Celsius) during the summer than prior to impoundment at Libby Dam (Partridge 1983).

However, during large water releases and spills at Libby Dam in the spring, water temperatures in the Kootenai River may be colder than under normal, non-spill, spring flow conditions.

Much of the Kootenai River has been channelized and stabilized from Bonners Ferry downstream to Kootenay Lake, resulting in reduced aquatic habitat diversity, altered flow conditions at potential spawning and nursery areas, and altered substrates in incubation and rearing habitats necessary for survival (Partridge 1983, Apperson and Anders 1991). Side-channel slough habitats in the Kootenai River flood plain were eliminated by diking and bank stabilization in the Creston Valley Wildlife Management Area in British Columbia and Kootenai National Wildlife Refuge in Idaho.

The overall biological productivity of the Kootenai River downstream of Libby Dam has also been altered. Libby Dam blocks the open exchange of water, organisms, nutrients, and coarser organic matter between the upper and lower Kootenai River. Snyder and Minshall (1996) stated that a significant decrease in concentration of all nutrients examined was apparent in the downstream reaches of the Kootenai River after Libby Dam became operational in 1972. Libby Dam and the impounded Lake Koocanusa reduced downstream transport of phosphorus and nitrogen by up to 63 and 25 percent respectively (Woods 1982), with sediment-trapping efficiencies exceeding 95 percent (Snyder and Minshall 1996). The Kootenai River, like other large river-floodplain ecosystems, was historically characterized by seasonal flooding that promoted the exchange of nutrients and organisms among a mosaic of habitats (Junk et al. 1989; Bayley 1995). As a result of channel alterations, the Kootenai River has a lowered nutrient and carbon-retention capacity. Wetland drainage, diking and subsequent flood control has eliminated the "flood pulse" of the river and retention and inflow of nutrients. Removal of riparian and floodplain forests has eliminated sources of wood to the channel and potential retention structures.

In relation to reduced productivity, potential threats to Kootenai River white sturgeon include decreased prey availability for some life stages of sturgeon, and a possible reduction in the overall carrying capacity for the Kootenai River and Kootenay Lake to sustain populations of white sturgeon and other native fishes. A limited food supply for young of the year could contribute to increased mortality rates, either through starvation or through increased predation mortality, because young of the year would spend more time feeding, thereby exposing themselves to higher predation risk. The reduction in native kokanee in the South Arm of Kootenay Lake may have also reduced nutrient contributions (deteriorating carcasses from spawners) from tributaries in Northern Idaho and British Columbia flowing into the Kootenai River. Kokanee were also considered an important food source for adult sturgeon to build reserves for the winter and help in final gonad maturation. Growth rates of sturgeon have declined and relative weights in the Kootenai River/Lake population are the lowest in reported sturgeon populations in the Northwest.

In the Adaptive Environmental Assessment modeling exercise performed for the Kootenai River system in 1997, predation on eggs and larvae was identified as a potential threat to successful white sturgeon recruitment. For broadcast spawners like white sturgeon, the mortality rate on eggs and larvae will increase with: 1) an increase in the number of predators; 2) an increase in the vulnerability of eggs or larvae to predation associated with changes in habitat or foraging behavior; and 3) a decrease in the volume or area of water that the eggs/larvae are dispersing into or over (as volume or area decreases, prey concentration to predators in increases). In post-impoundment years, Kootenai River springtime flows have been reduced substantially and vulnerability has increased due to an increase in water clarity and reduced food supply, as well as loss of habitat in the spawning reach.

Georgi (1993) noted that the chronic effects on wild sturgeon spawning in "chemically polluted" water and rearing over contaminated sediments, in combination with bioaccumulation of contaminants in the food chain, is possibly reducing the successful reproduction and early-age recruitment to the Kootenai River white sturgeon population. Results from a contaminant study performed in 1998 and 1999 showed that water concentrations of total iron, zinc, and manganese, and the PCB Arochlor 1260 exceeded suggested environmental background levels (Kruse 2000). Zinc and PCB levels exceeded EPA freshwater quality criteria. Several metals, organochlorine pesticides, and the PCB Arochlor 1260 were found above laboratory detection limits in ova from adult female white sturgeon in the Kootenai River. Plasma steroid levels in adult female sturgeon showed a significant positive correlation with ovarian tissue concentrations of the PCB Arochlor 1260, zinc, DDT, and all organochlorine compounds combined, suggesting potential disruption of reproductive processes. In an experiment designed to assess the effects of aquatic contaminants on sturgeon embryos, results suggest that contact with river-bottom sediment increases the exposure of incubating embryos to metal and organochlorine compounds (Kruse 2000). Increased exposure to copper and Arochlor 1260 significantly decreased survival and incubation time of white sturgeon embryos and could be a potentially significant additional stressor to the white sturgeon population

12.2) Cooperating and funding agencies.

USFWS Recovery Team

All recovery work is coordinated through the white sturgeon recovery team that includes members from the U.S. Fish and Wildlife Service (USFWS), Kootenai Tribe of Idaho (KTOI), Idaho Department of Fish and Game (IDFG), Montana Fish, Wildlife, and Parks (MFWP), University of Idaho (U of I), Army Corp of Engineers (ACOE), British Columbia Ministry of Environment, Land, and Parks (BC MELP), and Canada Department of Fisheries and Oceans (CDFO). White sturgeon in the Kootenai drainage constitute a transboundary population, crossing interstate and international boundaries. This project is a component of many different programs working concurrently on white sturgeon recovery and ecosystem rehabilitation.

Research is funded through BPA, USFWS, and numerous cost-sharing agreements with other agencies listed below:

Upper Columbia United Tribes – KTOI Fish and Wildlife Program Support

BC Ministry of Environment, Land, and Parks – Kootenay River and Lake Management

BC Ministry of Fisheries – Fail-safe facility staffing and expertise

Clear Springs Foods Research and Development – WSIV analyses, animal health consulting, and experiments to further knowledge about sturgeon pathogens

IDFG Fish Health Lab – animal health consulting

USFWS Dworshak Fish Health Center – Disease testing

USGS – Cost share for assessment of feasibility of improving white sturgeon spawning habitat

UC Davis – information transfer about sturgeon culture

College of Southern Idaho – information transfer about sturgeon culture

University of Idaho – Dept of Biology –cost share for developing cryopreservation techniques for sturgeon

University of Idaho Center for Salmonid and Freshwater Species at Risk – genetic analysis, program support, policy support, research (tagging, biological condition)

12.3) Principle investigator or project supervisor and staff.

University of Idaho Center for Salmonid and Freshwater Species at Risk and the Aquaculture Research Institute: Drs. Madison Powell, Ernie Brannon, and Paul Anders – genetics research, analysis of biological condition, permanent-tagging techniques

University of Idaho Biology Department: Dr. Joseph Cloud in cooperation with Serge Doroshov – cryopreservation of white sturgeon gametes

University of Idaho Fish and Wildlife Department: Dr. Dennis Scarnecchia – white sturgeon habitat use and growth

Clear Springs Foods Research and Development: Dr. Scott LaPatra – WSIV analyses, animal health consulting, and experiments to further knowledge about sturgeon pathogens (in cooperation with College of Southern Idaho and U of I Aquaculture Research Institute)

Free Run Aquatic Research: Gretchen Kruse – contaminant analysis and effects on reproductive success

12.4) Status of population, particularly the group affected by project, if different than the population(s) described in Section 2.

Status of population described in previous sections.

12.5) Techniques: include capture methods, drugs, samples collected, tags applied.

Research is conducted in conjunction with the conservation culture program and the on-going monitoring and evaluation program. No research is proposed that requires increased sampling of the population. Capture methods are described in previous sections.

12.6) Dates or time period in which research activity occurs.

Spawning of wild white sturgeon broodstock occurs during May-July. Research activities associated with gametes and larvae occur at this time.

12.7) Care and maintenance of live fish or eggs, holding duration, transport methods.

Care and maintenance of live fish or eggs, holding duration, and transport methods are described in earlier sections.

12.8) Expected type and effects of take and potential for injury or mortality.

No mortality expected for wild white sturgeon or juvenile white sturgeon released into the Kootenai River and subsequently recaptured. Any eggs and larvae used for research experiments are in excess of the conservation culture program needs.

12.9) Level of take of listed species: number or range of individuals handled, injured, or killed by sex, age, or size, if not already indicated in Section 2 and the attached "take table" (Table 1).

The Draft 2000 Biological Opinion for Kootenai River white sturgeon and the USFWS ESA Section 10 permit cover all activities associated with this program. All activities are also reviewed and approved by the Kootenai River White Sturgeon Recovery Team.

12.10) Alternative methods to achieve project objectives.

Research addressing habitat use, genetics, endemic pathogens or contaminants is population specific; therefore it would be difficult to use a surrogate population (other white sturgeon population or commercial stock) to accomplish project research objectives.

12.11) List species similar or related to the threatened species; provide number and causes of mortality related to this research project.

N/A

12.12) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse ecological effects, injury, or mortality to listed species as a result of the proposed research activities.

All white sturgeon activities have been reviewed by the USFWS white sturgeon recovery team and are conducted in compliance with Federal Guidelines and terms and conditions outlined in the USFWS ESA Section 10 permit

SECTION 13. ATTACHMENTS AND CITATIONS

Alden, W.C. 1953. Physiography and glacial geology of Western Montana and adjacent areas. Geological Survey Professional Paper 231. U. S. Government Printing Office.

Anders, P. J. 1997. The need for objective assessment of conservation aquaculture. Fisheries Vol. 22(5):46.

Anders, P. J., and D. L. Richards. 1996. Implications of ecosystem collapse on white sturgeon (Acipenser transmontanus) in the Kootenai River, Idaho, Montana, and British Columbia. Pages 27-40 In S. Doroshov, F. Binkowski, T. Thuemeler, and D. MacKinlay, eds. Culture and Management of Sturgeon and Paddlefish Symposium Proceedings. Physiology Section, American Fisheries Society, Bethesda, MD.

Anders, P. J., D. L. Richards, and M. S. Powell. 2000. The first endangered white sturgeon population: Repercussions in an altered large River-floodplain ecosystem. In: Proceedings of the 130th Annual Meeting of the American Fisheries Society. St. Louis MO., August 20-24, 2000.

Anders, P.J. 1991. White sturgeon (Acipenser transmontanus) movement patterns and habitat utilization in the Kootenai River system, Idaho, Montana and British Columbia. MS Thesis, Eastern Washington University. 153 pp.

Anders, P.J. 1995. Kootenai River White Sturgeon Studies. Report C: Kootenai River Tributary Kokanee Spawning Ground Survey. Annual Report. BPA Project No. 88-64.

Anders, P.J. 1998. Conservation aquaculture and endangered species: Can objective science prevail over risk anxiety? Fisheries 23(11):28-31.

Anders, P.J. and M. S. Powell. 1998. Preliminary report of mitochondrial DNA diversity and variation of white sturgeon (Acipenser transmontanus) from the Columbia River Basin. Report F. In: Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and Determine the status and habitat requirements of white sturgeon in the Columbia and Snake Rivers upstream from McNary Dam. Annual Progress Report to the Bonneville Power Administration. BPA Project 86-50.

Anders, P.J. and R.E. Westerhof. 1996. Conservation Aquaculture of endangered white sturgeon (Acipenser transmontanus) from the Kootenai River, Idaho. Pages 51-62 in S. Doroshov, F. Binkowski, T. Thuemeler, and D. MacKinlay, eds. Culture and Management of Sturgeon and Paddlefish Symposium Proceedings. Physiology Section, American Fisheries Society, Bethesda, MD.

Apperson, K.A. and P.J. Anders. 1991. Kootenai River white sturgeon investigations and experimental culture. Annual Progress Report FY1990. Idaho Department of Fish and Game and Bonneville Power Administration. Contract No. DE-A179-88BP3497; Project No. 88-65. Portland, Oregon.

Beamesderfer, R. C. P, and R. A. Farr. 1997. Alternatives for the protection and restoration of sturgeons and their habitat. Pages 407-417 in V.J. Birstein, J.R. Waldman, and W.E. Bemis, editors. Sturgeon Biodiversity and Conservation. Kluwer Academic Publishers, Dordrecht.

Bonneville Power Administration. 1997. Kootenai River white sturgeon aquaculture project: environmental assessment. Bonneville Power Administration, DOE/EA-1169, Portland, OR.

Brannon, E. L. 1993. The perpetual oversight of hatchery programs. Fisheries Research (18):19-27.

Brown, J.R. 1992. Mitochondrial DNA length variation and heteroplasmy in populations of white sturgeon (Acipenser transmontanus). Genetics. 132:221-228.

Brown, J.R., K. Beckenbach, A.T. Beckenbach, and M.J. Smith. 1996. Length variation, heteroplasmy and sequence divergence in the mitochondrial DNA of four species of sturgeon (Acipenser). Genetics. 142:525-535.

Buroker, N.E., J.R. Brown, T.A. Gilbert, P.J. O'Hara, A.T. Beckenbach, W.K. Thomas, and M.J. Smith. 1990. Length heteroplasmy of sturgeon mitochondrial DNA; an illegitimate elongation model. Genetics 124: 157-163.

Conte, F.S., S.I. Doroshov, P.B. Lutes, and M.E. Strange. 1988. Hatchery manual for the white sturgeon (Acipenser transmontanus) with application to other North American Acipenseridae. Publications Division, Agriculture and Natural Resources, University of California, Oakland. Publication 3322.

DeVore, J. D., B. James, and R. Beamesderfer. 1999. Lower Columbia River white sturgeon: Current stock status and management implications. Washington Department of Fish and Wildlife. In Press.

Duke, S., P. Anders, G. Ennis, R. Hallock, J. Hammond, S. Ireland, J. Laufle, R. Lauzier, L. Lockard, B. Marotz, V. Paragamian, and R. Westerhof. 1999. Recovery plan for the Kootenai River white sturgeon. Journal of Applied Ichthyology 15(1999): 157-163.

EcoAnalysts, Inc. 1998. Stream Habitat Survey of Long Canyon, Parker, and Trout Creeks: Tributaries to the Kootenai River, Idaho, with Special Consideration of Kokanee Spawning Habitat and Enhancement Potential. Prepared for Kootenai Tribe of Idaho.

Giorgi, A. 1993. The status of the Kootenai River white sturgeon. Report prepared for the Pacific Northwest Utilities Conference Committee. September 1993.

Graham, P.J. 1981. Status of white sturgeon in the Kootenai River. Montana Department of Fish Wildlife and Parks. Kalispell, Montana.

Hindar, K., N. Ryman, and F. Utter. Genetic effects of cultured fish on natural populations. Can. J. Fish. Aquat. Sci. 48:945-957.

Ireland, S. C. 1997. Kootenai River White Sturgeon Studies and Conservation Aquaculture. Annual Report. BPA Project No. 88-64. Portland, Oregon.

Ireland, S. C. 1998. Kootenai River White Sturgeon Studies and Conservation Aquaculture. Annual Report. BPA Project No. 88-64. Portland, Oregon

Ireland, S. C. 1999. Kootenai River White Sturgeon Studies and Conservation Aquaculture. Kootenai Tribe of Idaho. Prepared for Bonneville Power Administration. Progress Report, Contract DE-B179-88BI93743, Project 88-64, Portland, OR.

Ireland, S. C., P. J. Anders, and J.T. Siple. 2000. Conservation aquaculture: An adaptive approach to prevent extinction of an endangered white sturgeon population. Manuscript in prep. Draft in: Proceedings of the 130th Annual Meeting of the American Fisheries Society. St. Louis MO., August 20-24, 2000.

J-U-B Engineers. 1997. Preliminary Engineering Report - Hatchery Improvements for the Recovery of White Sturgeon. Prepared for Kootenai Tribe of Idaho. BPA Project No. 88-64.

Junk, W.J., P.B. Bayley, and R.E. Sparks. 1989. The flood pulse concept in river floodplain systems. Can. Spec. Publ. Fish. Aquati. Sci. 106:110-127.

Kincaid, H. 1993. Breeding Plan to Preserve the Genetic Variability of the Kootenai River White Sturgeon. Final Report to Bonneville Power Administration, U.S. Fish and Wildlife Service. Project 93-27. Contract Number DE-AI79-93B002886. Portland, Oregon.

LaPatra, S.E., J.M. Groff, G.R. Jones, B. Munn, T. L. Patterson, R.A. Holt, A.K. Hauck, and R.P. Hedrick. 1994. Occurrence of white sturgeon iridovirus infections among cultured white sturgeon in the Pacific Northwest. Aquaculture Vol. 126:201-210.

LaPatra, S.E., J.M. Groff, T.L. Patterson, W.D. Shewmaker, M. Casten, J. Siple, and A.K. Hauck. 1996. Preliminary Evidence of Sturgeon Density and Other Stressors on Manifestation of White Sturgeon Iridovirus Disease. Journal of Applied Aquaculture. Vol. 6, No. 3 pp. 51-58.

LaPatra, S.E., S.C. Ireland, J.M. Groff, K.M. Clemens, and J.T. Siple. 1999. Adaptive disease management strategies for the endangered population of Kootenai River white sturgeon. Fisheries 24(5): 6-13.

Marcusen, P., V. Wakkinen, and G. Kruse-Malle. 1995. Kootenai River white sturgeon investigation. Idaho Department of Fish and Game. Annual Report prepared for Bonneville Power Administration. Contract No. DE-B179-88BP43497; Project No. 88-65, Portland, Oregon.

May, B., C.C. Krueger, and H.L. Kincaid. 1997. Genetic variation at microsatellite loci in sturgeon: primer sequence homology in Acipenser and Scaphirhynchus. Can. J. Aquat. Sci. 54:1542-1547.

McCabe, G. T., Jr. and C. A. Tracy. 1992. Spawning and life history of white sturgeon, Acipenser transmontanus, in the lower Columbia River. Fishery Bulletin 92:760-772.

McCabe, G.T., and L.G. Beckman. 1990. Use of an artificial substrate to collect white sturgeon eggs. California Fish and Game 76 (4) : 248-250.

Meffe G.K , and C. R. Carroll. 1994. Principles of Conservation Biology. Sinauer and Associates Inc. Sunderland, MA. USA.

MFWP, CSKT, and KTOI. 1997. Fisheries mitigation and implementation plan for losses attributable to the construction and operation of Libby Dam.

Miracle, A.L., and D.E. Campton. 1995. Tandem repeat sequence variation and length heteroplasmy in the mitochondrial DNA D-loop of the threatened Gulf of Mexico sturgeon, Acipenser oxyrhynchus desotoi. J. Heredity 86: 22-27.

Northcote, T.C. 1973. Some impacts of man on Kootenay Lake and its salmonids. Great Lakes Fishery Commission. Technical Report, Number 2.

Northwest Power Planning Council. 1994 as amended in 1995. Fish and Wildlife Program (FWP). Portland, Oregon.

Paragamian, V.L. 1994. Kootenai River Fisheries Investigations. Annual Progress Report FY 1993. Prepared for U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-AI79-88BP93497; Project No. 88-65, Portland, Oregon.

Paragamian, V.L., G. Kruse, and V. Wakkinen. 1996. Kootenai River White Sturgeon Investigations. Annual Progress Report FY 1996. Prepared for U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-AI79-88BP93497; Project No. 88-65, Portland, Oregon.

Paragamian, V.L., G. Kruse, and V. Wakkinen. 1997. Kootenai River white sturgeon spawning and recruitment evaluation. Idaho Department of Fish and Game. Annual Report prepared for Bonneville Power Administration. Contract No. DE-B179-88BP43497; Project No. 88-65, Portland, Oregon.

Paragamian, V.L., V. Whitman, J. Hammond, and H. Andrusak. 2000. Collapse of burbot fisheries in the Kootenai River, Idaho, USA, and Kootenay Lake, British Columbia, Canada. Pages 155-164 in V.L Paragamian and D.W. Willis, editors, Burbot Biology, Ecology, and Management. Publication Number 1, Fisheries Management Section of the American Fisheries Society, Spokane, Washington, USA.

Parsley, M.J., L.G. Beckman, and G.T. McCabe. 1989. Report I in A.A. Nigro, editor. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Report to Bonneville Power Administration, Project 86-

Partridge, F. 1983. Kootenai River Fisheries Investigations. Idaho Department of fish and Game. Job Completion Report. Project F-73-R-5, Subproject IV, Study VI, Boise, Idaho.

Powell, M.S., and P. J. Anders. 1999. Assessing genetic variation among Columbia Basin white sturgeon populations. Annual Progress report to the Bonneville Power Administration. BPA Project 99-22.

Resident Fish Manager's Caucus of the Columbia Baisn Fish and Wildlife Authority (RFM-CBFWA). 1997. Multi-Year Implementation Plan for Resident Fish Protection, Enhancement, and Mitigation in the Columbia River Basin. Final Draft, June 3, 1997. Columb

Roff, D. A., and P. Bentzen. 1989. The statistical anlysis of mitochondrial DNA polymorphisms: X2 and the problem of small samples. Molecular Biology and Evolution (6):539-545.

Shaffer, M. L. 1987. Minimum viable populations: Coping with uncertainty. In: M.E. Soule (ed.) Viable populations for Conservation pp.69-86. Cambridge University Press, Cambridge.

Siple, J.T. and G. Aitken. 1991. Annual Kootenai Hatchery Report In: Kootenai River White Sturgeon Studies. Annual Report. BPA Project No. 88-65.

Siple, J.T. and G. Aitken. 1992. Annual Kootenai Hatchery Report. In: Kootenai River White Sturgeon Studies. Annual Report. BPA Project No. 88-65.

Siple, J.T. and P.J. Anders. 1993. Annual Kootenai Hatchery Report. In: Kootenai River White Sturgeon Studies. Annual Report B. BPA Project No. 88-64.

Siple, J.T. and P.J Anders. 1994. Annual Kootenai Hatchery Report. In: Kootenai River White Sturgeon Studies. Annual Report B. BPA Project No. 88-64.

Siple, J.T. and P.J Anders. 1995. Annual Kootenai Hatchery Report. In: Kootenai River White Sturgeon Studies. Annual Report B. BPA Project No. 88-64.

Siple, J.T. and S.C. Ireland. 1996. Kootenai River White Sturgeon Studies. Annual Hatchery Report. BPA Project No. 88-64

Siple, J.T. and T.L. Patterson. 1991. Snake River Sturgeon Report. Information from 1988-1990. Progress Report. Idaho Department of Fish and Game. Boise, Idaho.

Snyder, E.B., and G.W. Minshall. 1996. Ecosystem metabolism and nutrient dynamics in the Kootenai River in relation to impoundment and flow enhancement for fisheries management. Annual Report. Stream Ecology Center, Idaho State University, Pocatello, Idaho.

Stabile, J. J.R. Waldman, F. Parauka, and I. Wirgin. 1996. Stock structure and homing fidelity in Gulf of Mexico sturgeon (Acipenser oxyrinchus desotoi) Based on restriction fragment length polymorphism and sequence analysis of mitochondrial DNA. Genetics. 144:767-775.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; determination of endangered status for the Kootenai River population of white sturgeon-Final Rule. Federal Register 59(171): 45989-46002. (September 6, 1994).

U.S. Fish and Wildlife Service. 1999. Recovery plan for the Kootenai River population of the white sturgeon (Acipenser transmontanus). Region 1, USFWS, Portland, OR.

U.S. Fish and Wildlife Service. 2000. U.S. Policy regarding controlled propagation of species listed under the Endangered Species Act. Federal Register 65 (183) (September 20, 2000).

Van Eenennaam, J.P., S.I. Doroshov, and G.P. Moberg. 1996. Spawning and reproductive performance of domestic white sturgeon (Acipenser transmontanus). Pages 117-122 in S. Doroshov, F. Binkowski, T. Thuemeler, and D. MacKinlay, eds. Culture and Management of Sturgeon and Paddlefish Symposium Proceedings. Physiology Section, American Fisheries Society, Bethesda, MD.

Waples, R. S., and D. J. Teel. 1990. Conservation genetics of Pacific Salmon I. Temporal changes in allele frequency. Conservation Biology Vol. 4(2):144-156.

Waples. R. 1991. Genetic interactions between hatchery and wild salmonids: lessons from the Pacific Northwest, Canadian Journal of Fisheries and Aquatic Sciences 48(Suppl. 1):124-133.

SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the foregoing information is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C.1531-1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Name, Title, and Signature of Applicant:

Certified by: Susan C. Ireland
Kootenai Tribal Fisheries Program Director
December 15, 2000