BONNEVILLE
POWER ADMINISTRATION

US ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT
KOOTENAI RIVER BASIN

SUPPLEMENTAL BIOLOGICAL ASSESSMENT ON THE EFFECTS OF THE OPERATION OF LIBBY DAM ON KOOTENAI RIVER WHITE STURGEON AND BULL TROUT

July 2004

US ARMY CORPS OF ENGINEERS
NORTHWESTERN DIVISION

1. Introduction

In accordance with the Endangered Species Act (ESA), a federal agency must insure, in consultation with the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS) (also called NOAA Fisheries or NOAA), that any action carried out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat of such species. The U.S. Army Corps of Engineers (Corps), Bonneville Power Administration (BPA), and the U.S. Bureau of Reclamation (Reclamation) (together, the action agencies), submitted a Biological Assessment (BA) in December, 1999 and entered into ESA Section 7 consultation on multiple species with the USFWS and NMFS on the operation of the Federal Columbia River Power System (FCRPS). The FCRPS projects subject to this consultation included fourteen Federal projects on the Columbia River and major tributaries, including the Snake, Clearwater, Pend Oreille, Flathead, and Kootenai rivers. The Corps and Reclamation operate these projects for multiple uses including flood control, navigation, hydropower, water supply, water quality, fish and wildlife, irrigation, and recreation. BPA markets the power produced at these projects.

The USFWS and NMFS issued Biological Opinions (BiOps) in December 2000 concerning operation of the FCRPS. The USFWS 2000 BiOp concluded that the proposed FCRPS operation would not jeopardize the continued existence of bull trout (*Salvelinus confluentus*). As to the effects of the proposed action on the listed Kootenai River white sturgeon (sturgeon), *Acipenser transmontanus*, the USFWS made a jeopardy determination and recommended a Reasonable and Prudent Alternative (RPA). The NOAA Fisheries 2000 BiOp concluded jeopardy on the effects of the FCRPS on eight of twelve listed evolutionarily significant units (ESUs) of anadromous species (salmon and steelhead) in the Columbia Basin, and also recommended an RPA. The USFWS and NOAA Fisheries BiOps included an adaptive management framework, in recognition of the flexibility necessary to operate the FCRPS for multiple uses. A Regional Forum process, originally recommended by NOAA Fisheries, has served as a forum for adaptive management and ESA coordination activities, including those under the USFWS BiOp.[1]

The Corps signed a Record of Consultation and Statement of Decision (ROCASOD) on May 15, 2001 to implement actions consistent with both BiOps and incidental take statements to meet its responsibilities under the ESA to avoid jeopardizing the twelve listed anadromous ESUs (salmon and steelhead), the Kootenai River white sturgeon, and bull trout. BPA signed a Decision Document[2] describing its decision to implement the

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[1] The Regional Forum invites membership of federal agencies (the action agencies, NOAA Fisheries, the USFWS, the Environmental Protection Agency (EPA), and others); the states of Montana, Idaho, Washington, and Oregon; and the Columbia Basin Tribes.

[2] Decision Document Regarding Responsibilities under the Endangered Species Act, Clean Water Act, and Additional Laws Following the December 2000 National Marine Service Biological Opinion and December 2000 U.S. Fish and Wildlife Service Biological Opinion on Operation of Major Projects of the Federal Columbia Power System

NOAA Fisheries and USFWS BiOps in August 7, 2001; and Reclamation signed their "Finding and Commitments" decision document on August 8, 2001.

The USFWS published its critical habitat designation for the Kootenai River white sturgeon in September 2002, subsequent to the action agencies' adoption of the recommendations in the BiOps. ESA regulations require initiation of consultation when critical habitat is designated. Additionally, the ESA regulations require reinitiation when there is new information concerning the effects of the action on the species not previously considered, and when the identified action is modified in a manner that causes an effect to the species or critical habitat that was not considered. Because such circumstances arose following issuance of the 2000 USFWS BiOp, the Corps and BPA requested reinitiation of consultation on the effects of the operation of Libby Dam on Kootenai River white sturgeon and its critical habitat.[3]

As noted above, in the USFWS 2000 BiOp the action agencies were provided an RPA for the operation of Libby and the effects on the sturgeon. ESA regulations allow for identification of an RPA when the USFWS makes a determination that the action agency's proposed action is likely to jeopardize the continued existence of the listed species or result in the destruction or adverse modification of critical habitat. The RPA is an alternative action that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the agency's legal authority and jurisdiction, that is economically and technologically feasible, and that the USFWS believes would avoid the likelihood of jeopardizing the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

The Corps and BPA have concluded that some components of the USFWS RPA may not be consistent with the RPA criteria. Consequently, the Corps and BPA are proposing a modification of some actions in the 2000 USFWS RPA concerning Libby operations. The Action Agencies believe the proposed action in this Supplemental BA is consistent with the intended benefits contained in the 2000 USFWS BiOp and provides similar or better benefits to the sturgeon and its critical habitat.

This Supplemental BA will consider the effects of Libby Dam operations on the sturgeon, its critical habitat, and on the bull trout above and below Libby Dam. The operation of the remainder of the FCRPS projects will continue consistent with the 2000 NOAA Fisheries and USFWS BiOps. Further, the Corps and BPA have determined that the proposed action described in this Supplemental BA will not modify the effects on other species previously considered in the 2000 NOAA Fisheries and USFWS FCRPS consultations, and therefore are not addressed in this BA. These other species include the listed anadromous species, the bald eagle, grizzly bear, gray wolf, Canada lynx, and Ute ladies' tresses.

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[3] Reclamation is not an action agency for purposes of this reinitiation of consultation on Libby operations.

The Corps and BPA, working in conjunction with regional state and tribal scientists, have taken into account the best science and information available and conclude that the proposed action described in this Supplemental BA concerning the effects of Libby operations will avoid the likelihood of jeopardizing the continued existence of the listed sturgeon and bull trout in the vicinity of Libby Dam, and will not result in the adverse modification of the sturgeon's designated critical habitat.

2. Basis for Reinitiation of Consultation

As noted above, since the issuance of the 2000 BiOp and subsequent consultation activities, additional factors have arisen that support the reinitiation of consultation and the preparation of this BA. The critical habitat designation, information that has become available since completion of the 2000 USFWS FCRPS BiOp, and the Corps and BPA's perspectives on the need to revise the BiOp are described below.

2.1. Designation of Critical Habitat

The USFWS designated 11.2 miles of the Kootenai River in Boundary County, Idaho as sturgeon critical habitat on September 6, 2001 (66 FR 46548). The location and characteristics of the designated critical habitat is further described in Chapter 4 and mapped on Figure 4-1. In accordance with 50 CFR §402.16(d), and as stated in the 2000 USFWS FCRPS BiOp, reinitiation of consultation is required if the designated critical habitat may be affected by the action. This BA provides an analysis of the effects of the revised proposed action on the sturgeon's designated critical habitat.

2.2. Updated and Additional New Information

Since the issuance of the 2000 USFWS FCRPS BiOp, additional information has prompted the Corps and BPA to propose actions that will lead to a more comprehensive understanding of the biological and habitat attributes necessary for successful spawning and recruitment. To avoid jeopardizing the listed species, the 2000 USFWS RPA included operational changes and structural modifications of Libby dam and downstream levees to provide discharges of up to 35 kcfs, approximately 10 kcfs above the existing powerhouse capacity. The USFWS believes that increased flow capacity would increase the chances for successful spawning, incubation, and recruitment and scouring of sediment to provide the gravel substrate needed for successful recruitment. The following is a synopsis of information contributing to the Corps and BPA's rationale for the revised proposed action.

2.2.1. Status of the Species

The Kootenai River population of the white sturgeon has been declining for at least four decades and recruitment has been insignificant since 1974. The last successful sturgeon recruitment of over 20 fish is believed to have occurred in 1974.

The following excerpt from Paragamian et al. (*In Review* at Transactions of the American Fisheries Society) is the best available information on the current status of the species.

> Synthesis of sampling data from 1977 through 2001, including extensive mark-recapture data, provided a comprehensive and current picture of the status, population dynamics, and future prospects of the endangered Kootenai River white sturgeon. Natural recruitment failed in the 1960s and with the additional impact of Libby Dam since the 1970s the wild population now consists of an aging cohort of large, old fish. Jolly-Seber population estimates have declined from approximately 7,000 sturgeon in the late 1970s to 760 fish in 2000. At the current mortality rate of 9% per year, fewer than 500 adults will remain by year 2005, and fewer than 50 adults will remain by year 2030. Based on current growth and maturity rates, hatchery fish being released since 1992 will begin recruiting to the adult population around year 2020. Population projections describe a significant bottleneck in spawner numbers as the wild population declines but hatchery fish are not yet mature. Only 113 to 203 wild females are projected to contribute to hatchery broodstock over the expected life span of the current population. With current levels of hatchery production, the population is projected to stabilize at about 3,000 adults although numbers predicted by these population simulations are extremely sensitive to survival rate estimates. The next generation will be produced primarily from hatchery spawning of wild adults. Increasing numbers of brood stock used in the hatchery will reduce risks of genetic founder effects. Increasing numbers of juveniles produced per family in the hatchery will provide a hedge for uncertainty in brood stock availability as the population declines.

2.2.2. Sturgeon Flows

Before the construction and operation of Libby Dam in the early 1970's, the natural hydrograph of the Kootenai River downstream of the dam consisted of a spring freshet with high peak flows, followed by a rapid drop in flows into August (Figure 2-1). Since the construction and operation of Libby Dam, the hydrograph has changed with curtailment of the peak flows during the spring freshet (Figure 2-1).

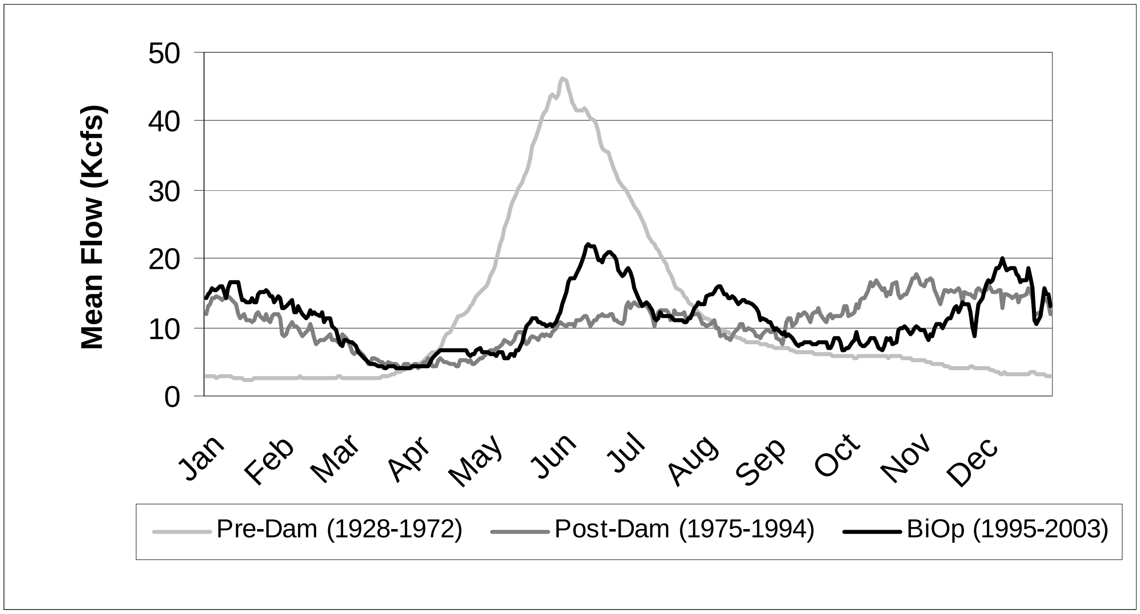

Figure 2-1. Annual hydrograph based on daily average flows at Libby Dam: pre-dam -1928 through 1972; post-dam - 1975 through 1994; and BiOp - 1995 through 2003.

In their 2000 USFWS FCRPS BiOp, the USFWS postulated that approximating the flow regime from 1974 is necessary for successful spawning and recruitment. Figure 2-2 compares natural recruitment densities with flows at Bonners Ferry from 1957 to 1997; the data indicate that there is some survival from natural spawning occurring since Libby Dam was completed, though at a suppressed level. As shown, the data indicate that the relationship between the flows recommended in the USFWS 2000 BiOp and the benefits to recruitment remain uncertain. There appears to have been minimal natural recruitment in several years since the mid-1950's based on age information for these fish (Pete Rust, IDFG, pers. comm. 2004), given associated aging error, particularly in fish first aged at 15 years or older. However, presence of these naturally recruited fish does not necessarily indicate that conditions were favorable for desirable levels of recruitment during any of these years.

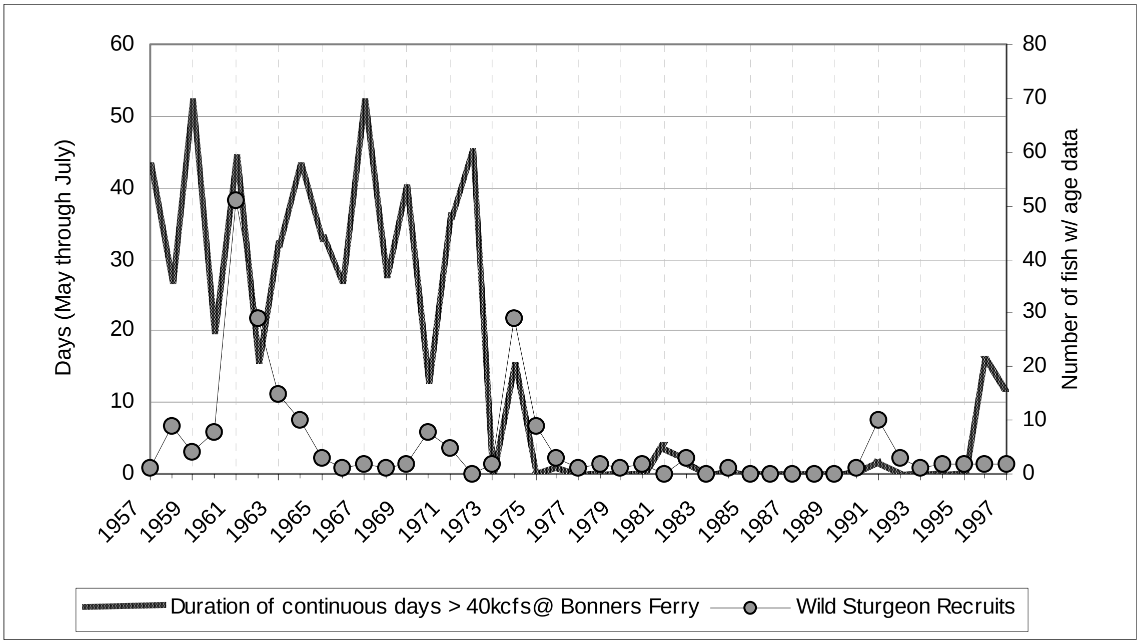

Figure 2-2. Natural recruitment densities from age approximations derived from wild sturgeon captured by IDFG since 1977 (Pete Rust, IDFG, pers. comm. 2004) in relation to the number of days of flow in duration of 40 kcfs at Bonners Ferry. Libby Dam began to influence Bonners Ferry flow in 1972, and became fully operational in 1974.

In reference to achieving similar flow conditions at Bonners Ferry, the USFWS stated (see page 32), "[t]he best scientific information available to the Service indicates that the last successful, significant sturgeon spawning occurred in 1974, when the water surface elevation was at 1765.5 feet (USFWS, 1999b). Peak flows in 1974 were 55,000 cfs, and base flows were about 40,000 cfs."

The Corps has reviewed the data and has determined that Bonners Ferry flows and the flood stage reported in the 2000 USFWS BiOp are not consistent with Corps data. The calculated peak regulated flows at Bonners Ferry in 1974 were 50,900 cfs and the peak regulated river stage elevation was 1765.2. Calculated average April-June regulated flows at Bonners Ferry were 34,500 cfs and the average April-June regulated river stage elevation was 1757.4.

Below is a table showing conditions in 1974, as well as selected years with one or more hydrologic parameters that were somewhat similar to 1974. The table includes calculated peak regulated Bonners Ferry flows, peak regulated Bonners Ferry stage, calculated average April – June regulated Bonners Ferry flows and average April – June regulated Bonners Ferry stage. [4] The data indicate that there have been years since the construction

[4] The data for the current period of record at Bonners Ferry consists of gage height at Bonners Ferry. Since no actual flow data is measured at Bonners Ferry, an estimate of the flows at Bonners Ferry is calculated based on several variables and will have some inherent deficiencies. 1 January 1974 – 27 September 2003 Bonners Ferry regulated flow

of Libby Dam with peak flow conditions somewhat similar to those in 1974, but without corresponding recruitment of sturgeon to the adult population[5].

Year	Peak reg BF flow	Peak reg BF stage	Apr – Jun avg reg BF flow	Apr-Jun avg reg BF stage
1974	50900	1765.2	34500	1757.4
1976	41100	1759.2	16700	1750.7
1981	45588	1761.5*	20300	1750.4
1982	43000	1760.8	21200	1752.1
1991	45000	1760.1	24600	1753.5
1995	38400	1758.5	21800	1751.7
1996	51000	1763.2	33000	1756.7
1997	57300	1764.3	33000	1757.5
1998	42800	1760.4	19400	1751.9
1999	40300	1761	19400	1751.3
2002	49500	1761.5*	26100	1752.9
*Spring/summer peak in 1981 and 2002 occurred in early July. All other years, the spring/summer peak occurred in April-June period. All years in the table above, with the exception of 1981 and 2002 (both years when Libby spilled water), involved outflows within the current powerhouse capacity.				

Historically, sturgeon spawning generally coincided with the receding flow following the spring freshet. Recent spawning events, 1994 – 2000, (Figure 2-3) have followed the same general pattern of occurring on the receding limb of the hydrograph (compare Figure 2-1 with Figure 2-3). The data reflect the uncertainties concerning the relationship of flow and its characteristics; and successful sturgeon spawning, incubation and larval survival. Physical attributes that may be critical include water velocity, turbidity, substrate, turbulence or hydraulic complexity, depth, and temperature (Figure 2-4).

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data represents post-dam conditions and is calculated using the USGS stream gage readings on the Kootenai River at Leonia and on the Yaak River near Troy. The data represents the current channel and levee configuration for the Kootenai River at Bonners Ferry. Data from 1961 – 1971 represents pre-Libby Dam conditions and data after 1974 represent post-Libby Dam conditions. Data from 1972-1973 represent the period over which the reservoir filled.

[5] Recruitment success from 2002 is unknown since any fish produced in 2002 have not yet reached sufficient size to effectively sample.

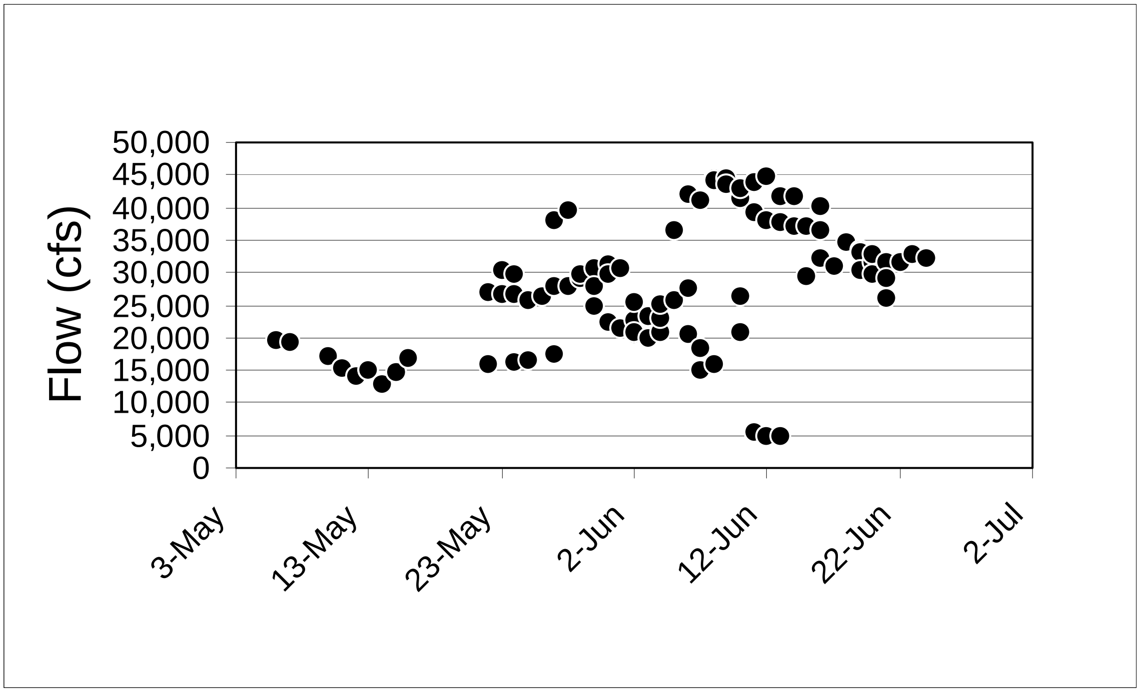

Figure 2-3 – Documented Kootenai River white sturgeon spawning events 1994-2000 (via egg collection mats) in relation to flow (graph courtesy of B. Marotz, MFWP, via data provided by V. Paragamian, IDFG, pers. comm. 2004).

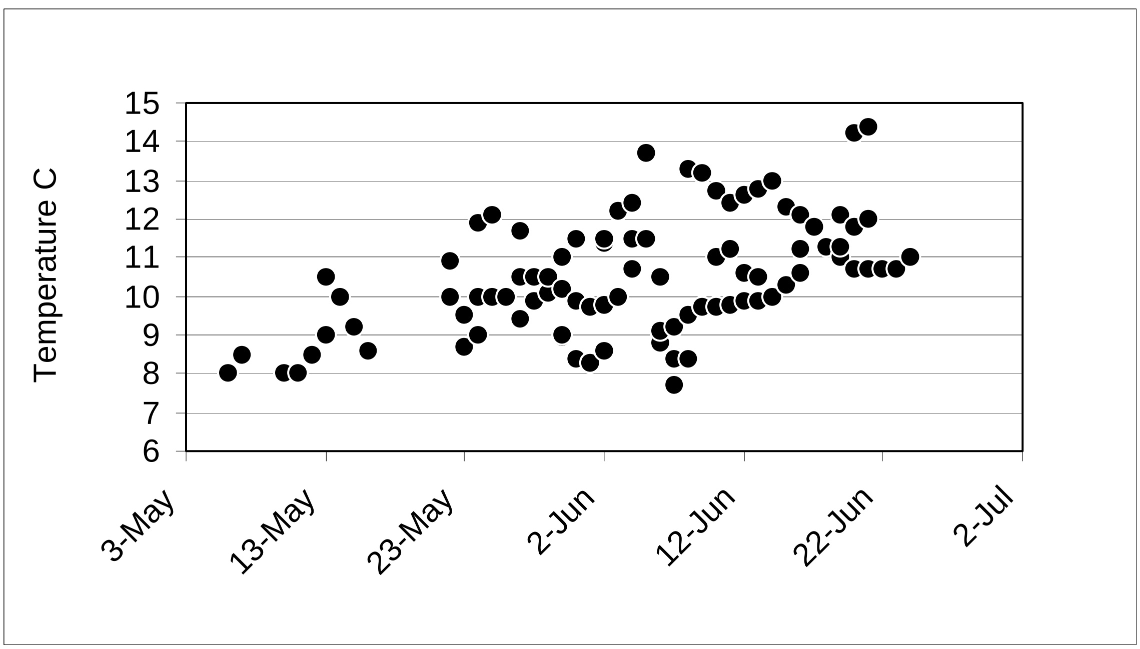

Figure 2-4 – Documented Kootenai River white sturgeon spawning events 1994-2000 (via egg collection mats) in relation to water temperature (graph courtesy of B. Marotz, MFWP, via data provided by V. Paragamian, IDFG, pers. comm. 2004).

The altered hydrograph may have other effects on sturgeon and their habitat. The annual peak elevation at Bonner's Ferry currently is lower than it had historically been in most years (see Figures 2-5). At Bonners Ferry, since Libby Dam operation began, elevation1766 is reached approximately 2% of the time. By contrast, pre-Libby Dam, elevation 1766 was reached in approximately 82% of the years and elevation 1773 was reached in 50% of the years. Higher Kootenay Lake levels prior to dam construction (Figure 2-6) may have also pushed the low-velocity backwater from the lake upstream as far as Bonners Ferry, and possibly well into the braided channel reach upstream of the Highway 95 bridge. If spawning sturgeon key into the break between the backwater and the higher velocity river, these conditions may have resulted in sturgeon spawning over suitable gravel/cobble substrate upstream of Bonners Ferry. It has been hypothesized that the location the sturgeon select to spawn may be influenced in part by the elevation of Kootenay Lake. Since Libby Dam construction, Kootenay Lake levels have been lower during the spring (Figure 2-7), which may result in sturgeon spawning in areas downstream of Bonners Ferry over unsuitable substrate.

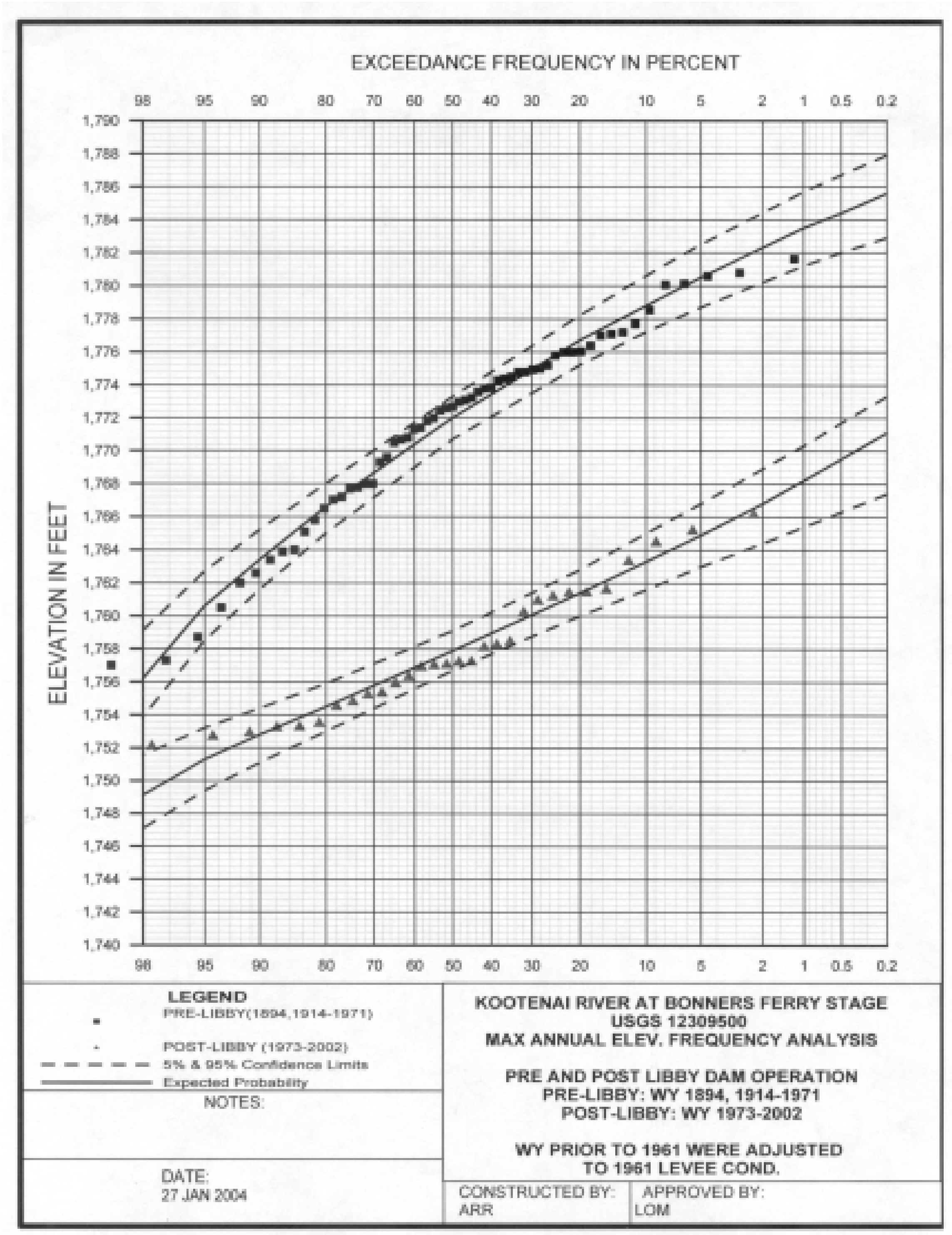

Figure 2-5. Kootenay Lake Elevation, Pre- and Post-Libby Dam.

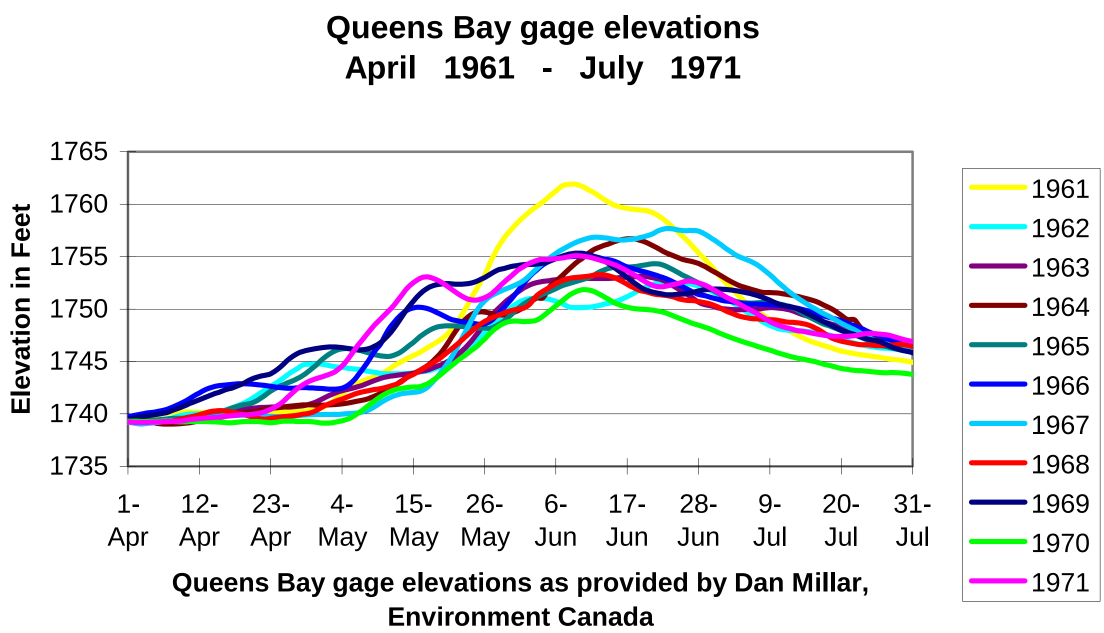

Figure 2-6

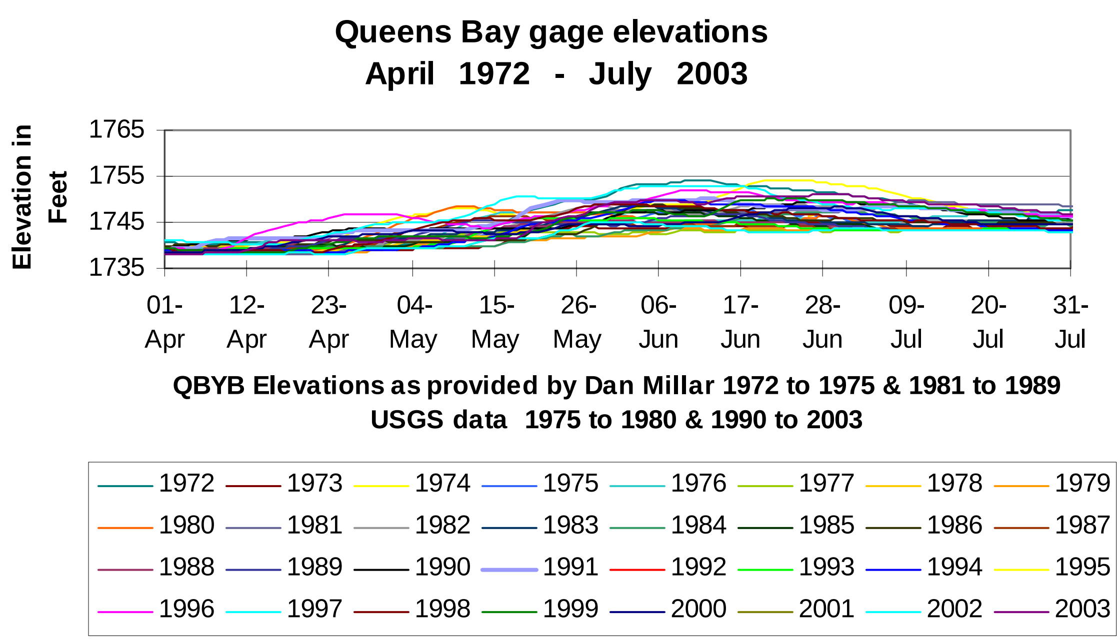

Figure 2-7

The Corps has been augmenting flows from Libby since the early 1990's. The available data indicate that sturgeon spawning has occurred on an almost annual basis, but successful recruitment has been very limited[6]. Since the 2000 USFWS BiOp, biologists,

[6] Successful recruitment in the Kootenai River White Sturgeon Recovery Plan (USFWS,

including members of the Kootenai River White Sturgeon Recovery Team (KRWSRT), have reached general consensus that increasing flow is not sufficient to address the biological requirements of the sturgeon in the absence of other environmental manipulation. Successful sturgeon recruitment is likely the result of the co-occurrence or co-presence of a number of biological and physical variables, or ecosystem factors, during critical periods; the strength of each year-class being dependent upon the nearness of each of these factors to optimal conditions in relation to the other factors. Characteristics of flow are likely important factors in creating the necessary river conditions for successful sturgeon spawning and recruitment. However, the confinement and regulation of the Kootenai River has also created environmental conditions such that increases in flows alone will not provide the conditions necessary for sturgeon recovery.

A better understanding of flow characteristics and other ecosystem factors affecting sturgeon spawning and recruitment is needed in order to modify conditions in a manner that will effectively contribute to sturgeon recovery. Important characteristics of flow, such as water velocity, water temperature, turbulence, turbidity, and depth, appear to provide cues to trigger sturgeon spawning and provide conditions suitable for egg and larvae survival, which include unembedded substrates for egg attachment and development, and larval hiding cover. Other ecosystem factors, such as nutrient deficiency and potential contaminated substrates, are also likely contributing to limited sturgeon recruitment.

The proposed action, recognizing the uncertainties regarding flow characteristics, includes both short term habitat actions to benefit sturgeon as well as continued long term monitoring and evaluation to inform future decisions in an adaptive management framework.

The following discussion first addresses the uncertainties associated with flow characteristics, and then addresses other ecosystem factors affecting sturgeon spawning and recruitment. The proposed action is designed to acquire information to better understand the relationship of flow characteristics and other ecosystem factors to the recovery of the sturgeon.

Flow Characteristics

Velocity. High velocities may serve a variety of habitat functions, such as inducing spawning behavior, removing fine sediments, reducing predation on eggs and larvae, increasing turbidity, and moving larvae quickly downstream. In the Fraser River, British Columbia, it was found that white sturgeon spawn when velocities are between 1.5 and

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1999) is defined as natural production in at least 3 different years within a 10-year period. To be successful, the natural production must include at least 20 juveniles from each year class when sampled at more than 1 year of age. These criteria apply to downlisting from endangered to threatened status; criteria have not been developed for delisting.

3.2 m/sec, while the average velocity where eggs were found was 1.8 m/s (Perrin *et al.* 2003). In the Kootenai River, Paragamian *et al.* (2002) measured velocities of <1 m/s where sturgeon were found to be spawning, though noted that changed velocities due to operation of Libby Dam may trigger a spawning response. While spawning is occurring, the operation of Libby Dam may now be limiting velocities in the Kootenai River where sturgeon currently spawn to a level that is too low to effectively accomplish the other functions listed above.

Temperature. The following information is excerpted from the Kootenai Sub-Basin Summary (Marotz et al. 2000).

> The thermal regime of the Kootenai River has been changed from pre-Libby Dam. Kootenai River water is now 4^{o}C warmer during the winter and 2^{o}C cooler during the summer (Partridge 1983) because of Lake Koocanusa. Temperature changes caused by Libby Dam may affect white sturgeon spawning migration and spawning behavior. Paragamian and Kruse (2001) found female Kootenai River white sturgeon spawning migration was primarily attributable to water temperature. Changes in water temperature could disrupt spawning migration of females, as it has male sturgeon held in the KTOI hatchery for spawning (Ireland, S., KTOI, pers. com.).

Turbulence. The following discussion is excerpted from a report by Coutant (2004).

> The turbulence of spawning areas may be more significant functionally for white sturgeon spawning than velocity. Spawning areas have generally been characterized by high water velocity, solid substrate, and moderate depth, using standard instream-flow habitat variables (Anders et al., 2002; Parsley et al., 2002). High velocity presumably attracts mature spawners, solid substrate is presumably needed for attachment of the adhesive eggs, and depth simply needs to be sufficient to allow for the active staging and spawning activity. This characterization may be missing a critical factor – turbulence, especially turbulent upwelling. High velocity may, indeed, be an attractant. However, there are numerous riverine reaches not used for spawning where velocities are equal to those of the zones used for spawning (0.03-2.8 m/sec mean water column velocity as tabulated by Anders et al., 2002). Although quantitative turbulence measurements have not been made in spawning areas, it appears from the geomorphology of existing spawning zones that particularly turbulent flows occur there. Field study observations by Chandler and Lepla (1995) of known spawning areas showed them to be highly turbulent. The high-velocity area below C.J. Strike Dam, which attracts nonspawners and has little recruitment, differs from known spawning areas by a lack of turbulent upwelling (J. Chandler and K. Lepla, personal communication, 2003). Observations in the Kootenai River showed that recent spawning occurred near the outside of a bend where flows were interrupted by exposed dike-building material (consisting of old automobile bodies), which generated considerable turbulence but not

> noticeably higher velocities (the author and V. Paragamian, personal observations, 2000). Spawning also occurred near a few fallen and submerged trees, which also generated turbulent wakes. Below lower Columbia River dams, spawning occurs in the tailraces where high levels of turbulence are induced by river bedforms, including rock outcrops and gravel beds. Most spawning occurs too far downstream to be attributed directly to spill flows or turbine releases. That fish, in general, will respond to turbulence and choose areas of a stream with certain turbulence has been demonstrated (Pavlov et al., 2000). In the Sacramento River, California, spawning occurred where there was a right-angle bend in the river and snags in the water (Schaffter 1997), likely causing turbulence. The Sacramento River spawning areas do not have large, hard substrate as is presumed necessary by white sturgeon spawning criteria (Gard 1996).
>
> A mechanistic link between turbulence and spawning has not been made empirically, but can be speculated upon. Traditionally, the hydraulics of spawning sites has been linked to maintaining clean substrate for nearby egg attachment (Parsley et al. 1993, 2002). But the solid substrate found in spawning areas may be coincidental, rather than being a habitat feature needed for egg incubation. The substrate more likely simply reflects the turbulent hydraulics of the spawning site. Turbulent flows would generate scour and thus expose boulder and cobble substrate if these materials were part of the riverbed. Turbulence (turbulent upwelling, especially) may aid the spawning act and gamete fertilization, but so few white sturgeon have been observed spawning that this feature is a mere guess. I believe that the evidence points more toward white sturgeon using hydraulic turbulence, upwelling, and high velocities to disperse eggs to other locations for incubation…

Turbidity. Turbidity has been considered to be an important component in sturgeon spawning. Perrin *et al.* (2003) found that white sturgeon in the Fraser River, British Columbia, spawned in turbid water (averaging 42.2 NTU, with suspended solids measured at 102.2 mg/L on average). Spawning may be triggered by light attenuation, although spawning did occur in clear, low-flow conditions in the Kootenai River in 2001. Perrin's (2003) Secchi disk readings at sturgeon spawning sites were less than 30 cm, which meant that sturgeon might more easily spawn in relatively shallow water because of the visual cover such turbidity might afford. As turbidity decreased, Perrin *et al.* (2003) suggested there may be a correlation with spawning at greater depth and recommended further study. They pointed out that dams trap sediment loads and "substantially reduce turbidity."

Other Ecosystem Factors

Biologists are concerned about a variety of other ecosystem factors affecting the recovery of the sturgeon. There have been numerous environmental changes in the Kootenai River that affect sturgeon recruitment, and the aquatic ecosystem as a whole. These changes are due in part to the construction of Libby Dam, levee construction and floodplain development. The following excerpt from the Kootenai Sub-Basin Summary (Marotz et al. 2000) summarizes alterations to the Kootenai River ecosystem function:

> *Altered Hydrograph*
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> Hydropower-related discharge fluctuations in the Kootenai River have resulted in a wider zone of water fluctuation, or *varial zone*, which has become biologically unproductive. Research has shown that normal vegetated varial zones are significantly impacted where abnormal fluctuating water levels and flows produce a highly altered riparian zone (Mack et al. 1990, Mackey et al. 1987, Suchomel 1994). Reduction in natural spring freshets due to flood control has eliminated much of the hydraulic energy needed to maintain the river channel and periodically re-sort river gravels. Lack of flushing flows has resulted in sediment buildup in the river cobbles, which are important for insect production, fish food availability, and security cover. In addition, large daily fluctuations in river discharge and stage (4-6 feet per day) strand large numbers of sessile aquatic insects in the varial zone. The reduction in magnitude of spring flows has caused increased embeddedness of substrates, resulting in a loss of interstitial spaces in cobble and gravel substrates, and in turn, a loss of habitat for algal colonization and an overall reduction in species diversity and standing crop. Benthic macroinvertebrate densities are one of the most important factors influencing growth and density of trout in the Kootenai River (May and Huston 1983). Caving of riverbanks has increased silt loads, which in turn further reduces productivity by reducing transparency and covering invertebrates…
>
> *Floodplain Alterations*
>
> In the mainstem and valley tributaries, wetlands and other floodplain habitats have been lost to agricultural row crop and pastureland. The substantial wetland losses that have occurred in the subbasin are attributed to a combination of factors that include the operations of Libby Dam, river diking, draining associated with development, and tributary channelization (Richards 1997).
>
> Prior to the construction of Libby Dam, the river often topped dikes and flooded agricultural grounds. Those overland flows supplied a natural source of river nutrient inputs, created low velocity, backwater, and side-channel habitats and introduced pioneering riparian species (Johnson et al. 1976, Miller et al. 1995). The overland flows ended when the dam was built.

Water Pollution

The two largest point source discharges to the Kootenai River are the Crestbrook Forest industries' pulp mill in Skookumchuck, B.C. and the Cominco mining, milling, and fertilizer plant in Kimberley, B.C. Point source pollution containing toxic levels of heavy metals is well documented in the Kootenai River (KRN 2000). Other mines that have contributed to water quality degradation include: Snowshoe Mine in Libby Creek, Great Northern Mountain area in the Fisher Creek drainage, operations in lower Boulder Creek, ASARCO mine on Lake Creek, and the Continental Mine in the headwaters of Boundary Creek (Knudson 1994). Major municipalities discharging secondary treated waste to the Kootenai River include: Cranbrook, Kimberly, Fernie, Creston, Sparwood, and Elkford, B.C.; Libby, Troy, and Eureka, MT; and Bonners Ferry, ID. The waste treatment plant at Bonners Ferry has added chlorine gas since 1984 to kill bacteria. Chlorine and ammonia have been associated elsewhere with toxicity and migration barriers for aquatic life.

Nutrient Sink

Duncan and Libby Dams have negatively impacted productivity in Kootenay Lake. The reservoirs formed by these impoundments trap nutrients, phosphorus and nitrogen, and thereby reduce productivity in downstream waters. Serious concerns over this issue were first raised in late 1980, when Kootenay Lake kokanee, bull trout, and rainbow trout experienced patterns of declining growth and numbers. Intensive study, modeling, and a review of options to address this problem were begun in 1990. A large scale, experimental lake fertilization project was subsequently implemented in 1992. B.C. Hydro and the B.C. Ministry of Environment have provided funding for the experiment. Results to date suggest current methods show great promise as a long-term mitigation measure, and it is reasonable to expect the fertilization will need to continue annually as long as flows are required for downstream salmon migration.

Nutrient Stripping

The Kootenai River downstream of Libby Dam is nutrient poor because Lake Koocanusa acts as a nutrient trap. 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 Koocanusa Reservoir 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 less 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. The limited productivity is a limiting factor for white sturgeon because it results in 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.

Predation

Predation on sturgeon eggs and larvae is 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.

In addition t the ecosystem factors discussed above, riparian habitat may also be an important factor in sturgeon recruitment success. Coutant (2004) states:

> Submerged riparian habitat during seasonal high water is needed for early development… Where recruitment is successful, channels are complex and floodable riparian vegetation or rocky substrate is abundant. There, spawning occurs in turbulent zones upstream (1-5 km) of seasonally submerged riparian habitat, eggs can disperse into inundated habitat and adhere to newly wetted surfaces for incubation, yolk-sac larvae have food-rich flooded habitat for early growth, and larvae can transition to juveniles as water recedes to permanent channels. Such habitat is lacking where recruitment is low and present only in high-flow years where recruitment is sporadic.

Of twenty river reaches in the Columbia River basin where white sturgeon are found, the Kootenai River reach above Corra Linn Dam harbors the only population that does not exhibit recruitment (Coutant 2004). It is also the only river system among those reaches that does not possess gravel/cobble substrate in the spawning area, the only system that does not have newly inundated surfaces for egg attachment immediately after spawning events, and the only system that does not provide hiding and feeding places for larvae. Each of the other nineteen white sturgeon populations are found in river reaches that at least intermittently provide these habitat attributes (Coutant 2004).

The habitat conditions in the reach near Shorty's Island where sturgeon appear to prefer to spawn is another factor that appears to be affecting sturgeon reproduction. In this area, the bottom substrate is sand, not the gravel/cobble/boulder substrate commonly encountered in other rivers where white sturgeon successfully reproduce. Members of the KRWSRT hypothesize that the eggs spawned in the Shorty's Island reach sink to the bottom where they are smothered in the sand and subsequently die. Potential efforts to encourage successful reproduction could involve (1) providing the conditions necessary for early life history stages of sturgeon near the current spawning area, or (2) providing river conditions that will encourage adult sturgeon to spawn further upstream (ideally above Bonners Ferry) in areas of the river that currently have more suitable substrate conditions. Both of these courses of action can be achieved with the flow levels possible within the existing discharge capacity of Libby Dam.

Contaminants in the sediments can also have adverse effects on sturgeon reproduction. 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, could possibly be reducing the successful reproduction and early-age recruitment to the Kootenai River white sturgeon population. Since white sturgeon are a long-lived, bottom feeding and relatively sedentary species, contaminants that are bioaccumulated and passed to progeny through ova or sperm can impact viability, survival, and development of naturally spawned sturgeon eggs (Adams 1990; Heath 1995). The Kootenai River has indications of contamination by PCBs, organochlorine pesticides, dioxins, and certain metals. Recent research indicates that Kootenai River water concentration of total iron, zinc, manganese, and the PCB Arochlor 1260 exceeded suggested environmental background levels (Kruse and Scarnecchia 2002a; Kruse and Scarnecchia 2002b). 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. 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 (Kruse, personal communication 2004).

Kruse and Scarnecchia (2002) found that sturgeon embryos reared in a medium of Kootenai River-bottom sediments and filtered river water showed higher concentrations of Arochlor 1260 and copper, which have been shown in several other studies to disrupt normal embryonic survival, than embryos reared in other media; the study found no significant differences in uptake of metals by embryos reared in a medium of unfiltered river water and suspended sediment, and the control medium of filtered river water and Fuller's earth. A study on sheepshead minnow (*Cyprinodon variegatus*) by Hansen et al. (1975) showed that concentrations of the PCB Arochlor 1254 greater than 5 ppb in fertilized eggs correlated with reduced survival of offspring. Concentrations of Arochlor 1260 in white sturgeon embryos from Kruse and Scarnecchia's study ranged from 92-160 ppb; these results suggest that contaminated sediments in the Kootenai River where sturgeon spawn may be a limiting factor to recruitment.

The information presented in this section demonstrates there are many unknowns about restoring the form and function of this altered ecosystem to lead toward recovery of the sturgeon. Biologists agree that the factors affecting successful recruitment need to be better understood and that the principal reliance on the additional flows identified in the USFWS FCRPS 2000 RPA are not likely to avoid jeopardizing the continued existence of the sturgeon or result in recovery.

2.2.3. Scouring Flows (Geomorphology, Sediment, and Hydraulics)

The 2000 USFWS BiOp recommended the action agencies investigate the substrate between RKM 228-246 and evaluate the flow conditions necessary to move the sandy sediments to provide substrate more suited to successful recruitment. The premise is that current sturgeon spawning is occurring where they spawned historically, and that successful recruitment would occur if the fine materials were scoured away and not redeposited in this reach. The USFWS suggests April would be the most desirable month to achieve scouring since Kootenay Lake is lower in April, and the increased flows would not affect sturgeon as they have usually not yet begun to move upstream to spawning sites.

One hypothesis is that the high flows that historically occurred during the spring freshet before the construction of Libby Dam served to scour fine materials from the substrate to maintain suitable distribution of cobbles and gravels in the Kootenai River white sturgeon spawning reaches. The Corps and U.S. Geological Service (USGS) are conducting studies that should improve the overall understanding of the geomorphology, sediment transport, and hydraulic characteristics of the Kootenai River between Libby Dam and Kootenay Lake, many with special emphasis on the "spawning reach" between Bonners Ferry and below Shorty's Island. Many of the models developed for these studies will provide resource managers with tools to test various flow and river stage scenarios, coupled with structural changes to the channel geometry, with the intent of enhancing white sturgeon spawning habitat in the study reach.

One preliminary finding of these studies provides information about existing conditions, which may help to explain some of the observed spawning behaviors of Kootenai River white sturgeon. IDFG has collected higher numbers of eggs in the river reaches with increased velocity and turbulence (coincident, multi directional velocity vectors) as reported by the USGS 3D River Model. The USGS model indicates slightly higher velocity flows and turbulence in the Shorty's Island reach as compared to the reaches immediately upstream and downstream. IDFG egg density data also indicate substantial increase in egg density in this reach.

The USGS model also indicated velocity and turbulence regimes similar but less profound to those in the Shorty's Island area in the reach adjacent the Bonners Ferry dock and Ambush Rock. IDFG egg collection and spawning event data also indicate increased spawning behavior and egg collection in this reach.

2.2.4. Increased Release Capacity at Libby Dam—RPA 8.2

The 2000 USFWS RPA recommended the action agencies provide increased release capacity from Libby Dam as a means of increasing flows for sturgeon spawning and recruitment, and to provide scouring flows to improve the substrate in the reach of the Kootenai River later designated as critical habitat. The 2000 USFWS FCRPS BiOp called for the Corps to be prepared to release progressively higher flows, in 5000 cfs increments, up to a total release of 10,000 cfs above powerhouse capacity. Investigation of using the spillway and increasing the powerhouse capacity was recommended. This section describes tests and studies done by the Corps and BPA since the issuance of the 2000 BiOp regarding these mechanisms for releasing water above powerhouse capacity.

Spill: The 2000 USFWS BiOp recommended a spill test at Libby Dam to evaluate whether passing additional water via the spillway is a feasible means of providing the additional flow augmentation water. The Corps conducted a spill test in 2002 to assess the relationship between volume of water spilled and effects on total dissolved gas (TDG) levels. During the test, high project inflow coupled with limited lake storage resulted in involuntary spill conditions, with spill as high as 15,600 cfs during a two-week period.

The spill test was coordinated with Montana to address the expected exceedance of the 110% state water quality standard for TDG. Observed TDG saturations in spilled water immediately downstream of the spillway ranged from 104% saturation during a 700-cfs spill to 134% saturation during a 15,600-cfs spill. The TDG saturation in spillway releases, as measured in the stilling basin, increased rapidly from 104% to 129% saturation as the spill discharge increased from 0 to 4,000 cfs. A slight increase in TDG saturation of spillway releases of 129% to 134% saturation was observed as spillway discharges increased from 4,000 to 15,600 cfs. TDG saturations in water discharged from the powerhouse ranged from approximately 102% to 104% saturation during the study. During spillway releases, a strong lateral gradient in TDG concentration was present across the river, with higher TDG saturations observed on the spillway side of the river (left bank). Maximum TDG saturations at the Thompson Bridge, located about 2,000 feet downstream of the dam, were 127% saturation during spillway releases of 15,600 cfs, somewhat lower than TDG saturations directly downstream of the spillway due to de-gassing of the river water and some amount of mixing of spillway and powerhouse water. At the USGS transect station (located about 3,500 feet downstream and the current location of the TDG monitoring station), the maximum TDG concentration ranged from about 111 % during a spill of 3,000 cfs to 125% for a spill of 15,600 cfs. TDG concentration was generally well mixed across the river at a transect 8.6 miles from the dam (the re-reg dam or haul bridge site) (ERDC, 2002).

Fish were monitored during the 2002 spill at Libby Dam for signs of gas bubble disease. The monitoring protocol included placing captive fish in areas where maximum TDG exposure was anticipated. The following is an excerpt from the report[7] (Dunnigan *et al.* 2003) discussing the fish monitoring activities that occurred during the 2002 spill.

> Fish monitoring during the spill activities at Libby Dam in the summer of 2002 used three general approaches. Sentry fish were held in cages and checked for signs of gas bubble disease, fish were captured using electrofishing gear and examined for signs of gas bubble disease, and finally radio telemetry was used to investigate fish movement or displacement during spill activities.
>
> Fish can escape the effects of supersaturated water by either avoiding it, if the choice exists, or by sounding to compensate for supersaturated conditions at surface pressures. However, Weitkamp and Katz (1980) report that it is generally accepted that fish are not able to detect supersaturated conditions and avoid them. A study by Ebel (1971) supports this statement. He found that juvenile chinook salmon held in volitional 0-4.5 m deep cages suffered higher mortality than fish forced to remain in deep (3-4 m) cages. Ebel (1971) concluded that these fish were unable to detect or not willing to avoid saturated water. However, several studies contradict this generalization and suggest that the ability to detect and avoid saturated water may be species specific. Blahm et al. (1976) found that juvenile chinook salmon were able to detect and avoid supersaturated water when given a choice, but that juvenile steelhead (*Oncorhynchus mykiss*) were not able to detect supersaturation. Dawley et al. (1976) concluded that both juvenile steelhead and chinook salmon were able to detect and avoid supersaturated water by sounding. Meekin and Turner (1974) found that juvenile chinook salmon were able to detect and avoid supersaturated water when given the choice, but that steelhead were not. However, temperature differences during this study limit its inferential power. Bentley et al. (1976) also demonstrated that northern pikeminnow (*Ptychocheilus oregonensis*) may be able to detect and avoid supersaturated conditions given the opportunity. Nevertheless, Weitkamp and Katz (1980) concluded that insufficient information

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[7] Chapter 4, Kootenai River Fisheries Monitoring Results From the Spill Events at Libby Dam, June-July 2002.

exists to conclude whether or not fish are able to detect and avoid supersaturated water.

During the 2002 Libby spill event, signs of gas bubble disease developed rapidly in the captive fish, and quickly escalated to 100% incidence. Approximately 86% of the free swimming rainbow trout (*Oncorhynchus mykiss*), 80% of the bull trout (*Salvelinus confluentus*), and 31% of the mountain whitefish (*Prosopium williamsoni*) collected by electrofishing during the peak spill at Libby Dam exhibited signs of gas bubble disease. No signs of gas bubble disease were observed in any noncaptive fish collected on June 26 following one day of spill ranging from 700 to 6,000 cfs. Signs of gas bubble disease were first observed in noncaptive fish on July 1 following six days of spill ranging up to 15,600 cfs. Similarly, no signs of gas bubble disease were observed on July 24 after spill was stopped. In their report MFW&P stated, "[r]esults from the radio telemetry work suggests [sic] that most radio tagged rainbow trout (n= 7; 100%), bull trout (n = 3; 75%) and mountain whitefish (n = 2; 67%) did not move substantially during the spill activities at Libby Dam, and remained within the general vicinity of Libby Dam (RM 221.7) downstream to Dunn Creek (RM 219.8), with the center of gravity more near Libby Dam."

The release water temperatures from the spillway were warmer than water temperatures released through the powerhouse throughout the study. A lateral temperature gradient is generated in the Kootenai River below the dam that may bias temperature measurements made in the tailwater. Additionally, the water temperature of spillway flows increased during the study from about 9.6 to 12° C. This small variation in water temperature influenced the rate and total mass of dissolved gas exchanged during the spill but likely had only a minor influence on the TDG pressures observed in spillway flows.

In order to increase releases from Libby to those recommended in the USFWS RPA, the Corps and BPA met with the state of Montana to explore the possibility of obtaining a variance from the state's TDG standard. In response, the state of Montana expressed concerns about effects on the fishery above and immediately downstream of the dam, the effects on communities downstream of the dam, and the uncertainty surrounding the science concerning the spill regime to increase flows[8]. Accordingly, the Corps and BPA have determined that the use of the spillway as a means of providing additional flow augmentation water is constrained by TDG levels and the effects on fish immediately downstream of the project. The Corps plans to utilize the spillway to provide flows for sturgeon consistent with Montana's 110% TDG standard.

Flow Deflectors: The BiOp also recommended the Corps evaluate installing flow deflectors on the Libby Dam upper spillway as a means of reducing TDG when using the

[8] Judy Martz, the Governor of Montana, sent a letter dated November 25, 2003 to Gale Norton, Secretary of the Department of the Interior and John Paul Woodley, Jr. Assistant Secretary of the Army (Civil Works), expressing the state's concerns on the impacts caused by changes in Libby Dam operations.

spillway to provide additional flows. A preliminary assessment on the installation of flow deflectors on Libby's upper spillway, based on the performance of flow deflectors at Columbia/Snake River projects, indicates that the desired reduction in TDG to the Montana 110% standard would not occur. Additionally, the usefulness of this feature is limited as the pool elevation needs to be above 2418 feet to pass 10 kcfs. Numerical model results indicate, based on historical reservoir inflows, that there would be a significant number of years where the spillway would not be able to pass the full 10 kcfs if requested before the first part of June.

The Corps is in the process of completing an initial assessment report (IAR) on a comprehensive list of operational and structural alternatives, such as flow deflectors, that might enable the project to pass an additional 10 kcfs. This study is looking at options for reducing TDG levels generated by use of the spillway and/or sluiceways, use of using one or more of the unused penstocks, and new conveyance structures.

Additional Powerhouse Capacity: The Corps and BPA investigated options for increasing the powerhouse capacity and transmission facilities to accommodate the USFWS request for providing additional flows at Libby Dam.

Installation of Additional Units. Libby Dam was originally designed for eight units, five of which were installed. The 2000 USFWS BiOp recommended that the Corps and BPA investigate installing up to two additional units as an alternative to using the spillway to achieve desired flows in the lower Kootenai River.

The Corps' report "*Additional Hydroelectric Unit Study Libby Dam,*" (prepared for the Corps of Engineers by Berger/ABAM in October, 2002) indicates that adding one or two units (turbines/generators) at Libby Dam appears technically feasible. Technical feasibility was evaluated by visual inspection of the accessible portions of currently installed unit components and the accessible plastic wrapped uninstalled components stored in the powerhouse. Currently inaccessible for inspection are the turbines in units 6, 7, and 8. Further inspection of the installed turbines would require pulling turbines to inspect thrust bearings, which involves confined space entry requiring dewatering, drying, ventilation, scaffolding, pressure washing and ongoing dewatering to accomplish visual inspection and non destructive testing. The engineers also observed no obvious damage to any of the larger, major, accessible components. However, none of the installed or uninstalled components were tested. Additional funding would need to be obtained to accomplish this investigation.

This study also looked at configuration changes such as using the existing installed, but not commissioned, penstocks and wicket gates to release water without using additional generators and turbines. The study found that use of the penstocks without generators and turbines would not be feasible on a dam the height of Libby Dam. The technical hurdle with passing flow through the unused penstocks involves dissipating the large amount of energy present due to the difference in elevation between the forebay and the tailwater. When water is spilled over the spillway, this energy is dissipated in the stilling basin before it reaches the river. Almost all of this energy needs to be dissipated before discharge to the river to ensure that no conditions that will cause scour or erosion, and/or damage to structures, will occur. With operating penstocks, energy is dissipated through the turbines via electricity generation. Use of the penstocks to pass flow without a turbine/generating unit and without a means to dissipate the large amount of head would cause severe erosion and scour in the tailrace downstream of the powerhouse, as well as damage to the draft tube, spiral case, penstock and powerhouse structures. Even the lowest operating pool elevations would require energy dissipation measures to the penstock/draft tube system to ensure safe discharge to the river. Structural, hydraulic (such as cavitation), and physical space constraints prevent the development of an energy dissipating system for the Libby penstocks/draft tube system. The Corps has concluded pursuing converting the powerhouse penstock to a regulating outlet is not feasible.

<u>Unit/Transmission Integration Costs and Complexities</u>. BPA has completed an analysis of the cost to add additional units at Libby. Table 2-1 summarizes the results of this evaluation.

Table 2-1
Unit/Transmission Considerations/Costs

Increase Libby Flow Capacity	**Install Unit 6**	**Install Unit 7**
Unit Installation	The cost to install Unit 6 would be $6 million. Debt repayment rules would require that $15 million in sunk costs be repaid when the unit is operational.	The cost to install two units would be $20.5 million as a new transformer would be required to integrate the second turbine. Debt repayment rules would require that $30 million in sunk costs be repaid when the units become operational.
Transmission Integration	At a minimum the Libby Remedial Action Scheme (RAS) would need to be upgraded ($4 million). Additional transmission studies would be required to ensure that the RAS option would eliminate the need for other voltage/stability mitigations, such as an SVC or STATCOM installed in the Flathead Valley ($20 million). Costs could be as high as $150 million to remove current generation limits.	At a minimum the Libby Remedial Action Scheme (RAS) would need to be upgraded ($4 million). Additional transmission studies would be required to ensure that the RAS option would eliminate the need for other voltage/stability mitigations, such as an SVC or STATCOM installed in the Flathead Valley ($20 million). Costs could be as high as $150 million to remove current generation limits.
Total Cost:	$ 25 - $ 171 million	$ 54.5 - $ 200.5 million

BPA's conclusion is that the high cost of installing additional units together with the associated transmission upgrades that would be needed, make flow augmentation via added powerhouse capacity both unreasonable and imprudent. Without clear evidence that this would lead to successful spawning and recruitment of Kootenai white sturgeon, these investments would be unjustified. The discussions below further describe the reasons for this conclusion.

As shown in Table 2-1 the cost of making unit 6 operational would be $21 million. Six million dollars is required to physically install the unit and connect it to an existing transformer, which is capable of handling the added 121 Megawatts of capacity. Fifteen million dollars in sunk costs that were invested in this turbine will need to be amortized when this turbine is operational. The sum of these costs is $21 million. Adding both units 6 and 7 would cost $50.5 million. The cost to install two units would be $20.5 million. Adding a 7th unit requires an additional transformer, which is why the cost is more than double that of one unit. This cost includes the acquisition of an additional transformer, which is why the cost is more than double that of one unit. The sunk cost that will need to be repaid for two units is $30 million (twice that of one unit).

One aspect that is not well understood is that adding units will not increase power revenues. Involuntary spill at Libby has been very infrequent (1984 and 2002 are the last two occurrences). Thus the availability of extra unit capacity to reduce involuntary spill is not measurable. Adding units and operating them to augment flows for sturgeon would shift the timing of when power production now occurs, from winter or summer months when power rates are high to the spring months of May and June when power rates are typically lower. Thus, as most are not aware, no added power revenues accrue from adding units to offset their cost.

The transmission system serving Libby Dam was developed when the dam was built in 1975. No substantial changes have been made to this system since this date. The reduced operation of Columbia Falls Aluminum further limits the combined summer generation level from Libby and Hungry Horse to 900 MW (the full capacity of these projects is 1025 MW). The least expensive alternatives for adding one or two additional units at Libby require an equal reduction in generation at Hungry Horse because of transmission system limitations.

The existing transmission system in western Montana is highly stressed. Currently, a Libby remedial action scheme (RAS-an automated electronic operation system) is in place that requires generation dropping for certain transmission outages, additional units at Libby will further reduce the stability of the transmission system.

BPA's Transmission Business Line (TBL) has completed an analysis of the transmission system changes that would be needed to integrate a 6th and 7th unit at Libby (BPA 2004). Table 2-1 summarizes the transmission upgrade options and their costs and issues. The integration of units 6 and/or 7 at Libby requires, at a minimum, the installation of additional RAS at Libby and the installation of RAS at Hungry Horse ($4 million). Additional transmission studies would be required to ensure that the RAS option would eliminate the need for other voltage/stability mitigations, such as an SVC or STATCOM installed in the Flathead Valley ($20 million).

These actions do not alter the combined summer generation limit of 944 MW and thus if six turbines were generating at Libby, only two units could operate at Hungry Horse (two less than capacity) (121 MW x 6 = 727 MW, 106 MW x 2 = 212 MW, 727 + 212 MW = 939MW). As a result of adding more transmission outages to the RAS the frequency of generator dropping increases. Problems with voltage control in the area could also potentially increase (more analysis needs to be completed to determine solutions). Reduced generation at Hungry Horse also increases the likelihood of involuntary spill at levels that would cause violations of the Montana 110% TDG standard and would reduce power revenues. If two units are added to avoid violating the combined summer generation limit of 944 MW, generation at Hungry Horse would need to be further reduced to one unit (three less than capacity).

The minimum cost to add one additional turbine would be $25 million when the turbine cost ($21 million) and the transmission RAS additions ($4 million) are combined. Costs may be higher if voltage/stability mitigations are not corrected by installing the RAS additions. The minimum cost to add two turbines would be $54.5 million when turbine costs ($50.5 million) are combined with transmission RAS additions ($4 million). Neither of these solutions corrects the 900 MW limitations on generation capacity. Removing this limitation (which would be desirable) would increase transmission costs to at least $150 million.

The Bureau of Reclamation analyzed the potential impacts of operational changes at Hungry Horse to accommodate the increased generation from Libby with the current transmission grid. The draft report titled “Impacts to Hungry Horse Reservoir Operations From Adding Additional Generation at Libby,” points to a number of adverse impacts with this operation. They found that these operational changes would result in deeper Hungry Horse drafts that either conflict with recommendations in the 2000 USFWS FCRPS BiOp and the 2000 NOAA Fisheries FCRPS BiOp, or result in increased spill to levels that may exceed Montana’s TDG standards, or both. Reclamation concluded that shifting load from Hungry Horse to Libby is not a supportable operation.

The Corps and BPA have concluded that adding units 6 and 7 to increase the powerhouse capacity is not a reasonable or economically prudent near term option.

2.2.5. Flood Stage Constraints to Sturgeon Recruitment—(RPA 8.3).

The 2000 USFWS 2000 BiOp notes that sturgeon have spawned successfully with peak river stages between elevation 1765.5 and 1770. The RPA called for the Corps to investigate changes in flood stage constraints through the evaluation of channel capacity and the condition of levees in order to accommodate additional flows at Bonners Ferry. This includes investigations into levee conditions, stage relationship, and seepage. In the interim the RPA limits sturgeon spawning flows so as not to exceed the National Weather Service's flood stage of 1764 as measured at Bonners Ferry.

Levee Condition. The Corps completed a reconnaissance study of flood control in the Bonners Ferry area in July 2001 (General Investigation (GI) Reconnaissance Study, Kootenai River in Boundary County, Idaho, Section 905(b) Analysis, July 24, 2001). The condition and serviceability of the levees was investigated on Kootenai River from Bonners Ferry, Idaho, downstream to the Canadian border. The investigation disclosed that some portions of the levees are in poor condition and are in need of repair at several locations; however, the economic analysis included in the Corps' study did not support the federal government's participation in repairing or enhancing these non-federal levees at this time. Currently maintenance of the levees is the responsibility of local entities[9].

Bonners Ferry Stage In Relation to Bonners Ferry Flow. The 2000 BiOp stated that a 1 foot change in Bonners Ferry stage equates to about 10,000 cfs flow at Bonners Ferry. Analysis of 1961 – 2003 data comparing annual peak Bonners Ferry flow with annual peak Bonners Ferry stage indicates a 1-foot change in Bonners Ferry stage equates to approximately 3,000-4000 cfs flow at Bonners Ferry, depending on the Kootenay lake elevation. This is a significantly smaller increase in flow that would affect a 1-foot change in stage than indicated in the 2000 BiOp during the peak of the runoff season (Figure 2-8).[10] Therefore, it would take a lesser increase in flows to exceed the current flood stage of 1764 and the 2000 BiOp's desired flood stage of 1770 than what was assumed in the 2000 BiOp.

[9] Under Public Law 84-99, Boundary County can request inspections of the levees to determine which levees would need to be repaired.

[10] 1961 – 1971 data was unregulated flow and stage, and represents pre-dam conditions; the1972 – 2003 data was regulated flow and stage and represents post-dam conditions. The relationship of 1-foot to 3,000 cfs flow is further substantiated by an analysis of Chart 4-4, Stage-Discharge Curve Kootenai River at Bonners Ferry, dated 15 September 1982 in the Libby Water Control Manual. This demonstrates that Bonners Ferry elevation is dependent on Kootenay Lake elevation and Bonners Ferry flow.

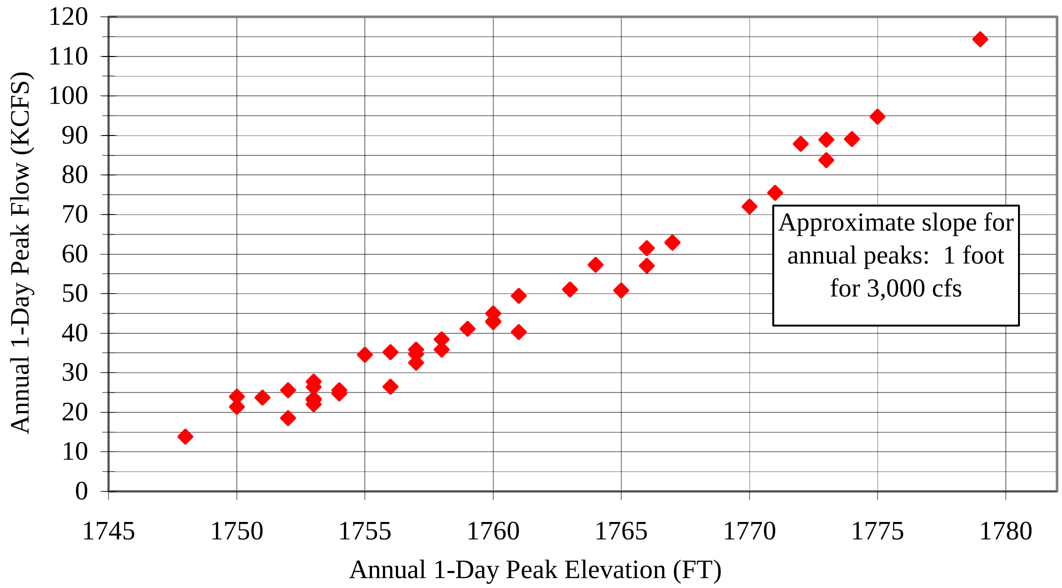

Figure 2.8: Bonners Ferry Peak Elevation vs. Peak Flow (1961 - 2003)

Seepage**.** The Corps commissioned an investigation by HDR Inc. in 2003 (report is still in preparation) to update Kootenai Flats seepage information as part of the Upper Columbia Alternative Flood Control and Fish Operations NEPA EIS (UCEIS). The purposes of the investigation were to update and document: (1) potential seepage impacts to agricultural production; (2) the extent to which the seepage impacts were related to various river stages, (3) the type, location, and extent that valley agricultural practices have been affected by various river stages, and (4) changes in agricultural activities attributable to various river stages.

HDR collected information from previous investigations and observations. HDR interviewed, conducted field surveys, and inspected seepage areas in fields with landowners and growers. The interviews and field surveys covered all 16 diking districts and over 90% of the agricultural acreage in the valley.

Preliminary information indicates that the Kootenai Flats geohydrology is very complicated. The juxtaposition of very permeable soils and gravels left by historic Kootenai River channels and current and historic valley tributary routes with very impermeable lake bottom clays and silts left during the Ice Age by the much larger Kootenay Lake creates a very complex system.

The preliminary information indicates that approximately 30,000 acres in the Kootenai Flats are in agricultural use, of which approximately 2,000 acres are directly and adversely affected by seepage.[11] Impacts from seepage attributable to Kootenai River stages generally begin when stages are above 1758 feet at Bonners Ferry for longer than one week. Some lower-elevation farmed areas experience seepage impacts when the Bonners Ferry stage exceeds 1755 feet for 10 days or more. Precipitation and snowmelt/tributary runoff could combine with high river stages to cause ground water elevation to rise to problematic levels. Higher river stages also inhibit tributary stream drainage to the river, causing or prolonging seepage impacts to agriculture. This information will be finalized and reported in the UCEIS.

2.2.6. Other Information

The Northwest Power and Conservation Council (Council) adopted Mainstem Amendments to its Fish and Wildlife Program this last year. One recommendation is to change the current summer drafting operation for the Libby based on the Council's concern that the current practice of drafting water to 20 feet (from full) by August 31st adversely impacts recreational opportunities at Libby but also is damaging to bull trout and other resident fish in the Kootenai River. The Council recommended that a new summer draft, limited to 10' (except in the lowest 15% of water years), be studied. They also recommended shifting the target date for the 10' drawdown from August 31 to September 30. It was also recommended that the Corps keep outflows from Libby during this summer period (July-September) relatively constant for the benefit of resident fish below the dam. This operation is currently being evaluated by the Corps, BPA, Reclamation, USFWS, and NOAA Fisheries to assess whether there are effects on the sturgeon, bull trout, and listed Columbia River salmon and steelhead.

In 2003, a sturgeon released from the hatchery in 1997 near the mouth of the Moyie River in Idaho, was caught and harvested near the mouth of the Yaak River in Montana. The angler that harvested the fish turned in a PIT-tag to MFW&P, allowing biologists to determine that the fish was of hatchery origin and was 5 years old. As this fish was caught farther upstream than biologists believe to be the sturgeon's range, this provides new information about the sturgeon's range.

In summary, in addition to the designation of sturgeon critical habitat, there is important information that the Corps and BPA have obtained since the issuance of the 2000 BiOp. The proposed action in this supplemental BA incorporates the Corps' and BPA's response to this new information. The proposed action expands on the adaptive management process described in the USFWS 2000 BiOp and is consistent with the adaptive management framework contained in the NOAA Fisheries 2000 BiOp. This

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[11] Wheat is the dominant crop grown in the valley, accounting for slightly less than 60% of the farmed acreage. Barley, canola, alfalfa, grass, and timothy are other important, annual crops. Long-lived, high value hops farms account for approximately 400 to 500 acres, or 25%, of the 2000 acres that are potentially affected by seepage.

process will enable the agencies to accommodate and better respond to additional new information and lessons learned through implementation.

2.3. The Corps and BPA's Position Concerning the USFWS 2000 RPA

The 2000 USFWS BiOp RPA included actions 8.2 and 8.3 that called for increasing release capacity at Libby Dam and removing flood stage constraints below Libby Dam to provide flows above the existing powerhouse capacity for the benefit of sturgeon recruitment. The 2000 USFWS BiOp states: "[t]he current strategy related to operation of the FCRPS to improve the recruitment of juvenile sturgeon into the population involves flow augmentation from Libby Dam for sturgeon spawning and incubation."

The Corps and BPA believe that relying on additional flow augmentation from Libby Dam by increasing the flow capacity at Libby Dam (RPA action 8.2) and removing the downstream flood constraints (action RPA 8.3) are not consistent with the regulatory criteria for an RPA for the following reasons. First, based on the best science and information available, it has not been demonstrated that providing the recommended additional 10 kcfs will result in the intended biological benefits. Second, these components of the RPA are not consistent with the intended purpose of the action, i.e. the operation of Libby, which includes providing flood control downstream of Libby Dam. Finally, some components of the RPA are not consistent with the Corps' authority and jurisdiction.

Our conclusion is based on the following. The Corps was authorized by Congress to construct, operate, and maintain Libby Dam, in large part to provide for system and local flood control. The Corps and BPA's proposed action contained in this Supplemental BA recognizes this responsibility. To the extent practicable, the Corps plans to continue operating Libby Dam to achieve the Bonners Ferry 1764-foot flood stage as designated by the National Weather Service, and to meet the requirements of the International Joint Commission 1938 Order on Kootenay Lake.

As previously mentioned, the USFWS's 2000 RPA was designed to replicate the 1974 conditions. The 2000 USFWS RPA calls for increasing the routine release capacity at Libby Dam, including potential use of the spillway to pass additional volume of water, while staying within a total dissolved gas level of 110% (the state water quality standard). Although use of the spillway is the only option available in the near term to provide the additional water for augmenting flows (as noted earlier in Section 2.2), it is not possible to achieve the RPA-recommended flow levels within the 110% TDG standard. The Corps and BPA met with Montana to discuss whether an adjustment to the TDG standard for the benefit of the sturgeon could be considered. Montana expressed concerns about the relative value of this operation on fisheries and recommended the federal agencies consider designing a short-term test with specified objectives for the state to consider. As the Corps' policy is, to the extent practicable, to operate its projects in accordance with the state's water quality standards, the Corps does not believe it prudent to voluntarily exceed Montana's water quality standard for TDG unless the state is in agreement, or USFWS determines the operation is required to minimize incidental take of the species.

Regarding the installation of flow deflectors on the Libby Dam spillway to reduce TDG level when spilling water, a preliminary assessment indicates that the desired reduction in TDG to the Montana 110% standard would not occur.

The evaluation of the installation of additional units at Libby Dam concluded that this action is not feasible in the near term because additional transmission facilities would be needed and these new lines are considered low priority as the current market for hydroelectric power does not justify the expense of building them. Again, because of the scientific uncertainty associated with the biological benefits attributed to the recommended flows, the Corps and BPA do not feel it prudent to implement this action until there is resolution of these uncertainties.

The 2000 RPA action concerning the removal of flood constraints recommends investigation of the channel capacity of the Kootenai River to accommodate the recommended higher flows. Given the Corps' responsibilities to provide for flood control, the Corps does not believe these actions are consistent with the intended purpose of the proposed operation of Libby, and does not believe it is prudent to remove the flood constraints in light of the scientific uncertainties associated with the biological benefits of the recommended additional 10 kcfs.

Therefore, taking into account the best scientific and commercial data available, the Corps and BPA are proposing an alternative to RPA action 8.2 and RPA action 8.3, to avoid the likelihood of jeopardizing the continued existence of the listed sturgeon and bull trout in the vicinity of Libby Dam, and avoid the adverse modification of the sturgeon's critical habitat. Based on the most current and best available science, the Corps and BPA propose to focus near-term efforts on habitat, conservation aquaculture, and other actions including Libby Dam operations to help sustain and recover Kootenai River white sturgeon. As additional new information on the status of sturgeon, their habitat requirements, and potential restoration actions to achieve improvements becomes available, the Corps and BPA, in coordination with the USFWS and regional biologists, will re-evaluate and adapt actions to maximize potential benefits for sturgeon. This adaptive management approach will enable the agencies to tailor actions to meet the needs of sturgeon. It is recognized that as the biological uncertainties regarding characteristics of higher flows and sturgeon recruitment are resolved, increased release capacity at Libby Dam may be necessary. However, given these biological uncertainties and proposed alternatives to achieve similar flow characteristics, the Corps and BPA believe that additional information on higher flows, recruitment requirements, and sturgeon population levels needs to be obtained before making a commitment of resources of the magnitude required to provide the additional release capacity and remove downstream constraints.

3. Proposed Action Description

The Corps and BPA's proposed action (PA) focuses on providing a more normative aquatic ecosystem by setting forth a comprehensive and integrated set of measures to avoid jeopardizing the Kootenai River white sturgeon by improving reproduction and recruitment. The objective of the proposed action is to create habitat conditions that will induce sturgeon to spawn naturally over appropriate substrate and repeatedly recruit new individuals to the population so that natural recruitment and subsequent natural production are reestablished. These habitat conditions include augmented flows and temperatures within the current project configuration recommended in the KRWS recovery plan (USFWS 1999).

To further this objective, the proposed action includes a research, monitoring, and evaluation (RM&E) program designed to integrate the most current and applied biology relying on the Kootenai River White Sturgeon Recovery Team to resolve critical uncertainties through development of a better understanding of the sturgeon's biological requirements and habitat needs. While we are acquiring better scientific information to make well reasoned and supportable long-term decisions, it will be necessary to augment the population through continuation and expansion of the hatchery program, and provide the means for sturgeon to spawn over appropriate habitat and to successfully recruit. The fundamental goal for downlisting the sturgeon to threatened status, as defined in the Kootenai River White Sturgeon Recovery Plan (USFWS, 1999), is natural production in at least 3 different years within a 10-year period. To be successful, the natural production must include at least 20 juveniles from each year class when sampled at more than 1 year of age.

The PA is composed of actions within the following categories:

- Operate Libby Dam to support spawning, incubation, and rearing of white sturgeon, and to support bull trout habitat;
- Expand the Kootenai Tribe of Idaho's Conservation Aquaculture program to prevent extinction;
- Implement an Research, Monitoring and Evaluation (RM&E) Program to Define Sturgeon Spawning and Recruitment Needs; and
- Increase primary productivity of Kootenay Lake.

The Corps and BPA proposed to use an adaptive management framework to implement the proposed actions that include:

- Performance Standards to help set action agencies' priorities and achieve recruitment; and
- Adaptive Management Approach to modify actions based on new scientific information.

3.1. Operate Libby Dam to support spawning, incubation, and rearing of white sturgeon, and to support bull trout habitat.

Libby Dam is one of fourteen projects of the FCRPS operated by the Corps and Reclamation for flood control, navigation, hydroelectric power, recreation, irrigation, water quality and fish and wildlife. Congress authorized the construction of Libby Dam, in part to provide for system and flood control downstream of the project. Because the construction of Libby Dam has changed the hydrograph, there are effects on the species largely due to their existence. The proposed action for this consultation includes the operation of Libby Dam consistent with the authorized uses of this project.

The Corps is responsible for taking into account a variety of statutes, treaties, executive orders, etc., in its operation of Libby Dam. These include, but are not limited to, the Columbia River Treaty, the International Joint Commission (IJC) 1938 Order on Kootenay Lake, the 2000 NOAA Fisheries and the 2000 USFWS BiOps, the Northwest Power Act[12], and Libby Dam's enabling legislation. Planning and implementing Libby Dam operations, factoring in weather forecasts and water supply forecasts among other things, requires extensive coordination across the region. The "real time" reservoir operations are coordinated with federal, tribal and state representatives through the NOAA Fisheries Regional Forum Technical Management Team (TMT).

The Corps and BPA propose to continue operating Libby Dam in a manner to avoid jeopardizing the listed species. This PA includes continued implementation of the following operational actions identified in the 2000 USFWS BiOp: interim implementation of VARQ, variable end-of -December flood control, forecasting procedures, tiered sturgeon flows, bull trout flows, and ramping rates. In addition, the Corps will continue to operate Libby Dam consistent with actions recommended in the NOAA 2000 BiOp.

3.1.1. Implement Interim VARQ flood control to maximize water storage and thereby fish operational flexibility.

RPA 8.1.b. and 8.1.d. recommended the implementation of VARQ Flood Control (VARQ refers to variable discharge, where Q is shorthand for discharge). VARQ provides more reliable reservoir refill while allowing for spring and summer flows for conservation and recovery of threatened and endangered species downstream of the projects. In December 2002, the Corps prepared an Environmental Assessment and signed a Finding of No Significant Impact to implement VARQ on an interim basis starting in January 2003. The Corps, in cooperation with Reclamation, is continuing preparation of an EIS to evaluate the long-term impacts of implementation of alternative flood control operations, including VARQ, and fish flow operations at Libby and Hungry Horse dams. The final EIS and a Record of Decision (ROD) on long-term flood control procedures at Libby and Hungry Horse dams, and fish flows are scheduled for 2005.

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[12] The Pacific Northwest Electric Power Planning and Conservation Act.

Under the VARQ flood control procedure, the pool elevation at Libby is higher than under the standard flood control procedure given certain runoff conditions. This results in an increased likelihood of refill, and thus having more water available to provide higher flows through the spring freshet and slightly higher Kootenay Lake elevations. In addition to operating for system flood control under the VARQ or standard flood control procedure, the Corps operates Libby to the extent possible not to exceed the 1764' Bonners Ferry flood stage elevation designated by the National Weather Service. This PA includes continued implementation of interim VARQ while continuing to work on the EIS evaluating alternative flood control operations and fish flows.

3.1.2. Investigate and Implement the Libby Variable End-of-December flood control draft at Libby Dam based on the seasonal water supply forecast issued on 1 December.

Variable End-of-December Draft: The Corps recently released a study report evaluating the feasibility of using a variable December 31 flood control draft at Libby in conjunction with the VARQ storage reservation diagram, as well as a variable December 31 flood control draft in conjunction with the standard flood control storage reservation diagram (USACE 2003). The study concluded that a variable end-of-December draft is permitted only in conjunction with VARQ flood control.

For VARQ, the end-of-December draft requirement can be reduced by as much as 600 kaf, depending on the 1 December runoff volume forecast. If the December 1 forecast is less than 5.5 MAF (April-August volume), the end-of-December flood control draft requirement is reduced by 600 kaf, resulting in a draft of 1.4 MAF (el. 2426.7 feet). However, if the 1 December forecast is greater than 5.9 MAF, no draft reduction is allowed and the end-of-December draft requirement remains 2 MAF (el. 2411.0 feet). If the forecast falls between 5.5 MAF and 5.9 MAF, the draft reduction is determined by interpolating between 600 kaf and 0 kaf. For instance, a 1 December forecast of 5.7 MAF would result in a 300 kaf reduction, making the end-of-December draft requirement 1.7 MAF. This flood control relaxation procedure is intended to increase the probability of reservoir refill in less-than-average runoff years. The Corps began using this procedure in December 2003. However, due to the above-average 1 December forecast, no reduction in the 2 MAF draft requirement was allowed.

Alternative Forecasting Procedures: An early-season forecast procedure has also been completed by the Corps and is designed to provide a prediction of the seasonal water supply prior to the first of the calendar year. The early November and early December water supply forecasts will facilitate such operations as the variable end-of-December draft. The procedure uses values of the Southern Oscillation Index (SOI) for the previous summer along with observed fall precipitation measurements. The SOI reflects ocean and atmospheric factors that are believed to have near-term influences on climate. Snowpack data are incorporated as the first snow measurements are made available in early January and are used to make a new January forecast. The early-season water supply forecasts were available in fall 2002 and used for the first time for the variable end-of-December draft in water year 2004. In addition to the early-season forecasts issued in November and December, new equations for the seasonal water supply forecast have also been developed for the months of January, February, March, April, May, and June. The Corps began using the new forecast equations for Libby Dam in November 2003, which have improved forecasting significantly (Brooks, 2004).

3.1.3. Provide white sturgeon flow augmentation

The 2000 RPA action 8.1.d calls for storage and tiered water releases based upon water availability as determined by the seasonal runoff forecast. The action agencies propose to continue providing sliding-scale tiered volumes as revised in March 2002 from the 2000 USFWS BiOp and described in a letter from the Corps to the USFWS in a letter dated August 23, 2002. That operation is summarized below.

Specified volumes of water from Libby Dam for sturgeon flows can vary from either zero or 0.8 to 1.6 million acre-feet based on the seasonal water supply forecast (Figure 3-1). Using these volumes as guidelines, the USFWS requests specific dam releases each year that are shaped and timed when the USFWS determines that benefits for sturgeon are likely to occur. The requested sturgeon flows are coordinated with the region at TMT. Water releases may be reduced if needed for flood control purposes and maintaining flows at Bonners Ferry below flood stage at 1764 feet to the extent possible. In recent years, sturgeon augmentation operations have generally started between early May and late June, based on in-season monitoring of wild sturgeon, water temperature, and releases of larvae from the sturgeon hatchery operated by the Kootenai Tribe of Idaho. The augmentation volumes do not include the 4,000 cfs minimum outflow from Libby Dam.

The Action Agencies propose that the water volume allocated to sturgeon be based on the most recent month’s final water supply forecast. For instance, a sturgeon operation beginning after the May final water supply forecast is issued (but before the issuance of the June final forecast) will be based on the May forecast. If a new month’s final water supply forecast is issued while the sturgeon operation is still underway (changing the volume of water for sturgeon), the volume allocation and operation will be re-assessed and may be modified through regional coordination at TMT.

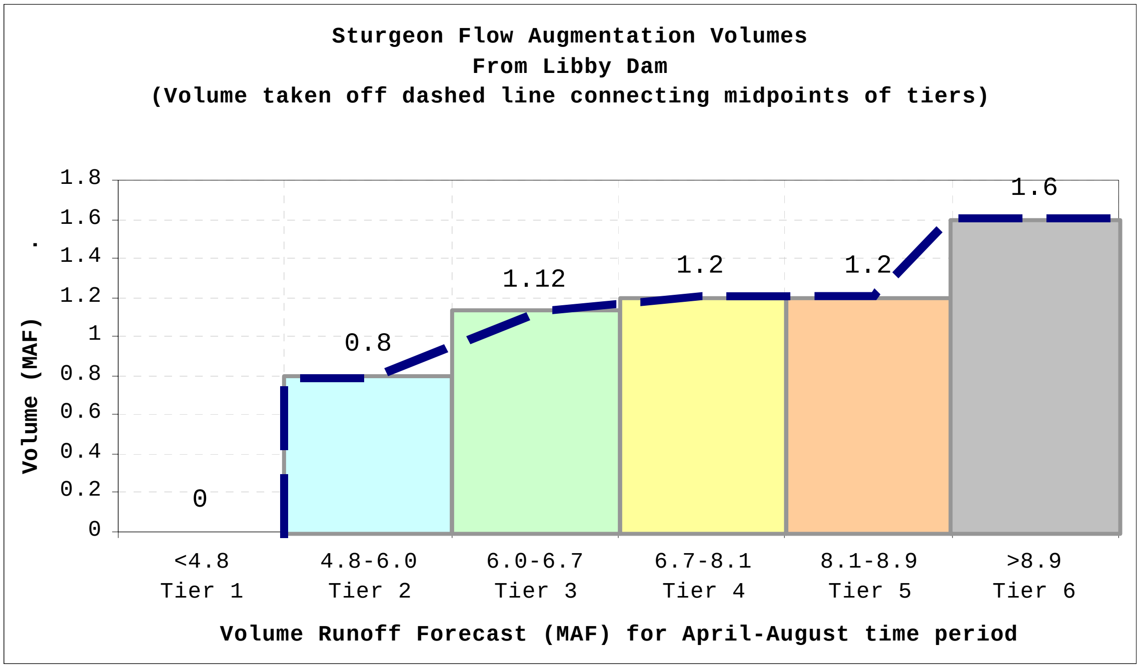


Figure 3-1. Volume of water to be provided by Libby Dam for sturgeon flow augmentation based on the April-August seasonal water supply above the dam (as agreed upon with USFWS and documented in a letter from the Corps to USFWS dated 23 August 2002)

The start of sturgeon flows is typically determined by some combination of water temperature, sturgeon migration and/or spawning events (as determined by radiotelemetry tracking or egg sampling), or releases of larval sturgeon from the Kootenai Tribe of Idaho's conservation aquaculture program. Sturgeon monitoring data indicate that sturgeon spawning typically occurs between early May and late June. The observed sturgeon spawning events have occurred after or within several days prior to when the water temperature at Bonners Ferry reaches 10^{o} Celsius. Larval sturgeon from the hatchery are typically ready for release between mid and late June.

Currently, the existing five-turbine configuration limits Libby Dam powerhouse releases to a maximum of between about 19,000 and 28,000 cubic feet per second (cfs), depending on the elevation of Lake Koocanusa behind the dam.[13] Given likely pool elevations at the time when sturgeon flows would be released, the practical range of maximum powerhouse release is slightly less than 25,000 cfs to slightly less than 28,000 cfs. If requested by USFWS, the Corps will use full powerhouse capacity and spill up to the 110% TDG Montana state standard during the sturgeon operation. TDG in the Kootenai River is monitored at the USGS gauging station (No. 12301933) located about 0.6 miles downstream of the dam. The probe is located along the left bank of the river and would measure dissolved gas in spill water in the event of a spillway release from

[13] Maximum powerhouse release capacity would be less if fewer than five units are operational due to equipment breakdowns or transmission limitations.

Libby Dam. Total dissolved gas is continuously monitored from April 1 through September 15, and measurements are made every hour. Data are sent out every 4 hours via the Geostationary Operational Environmental Satellite (GOES) system to the Corps Northwestern Division Office in Portland, Oregon, and stored in the Columbia River Operational Hydromet Management System (CROHMS) database.

3.1.4. Use Libby's selective draft capability to optimize water temperatures for sturgeon spawning.

Temperatures in the Kootenai River may be too low during spawning season (Paragamian *et al.* 2002; Hoffman 2003) to promote successful recruitment. The Corps will continue to provide warmer water from the upper strata of Lake Koocanusa via the selective withdrawal system during spring and early summer to the extent possible. Currently data are measured on the face of the dam to regulate the temperature of water released from the dam via the selective withdrawal system. The Corps initiated a temperature study at Lake Koocanusa in 2002 to better aid in determining Libby Dam release temperatures to benefit downstream sturgeon populations. The study was designed to investigate the thermal properties in the forebay. A single temperature string was deployed in the forebay consisting of temperature loggers attached at various depths between the surface and bottom of the reservoir. Temperature was recorded every hour from June through November in 2002 and 2003. The results of this study will improve the accuracy and reliability of water temperatures released from Libby Dam starting in 2004 and will aid in the selection of water release points in the dam to provide the most appropriate water temperature for sturgeon.

Temperatures in the Kootenai River are warmer during the fall and winter than historical temperatures, which may be detrimental to juvenile sturgeon if there is an increase in their metabolic rate and thus an increase in their use of energy reserves which they must maintain at that time of year due to scarcity of food. The Corps is examining the selective withdrawal system to determine whether colder water can be sent through the dam during the fall period.

3.1.5. Ramping Rates to avoid fish stranding and habitat dewatering.

The current operations (based on ramping rates in the 2000 USFWS BiOp) limit power peaking and have ramping rates to benefit listed bull trout. There is no daily load fluctuation, and weekly fluctuations are allowed only above 10,000 cfs, during summer months (April-August). Reducing fluctuations results in keeping a greater area of the perimeter of the river wetted more consistently and for longer periods, resulting in increased productivity of aquatic insects and other food organisms upon which resident fish depend. Reducing fluctuations also results in reducing the risk of displacing juvenile sturgeon out of optimal habitat due to sudden increases in flow. The 10,000 cfs criterion provides protection for organisms in the main channel; above that flow there is less risk of major decreases in wetted perimeter when flows drop.

Revised ramping rates (Table 3-2) have been developed in consultation with regional biologists to continue to minimize the adverse biological impacts of power operations in the Kootenai River downstream of Libby Dam and also provide slightly greater flexibility in operating Libby Dam for project purposes including power. The amount of fish and insect habitat dramatically decreases, on average, when flows drop from 14,000 to 11,000 cfs, and again when flows decrease from 9,000 to 5,000 cfs. River operations that routinely water and dewater portions of the river channel will continue to be avoided. Evidence suggests that after 10 days, aquatic insects have begun to colonize newly wetted areas; therefore it is important to bring the river down slowly after it has been high for long periods.

Table 3-2. Ramping rate guidelines

		Summer (05/01 - 09/31)	
		Hourly	Daily
Ramp Up	4-6 kcfs	2500 cfs	1 unit
	6-9 kcfs	2500 cfs	1 unit
	9-16 kcfs	2500 cfs	2 units
	16-QPHC	5000 cfs	2 units
Ramp Down	4-6 kcfs	500 cfs	500 cfs
	6-9 kcfs	500 cfs	1000 cfs
	9-16 kcfs	1000 cfs	2000 cfs
	16-QPHC	3500 cfs	1 unit
		Winter (10/01 - 04/30)	
		Hourly	Daily
Ramp Up	4-6 kcfs	2000 cfs	1 unit
	6-9 kcfs	2000 cfs	1 unit
	9-16 kcfs	3500 cfs	2 units
	16-QPHC	7000 cfs	2 units
Ramp Down	4-6 kcfs	500 cfs	1000 cfs
	6-9 kcfs	500 cfs	2500 cfs
	9-16 kcfs	1000 cfs	1 unit
	16-QPHC	3500 cfs	1 unit

- Note that the divisions on this version (4-6, 6-9, 9-16, 16-QPHC) match very closely with the divisions in the 2000 BiOp and are based on biological breakpoints
- QPHC = Current powerhouse capacity

Another benefit of these guidelines is a decrease in riverbank sloughing and maintenance of levee stability downstream of Libby Dam. The ramping rate guidelines may be modified if downstream levee conditions are adversely affected or may be exceeded due to project emergencies.

Ramping rates agreed to in the 2000 BiOp were developed with current science to protect bull trout in the Kootenai River downstream of Libby Dam. Since that time, updated information has been developed that verifies that the 2000 BiOp intent to reduce impacts through tiered ramp rates was correct. The action agencies have identified opportunities to modify these rates to allow for additional flexibility for power production and water savings that may be applied to specific subsequent fish operations that would not be deleterious to bull trout or their associated habitats. In particular, ramp-up rates can be increased during all seasons without biological implications, and in fact may more closely emulate the pre-dam river condition during times of rain or snowmelt freshets. In general, ramp down rates should remain conservative to protect varial zone productivity and physical habitat of resident salmonids. However, regional biologists agree that during the less productive winter months, a certain level of conservative load shaping and associated ramping at higher tiers would not be measurably deleterious to the affected aquatic ecosystem. It is anticipated that throughout the winter months, Libby will be operated for conservative weekly load shaping. This is because this project and other headwater projects are projects of last resort for meeting load requirements. However, there may be daily shaping within the ramping rates to accommodate other project uses or unforeseen circumstances. The Corps and BPA are working to develop guidelines for these operations and will provide these to the Service once they are complete. In all circumstances, these operations would take into account the impacts on the aquatic ecosystem, and the resulting consequences to bull trout and their habitat.

3.1.6. Other Libby Dam Operations Affecting Operations for Sturgeon or Bull Trout

Operate to Provide Salmon Flows: Following operations for sturgeon flows, the project is operated to refill Lake Koocanusa to elevation 2,459 feet by June 30 when possible. This operation is to provide water for salmon flow augmentation as called for in the NOAA Fisheries 2000 BiOp RPA. Beginning July 1st, unless modified by TMT, Libby gradually drafts to elevation 2439 feet (20 feet from full) by the end of August to meet the salmon summer flow objectives in the Columbia River. This has resulted in releasing flows in excess of 20,000 cfs in August, at times resulting in a “double peak” downstream in the Kootenai River. The Corps attempts to minimize the double peak when releasing water from Libby Dam for sturgeon and salmon flow augmentation in order to minimize impacts to resident fish, including bull trout. If the Libby pool elevation is below 2439 feet by July 1, Libby passes inflow or minimum bull trout flow. This operation has often resulted in dropping flows to near the minimum bull trout flow of 6,000-9000 cfs immediately upon completion of sturgeon supplemental flows.

An operation known as the “Libby/Arrow swap” was negotiated between BC Hydro and the Corps in 1995, 1996, 1997, 1998, 1999, and 2002, which provided similar downstream salmon flows while retaining water in Libby Dam in the summer. Some of the salmon flow augmentation water called for in the NOAA 2000 BiOp was delivered to the confluence of the Kootenay and Columbia rivers from Canadian storage instead of Lake Koocanusa. This operation resulted in the Lake Koocanusa pool elevation remaining above elevation 2439 feet through August. This operation is negotiated on an annual basis. There are hydrologic and other circumstances in Canada that may preclude reaching an agreement for this operation in any given year, therefore it cannot be relied upon as a means to maintain higher elevations of Lake Koocanusa in summer.

Operate consistent with the Columbia River Treaty and the International Joint Commission: The Corps will continue to operate consistent with the Treaty and the IJC. Under the Columbia River Treaty, the Corps, BPA, and BC Hydro coordinate flood control and hydropower operations through the Columbia River Treaty Operating Committee.

The International Joint Commission (IJC),created under the Boundary Waters Treaty of 1909 between the U.S. and Canada, has appointed three local Boards of Control that affect the FCRPS. These are the Kootenay Lake Board of Control, the International Columbia River Board of Control, and the Osoyoos Lake Board of Control. The Order affecting the FCRPS operations is the 1938 Order on Kootenay Lake.

The 1938 Order can constrain the operation of Libby Dam because releases from Libby Dam cannot exceed the natural inflow if the level of Kootenay Lake (140 miles downstream in Canada) is above the elevation specified in the Order. Therefore, the 1938 Order may prevent the Corps from drafting Lake Koocanusa to its flood control rule curve in years of high winter runoff during January, February, March or April. The Corps coordinates Libby Dam operation with BC Hydro and Aquila, Inc. (formerly West Kootenay Power) to assure compliance with the 1938 IJC Order. Inability to draft to the flood control rule curve results in what is referred to as “trapped storage,” and is avoided whenever possible.

3.2. Expand the Kootenai Tribe of Idaho’s Conservation Aquaculture program to prevent extinction

A key component of the proposed action is the continued support and funding of the Kootenai Tribe of Idaho’s Multidisciplinary Conservation Aquaculture Program (hatchery program). As discussed above, sturgeon population estimates have declined, and the next generation will be produced primarily from hatchery spawning of wild adults. Given the current mortality rate of 9% per year, fewer than 500 adults will remain by year 2005, and fewer than 50 adults will remain by year 2030. Population projections describe a significant bottleneck in spawner numbers as the wild population declines and the hatchery fish are not yet mature. Increasing numbers of juveniles produced per family in the hatchery will provide a hedge for uncertainty in brood stock availability as the population declines (Paragamian et al., *In* review Transactions of the American Fisheries Society). Exacerbating the sturgeon’s dilemma and recovery hurdles is the fact that females may not reach sexual maturity until age 30. Since the hatchery went into production in the early 1990's, it will take at least another 20 years before hatchery-raised fish will contribute to the population. The Corps and BPA recognize the aquaculture program is an interim measure; however, it is a high priority to bridge the gap given the current status of the species. It is the Action Agencies intent to work toward restoring the form and function of the altered ecosystem for the survival and recovery of the wild population.

Additional hatchery facilities are currently being evaluated and expansion of the hatchery is planned in the upcoming years. These facilities are required to ensure conservation of current genetic diversity while the other measures of the PA are implemented and begin to have an effect on natural recruitment in the Kootenai River. Additional adult holding and juvenile rearing space is required to produce and raise additional families.

Temperature regulation in the adult holding facility would provide the opportunity to hold green males at the hatchery and to bring them into spawning condition as females become ripe. The current practice of relying on males spawned at capture will become increasingly risky as the population continues to decline. In such cases, it will become more likely that spawning opportunities will be lost when females are ripe but no males are available.

The biological justification for hatchery expansion is found in "An Adaptive Multidisciplinary Conservation Aquaculture Program for Endangered Kootenai River White Sturgeon," (Ireland, et al. 2003):

> 1. *Background* Aquaculture techniques were first applied to the Kootenai River white sturgeon population in northern Idaho in 1990 in response to concerns that missing year classes, failed recruitment, and skewed age class structure were threatening this population. From 1993 to 2002, operations of the Kootenai River White Sturgeon Conservation Aquaculture Program have been guided by the 'Breeding Plan to Preserve the Genetic Variability of Kootenai River White Sturgeon' (Kincaid 1993), subsequently referred to as the "Kincaid Plan". This Program generally met the Plan's objectives of reducing the threat of population extinction by: 1) providing frequent year classes from native brood stock; 2) representing inherent within-population genetic diversity in its brood stock and progeny; and 3) minimizing the introduction of disease into the recipient wild population (Ireland et al. 2002a). Many of the Kincaid Plan's objectives and recommendations remain relevant today, following an additional decade of failed natural recruitment since the Plan was first implemented. More detailed descriptions of Kootenai Hatchery operations, guidelines and results can be found in Ireland et al. (2002a, 2002b), Ireland and Anders (2003), Kincaid (1993), and the Kootenai Hatchery Genetics Management Plan (HGMP),
> (www.cbfwa.org/files/province/mtncol/subsum/KootenaiHGMP.doc)

Effective population size (N_e) and production goals recommended by the Kincaid Plan (1993) were designed to compensate for missing or limited natural production of Kootenai River white sturgeon years classes from 1973 to 1993.
The Kincaid Plan's recommended mean annual N_e was $\geq$ 10. The Plan supported this recommendation with the following rationale: "In light of the threatened status of Kootenai River white sturgeon, a random sample of 200 fish (100 males and 100 females) should be spawned to contribute progeny to the next generation over the next 20 years". The observed mean annual N_e for all years of the program was 6.9, due to challenges in the early years of the program with inadequate facilities. However, since 1995: 1) program performance greatly improved; 2) the facility was upgraded considerably; 3) the program annually approximated or exceeded the recommended mean annual N_e of 10; and 4) a fail-safe back-up hatching and rearing facility was arranged within the Kootenay Basin in British Columbia. The Kootenai River White Sturgeon Recovery Team (Recovery Team) subsequently incorporated the Kincaid Plan into its Recovery Plan, completed in 1999 (Duke et al. 1999; USFWS 1999).

Recent empirical population modeling, along with ongoing natural recruitment failure suggested that more immediate and dire challenges currently face this endangered population than previously assumed (Paragamian et al. In review Transactions of the American Fisheries Society)…

2. *Updated population condition*

a) Demographic characteristics - Recent population simulations (Paragamian et al. In review Transactions of the American Fisheries Society) suggested that:

The Kootenai River white sturgeon population declined by over 90% from 6,800 fish in 1980 to 630 in 2002, and total biomass declined by about 75% from 80 to 20 metric tons from 1980 to present.

Current (2002) is 600 individuals; population size decreases by 50% every 7.4 years.

Fewer than 500 adults from the existing wild population will remain by the year 2005, with fewer than 50 adult fish remaining by the year 2030.

Annual numbers of female spawners have decreased from 270 per year in 1980 to about 77 in 2002.

Fewer than 30 females will be spawning during any given year after 2015.

With the advent of hatchery releases in 1990, significant annual releases projected from 2000 through the foreseeable future, and assuming no additional natural recruitment, significant numbers of hatchery-reared fish can be expected to begin recruiting to the adult population after 2020.

The adult population will rapidly increase from 2020 to 2030 after which it is projected to stabilize to about 3,000 fish (depending on stocking and survival rates), when the population reaches equilibrium (Figure [3-2]).

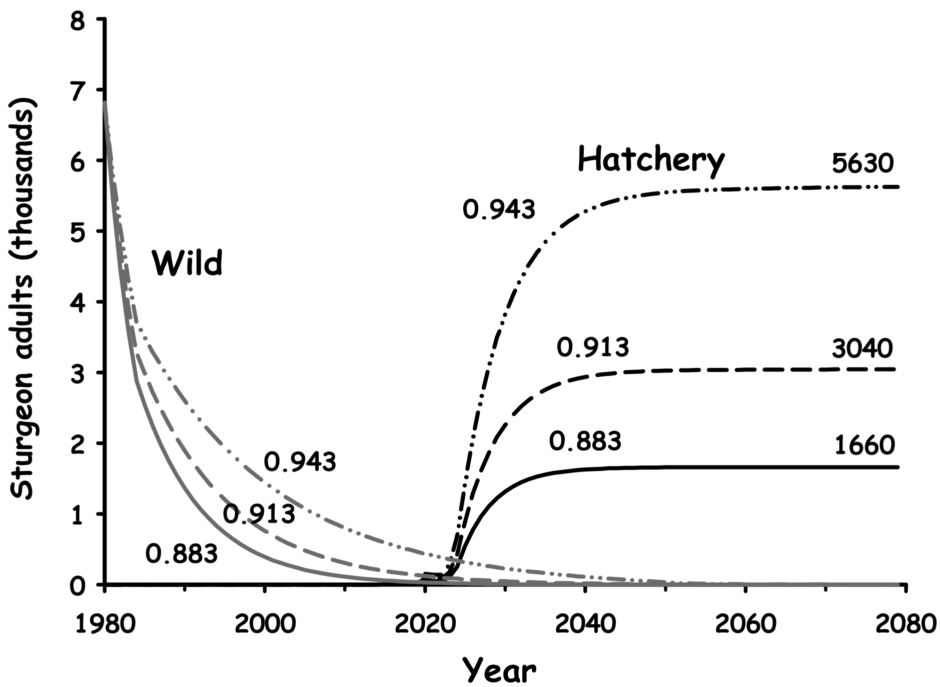


Figure [3-2]. The empirically modeled demographic bottleneck in the endangered Kootenai River white sturgeon population, indicating population trajectories with and without intervention [Figure 12 from Paragamian et al., *In* Review at Transactions of the American Fisheries Society**.] Differences between the three trajectories represent ± 3% of average (91.3%) survival rate."**

b) <u>Genetic characteristics</u> – Genetic and demographic hazards are associated with the impending disappearance of the current generation of wild Kootenai River white sturgeon. Risks associated with these hazards are simply their probabilities of occurrence (Busack and Currens 1995). Genetic hazards can include the loss of rare alleles, drift in gene frequencies, increased genetic load from inbreeding, and a small population founder effect affecting future generations (Krueger et al. 1981; Ryman and Utter 1987; Utter 1988; Ryman and Lairke 1991; Waldman and Wirgin 1988; Busack and Currens 1995; Waples 1999). The demographic hazard of small population size limits the possible range of genetic variability in future generations. Too few spawners in any year may fail to ensure synchronous maturation by sufficient numbers of males and females to take advantage of suitable habitat conditions if they occur. Limited empirical data suggest that female reproductive periodicity may range from 3 to 5 years (Paragamian et al. In review Transactions of the American Fisheries Society). This, in turn limits the amount and diversity of genetic material passed on to subsequent generations, increasingly as effective population size and numbers of spawners decline, due to mortality and natural recruitment failure.

Small spawner numbers may also confound the ability to recognize suitable recruitment conditions if they occur. Small spawner numbers also prompt decisions regarding whether mature fish are left in the river or removed to serve as brood stock. Finally, every reduction in numbers of available spawners increases the difficulties and costs of collecting ripe brood stock for the hatchery program, and jeopardizes the success of all programs to restore demographic and genetic vigor to the population.

3. *Rationale for Conservation Aquaculture* – Recent empirical model simulations suggested that the Kootenai River white sturgeon population will be functionally extinct within 20 to 30 years without hatchery intervention (Figure X). This assessment serves as the baseline for various management alternatives. This perilous population condition, along with ongoing failures to restore natural recruitment, supports immediate implementation of an upgraded conservation aquaculture program.

An increasing number of post-development ecosystems, like the Kootenai system, currently lack ecological structure and function necessary for natural recovery of some native fish populations. In some cases, the time required for successful ecosystem restoration may exceed estimates of individual population persistence without intervention (Figure 1). In other cases, ecological structure and function necessary for natural recovery of native fish populations may have been irreversibly lost. Finally, in all cases, the success of ecosystem rehabilitation and its effects on recovering native fish population are not guaranteed (Anders 1998).

Altered post-development ecological conditions in the Kootenai River ecosystem provide strong rationale for a carefully designed conservation aquaculture program. In the Kootenai River, system alteration, including impoundment, have been frequently cited as a major cause of decline for taxa across trophic levels (Duke et al. 1999; USFWS 1999; Paragamian 2002; Anders et al. 2002, 2003). Given well documented empirical ecosystem perturbation for the Kootenai River, conservation aquaculture programs can provide a "population safety net" to protect, generate, and maintain abundance, age class structure, and genetic variability required for population viability and persistence (Ireland et al. 2002a). However, the success of conservation aquaculture programs is not guaranteed either.

4. *Program overview* – Rather than a specific set of culture techniques, the Kootenai White Sturgeon Conservation Aquaculture Program involves an adaptive, expanding suite of approaches that prioritize the preservation of the endangered white sturgeon population and its locally adapted genotypes, phenotypes and behaviors (Brannon 1993; Kincaid 1993; Anders 1998; Ireland et al. 2002a). The goal of the Kincaid Plan (1993) was to: "Provide a systematic approach to preserve the Kootenai River white sturgeon gene pool, while management agencies work to restore river habitat conducive to natural spawning and larval survival". This goal remains relevant today, and was supported by the following objectives:

1. Describe a long-term approach to preserve genetic variability.

2. Provide a multi-year breeding system to re-establish age structure.

3. Provide a breeding structure to create and maintain a "high" effective population size.

4. Describe "preservation stocking" methods to minimize potential detrimental effects of conventional supplemental stocking programs.

5. Describe small-lot culture procedures to reduce the risk of detrimental genetic effects commonly associated with intensive hatchery propagation.

6. Describe a marking system to maintain family identity throughout the life cycle.

The term "preservation stocking" was used in the Kincaid Plan to indicate that preservation of genetic variability was the primary program objective. Gradual demographic expansion of the wild white sturgeon population in the presence of failed natural recruitment was at that time (1993) a secondary, yet important objective.

5. *Program results to date* – Ireland et al. (2002a) summarized pertinent results during the first 12 years (1999-2002) of the Kootenai River White Sturgeon Conservation Aquaculture Program:

- In 1990 a conservation program began to evaluate gamete viability and assess the feasibility of using aquaculture to aid in recovery of Kootenai River white sturgeon.

- Mature wild fish were captured prior to spawning and bred to produce four to 12 separate families per year to theoretically produce four to 10 adults per family at breeding age (assumed to be ~ Age 20 during the early 1990s).

- 20,496 age 1 to age 4 juvenile white sturgeon were released from 1992 to 2002.

- Recent capture of 659 juveniles (39 wild and 620 hatchery-reared) confirmed that wild recruitment of Kootenai River white sturgeon is very low.

- Average annual survival rates for hatchery-reared juveniles approximated 60% for the first year following release and 90% during all subsequent years.

- Growth rates and condition factors within 3 years after release were often poor as many hatchery fish adapted to natural conditions. Growth rates increased after the initial adjustment period.

- Relative weights of released juveniles were 88% of optimum at release, 78% of optimum at recapture, and increased with period at large.

- Empirical survival rate and condition values will provide a valuable empirical basis for adjusting release numbers of hatchery-reared fish consistent with the conservation goal of the hatchery program, quantified through future model simulation. Such releases can also provide a baseline for comparison with the results of future monitoring to determine carrying capacity of the Kootenai River system for juvenile sturgeon.

The following three paragraphs from Paragamian et al. (*In* review at Transactions of the American Fisheries Society) summarize recent and future conservation and management challenges for the Kootenai River white sturgeon population:

> Current numbers and population dynamics confirm that time has not yet run out for the Kootenai River white sturgeon but opportunities for effective intervention are rapidly dwindling. The long life span of sturgeon provides an extended period in which to identify and implement effective but possibly contentious recovery measures. However, 40 years of this window of opportunity has now passed for Kootenai River white sturgeon. Consistent recruitment appears to have collapsed 20 years prior to the first systematic population surveys around 1980. Another 20 years have passed, during which the species was listed under the U.S. Endangered Species Act, a recovery plan was completed (Duke et al. 1999; USFWS 1999), a conservation hatchery program was developed (Ireland et al. 2002a, 2002b), and spring spawning flow measures have been implemented (Paragamian and Kruse 2001; Paragamian et al. 2001; Paragamian and Wakkinen 2002).
>
> The next 5-20 years will be a critical period in the preservation of Kootenai River white sturgeon. A bottleneck in spawner numbers will occur as the wild population declines and hatchery-reared fish released beginning in 1992 are not yet recruited to the spawning population. The depth and duration of the bottleneck cannot be avoided by any action that has not yet been implemented.

> Even the immediate restoration of suitable habitat conditions for recruitment may not be sufficient to avoid adverse consequences of projected low population numbers.
>
> It now appears likely that the next generation will be produced primarily or entirely by the conservation hatchery program. Post-release assessments have found excellent condition, growth, and survival of hatchery juveniles, especially after an initial adjustment period (Ireland et al. 2002b). If fish managers had not initiated a conservation hatchery program as a contingency to habitat improvement measures, it now appears likely that the current sturgeon generation would have been the last.

A back-up hatchery near Fort Steele B.C. was established a couple years ago. The intent was to produce the same genetic families in case the Kootenai Tribe's facility in Idaho had a catastrophic failure. BPA assists in the funding of this operation. The current B.C. hatchery exists to stock produced fish directly into Canadian waters of the Kootenay.

The Corps' and BPA's proposed action will provide funding for the continued operation and expansion of the Kootenai Tribe of Idaho's hatchery operations as well as needed facility expansion.

3.3. Implement an Research, Monitoring and Evaluation (RM&E) Program to Define Sturgeon Spawning and Recruitment Needs

The PA includes a continuation of an RM&E program, in coordination with the USFWS and the KRWSRT. As discussed earlier, information developed from empirical research suggests that the white sturgeon are spawning, but there has been limited recruitment. Therefore, the RM&E program will be designed to focus on resolving critical uncertainties regarding egg and larvae survival. These uncertainties include: suitable habitat (substrate) for spawning, incubation, and larval development; flow characteristics such as water velocities, temperatures, depth, turbidity and turbulence; and nutrients and other limiting factors.

Actions and projects will be formulated depending upon the characteristics of different river reaches and where the sturgeon currently spawn. For purposes of describing the Kootenai River, the following is a characterization of the different segments (see Figure 3-3):

- Canyon Reach (also called Confined Reach) River Kilometer (RKM) 254-276 (note that this reach continues upstream to Kootenai Falls in Montana**),**
- Braided Reach – RKM 244-254 (the Bonners Ferry to Deep Creek reach is also referred to as the Straight Reach), and
- Meander Reach (RKM 170-244).

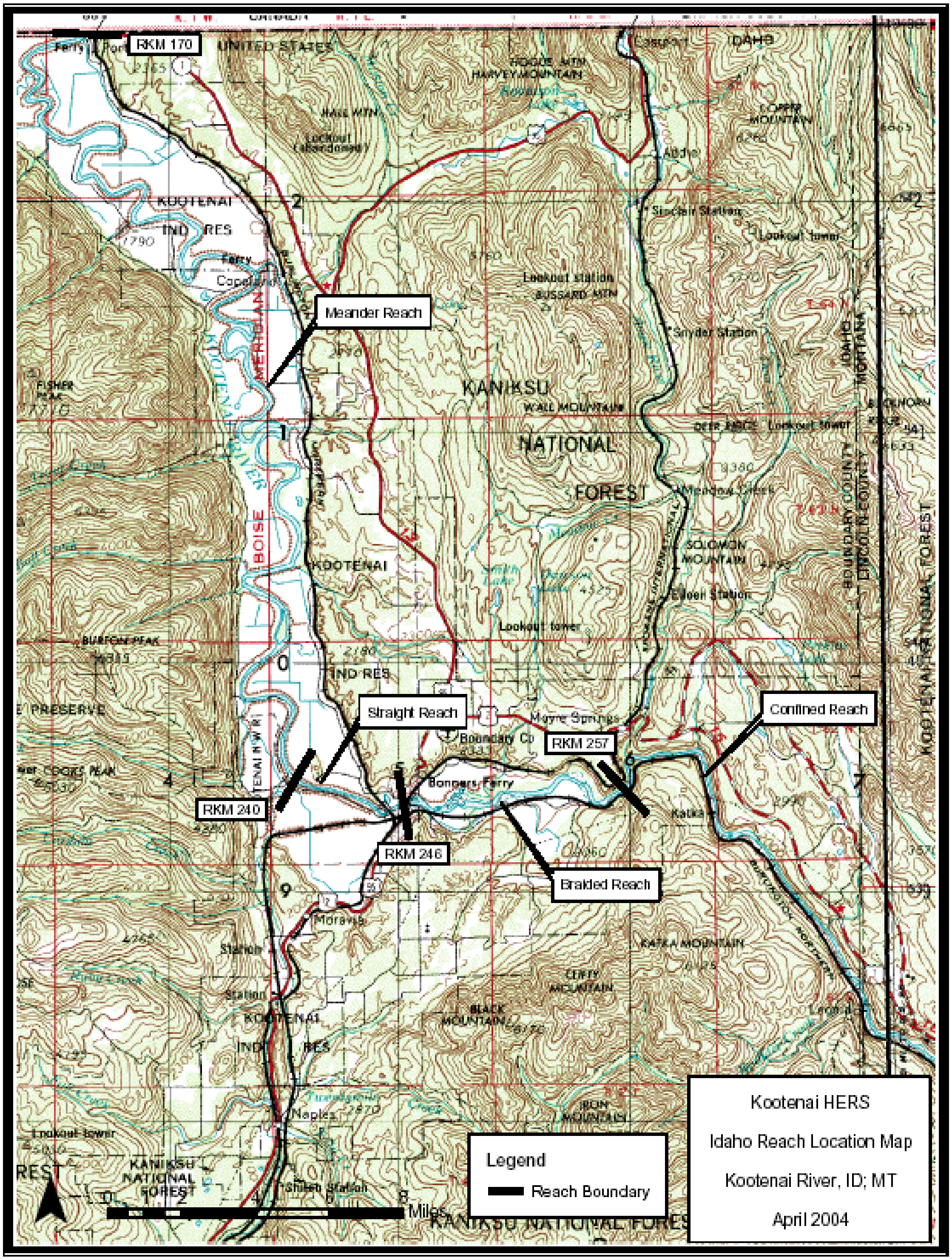


Figure 3-3: Kootenai River, showing the designated reaches and river kilometer end points (from USACE, 2004).

In the near term, the proposed action includes the following to further our understanding of the limiting factors concerning successful recruitment: 1) research on the geomorphology, sediment transport, and hydraulic characteristics of the Kootenai River and other factors, 2) the creation of improved spawning substrate, and 3) support KRWSRT's adaptive experiments to relocate spawning-condition males and females upstream of the braided reach. Each of these actions would further the scientific understanding that would lead to effective habitat development for the long-term.

3.4. Research on the geomorphology, sediment transport, and hydraulic characteristics of the Kootenai River and other factors

The BPA is funding several studies through the Council's Fish and Wildlife Program that are designed to provide information to assist in making informed decisions about the effectiveness of scouring flows. These studies are summarized below.

- <u>Characterization of Channel Substrate and Changes in Suspended Sediment Transport and Channel Geometry in White Sturgeon Spawning Habitat in the Kootenai River near Bonners Ferry, Idaho, Following the Closure of Libby Dam (Barton 2004).</u> The report detailing the findings of this study is available on-line at http://id.water.usgs.gov/PDF/ofr041045/ofr041045.pdf. The Cooperating Agency is the Kootenai Tribe of Idaho and the period of study is May 2000 to September 2002. This study was conducted by the USGS.

  This study was undertaken to evaluate changes to suspended sediment transport and channel geometry in the Kootenai River in a 21.7 km reach extending from just above Bonners Ferry, Idaho to Shorty's Island. Data collected as part of the study included seismic subbottom profiles at 18 cross sections within the study reach and sediment cores at or near each of the seismic cross section locations. Historic suspended sediment data from 1966 through 1983 were evaluated to determine pre- and post-dam effects on the reach's sediment transport characteristics. Suspended sediment samples were collected and analyzed and compared with samples collected prior to the closure of Libby Dam.

  The mean annual load of suspended sediment from 1966-71, prior to the closure of Libby Dam, was estimated at 1,743,900 metric tons while the mean annual load during the period from 1974-83, following the dam's closure, was estimated at 287,500 metric tons. A gravel and cobble lens of uncertain horizontal extent, buried by sand, was located near Bonners Ferry. White sturgeon spawning substrate in the Kootenai River meander reach is currently composed of alluvial sand and minor amounts of lacustrine clay and silt that generally are found in the river's thalweg. The present substrate composition in the meander reach is considered similar to that which existed prior to the closure of Libby Dam with one minor exception. Prior to the closure of Libby Dam, minor amounts of gravel and cobble may have been exposed on the riverbed in the spawning reach just below the mouth of Myrtle Creek. The substrate composition near Shorty's

Island, a reach in which white sturgeon spawning has been reported, is predominantly sand and is similar to that which existed prior to closure of Libby Dam.

The study provides information about existing conditions, which may help to explain some of the observed spawning behaviors of Kootenai River white sturgeon. IDFG has collected higher numbers of eggs in the river reaches with increased velocity and turbulence (coincident, multi directional velocity vectors) as reported and predicted by the USGS 3D River Model.

The USGS model indicates slightly higher velocity flows and turbulence in the Shorty's Island reach as compared to the reaches immediately upstream and downstream. IDFG egg density data also indicate substantial increase in egg density in this reach.

The USGS model also indicated velocity and turbulence regimes similar but less profound to those in the Shorty's Island area in the reach adjacent the Bonners Ferry dock and Ambush Rock. IDFG egg collection and spawning event data also indicate increased spawning behavior and egg collection in this reach.

Both sets of findings support the proposed habitat improvements in the Shorty's Island and Ambush Rock reaches to enhance spawning cues and egg maturation and larvae survival substrate.

- Establishment of Survey Control and Collection of Topographic Data for the Development of Hydraulic and Sediment Models of the Kootenai River. The cooperating agencies are the Kootenai Tribe of Idaho, Idaho Department of Fish and Game, and the Corps of Engineers. The period of study is April 2002 to September 2004. This study is being conducted by the USGS.

- USGS Hydraulic Model of the Kootenai River between Libby Dam and Kootenay Lake. The cooperating agency is the IDFG. The period of study is April 2002 to September 2004. A one-dimensional hydraulic model of the Kootenai River is being developed as a tool to help biologists and others from the IDFG, Kootenai Tribe of Idaho, USFWS, and the Corps of Engineers. Specifically, model-computed stage-discharge relations will be presented in lookup tables and (or) graphs by relating three parameters: stage, discharge, and the location in river miles where the flow transitions from backwater to free flowing water conditions. After the model has been calibrated, it will be used to simulate the response of the hydraulic system to four discharge levels (6 kcfs, 20 kcfs, 40 kcfs, and 60 kcfs) at three stages (15-percent stage duration, 50-percent, and 85-percent) for a total of twelve simulations that represent possible stage-discharge management alternatives in the river. The report for the hydraulic model is scheduled for release in September, 2004.

- Sediment Transport and Bed Shear Stress Models of the Kootenai River in the Sturgeon Spawning Reach near Bonners Ferry. The cooperating agency is the Kootenai Tribe of Idaho. The period of study is March 2002 to September 2004. The objective of the proposed study is to assess the feasibility of enhancing white sturgeon spawning substrate habitat in the Kootenai River. The objectives and scope of this proposed project will provide scientific information to the white sturgeon recovery team's adaptive management decision process regarding substrate enhancement measures in the spawning reach. This study is being conducted by the USGS.

  The study area includes the entire designated critical habitat for the Kootenai River population of white sturgeon from RKM (river kilometer) 246 at the U.S. 95 bridge at Bonners Ferry to RKM 228 (1.5 RKM down stream of Shorty's Island.) The scope of this study incorporates the following objectives: 1) survey the channel geometry at 60 or more cross-sections of the Kootenai River including elevation of the river bank/levee/dike on each side of the river, bathymetry, stage, and slope of the water surface; 2) monitor the concentration, load, and particle-size distribution of suspended sediments and bed sediments at the upstream and downstream boundary of the designated white sturgeon critical habitat and near the mouth of tributaries Deep Creek and Myrtle Creek; 3) collect bed material samples from the river substrate and conduct particle-size distribution analyses on these samples and previously collected cores of the river bottom sediments; 4) construct and calibrate a 1-dimensional sediment transport and 2-dimensional bed shear stress model; 5) where possible, use monitoring data and sediment transport model simulations to describe availability and movement of fluvial sediment through white sturgeon spawning habitat and identify where habitat substrate is currently aggrading, degrading or is stable; and, 6) utilize 2-dimensional bed shear stress model output to assess the feasibility of enhancing sturgeon spawning habitat. The report for the sediment transport and bed shear stress models is scheduled for release in September, 2004.

- Data Collection and Analysis for Addressing the Feasibility of Enhancing White Sturgeon Spawning Substrate Habitat in the Braided Reach of the Kootenai River, Idaho (see Figure 3-2). The cooperating agencies are the IDFG and USFWS. The period of study is August 2003 to September 2004. This study is being conducted by the USGS.

In addition to the BPA funded studies, the following studies are also being conducted.

- Survey of Kootenai River Cross Sections Between Libby Dam, Montana, and Kootenay Lake, British Columbia, Canada. This study was jointly funded by the USGS and the Corps of Engineers. The report has been published on-line and can be accessed at http://id.water.usgs.gov/PDF/ofr041045/index.html. The report provides a detailed description of the methods used to collect the data as well as a link to ASCII files containing distance and elevation data for 245 channel cross sections. These cross sections will provide information that can be used to develop hydraulic flow, sediment-transport, and bed-shear stress models of the river.

- Corps of Engineers Hydraulic Model of the Kootenai River between Libby Dam and Kootenay Lake. A one-dimensional hydraulic model of the Kootenai River is being developed by the Corps of Engineers. The model will utilize the cross-sections and survey control provided by the USGS, as well as overbank geometry developed from existing USGS digital elevation maps. The Corps of Engineers model will be used to verify the channel capacity of the river below Libby Dam, as well as evaluate flood levels and public safety concerns along the banks of the Kootenai River below Libby Dam. The report for this hydraulic model is scheduled for release in October 2004.

Until the results of the USGS study are presented, the Corps and BPA have determined it is premature to implement scouring flows since there is not sufficient information that it will effectively improve substrate conditions. However, a possible experimental spill test to determine if scouring flows would achieve the desired results may be considered in the future.

3.5. Creation of Improved Spawning Substrate and Rearing Habitat

The Corps and BPA are working with KRWSRT to identify projects for improving spawning substrate and rearing habitat, and programs to implement these habitat improvements. These projects include placing spawning substrate in various prescribed locations; increasing velocities to either induce spawning or reduce predation; and development of backwater habitat as discussed below.

- The first type of proposed projects is the creation of improved spawning habitat by placement of large rock or other suitable sturgeon recruitment substrate in the vicinity of Shorty's Island, which is included in the designated critical habitat. Successful sturgeon spawning has occurred in this area in the past decade; however, there has not been documentation of successful recruitment. This is very likely because the substrate in the meander reach upstream and downstream of Shorty's Island is predominantly sand. Eggs released over sand have little chance for hatching, as they either roll along the bottom, becoming encrusted with sand, and suffocating; or, they are highly visible to predators and are quickly eaten. Thus, placement of more appropriate substrate—rocks, cobbles, and gravels—for egg attachment and protection is proposed. Substrate would be placed on the outside bend(s) where velocities are sufficient to keep the interstitial space clean and minimize predation. The objective of this project is to provide fertilized egg access to protective substrate where river conditions currently trigger spawning. This strategy takes advantage of current known sturgeon spawning behavior and location and attempts to improve substrate conditions.

- Various methods will be investigated to increase velocities, which may induce spawning behavior, remove fine sediments, or reduce predation on eggs and larvae. Structural modifications, such as velocity pinch points or channel constrictions would be engineered to increase velocities by directing the river through confined channel reaches. Because of the relatively steep gradients in the braided and canyon reaches, velocities are probably sufficient for spawning. The measures would therefore be primarily focused in the meandering reach where they are most needed.

- Low-flow backwater habitat may also be an important component of sturgeon early life survival. Backwater channels are characterized by very slow moving (or still) water, fed primarily from the downstream end. The primary purpose of these backwater channels is to provide rearing habitat for juvenile sturgeon. The most favorable locations are downstream of Bonners Ferry, where the stream gradient becomes much flatter. In addition, since the channels are expected to be utilized by juvenile sturgeon (possibly including larval forms), the channels would be located downstream of the main spawning reach(es).

It is also noted that development of a side channel spawning and rearing complex has been discussed. It would be engineered to enable substrate composition, channel shape, velocities, depths, and turbidity to be carefully controlled. Such a facility could be thought of conceptually as an in-river hatchery. It could provide another potential opportunity for sturgeon recruitment, and provide the means to better understand sturgeon reproduction and rearing biology. This concept is in early development and may be considered in the future.

The Action Agencies have two efforts underway to construct improved spawning and rearing habitat.

- The Corps initiated a Habitat and Ecosystem Restoration Study (HERS) in FY 2003. The HERS study is collating the best available science concerning the biological requirements for successful sturgeon recruitment; evaluating the biological conditions present during successful year class recruitments; evaluating the potential for recreating the needed biological conditions necessary to support sturgeon recruitment in each reach; and identifying potential restoration construction projects to recreate the biological requirements. The HERS study team is coordinating with the KRWSRT to identify and evaluate alternative methods to meet the biological requirements for successful recruitment. The KRWSRT is also the independent technical reviewer of the HERS products and recommendations. The HERS will also use the findings of the USGS sedimentation modeling work to evaluate the feasibility and sustainability of contemplated long term projects.

  An initial report is scheduled for completion in the spring of 2004 (see Corps 2004). This report will identify a list of promising habitat and ecosystem restoration projects. The projects will be prioritized based on the ability of the project to be implemented and to recreate the biological conditions believed to be conducive to successful sturgeon spawning and recruitment.

The authorities available to the Corps to implement identified projects (e.g., Section 1135 of Water Resources Development Act (WRDA) of 1986, Section 206 of WRDA 1996, and others) require a local sponsor responsible for providing lands, easements and rights of way. The Corps and BPA are working with potential local sponsors, such as the State of Idaho or the Kootenai Tribe of Idaho, as specific projects are identified for restoring substrate habitat for spawning, incubation and larval development. Planning and design efforts would be coordinated with the USFWS and KRWSRT to assure the best available science and opportunity for success. A thorough monitoring and evaluation program would be developed to provide information so that long term solutions for habitat restoration can be developed.

- BPA through the Council's Fish and Wildlife Program also has funded habitat restoration evaluations. The Kootenai Tribe of Idaho received approval for a Habitat-Ecosystem restoration study in FY 04-05 ($1.5 M). A study that looks at opportunities to reconnect side-channel floodplain habitat has been underway for several years. The Council's Fish and Wildlife Program funding for the floodplain reconnection study has been provided for FY 04, and study results are expected soon. These studies are expected to define recommended projects to improve white sturgeon spawning and rearing habitat. The action agencies will work closely with the KRWST, the USFWS and the Kootenai Tribe of Idaho, and local governments and landowners as proposals are made.

3.6. Support KRWSRT's Adaptive Experiments

In 2003, the IDFG and the Kootenai Tribe of Idaho cooperated in relocating sexually ripe female and male sturgeon captured in the lower river to an area upstream of Bonners Ferry, near the mouth of the Moyie River. The purpose of this action, referred to as "set and jet," was to gain insight into the possibility of inducing sturgeon spawn over substrates that are thought to be more conducive to egg and larvae survival.

IDFG documented spawning of 2 relocated female sturgeon near Hemlock Bar on June 5, 2003. Radio signals of one of the ripe males and one of the ripe females were indistinguishable from each other at the time of tracking, and 5 sturgeon eggs were found on a sampling mat downstream of that site shortly afterwards. In all, 3 female and 9 male sturgeon were relocated; no other spawning events were documented after the June 5^{th} event. Verification that eggs were fertilized could not be made because they were of a very early development stage. If they were fertilized, the potential successful recruitment of sturgeon into the wild population from this experiment could be documented when the fish reach a size where they are vulnerable to sampling nets as juveniles, 2-3 years from spawning.

3.7. Continue KTOI (BPA-funded) examination of contaminants as a limiting factor for sturgeon recruitment.

Ecosystems are complex, interdependent, dynamic systems. In nearly every conceivable instance, they are subject to multiple stressors; therefore, even a single new (or old) stressor requires consideration of the potential for interactions to occur (Foran and Ferenc 1999). Given that the Kootenai River system is already stressed by physical limiting factors (which are presently being researched), it is necessary to determine the probability of changes to the ecosystem that have evolved in relation to chemical stressors. If contaminant studies and monitoring indicate significant effects of contaminants on reproduction, it may be possible and necessary to carry out mitigation measures at or near loading sites in order to reduce chemical impacts on the aquatic system (Kruse, personal communication 2004).

In order to provide a more complete picture about the effects of existing contaminants on the white sturgeon population, the contaminant study incorporates research that address bioavailability, chemical and physical interactions, effects of specific individual compounds and environmental monitoring to determine contaminant trends within the aquatic system. These topics are being addressed through research such as sediment residue and pore water analysis, laboratory-based toxicity studies, food-chain organism tissue residue analysis and dose-response analysis. Techniques for measuring the effects of contaminants on aquatic species are continually evolving. Many of the methods being developed are focused on determining sub-lethal (rather than acute or chronic) effects during various life stages. For example, researchers at the Columbia Environmental Research Center (CERC) in Columbia, Missouri, have developed fish egg injections techniques to allow the study of potential effects of contaminants on early embryonic development without the need to expose the adults to these contaminants. These and other developed techniques allow studies on various life stages of a long-lived species, without the need for elaborate holding, containment, and rearing facilities. When combined with in-situ research, methods such as these can become extremely useful tools for assessing the degree of impact that existing environmental contaminants are having on reproduction in the Kootenai River white sturgeon population (Kruse, personal communication 2004).

3.8. Increase Primary Productivity of Kootenay Lake

As described in Chapter 2, Libby and Duncan dams have altered downstream nutrients levels. British Columbia is currently fertilizing the North Arm of Kootenay Lake to increase biological productivity and restore native fish populations. BPA, through the Council’s Fish and Wildlife Program is also funding for fertilization of Kootenay Lake. This program was initiated to increase primary productivity in Kootenay Lake in response to mysid shrimp invasion, and the subsequent reduction in zooplankton abundance, which in turn affected kokanee salmon density. Kokanee are an important food item for adult and juvenile sturgeon. The fertilization program has been successful, and continued funding is proposed.

3.9. Use Performance Standards to help set action agencies' priorities and achieve recruitment

Performance standards and measures are critical for managing available resources to achieve species recovery under the Endangered Species Act.

A performance standard is defined as a specified numerical objective or target deemed necessary to improve ecosystem function, improve species survival, and ultimately result in recovery for listed fish. A performance standard is the performance-level objective of a performance measure. A performance standard can be expressed as an absolute quantitative target, a change in condition from some baseline, or simply used to verify the proper implementation of a particular management action (i.e., programmatic-level standard). Examples of performance standards include a specific level or quantity of adult fish, measured improvement in habitat conditions, etc.

A performance measure (metric) is the physical or biological parameter, in terms of a condition or response, which is monitored over time. A performance measure is either an actual measurement or an estimate and is generally a prerequisite for achieving a performance standard. For example, suitable spawning substrate, rearing habitat and shelter for juveniles, and flow velocities are performance measures that are needed to achieve the live stage survival standards.

3.9.1. Performance Standard Measuring Life Stage Survival of White Sturgeon

The overall performance standard for this proposed action is taken from the Kootenai River white sturgeon recovery plan (USFWS, 1999), and is defined as natural production in at least 3 different years within a 10-year period. To be successful, the natural production must include at least 20 juveniles from each year class when sampled at more than 1 year of age. These are the criteria in the recovery plan for downlisting Kootenai River white sturgeon from endangered to threatened status.

The Corps and BPA are also considering the development of performance standards/measures for bull trout in the vicinity of Libby.

3.9.2. Physical Performance Measures and Standards

The Corps and BPA recognize that additional work is required to develop a more complete and definitive set of life stage survival performance standards and measures for the sturgeon. The following is intended to provide an overview of the types of life stage performance standards to consider.

Velocity. Velocity is important to maintenance of proper substrate, and may be important to spawning itself. It also appears to be important to protection of larvae from predators.

Turbidity. Turbidity is associated with the spring freshet, created by the presence of suspended solids, as well as planktonic algae which "bloom" as water temperatures and day length increase, and as nutrients become more available. Turbidity may be an important visual factor for spawning sturgeon, allowing for photonegative behavior. Turbidity also serves to obscure floating eggs and larvae, making them less vulnerable to predation.

Water temperature. An increase in water temperatures to levels above 10^{o} C is believed to trigger sturgeon spawning behavior in the Kootenai, though they have been known to "stage" for spawning at lower temperatures.

Depth. Deeper water is potentially important in facilitating photonegative behavior that may be associated with spawning in sturgeon. Where water is clear, sturgeon may seek deep holes as part of the spawning process. In general, the greater the turbidity of the water, the shallower the depth of spawning location might be.

Flow. Flow may be a means for providing other physical cues, such as velocity, depth, possibly turbidity, as well as scouring substrate and providing nutrients.

Substrate. Clean substrate of gravel size or greater is necessary for egg survival and hatching success, as well as for survival of larvae.

3.9.3. Biological Performance Measures and Standards

Spawning over preferred substrate. It is important to be able to determine that spawners are consistently seeking and finding suitable substrate, rather than sand or other fine material that is detrimental to egg survival.

Evidence of hatching success and presence of larvae. Lack of evidence of sturgeon larvae in the Kootenai River has fueled concerns about a "bottleneck" in the early life stages of sturgeon. Larvae must be consistently documented as evidence of the success of measures to benefit sturgeon reproduction.

Survival of recruits to age 3. This is important because fish of this age are accessible to sampling gear. This may be the earliest age at which we can document survival of juveniles. Documentation of 20 individuals from a year class by age 3 would meet the criterion above.

Survival of recruits to sexual maturity. Lack of recruitment of spawners is a major reason for the listing of Kootenai River white sturgeon under ESA. Ultimate success of recovery actions will be gauged at this stage. Again, a downlisting criterion would be met if 20 fish from a year class were documented at this age.

3.10. Utilize an Adaptive Management Approach to modify actions based on new scientific information

The Corps and BPA are proposing to utilize an adaptive management approach for the listed Kootenai River white sturgeon and the bull trout above and below of Libby Dam, consistent with adaptive management that is underway in the NOAA Fisheries 2000 FCRPS BiOp.

In part, the intent is to develop a set of performance measures and standards that will result in successful recruitment of sturgeon. First priority would be placed upon providing the physical features or channel complexity (such as velocity, temperature, depth, and spawning substrate), as well as the actual biological measures of successful recruitment. The proposed action in this BA includes several specific actions that will be pursued to achieve these performance standards. Some actions are continued from the 2000 BiOp, some have been adjusted based on additional information since 2000, and some are new actions that have not been previously considered.

Adaptive management is a process by which the results of management actions are evaluated and adjusted. It constitutes an iterative cycle of planning, acting, monitoring and evaluating, until the desired goal or objective is reached. Ideally, a management action is formulated (planned) as an experiment to test a hypothesis, and once it is implemented (acted on), the results are scientifically monitored and evaluated. The process is more rigorous than simply trying some action “to see if it works.” There are numerous examples of its use in resource management, and specific tools, such as the Adaptive Environmental Assessment modeling already applied to the Kootenai, are available.

The Corps and BPA plan to work closely with the USFWS and the KRWSRT to evaluate the effectiveness of different actions as they are carried out and will incorporate new scientific information, including information provided by states, tribes, Northwest Power and Conservation Council, and KRWSRT.

The Corps and BPA are therefore proposing to incorporate an annual planning and review process similar to that found in the 2000 NOAA Fisheries FCRPS BiOp. The planning and review process provides flexibility for modifications based on current information while assuring that the needs of the species are maintained. The Corps and BPA propose to include a review of the previous year’s progress and an implementation plan that describes action for the upcoming years. The progress review will document the actions performed and the studies/monitoring conducted during the current year and what was learned, or is expected to be learned (including the time-line) about their effectiveness. The planning portion will identify the actions and studies proposed for the coming year, and the next five years. The Corps and BPA also propose a check-in at 2008 to assess information collected and determine if additional actions should be considered.

The Corps and BPA propose that in response to the plans provided by the Corps and BPA, the USFWS provide an assessment of the actions to confirm that implementation and any modifications are not likely to jeopardize the continued existence of the listed species or result in the destruction or adverse modification of the sturgeon's critical habitat.

4. Affected Environment

4.1. Kootenai River White Sturgeon

4.1.1. Consultation History

The ESA Section 7 consultations on sturgeon resulted in the issuance of a USFWS Biological Opinion, dated March 1, 1995 and December 20, 2000. Information used in these consultations is incorporated by reference in this section. Information acquired since the issuance of the 2000 BiOp is provided in this section.

4.1.2. Present Population Status

As indicated in Section 2.2, a 2003 population abundance estimate for Kootenai River white sturgeon was 600 fish (Paragamian *et al. In* review at Transactions of the American Fisheries Society). Ireland, et al (2003) state:

> Empirical demographic modeling during 2002 revealed the increasingly imperiled condition of this population. Model simulations suggested that 90%, 75%, and 72% reductions in population abundance, biomass, and annually available spawners, respectively, occurred from 1980 to 2002; population size is currently estimated to decrease by 50% every 7.4 years; this equates to about 9% per year. Aging of 659 juveniles (39 wild and 620 hatchery-reared) confirmed that wild recruitment of Kootenai River white sturgeon is very low (Paragamian *et al. In review* at Transactions of the American Fisheries Society).

Webb (2002) determined that reproductive senescence in Kootenai River white sturgeon was not likely, and that adults will continue to reproduce throughout their life span, though females may experience a decline in fecundity as they age.

> Reproductive senescence does occur in sturgeon (e.g., Veshchev and Novikova, 1986; Raspopov, 1987; Krykhtin and Gorbach, 1996; Van Eenennaam and Doroshov, 1998). Fecundity remains to be the most reliable predictor of reproductive senescence, however accurate measures of fecundity changes with age are not possible in the federally-listed population of white sturgeon in the Kootenai River as lethal sampling is required. It appears that the Kootenai River

white sturgeon population will remain reproductive throughout their life span. Females may experience a slight decrease in fecundity with age as this relationship has been described to date in all long-lived species, including sturgeon, as curvilinear. Evidence also suggests that fertility of the highly fecund, old females will not decline as the population ages. It is unclear at this time whether the spawning frequency will change with age. (Webb 2002)

4.2. Kootenai River White Sturgeon Critical Habitat

4.2.1. Background

The proposed rule for designation of sturgeon critical habitat was published on December 21, 2000 (65 FR 80698). The public comment period on the proposed rule was open from December 21, 2000, until February 20, 2001. The USFWS made a final designation for sturgeon critical habitat on September 6, 2001.

4.2.2. Designation for Kootenai River

Critical habitat for the Kootenai River population of white sturgeon was based on known spawning locations at the time of the designation, and was designated as follows (USFWS 2001):

> That portion of the Kootenai River within Boundary County, Idaho, from river kilometer 228 (about river mile 141.4, below Shorty's Island) to river kilometer 246 (about river mile 152.6, above the Highway 95 Bridge at Bonners Ferry, Idaho). The lateral extent of critical habitat is up to the ordinary high-water lines (as defined by the USFWS in 33 CFR 329.11) on each bank of the Kootenai River within this 18 kilometer (11.2-mile) reach.

Figure 4-1 shows the critical habitat extent on a map of the Kootenai River in Idaho.

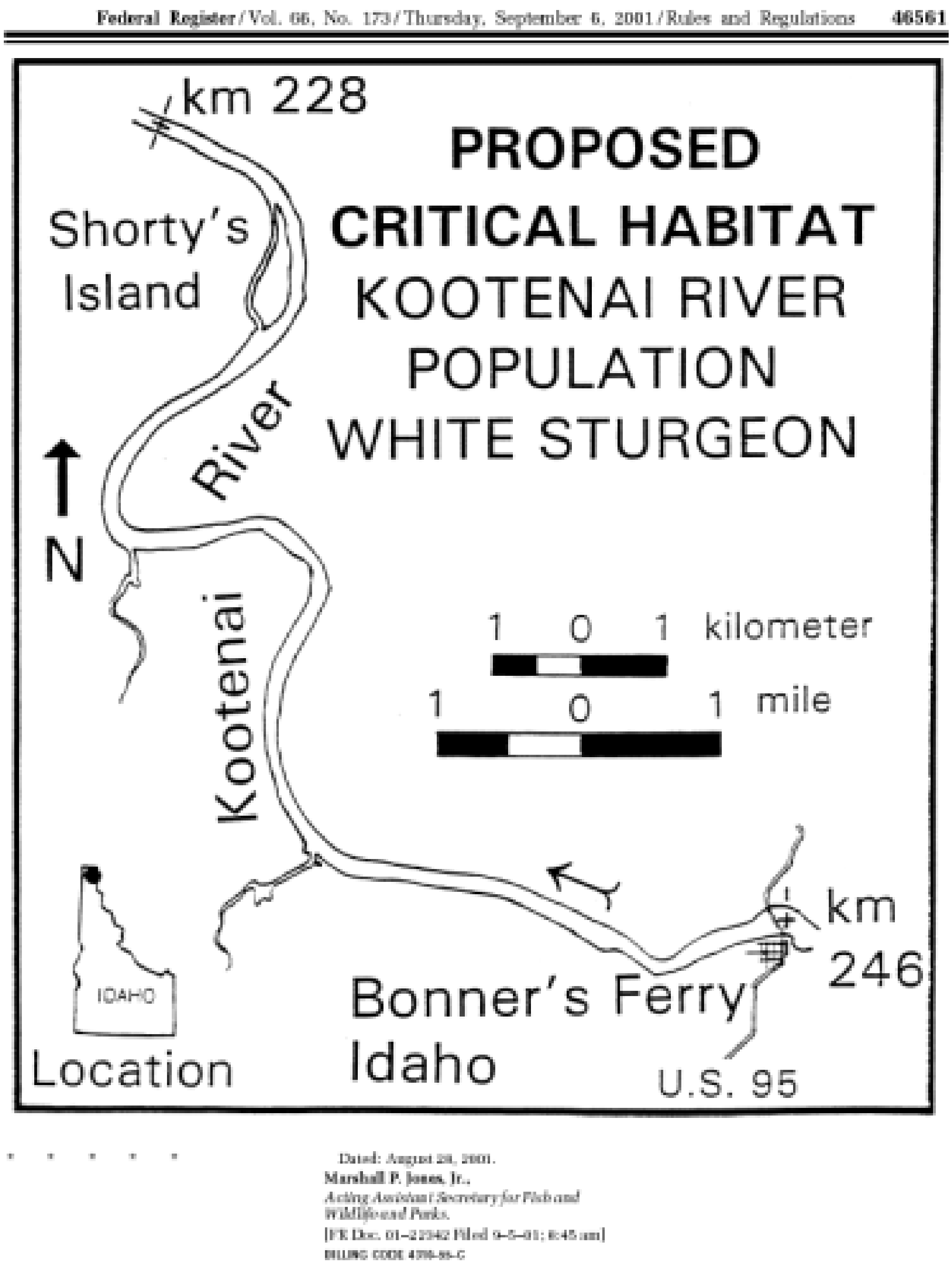


Figure 4-1 (from USFWS, 2001).

4.2.3. Components of Critical Habitat for Kootenai River White Sturgeon

Designation of critical habitat requires USFWS to consider those physical and biological features (primary constituent elements) essential to the conservation of the species, and which may require special management considerations and protection. These physical and biological features include but are not limited to the following: space for individual and population growth, and for normal behavior; food, water, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, or rearing of offspring; and, habitats that are protected from disturbance or are representative of the historical geographical and ecological distributions of a species. The important habitat features that provide for breeding and rearing of offspring through the free-swimming larvae stage include: water temperatures, depths, substrate, turbidity, and velocities appropriate to trigger sturgeon breeding, and water volumes and substrates sufficient to provide cover and shelter to incubating eggs and yolk sac larvae.

4.2.4. Relevance of Section 7 of ESA

Habitat is often dynamic, and species may move from one area to another over time. Furthermore, designation of critical habitat may not include all of the habitat areas that may eventually be determined to be necessary for the recovery of the species. For these reasons, critical habitat designations do not signal that habitat outside the designation is unimportant or may not be required for recovery (USFWS 2001). Areas outside the critical habitat designation will continue to be subject to conservation actions that may be implemented under section 7(a)(1), and to the regulatory protections afforded by the section 7(a)(2) jeopardy standard and the section 9 take prohibition.

4.3. Bull Trout Status

Bull trout were listed as threatened in the Columbia Basin on June 10, 1998, by the USFWS (USFWS 1998b). Designation of critical habitat has been proposed for this population segment of bull trout (USFWS, 2000).

As of spring 2004, bull trout recovery planning is ongoing through 26 or more recovery unit teams and a coordinating team. The draft plan is not yet available.

The 1999 Biological Assessment contains a complete summary of status and life history of bull trout in the Columbia River drainage (USACE et al, 1999). This document and the USFWS 2000 BiOp provided detailed information on bull trout life history in the Kootenai Basin, which is incorporated by reference. Only new information about bull trout obtained since issuance of the 2000 BiOp will be addressed in this BA.

4.3.1. Current Distribution- Migratory (Fluvial and Adfluvial) Populations

Figure 4-2 shows current bull trout distribution in the US portion of the Kootenai drainage. Construction of Libby Dam in 1972 resulted in a barrier to upstream fish movement and formed a 90-mile long reservoir. Habitat fragmentation may have also

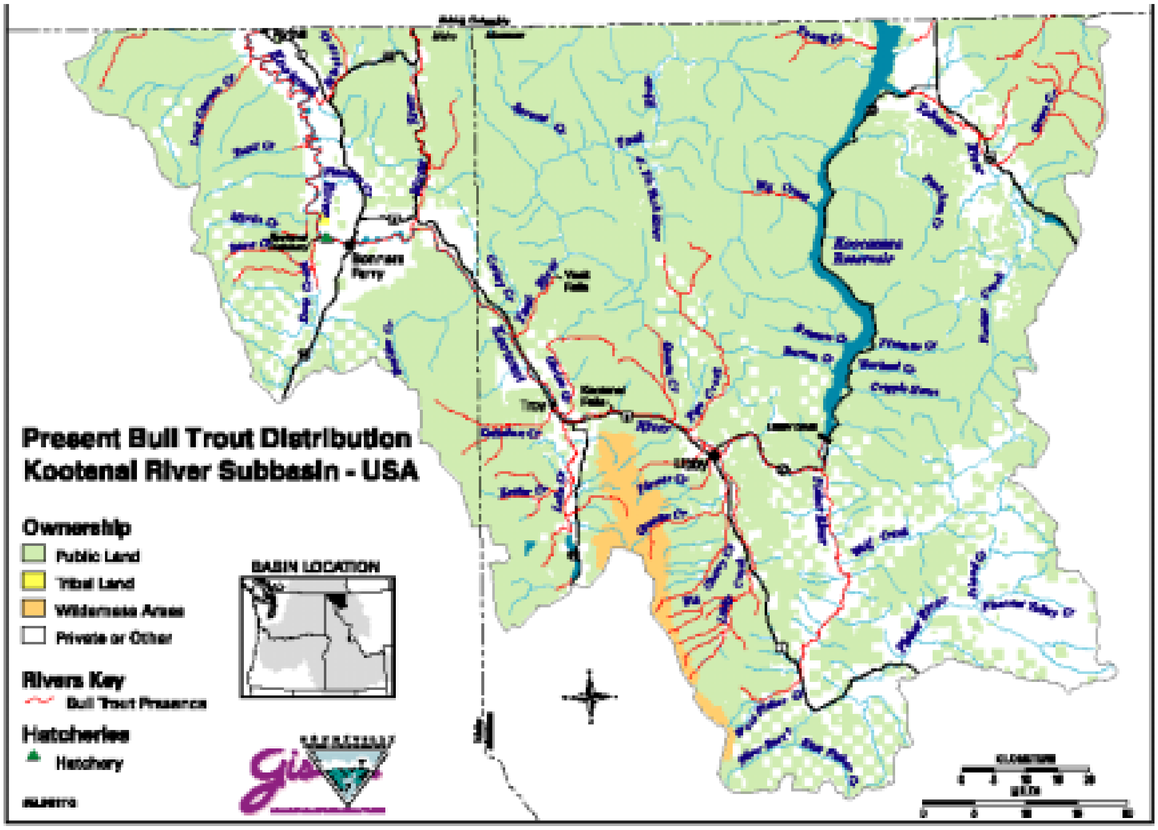


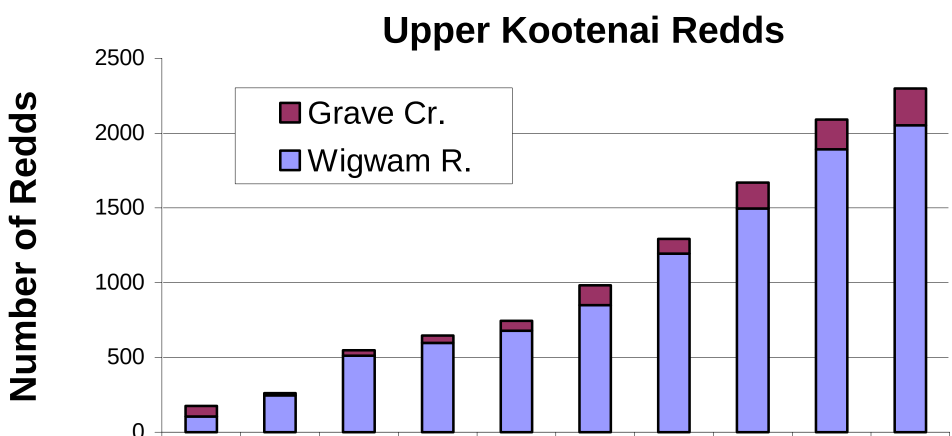
Figure 4-2. Current bull trout distribution in the US part of the Kootenai River drainage.

occurred with the construction of a dam on the Elk River in British Columbia (MBTSG 1996d). Bull trout in Koocanusa Reservoir migrate into tributary drainages to spawn. Juvenile fish rear for several years before moving back downstream to the river or reservoir. Sub-adults remain in the river or reservoir for several more years prior to maturity. The Kootenay River upstream of the reservoir in British Columbia likely supports migratory fish as well. The only known spawning and rearing area in the United States is located in the Grave Creek drainage. In 2003, 245 redds were counted on Grave Creek, the most ever in that creek (Vashro, 2003). The Ram River and Wigwam River drainages in British Columbia support the majority of the known spawning and rearing area for this population. Most of the upper Kootenai River bull trout range is in British Columbia.

MDFWP (Hoffman *et al.* 2002) recently confirmed movement of bull trout upstream and downstream over Kootenai Falls using radio telemetry. This indicates that prior to Libby Dam there was likely possible genetic exchange between Kootenay Lake populations and populations in the entire reach of the Kootenay/ai River. Recent detection of downstream migration from the Wigwam River in BC to O'Brien Creek, below Kootenai Falls, could indicate that these movements were even more common prior to construction of Libby Dam (Hoffman *et al.*, 2002). Libby Dam constitutes the only upstream migration barrier present in the Kootenai/ay River system, though it appears to allow fish downstream passage through the turbines. Mortality does occur during transport through the dam, but entrainment does not appear to be a regulating mechanism for the populations upstream.

4.3.2. Present Bull Trout Status in the Kootenai River Above Libby Dam

Bull trout redd surveys in the Wigwam River in BC, and in Grave Creek, both tributaries to Koocanusa Reservoir, indicate that the population is experiencing an upward trend (Figure 4-3). The regional fisheries manager for MDFWP reports "The Koocanusa populations meets [sic] all the criteria for a recovered bull trout population." (Vashro, 2003). The State of Montana, via Section 4(d) of the Endangered Species Act, instated a limited harvest of bull trout in Lake Koocanusa beginning in 2004. An angler is allowed to harvest 2 bull trout per season, and must report each harvest to the state via a "catch card"; anglers are instructed to record the date of catch, length, and area of the reservoir from which the fish was harvested.

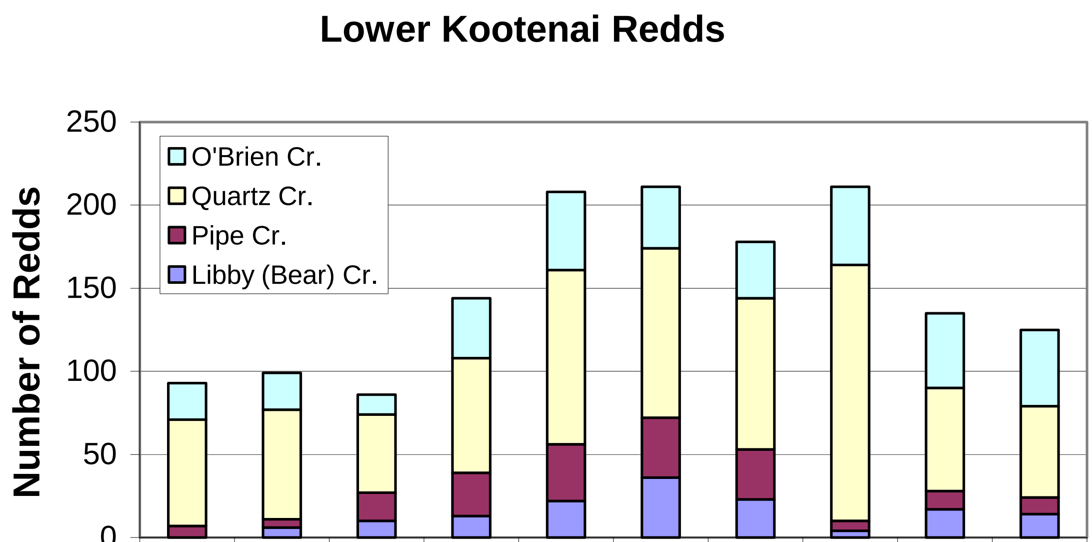


	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Grave Cr.	71	15	35	49	66	134	97	173	199	245
Wigwam R.	105	247	512	598	679	849	1195	1496	1892	2053

Figure 4-3. Bull trout redd counts - upper Kootenai River system.

4.3.3. Present Bull Trout Status in the Kootenai River Below Libby Dam

The most important spawning and rearing areas in the lower Kootenai system are Libby (Bear) Creek, Pipe Creek, Quartz Creek and O'Brien Creek (Figure 4-4). According to the Montana Bull Trout Scientific Group, bull trout have been recorded in Midas Creek, Dunn Creek, W. Fisher Creek, Granite Creek, Poorman Creek, Ramsey Creek, and Callahan Creek. Resident bull trout are also found in the upper reaches of Flower and Libby Creeks. There is no bull trout spawning in the Kootenai River mainstem.



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
O'Brien Cr.	22	22	12	36	47	37	34	47	45	46
Quartz Cr.	64	66	47	69	105	102	91	154	62	55
Pipe Cr.	7	5	17	26	34	36	30	6	11	10
Libby (Bear) Cr.	0	6	10	13	22	36	23	4	17	14

Figure 4-4. Bull trout redd counts- lower Kootenai River system.

5. Anticipated Effects of the Proposed Action

5.1. Effects on Kootenai River White Sturgeon

- **Operate Libby Dam to support spawning, incubation, and rearing of white sturgeon**

The Corps and BPA propose to continue operating Libby Dam to meet authorized project purposes, in a manner to avoid jeopardizing the listed species by implementing the following operational actions identified in the 2000 USFWS BiOp:

Forecasting procedures – The forecasting procedure is expected to provide more certainty in being able to provide augmentation water for sturgeon, bull trout and salmon in the spring and summer.

Variable end-of -December flood control draft - This operational action is intended to allow Koocanusa Reservoir to retain more water at the end of December in years forecasted to have a low runoff, in order to provide an increased likelihood of having augmentation water available during the ensuing spring and summer for sturgeon and salmon flows. This action is compatible with meeting VARQ flood control draft requirements in January, February, and March.

Interim VARQ - VARQ flood control increases the likelihood of refill and thereby ensures a more reliable source of water to provide flows more closely resembling a normative river during the refill period. It also improves the likelihood of having water available in the reservoir for flow augmentation.

Tiered sturgeon volumes - This operation provides for storage and tiered water volume releases based upon water availability as determined by the annual runoff forecast as called for in the 2000 RPA action 8.1.d (modified by August 2002 letter from the Corps to USFWS).

Use Libby's selective draft capability to optimize water temperatures for sturgeon spawning – The selective withdrawal system at Libby dam will continue to be used to optimize release temperatures as much as possible for the benefit of white sturgeon during spawning and incubation periods. Our ability to provide optimal temperatures is limited by the isothermic condition of Koocanusa Reservoir during the pre-spawn period.

Ramping rates – Summer ramping rates are the same as contained in the 2000 BiOp and the winter ramping rates have been modified as discussed in the PA allowing for some water savings that could be applied to subsequent fish operations.

Salmon flows – Implementation of salmon flows as described in section 3.2.6.1 will have no effect on sturgeon, as these occur following implementation of critical sturgeon flows.

Columbia River Treaty and International Joint Commission Operations – Libby Dam is operated within the parameters the Columbia River Treaty and International Joint Commission. This is consistent with the operational requirements in the 2000 BiOp.

In summary, the proposed operation of Libby Dam, in addition to providing for authorized project purposes, will also improve in-stream conditions and is expected to minimize adverse effects of the hydrosystem on the sturgeon.

- **Expand the Kootenai Tribe of Idaho's Conservation Aquaculture Program to prevent extinction**

Recruitment failures during the past few decades have created a temporal gap between naturally recruited adults and the recently released (1992 to present) families of juvenile Kootenai River white sturgeon produced by the conservation aquaculture program, and it appears that the next generations of sturgeon will be produced almost entirely by this program. Habitat alteration measures implemented to simulate pre-dam components of flow (velocity, turbidity, complexity, etc.) and provide long-absent channel morphologic complexity show promise, but "[c]ritically low fish numbers cannot be avoided by any action that has not yet been implemented" (Paragamian et al. In Review at Transactions of the American Fisheries Society). The conservation aquaculture program is the only measure that will preclude extinction of the species; all other actions such as changes in habitat and flow characteristics taken that will support recovery of the species are dependent on the presence of sturgeon produced by this program. The action agencies believe this program benefits white sturgeon by continuing to provide hatchery-raised juvenile sturgeon to the population during a time when wild recruitment is minimal.

- **Implement a Research, Monitoring and Evaluation Program to Define Sturgeon Spawning and Recruitment Needs**

  The RM&E program is designed to focus on resolving critical uncertainties regarding egg and larval survival. These uncertainties include: suitable habitat (substrate) for spawning, incubation, and larval development; water velocities, temperatures and depth; turbidity; turbulence; and nutrients.

  In the near term, the proposed action includes the following to further our understanding of the limiting factors concerning successful recruitment: 1) research on the geomorphology, sediment transport, and hydraulic characteristics of the Kootenai River and other factors, 2) the creation of improved spawning substrate, and 3) support KRWSRT's adaptive experiments to relocate spawning-condition males and females upstream of the braided reach.

  Each of these actions would further the scientific understanding that would lead to effective habitat development for long-term recovery actions, and thus would likely benefit Kootenai River white sturgeon. There is the likelihood of effects of construction activities associated with implementation of the proposed action that may have temporary discountable and insignificant adverse effects on sturgeon. However, these long-term measures may hold the key to sturgeon recovery without continued human intervention. The action agencies expect that these measures will result in annual sturgeon spawning and recruitment, eventually leading to an increase in the wild population and no further need for the conservation aquaculture program.

- **Increase Primary Productivity of Kootenay Lake**

  This program was initiated to increase primary productivity in Kootenay Lake in response to low nutrient availability, and the subsequent reduction in zooplankton abundance, which in turn affected kokanee salmon density. Kokanee are an important food item for adult and juvenile sturgeon. The fertilization program has been successful, and is ongoing. With improved primary productivity, juvenile sturgeon would be expected to grow faster, bigger, and stronger. No known adverse effects of fertilization to sturgeon are known. Therefore, this action is expected to benefit Kootenai River white sturgeon.

Determination of Effect for Kootenai River White Sturgeon

The action agencies believe the proposed action described in this BA provides a likelihood of meeting the population performance standard (and recovery goal) of enabling sturgeon survival and recruitment of 20 or more individuals from each age class when sampled at more than one year of age. The conservation aquaculture program provides a bridge until natural reproduction is re-established through implementation of Libby Dam operations and actions derived from the research, monitoring and evaluation program. Adoption of an adaptive management approach, reinforced by performance standards, will further support the successful execution of a program to recover the Kootenai River white sturgeon in the wild. While the proposed action is likely to adversely affect Kootenai River white sturgeon, the action agencies believe that the implementation of the proposed action will not jeopardize the continued existence of the sturgeon.

5.2. Effects on Kootenai River White Sturgeon Critical Habitat

- **Operate Libby Dam in support of spawning, incubation, and rearing of white sturgeon**

This BA includes continued implementation of the operational actions identified in the 2000 USFWS BiOp, including new forecast procedures, variable end of December flood control draft, interim VARQ, tiered sturgeon volumes, and ramping rates. These actions are being conducted to store and provide water for critical habitat features, including water depth and velocity, to the extent possible consistent with authorized project purposes.

- **Expand the Kootenai Tribe of Idaho's Conservation Aquaculture Program to prevent extinction**

The conservation aquaculture program has no effect on critical habitat.

- **Implement a Research, Monitoring and Evaluation Program to Define Sturgeon Spawning and Recruitment Needs**

The proposed action includes projects to further our understanding of the limiting factors concerning critical habitat and to improve in-stream habitats to promote sturgeon recruitment. Each of these actions would further the scientific understanding that would lead to effective habitat restoration for long-term recovery actions. Some in-stream construction would be required, which would result in localized changes to substrate, and would temporarily increase suspended sediment load.

- **Increase Primary Productivity of Kootenay Lake**

  Fertilization of Kootenay Lake has no direct effect on habitat. However, during higher flows, Kootenay Lake expands and backs up into the Kootenai River. As critical habitat includes biological factors such as nutritional or physiological requirements important to survival of sturgeon (USFWS 2001), fertilization of Kootenay Lake may lead to beneficial effects on Kootenai River white sturgeon critical habitat.

Determination of Effect for Kootenai River White Sturgeon Critical Habitat

The action agencies believe the proposed action described in this BA will not adversely modify designated critical habitat for the Kootenai River white sturgeon.

5.3. Bull Trout Above and Below Libby Dam

- **Operate Libby Dam in support of spawning, incubation, and rearing of white sturgeon**

  This BA includes continued implementation of the operational actions identified in the 2000 USFWS BiOp for white sturgeon and bull trout, of which ramping rates may be the most important component for bull trout.

  Forecasting procedures – Because of the lower standard error of the new procedures, it is expected to provide more certainty in being able to provide augmentation water for sturgeon, bull trout and salmon. While there is potential benefit to bull trout, there is no expected adverse effect on bull trout from implementation of the new forecast procedures.

  Variable end-of -December flood control draft - This operational action is intended to allow Koocanusa Reservoir to remain fuller at the end of December in order to provide an increased likelihood of having augmentation water available during the ensuing spring and summer for sturgeon and salmon flows. The desired outcome benefits reservoir bull trout by reducing drawdown in average to below-average years. The resulting volume for sturgeon flows and the ensuing bull trout minimum flows benefit riverine bull trout.

  Interim VARQ - Implementation of interim VARQ flood control limits reservoir drawdown in average to below-average water years, and is thus beneficial to reservoir bull trout. VARQ flood control facilitates reservoir refill, and thus aids the provision of flows more closely resembling a normative river through August (including sturgeon and salmon augmentation flows), and thus benefits riverine bull trout as long as a double peak in flows can be avoided.

Tiered sturgeon volume - Sturgeon spawning and incubation flows provided by tiered volumes of water are intended to more closely match natural conditions and as such may benefit bull trout downstream. After sturgeon volumes have been released, flows are returned to VARQ, flood control, salmon, or minimum bull trout flows ranging from 6,000 to 9,000 cfs, or they may remain at a level that avoids a "double peak" summer hydrograph. However, it may be possible for a "double peak" to occur (the sturgeon pulse, followed by bull trout minimums, followed by higher flows for the salmon draft). Because the "double peak" operation has adverse effects on riverine bull trout, the TMT coordinates operation, where practicable, to minimize the occurrence of a double peak.

Use Libby's selective draft capability to optimize water temperatures for sturgeon spawning – Optimizing river temperatures as much as possible for sturgeon equates to emulating a more natural river thermograph, which benefits biota downstream of Libby Dam, including bull trout.

Ramping rates – Current operations (based on ramping rates in the 2000 USFWS BiOp) limit power peaking and have ramping rates to benefit listed bull trout. There are no proposed changes to the 2000 BiOp rates for summer, but during winter months daily load shaping of up to 5,000 cfs is allowed at flows above 9,000 cfs. In general, ramp up rates would be relaxed to allow for an increase of 10,000 cfs during one 24-hour period, and the ensuing ramp down would allow for a decrease of 5,000 cfs during the next 24-hour period. Weekly fluctuations are generally allowed only above 10,000 cfs, during summer months (April-August), while daily load shaping is still avoided. Reducing fluctuations results in keeping a greater portion of the river perimeter inundated more consistently, resulting in increased productivity of aquatic insects and other food organisms upon which juvenile and adult fish depend. The amount of fish and insect habitat dramatically decreases, on average, when flows drop from 16,000 to 9,000 cfs, and again when flows decrease from 9,000 to 5,000 cfs. River operations that routinely wet and then dewater portions of the river channel will continue to be avoided. Evidence suggests that after 10 days, aquatic insects have begun to colonize newly wetted areas; therefore, it is important to reduce flows gradually after higher flows of 10 plus days in duration.

Revised ramping rates have been developed to continue to minimize the adverse biological impacts of operations in the Kootenai River downstream of Libby Dam and also provide slightly greater flexibility in operating Libby for project purposes including power during less productive winter months.

Salmon flows – Continued implementation of salmon flows of drafting to elevation 2439 will provide flows greater than minimum bull trout flows in certain years maintaining the wetted perimeter of the downstream river and the associated aquatic benefits.

International Joint Commission Operations – Libby Dam is operated within the parameters the Columbia River Treaty and International Joint Commission. This is consistent with the operational requirements in the 2000 BiOp. There is no clear effect to bull trout from these requirements.

In summary, the operations as developed since the 2000 BiOp are not expected to adversely affect bull trout

- **Expand the Kootenai Tribe of Idaho's Conservation Aquaculture Program to prevent extinction**

  This part of the proposed action has no known effect on bull trout

- **Implement a Research, Monitoring and Evaluation Program to Define Sturgeon Spawning and Recruitment Needs**

  The RM&E program is directed at providing information on sturgeon behavior, and restoring sturgeon habitat. No direct effect on bull trout is anticipated.

- **Increase Primary Productivity of Kootenay Lake**

  Increasing primary productivity would potentially increase food items for bull trout, as well as other fish. Increased competition among bull trout and other piscivorous fish would not be anticipated. The overall effect of increased productivity is beneficial to Kootenay Lake bull trout.

Determination of Effect for Bull Trout

The action agencies believe the proposed action described in this BA is not likely to adversely affect bull trout.

6.0 Relevant Reports

50 CFR 402, Interagency Cooperation—Endangered Species Act of 1973, as Amended; Final Rule. Vol. 51, No. 106, pp. 19926-19963.

58 FR 45989, Listing of Kootenai River White Sturgeon as Endangered, Sept, 1994.

65 FR 80698, Proposal to Designate Kootenai River White Sturgeon Critical Habitat, December 21, 2000.

66 FR 46548, Designation of Kootenai River White Sturgeon Critical Habitat, Sept, 2001.

66 FR 20962, Public Comment Period for Critical Habitat Designation for Kootenai River White Sturgeon, April, 2001.

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