Kinbasket - Upper Columbia Sturgeon Re-colonization Risk Assessment Pathogen and Local Knowledge Sections

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Executive Summary

The Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) has developed a Recovery Plan for white sturgeon in this area. The plan identifies a number of objectives to work towards the goal of re-establishing natural recruitment in this population. One component is to re-establish population segments in two or three areas that may become self-sustaining thus establishing recovery areas.

An initial step in evaluating a recovery area is determining the risks associated with planting of hatchery produced juveniles with a target of establishing an adult population size of 2,500. This report documents the local knowledge of sturgeon shared by First Nations and long-term residents of the area and an assessment of risk of pathogen introduction from stocked juvenile sturgeon. An assessment of ecological risks associated with the establishment of a failsafe white sturgeon population upstream of Mica Dam was undertaken separately.

First Nations, residents and construction workers on Mica Dam were interviewed between 2001 and 2003 to determine if historic use of the Columbia River above Mica Dam could be documented. First Nations had heard of sightings but do not recall historic harvest of sturgeon in the study area. In contrast, some local residents reported occasional historic harvest of sturgeon up to Windermere Lake. Workers on Mica Dam reported moving sturgeon when the channel was dewatered during dam construction. The combined reports of sturgeon use in the area indicate the natural range of sturgeon included the Columbia River up to historic Kinbasket Lake. However, infrequent sightings of sturgeon in the area have lead to a hypothesis that sturgeon were transient to the study area, not resident.

Sturgeon are affected by viral, bacterial, fungal and protozoan diseases. Five viral diseases have been documented for white sturgeon, two that appear to be host specific and three that have limited information available regarding transmissibility and pathogenicity in the wild and to other species. Several bacterial, fungal and protozoan diseases have been reported, most of which can be limited through good husbandry techniques and effective disinfection methods. Five parasites have been identified in wild white sturgeon, four host specific to white sturgeon. Parasites generally require an intermediate host and can be limited by effective disinfection methods, groundwater sources for water and a covered above ground rearing facility.

Current standards for testing juvenile sturgeon prior to release test all known white sturgeon viruses using histology and virus isolation, as well as holding sentinel rainbow trout in effluent. Eggs are disinfected using an Iodophore substance. To date no known pathogens of concern have been identified from Upper Columbia white sturgeon juveniles or sentinel salmonids at the Kootenay Sturgeon Hatchery.

The pathogen risk assessment concluded that a low risk of introducing pathogens to the study area would result if existing rearing and health protocols are maintained, juveniles are reared to at least one year and existing health testing protocols undertaken prior to release. Several assessments would improve the ability to assess the impact of introducing white sturgeon upstream of Mica Dam, including improving the understanding of the status of white sturgeon residing in the study area, improve the understanding of causes of fin deformities documented in the Kootenay Sturgeon Hatchery and in juveniles released downstream of Hugh Keenleyside Dam and conduct

an inventory of existing pathogens within the study area to determine the potential impact to introduced juvenile white sturgeon.

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Introduction

The upper Columbia River white sturgeon population has declined due to lack of recruitment (UCWSRI, 2002). Multiple changes to the system contribute to this decline, including habitat alteration and fragmentation, water quality changes, flow changes, reduced food supply (e.g., loss of anadromous salmon runs) and loss of habitat diversity (UCWSRI, 2002). A recovery plan for this white sturgeon population has been prepared that includes restoration of habitat and connectivity as measures for the initiative (UCWSRI, 2002). Short to medium term measures include hatchery supplementation of existing populations in two to three areas within the historic range (UCWSRI, 2002). The third recovery area provides two options:

- as a failsafe population that would be established as insurance against loss of population(s) elsewhere in the system due to a catastrophic event or inability to establish natural recruitment. Hatchery reared juvenile white sturgeon would be used to stock the failsafe population; or
- as a self-sustaining population segment if natural reproduction and recruitment is established in the area.

Current recovery areas include (i) the transboundary reach of the Columbia River, from Hugh Keenleyside Dam to Lake Roosevelt, including the lower Kootenay River and particularly the only known spawning area within this reach at the confluence of the Pend d'Oreille and Columbia Rivers; and (ii) the Arrow Lakes reach, including the only known spawning area within the reach downstream of the Revelstoke Dam (UCWSRI, 2002). One area under consideration is the Columbia River upstream of Mica Dam. Anecdotal reports indicate that sturgeon used this area historically, though possibly only seasonally (R.L.&L., 1996; Prince, 2001).

Re-establishing a sturgeon population in this area has raised agency, public and First Nations concerns. While white sturgeon are not thought to be exotic to the Kinbasket-upper Columbia reach, adverse affects from stocking introduced species, including introduction of parasites and diseases, and changes in community structure, have contributed to 66% of the fish extinctions in North America in the twentieth century (Rahel et al., 1999). In addition, amphibians and aquatic invertebrates may be negatively affected by stocking fish.

To address these concerns, the Recovery Team has recommended a risk assessment be prepared to predict potential impacts of hatchery supplementation of sturgeon above Mica Dam. The objectives of this assessment are:

(i) Assess the probability of disease or parasite introduction; and
(ii) Document historic distribution and abundance of white sturgeon in the Columbia River upstream of Mica Dam by interviewing First Nations and other local knowledge holders.

An assessment of ecological risks associated with establishing a failsafe population upstream of Mica Dam also has been prepared (Prince and Beers, 2005).

Study Area

The area covered by this risk assessment is the Columbia River upstream of Mica Dam to the headwaters and accessible tributary reaches (Figure 1). The headwaters of the Columbia River is the only section of the mainstem that retains a natural hydrograph and turbid conditions in which sturgeon evolved. The remainder of the Canadian Columbia River is comprised of reservoirs and short riverine sections where flow is controlled by dam discharges.

A variety of habitats are included in the study area: Kinbasket Reservoir; large glacial tributaries: Canoe, Wood, Sullivan, Bush, Blaeberry, Kicking Horse and Spillimacheen rivers; the Columbia Wetlands, Columbia and Windermere lakes and numerous small (first to third order) tributary streams. Columbia and Windermere lakes are large, shallow lakes (Table 1) at the headwaters of the Columbia River. The Columbia Wetlands are one of the longest contiguous wetlands in North America, stretching from Columbia Lake to Donald, and encompassing approximately 27,400 hectares of habitat. Kinbasket Reservoir was formed by Mica Dam and has a capacity of 24,700 million m^3, the potential drawdown is 47 metres and average drawdown is 19 metres.

Table 1. Morphometry of lakes and reservoirs in the Columbia River upstream of Mica Dam.

	Columbia Lake[1]	Windermere Lake[2]	Kinbasket Reservoir[3]
Mean Depth (m)	2.9	3.4	57 (at full pool)
Maximum Depth (m)	6.0	6.4	194 (at full pool)
Surface Area (ha)	2,510	1,610	41,060 (at full pool)

[1] Bisset et al. 2002
[2] Urban Systems 2001
[3] Sebastian et al. 1995

Twenty fish species have been documented in the study area (Table 2), including 16 indigenous and four introduced species. Two of the indigenous species, bull trout and westslope cutthroat trout, are blue listed in British Columbia. Five amphibian species have been recorded in the Columbia Wetlands portion of the study area: long toed salamander (*Ambystoma macrodactylum*), western toad (*Bufo boreas*), Columbia spotted frog (*Rana luteiventris*), wood frog (*Rana sylvatica*) and the northern leopard frog (*Rana pipiens*) (Larry Halverson, pers. comm.). Northern leopard frogs are red listed and have been extirpated from the study area; the other four species are yellow listed.

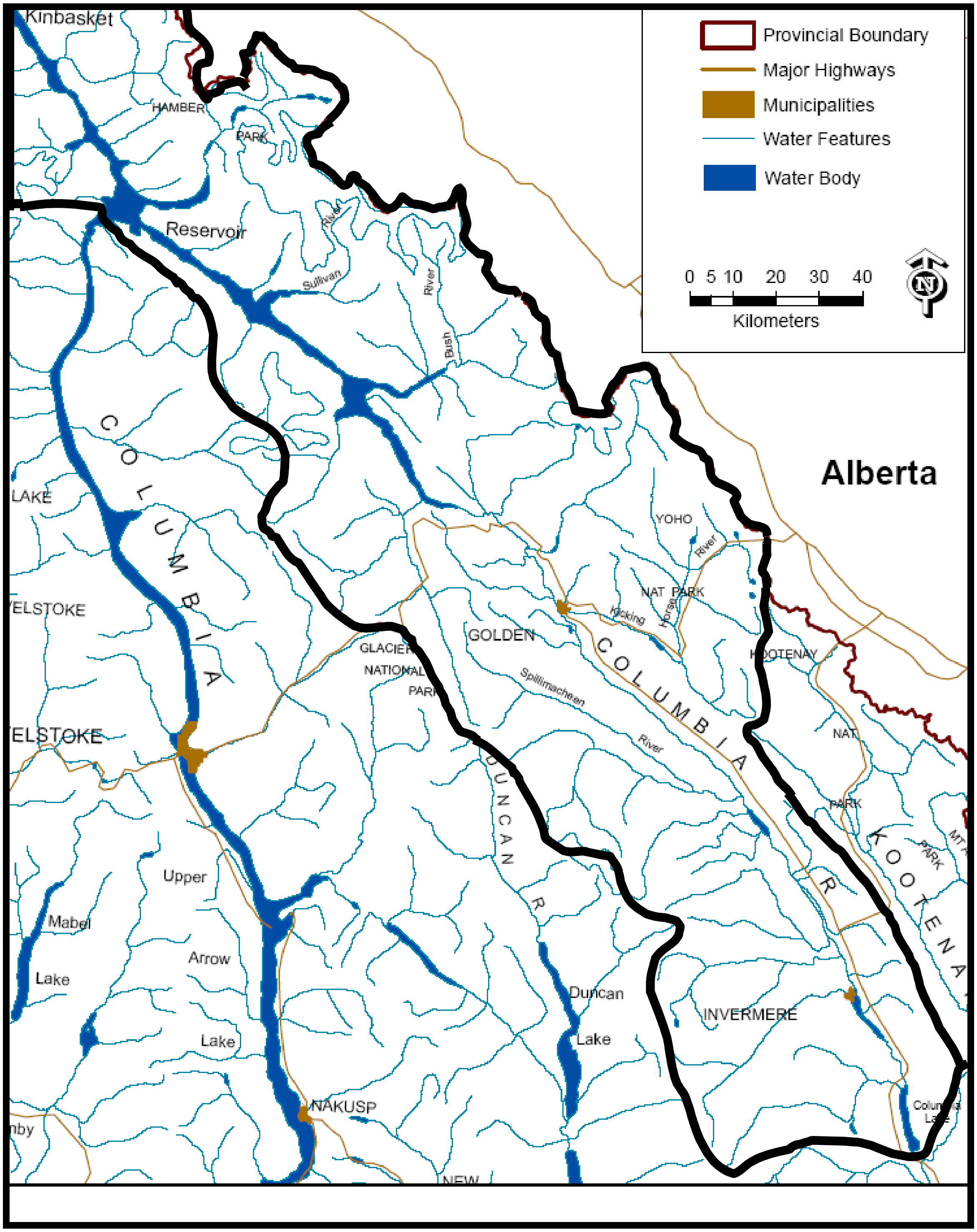

Figure 1. Location of study area.

Table 2. Fish species in the Columbia River upstream of Mica Dam. (McPhail and Carveth, 1993; FISS Maps)

Common Name	Scientific Name	Provincial Status	Introduced
White Sturgeon	*Acipenser transmontanus*	Red listed	No
Peamouth	*Mylocheilus caurinus*	Yellow listed	No
Northern Pikeminnow	*Ptychocheilus oregonensis*	Yellow listed	No
Longnose Dace	*Rhinichthys cataractae*	Yellow listed	No
Redside Shiner	*Richardsonius balteatus*	Yellow listed	No
Longnose Sucker	*Catostomus catostomus*	Yellow listed	No
Largescale Sucker	*Catostomus macrocheilus*	Yellow listed	No
Westslope Cutthroat Trout	*Oncorhynchus clarki lewisi*	Blue listed	No
Rainbow Trout	*Oncorhynchus mykiss*	Yellow listed	No
Kokanee Salmon	*Oncorhynchus nerka*		Yes
Chinook Salmon	*Oncorhynchus tshawytscha*	Extirpated from study area	No
Bull Trout	*Salvelinus confluentus*	Blue listed	No
Brook Trout	*Salvelinus fontinalis*		Yes
Pygmy Whitefish	*Prosopium coulteri*	Yellow listed	No
Mountain Whitefish	*Prosopium williamsoni*	Yellow listed	No
Burbot	*Lota lota*	Yellow listed	No
Slimy Sculpin	*Cottus cognatus*	Yellow listed	No
Torrent Sculpin	*Cottus rhotheus*	Yellow listed	No
Prickly Sculpin	*Cottus asper*	Yellow listed	No
Pumpkinseed	*Lepomis gibbosus*		Yes
Largemouth Bass	*Micropterus salmoides*		Yes

Methods

This component of the risk assessment includes evaluation of three components:

1) Compilation of local knowledge of historical sturgeon abundance and distribution in the study area;
2) Risk of disease introduction; and
3) Risk of parasite introduction.

Limited sampling for white sturgeon was conducted in the study area in 1995, with no captures of sturgeon (R.L.&L., 1996), indicating sturgeon are either rare or absent in the study area. To supplement this research, interviews with First Nations elders, long-term residents, active fishers and workers involved with the construction of Mica Dam have been undertaken in the last three years. Formal interviews of local residents were completed in 2001 (Prince, 2001) and a workshop with Ktunaxa-Kinbasket Elders from ?Akisq'nuk First Nation (formerly the Columbia Lake Band) and Shuswap Band was held in April 2002. Informal discussions with three residents (Bob Campsall, Paul Galbraith and Janice Jarvis) provided additional information, including a site visit to the confluence of the Columbia River and Bugaboo Creek to view where sturgeon were reported historically.

The risks of disease or parasite introductions were evaluated by examining the literature to determine what diseases and parasites sturgeon have been documented to carry, reviewing data collected from sturgeon collected in the upper Columbia River, compiling evidence for diseases and parasites documented in the Columbia, and assessing procedures at the hatchery for minimizing disease and parasite transmission.

Results and Discussion

Local Knowledge

Ktunaxa/Kinbasket Elders indicated they had no memory of sturgeon in the Columbia River above historic Kinbasket Lake, nor did they recall family or community members telling stories of white sturgeon. The lack of an oral tradition of sturgeon in the area indicated to these Elders that a resident sturgeon population likely did not exist upstream of Kinbasket Lake, as these fish are quite distinctive. However, they did recall hearing second or third hand accounts of sturgeon sightings. The sightings described were of sturgeon feeding on salmon near the Spillimacheen River and one of sturgeon spawning at Surprise Rapids (between historic Kinbasket Lake and Golden). Elders suggested sturgeon occasionally followed salmon runs into the area, resulting in infrequent sightings. The Elders indicated concern about introducing sturgeon into the study area because of the potential impacts to the ecosystem from introduced species.

Formal interviews conducted in 2001 with residents in the Golden and Invermere communities supported the First Nations Elders conclusions, as anglers had no recollection of sturgeon upstream of Kinbasket Lake (Prince, 2001). Informal discussions with two long-term residents indicated that sturgeon had been reported in the Spillimacheen to Windermere Lake area. Bob Campsall reported that he'd been told of sturgeon captured in Lake Windermere. The reports were infrequent (once or twice) and occurred in the 1920's when anadromous salmon runs were still large. No captures were reported after salmon runs declined in the late 1920's. Paul Galbraith reported his grandfather, a homesteader in the Spillimacheen area, reported sighting sturgeon near the confluence of the Columbia River and Bugaboo Creek during the early 1900's. A shallow riffle was used as a crossing during low water periods and sturgeon were seen near this crossing. Mr. Galbraith provided a tour of the site, where two channels of the Columbia River join and Bugaboo Creek flows in from the west and a small tributary flows in from the east. The timing of these sturgeon sightings was not certain and may have coincided with salmon runs. These reports are consistent with the belief of First Nations Elders that sturgeon occasionally were present in the Columbia River upstream of historic Kinbasket Lake, but no resident population existed historically.

Several construction workers on the Mica Dam, or their family members, recalled moving sturgeon following channel dewatering though none recalled if sturgeon were replaced upstream or downstream of the dam (Prince, 2001; Janice Jarvis, pers. comm). A Golden resident reported that bush pilots continue to see sturgeon "sunning" in Kinbasket Reservoir near Windy Creek and the Sullivan River inflows (Prince, 2001). Thus, it is probable that a small number of white sturgeon are present upstream of Mica Dam.

Anecdotal evidence indicates sturgeon were present in the study area historically. However, it appears likely that sturgeon were either transient, or only small numbers were present, as sightings were infrequent.

Diseases

Bacterial, viral, fungal and protozoan diseases have been reported in sturgeon reared in hatcheries (Bury and Graves, 2000; LaPatra et al., 1998). Five viral diseases have been reported to affect sturgeon in commercial aquaculture programs: white sturgeon adenovirus (WSAV), two herpesviruses (WSHV type 1 and 2), white sturgeon iridovirus (WSIV) and white sturgeon papova-like virus (WSPV) (Bury and Graves, 2000; Hedrick et al., 2001; Bauer et al., 2002).

The WSIV is the best understood and most prevalent of the viral diseases and originally was detected in hatchery-raised sturgeon in 1988 (LaPatra et al., 1994; LaPatra et al., 1998). The virus has an affinity for epithelial tissue of the skin and gills and may cause high mortality (>90%) in young (< age 1) fish (Hedrick et al., 1990; LaPatra et al., 1999; Bauer et al. 2002). Symptoms are disruption of respiration and osmoregulation, with secondary infections such as fungal infections also reported (LaPatra et al., 1999). WSIV has been reported in numerous locations, including the lower Columbia and Kootenay rivers and may be endemic in wild sturgeon populations throughout the Pacific Northwest, likely facilitated by the long life span and migratory nature of white sturgeon (LaPatra et al., 1994).

WSIV appears to be host specific to some acipenserids as efforts to isolate WSIV from diseased sturgeon using cell lines from salmonid, percid, ictalurid and centrarchid origin were unsuccessful (Hedrick et al., 1991b). Also, while experimental exposure of chinook salmon (*O. tshawytsha*), channel catfish (*Ictalurus punctatus*), and striped bass (*Morone saxatilis*) indicated they were all resistant; lake sturgeon (*A. fulvescens*) developed a mild form of the disease when exposed (LaPatra et al., 1999). Laboratory exposures of green (*A. medirostris*), pallid (*Scaphirhynchus albus*) and shovelnose (*S. platorhynchus*) sturgeons to WSIV did not result in infection (Hedrick et al., 2001). Factors that are likely to reduce the probability of introducing WSIV with transplanted sturgeon include: iodophor disinfection of eggs, stocking juveniles older than one year, reducing handling stress and avoiding high densities during rearing (LaPatra et al., 1994; Metcalf and Zajicek, 2000).

White sturgeon adenovirus infects the cells of the gut and results in lethargy, anorexia and starvation (Hedrick et al., 1985; Conte et al., 1988; PSMFC, 1992). This virus is sufficiently distinct from other adenoviruses to be considered a new genus (Benk et al., 2002). Initial attempts to culture the virus in cell lines from white sturgeon (SH-1 heart and SS-2 – spleen), blue gill (*Lepomonis macrochirus*), brown bullhead (*I. nebulosus*), fathead minnow (*Pimephales promelas*), channel catfish (*I. punctatus*) and chinook salmon (*O. tshawytshca*) were unsuccessful (Hedrick et al., 1985). However, recent experiments have successfully cultivated WSAV in sturgeon spleen cell cultures (WSS-2 spleen cells) and adenovirus-like particles have been reported in other fishes (Benk et al., 2002). Transmissibility and pathogenicity to other fish species is not known for WSAV.

There is limited information on the two herpes viruses and the papova-like virus. Herpes viruses are common in fishes and usually host specific (Hedrick et al., 1991a). WSHV1 infects juvenile sturgeon (<10 cm), potentially causing serious losses of cultured sturgeon (LaPatra et al. 1998). This virus affects the skin and oropharyngeal mucosa (LaPatra et al., 1993). White Sturgeon Herpes Type 2 infects older sturgeon, causing small blisters and open lesions on the body surface that can become infected with secondary pathogens (MWH, 2003). Mortality is generally less than 10% with WSHV2 (MWH, 2003). The white sturgeon papova-like virus was identified from one wild subyearling Columbia River white sturgeon (Hedrick et al., 2001). No obvious external signs were noted, but microscopic lesions were detected in the gill, liver, spleen and kidney (Hedrick et al., 2001). Transmissibility and pathogenicity to other fish species are not known for these three viruses.

Two viruses known to cause mortality in salmonids have been researched in sturgeon: IHNV (Infectious Hematopoietic Necrosis virus) and IPNV (Infectious Pancreatic Necrosis virus). IHNV is one of the most lethal diseases of early life stages of rainbow trout (LaPatra et al., 1995). Transmission has been reported from one generation to the next (vertical transmission), direct fish to fish (horizontal transmission) and potentially via parasites (a copepod, *Salmincola* sp., and a leech, *Piscicola salmositica*) (Mulcahy et al., 1990). Experimental exposures of white sturgeon resulted in mortality linked to IHNV for larvae, though older fish showed no mortality and cohabitation with rainbow trout did not result in viral transmission to the trout (LaPatra et al., 1995). Additionally, white sturgeon fed infected trout did not show signs of infection or transmit the disease to cohabiting rainbow trout (LaPatra et al., 1995). Stocking older sturgeon may reduce the probability of transmission of IHNV to salmonids.

IPNV infects juvenile salmonids, causing necrosis of pancreatic ascinar cells and may result in necrosis of other organs such as the liver (MWH, 2003). Sturgeon cell lines exposed to IPNV have not been susceptible to this virus (Hedrick et al., 1991b). IPNV has been detected within the Pend d'Oreille River drainage (Dan Sneep, *pers. comm.*); which may result in exposure of white sturgeon broodstock collected at the mouth of the Pend d'Oreille to this virus. Highest mortality has been observed at temperatures of 50° – 57°F, with lower mortality at higher and lower temperatures (MWH, 2003). A recent test exposing white sturgeon juveniles to IPNV held fish in water with the virus and injected high concentrations of IPNV intraperitoneally (LaPatra et al., in prep.). There was no evidence of the virus in waterbourne exposures (tested 34, 40, 47 and 54 days post exposure). IPNV was detected in one of five sturgeon injected with the virus at 34 and 40 day tests, but no virus was detected in 47 and 54 day tests (LaPatra et al., in prep.). Even with the high concentrations used in this test, no morbidity, mortality or evidence that a virus carrier state was established was found (La Patra et al., in prep.).

As with all aquatic organisms, white sturgeon are continually bathed in a medium that includes bacteria, fungi and protozoans, some of which cause diseases. Most of these that are observed in cultured white sturgeon can be treated with antibiotics or disinfectants (Table 3). *Cryptobia salmositica* is a widely distributed freshwater protozoan that has been reported in North American white sturgeon (Bauer et al., 2002). This protozoan has been documented in all Pacific salmon (*Oncorhynchys spp.*). In laboratory and hatchery conditions, direct (fish to fish) transmission has been reported, while in streams and rivers transmission is by a blood sucking freshwater leach, *P. salmositica (*Woo, 1997). Infected fish exhibit a variety of symptoms, including anorexia, anemia, reduced metabolism and swimming performance (Woo, 1997).

Table 3. Summary of bacterial, fungal and protozoan diseases reported in cultured white sturgeon and recommended treatment options.

Disease	Cause	Symptoms	Treatment
Myxobacteriosis	*Myxobacter sp.* bacteria		Oxytetracycline
Motile aeromonas septicemia	*Aeromonas* spp	Red colouration on ventral surface of fish (from hemorrhage)	Oral antibiotics
Columnaris	*Flavobacterium columnare*	Skin and gill lesions with yellow pigmentation at center	Oxytetracycline
Unnamed notochord infections	Unknown	Systemic fungal infection in notochord	Unknown
Gut Infection, unnamed	*Saprolegnia sp.*	Internal fungus of gut	Unknown, recorded in fish fed spoiled live diets
Skin and gill infection	*Epistylis* spp	Skin and gill infection	Salt, formalin and/or hydrogen peroxide
Skin and gill infection	*Trichodina* spp	Skin and gill infection	Salt, formalin and/or hydrogen peroxide
External fungus	Assorted fungi		Formalin Methylene Blue Salt
Liver disease	Unknown	Livers pale yellow to waxy, fish usually weak and thin	Unknown
Gut inflation – unnamed	Unknown	Fish lie upside down with noticeable distention in gut	Unknown
Ichthyobodosis (formerly Costia)	*Ichthyobodo necatrix* (flagellated protozoan)	Causes tissue irritation in skin and gills, may lead to epithelieal hyperplasia	Formalin bath, potassium permanganate, salt bath
Epitheliocystis	Chlamydia-like bacterium	Respiratory distress	Improve water quality and reduce fish densities

Sources: Conte et al., 1988; Hedrick et al., 2001; MWH, 2003

White sturgeon juveniles from the upper Columbia River conservation aquaculture program (produced from broodstock collected in the Keenleyside - Roosevelt reservoir reach) are tested for WSIV, WSHV-1, WSHV-2, WSAV, IPNV and IHNV prior to release (Appendix A). Testing includes histology sections of gill, pectoral fin and intestine tissue as well as isolation on cell lines. To date, all virology and histology samples have been negative (Appendix A; Ron Ek, pers. comm.). In addition, salmonids are maintained as sentinels in effluent from the sturgeon tanks. These fish are tested at least three times a year, with no detection of pathogens of concern to date (Sherry Guest, pers. comm.).

The only pathogen that has been found in juvenile upper Columbia River white sturgeon is *Aeromonas hydrophila*, bacteria that are common in freshwater habitats (Sherry Guest, pers. comm.). While *A. hydrophila* may cause disease in fish (Motile Aeromonas Septicemia), generally a stressor (e.g., overcrowding, poor water quality, poor nutrition) is required to produce the disease (Swann and White). Infections from exposure to *A. hydrophila* are less likely if fish are maintained in water with adequate oxygen and suitable temperatures, and are not crowded, mishandled or poorly nourished (Swann and White). Where infections are identified, two antibiotics have been recommended for treatment, Terramycin® and Remet-30® (Swann and White).

<u>Parasites</u>
Surveys of gut helminth parasites in sturgeons indicated the majority of parasites were host-specific, defined as specific to acipenserids, not necessarily white sturgeon (Margolis and McDonald, 1986; Choudhury and Dick, 1998). Non-host specific helminth parasites occur sporadically (Choudhury and Dick, 1998). Many non-host specific helminthes are shared with cypriniform and salmoniform species, transmitted by benthic and epibenthic organisms (Choudhury and Dick, 1998).

Five parasites have been documented in the Columbia River, three trematodes (*Nitzschia quadritestes, Tubulovesicula lindbergi, Cestrahelmins rivularis*), a cestode (*Amphilina bipunctata*), and a nematode (*Cystoopsis acipenseri*) (Hoffman, 1967; Margolis and McDonald, 1986; PSMFC, 1992). *T. lindbergi* is a marine species common on many marine and anadromous fishes. Its presence in sturgeon is hypothesized to have resulted from sturgeon consuming anadromous salmon, as the sturgeon examined did not have access to the sea. Presently, anadromous salmon do not have access to Kinbasket Reservoir, thus this parasite is not likely to be of concern in the study area. The remaining four species are considered specific to sturgeon (Margolis and McDonald, 1986). Similarly, in the Fraser River, five of six helminth species identified were considered specific to sturgeon (Margolis and McDonald, 1986).

Cystoopsis acipenseri have been reported in white sturgeon in the Columbia River, Oregon and the Fraser River, British Columbia, as well as several sturgeon species in the former USSR (McDonald et al., 1989; PSMFC, 1992; McCabe, 1993). It is not known how the parasite infects sturgeon, but likely is ingested via an intermediate host, as *C. acipenseri* has been documented in amphipods in the former USSR (McCabe, 1993). After entering the sturgeon's intestine, the larval parasite burrows through the intestine and surrounding tissues until it reaches subcutaneous fatty tissue (McCabe, 1993). The parasite encysts and matures here and creates blisterlike cysts in infected fish (Hoffman, 1967; McCabe, 1993). Only small sturgeon have been documented to carry the infection (Table 4). There is limited information on the other three parasites documented for Columbia River white sturgeon.

Table 4. Sizes of sturgeon infected with *C. acipenseri.*

Location	Size Range (mm)	Reference
Lower Columbia	240-452	McCabe, 1993
Columbia Upstream of Bonneville Dam	317 - 765	Duke et al., 1990 referenced in McCabe, 1993
Fraser River	243 - 798	McDonald et al, 1989 referenced in McCabe, 1993

At present, parasite testing is not part of fish health protocols for the upper Columbia conservation aquaculture program. Most parasites of fish are transmitted directly from fish to fish or through an intermediate host, not from parent to offspring (Hoffman, 1967). Therefore, there is limited risk of parasite introduction from broodstock via stocked juvenile sturgeon reared in the current facility that uses groundwater for its source.

Assessment of Risk

Pathogens are natural components of aquatic ecosystems and require presence of the pathogen, a susceptible host and environmental conditions conducive to disease outbreak or parasitic infections to occur. Host-pathogen interactions are complex; pathogen presence alone should not be equated with disease, as the pathogen may be present in the absence of disease. Disease outbreaks that have been documented in hatcheries usually occur following a stressful event (e.g., overcrowding, high water temperatures) and parasites require intermediate hosts that are not present in the current conservation aquaculture facility. The experimental conditions under which pathogen transmissibility have been tested have limited probability of natural occurrence (e.g., high concentrations of pathogen, high numbers of infected individuals, direct injections, etc.).

Introduction of diseases via stocked hatchery reared juvenile white sturgeon likely has a low probability of affecting Kinbasket Reservoir fishes if juveniles older than one year are used and existing health and rearing protocols are maintained because:

- Use of groundwater, effective disinfection and an above ground covered facility should minimize risk of pathogen transmittance;
- Several diseases documented in white sturgeon are host specific (e.g., WSIV, WSAV);
- Many non-host specific diseases are treatable with antibiotics or disinfectants;
- Kootenay Hatchery health testing protocols, including IPNV and IHNV, have a high probability to detect infected fish prior to release;
- Pathogens of concern have not been detected in Columbia River juvenile sturgeon to date; and
- Pathogens of concern have not been found in sentinel salmonids maintained in effluent.

Parasite transfer through introduced juvenile sturgeon also has a low probability of impacting existing fish populations in the Columbia River upstream of Kinbasket Reservoir. Most parasites are transferred directly from fish to fish or via an intermediate host. Probability of parasite transmission is limited as eggs are disinfected at time of spawn with an Iodophore substance and juvenile sturgeon are not exposed to intermediate hosts during hatchery rearing (Sherry Guest, pers. comm.). Therefore, there is very limited probability that parasites from broodstock would be transferred to the Columbia River headwaters via juvenile sturgeon. In addition, four of the five parasites documented in Columbia River white sturgeon are host specific, therefore would only impact other sturgeon.

Additional areas for Assessment

Several additional studies prior to submitting an application to transfer juvenile sturgeon would improve the assessment of risk associated with establishing a white sturgeon population, including:

- Determine presence and age structure, if possible, of white sturgeon in study area;
- Inventory to determine fish species, parasites and diseases, in Kinbasket Reservoir and the Columbia River upstream of Kinbasket Reservoir;
- Establish the risk to stocked white sturgeon juveniles by pathogens in the Columbia River above Mica Dam by identifying pathogens of concern and conducting an inventory of Kinbasket Reservoir for these pathogens;
- Co-habitation or experimental exposure studies for sturgeon viruses with salmonid(s) and alternate species (e.g., burbot, peamouth chub, amphibians); and
- Improve the understanding of the implications of fin deformities and ability to detect them prior to release. This assessment does not consider the fin deformities identified in juveniles collected in the Lower Columbia River, as the causes and effect on survival are not known.

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Appendix A

Kootenai* Sturgeon Health Protocols

*Note the same protocols are used for Kootenai and upper Columbia white sturgeon.

Pathology testing protocols for Kootenai Sturgeon 2003

An extensive Pathology testing program has been implemented on the Kootenai sturgeon program by the Freshwater Fishery Society of BC (FFSBC) in order to meet transplant approval requirements regulated by the Introductions and Transfers Committee (ITC). The ITC is a group of representatives from all governing bodies with an interest in fish movements entering, leaving and within British Columbia. Equal representative positions are appointed from the federal level from the Department of Fisheries and Oceans (DFO) and at the provincial level from the Ministry of Water, Air and Land Protection (WLAP) and Ministry of Agriculture, Fisheries and Foods (MAFF). This committee is responsible for approving all permits related to fish movements within BC and also to assess all risks and mandate any quarantine measures to any species of fish being introduced into BC waters.

The Kootenai River system is a transboundary river system stemming from its headwaters located in Canada, through lake Koocanusa, looping down through Montana and Idaho and crossing back up across the 49th parallel border to empty into Kootenay Lake BC. The brood stock for the Kootenai white sturgeon are captured in the Kootenai river around the Libby dam area in Idaho and are spawned at the Kootenai Tribes of Idaho Hatchery. As part of the recovery conservation initiative, a portion of disinfected fertilized eggs are transported up across the border to be reared in the FFSBC's Kootenay Sturgeon Conservation Hatchery.

Historically the tributary waters feeding into the Kootenai River in Idaho were at one time stocked with fish known to carry a fish virus know as Infectious Pancreatic Necrosis Virus (IPNV). This virus can cause devastating mortalities in hatcheries rearing salmonids and can be detrimental to some freshwater species such as Rainbow trout and Brook trout. There is not much documented in the literature as to whether sturgeon can be carriers of salmonid diseases however there was paper cited from France which indicated that IPNV had been detected in a sturgeon species form the wild. It should also be noted that to date IPNV has not been detected I any fish within the waters of the Province of British Columbia. Since the original proposal was to bring sturgeon eggs across the border into BC and the sturgeon brood came from historically potential IPNV water the ITC assessed it as a moderate to high risk introduction an imposed strict quarantine guidelines and an intensive Fish Health Monitoring program. Quarantine measures included sentinel salmonid fish reared in discharge effluent (the thought being that if sturgeon were shedding virus (in particular IPNV) the salmonids would pick it up and the virus could be isolated from them), and ozonation of effluent plus intensive sampling of individual family groups during the first 120 days of rearing. We have managed to get some modifications to the sampling schedule over the past two years as test results have come up consistently negative for pathogens of concern. All Canadian reared Kootenai sturgeon are tested at the FFSBC Fish Health Unit, located in Nanaimo, BC. The current testing protocol is as follows:

Sample type	Submission time	Number of fish per submission	Histology performed Y/N	Comments
Sentinel RBT	Pre-test 6 weeks in advance	60 fish	N	Done prior to fish entering into sentinel tank 6 weeks prior to receipt of first egg shipment
Family 1	30 dph 60 dph	30 fish 60 dph	Y Y	dph: days post hatch
Family 2	30 dph 60 dph	30 fish 30 fish	Y Y	dph: days post hatch
Family 3	30 dph 60 dph	30 fish 30 fish	Y Y	dph: days post hatch
Family 4	30 dph 60 dph	30 fish 30 fish	Y Y	dph: days post hatch
Family 5	30 dph 60 dph	30 fish 30 fish	Y Y	dph: days post hatch
Pooled sample Pre-release	60 days prior to release	60 fish	Y	1 Pooled sample of all families

All submitted samples are tested using virus protocols laid out in the Fish Health Protection regulations Manual of Compliance. Homogenized samples used for sturgeon are generally done in pools of three fish each and include the following extracted tissue:

- 1 operculum
- 1 set of gills
- barbels /skin
- 1 pectoral fin
- small piece of spleen
- small piece of liver
- small piece of pyloric ceaca
- and kidney tissue

Samples are homogenized in Hank's balanced salt solution using a Polytron Homogenizer. The samples are then diluted to a 2% concentration, centrifuged, filtered through a 0.45 um filter paper and inoculated onto the following cell lines:

- EPC (best line for IHNV)
- CHSE-214 (salmonid cell line of choice for detection of IPNV)
- WSS-2 (white sturgeon spleen cell line)
- WSSK (white sturgeon skin cell line)
- WSG (white sturgeon gill cell line)

The sturgeon are monitored for the following known fish viruses:

- IPNV (Infectious Pancreatic Necrosis) Salmonid virus
- IHNV (Infectious Hematopoietic Necrosis) Salmonis virus
- WSIV (White Sturgeon Iridiovirus) sturgeon virus
- WSHV-1 (White sturgeon herpesvirus type 1)
- WSHV-2 (White sturgeon herpesvirus type 2)
- Adenovirus (White sturgeon Adenovirus) (detectable by histology using intestine tissue, not isolated on cell lines)

Sturgeon viruses are very difficult to isolate on cell lines so we use Histology sections of gill and pectoral fin as a back up measure to try and detect some of the viruses. To date all virology samples and histology samples have been negative.

In 2003 we had to apply to the ITC to make changes to our effluent treatment. In order to reduce time required to ozonate effluent we had to ensure ITC brood fish would test negative for IPNV prior to the ozone being turned off. We introduced the PCR test for IPNV to check adults. Reproductive fluids are collected at time of spawn and shipped to the FFSBC Fish Health lab for testing for IPNV using the IPNV PCR test.

If you have any questions regarding procedures please contact Sherry Guest, FFSBC Fish Health Unit.

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