# Draft Kootenai River Adaptive Management Plan

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## I. Long term adaptive management of the Kootenai River ecosystem

*Experimental design* - In ecosystem management situations where there is high uncertainty about efficacy of some policy options and where multiple options may be implemented at the same time, adaptive management cannot safely proceed as a simple process of trying options and monitoring whether or not they succeed. Instead, we generally recommend developing a long term plan for implementing options over time in some experimental sequence that will provide deliberate experimental contrast in management "treatments", along with replication, where possible, of treatment versus control or reference policy comparisons. Such designs might involve factorial arrangement of policy treatments (classic experimental design), but it is typically simpler and more effective to use a "titration" approach where treatments are added successively (or are started all at once as a "kitchen sink" approach then deleted successively) until a desired system response is assessed.

At a recent multi-agency adaptive management workshop (July 22-23, 2004), we had an opportunity for multiple scientific and management stakeholders involved with ecosystem management for the Kootenai River to develop such a long term plan. The workshop discussions leading to the plan involved three steps: (1) identification of particular management options that have potential for restoring key functions in the Kootenai River ecosystem, and important attributes of these options (cost, possible negative side effects, monitoring time required for detection of response, etc.); (2) evaluation of alternative plans for applying combinations of these options over the next few decades, so as to identify plans that offer opportunities for contrasting effects of each option along with prudent economic cost trajectories over time; and (3) review of key needs for improvement of monitoring programs so as to insure timely detection of intended immediate effects of each option as well as possible longer-term side effects.

The basic plan that emerged from the discussions as a clear consensus favorite of the participants is described in Tables 1 and 2. This plan aims to restore a range of critical ecosystem functions in the Kootenai River, through manipulation of productivity, habitat features, and seasonal flow regimes, while utilizing hatchery production systems as a backup to guard against extinction of species that are still declining. The critical components of this plan are (a) a nutrient restoration program to restore basic productivity and carrying capacity for fish of the River, to near historical levels from the Montana border through the South Arm of Kootenay Lake; (b) experimental restoration of hard-bottom features in the river reach where sturgeon now spawn unsuccessfully; (c) experimental manipulation of sturgeon hatchery operations so as to test for possible competitive effects of hatchery releases on wild sturgeon survival and to determine optimum size and location of release for hatchery sturgeon juveniles; (d) development and testing of a plan "aquatic ecosystem management" hydrograph for Libby Dam releases, where this plan hydrograph involves both lower winter flows to provide a more natural ecosystem low-flow "reset" feature (and more natural conditions for burbot spawning and migration) and also spring-summer peak flows to improve conditions for sturgeon spawning and also restore some sediment transport functions; and (e) opportunistic, small-scale experimentation with localized restoration of connections between the channelized river and its flood plain, in areas where such connections can be restored without serious impact to flood plain land users.

The experimental treatment sequence shown in Table 2 is not ideal from a scientific viewpoint, i.e., effects of nutrient restoration/hydrograph modification options will be partly confounded during the first few years of application. Most options will be implemented as quickly as possible, so the experimental design is a reverse-titration or "kitchen sink" structure. Considering response lags in key ecological variables (e.g. sturgeon recruitment), it should be possible to begin reviews of monitoring results after about five years, and these will likely lead to changes in the treatment sequence so as to more clearly separate effects that are confounded in the initial treatment results.

**Table 1. Characteristics of proposed adaptive management activities including potential outcomes.**

| | Nutrient restoration Kootenai River | South Arm Nutrient Restoration and Kokanee introductions tributary enhancement | Hatchery sturgeon / burbot | Substrate modification (Gravel/cobble additions over sand substrate, hydraulics) | Ecosystem restoration flows winter low, spring runoff peaking, sediment augmentation | Flood plain reconnection |
|---|---|---|---|---|---|---|
| **Target Benefit** | Community, increased growth, survival, and biol. condition | Kokanee, burbot, sturgeon, | Addresses potential sturgeon reproductive stock limitation | Increase survival of eggs, larvae | Sturgeon recruitment, cottonwood recruitment, natural processes | Increased surv/growth of larvae, juv for sturgeon, increase productivity for comm. |
| **Potential Negative Effects** | Stimulation of non-target species. | | Overstocking sturgeon could limiting wild production | Unintended hydraulic consequences | Seepage at higher flows, cooler water temperatures inhibit sturgeon spawning, reduced productivity in reservoir (not refilled) | |
| **Required Time to See Effect** | Periphyton =wks, invert=months, fish = 1-5 yrs, | Kokanee =1-3 yrs | Variable dep. on life stage and objective (e.g. 30 to det. spawn) | In-season detection of larvae, 2+ yrs to fully recruit to gill nets | Same as above | |
| **Monitoring Requirements** | All taxa responses in Kootenay Lake and lower Kootenai River | All taxa responses in Kootenay Lake | Ongoing | Better definition of spawning and egg deposition areas. Start at small-scale to work-out mechanics, spawning pref. studies | Same as above | Assess nutrient and habitat heterogeneity contribution |
| **Small Scale** | No | No | Yes for reduced sturgeon growth due to pot'l overstocking | Yes | No | Yes |
| **Pre-Implementation** | Mesocosm studies | | Completed population | Small-scale evaluation | Evaluation of flow alteration | Feasibility |

## Table 2. Draft 20-Year Multi-agency Adaptive Management Program Framework

| | Aquatic | | | | | | | Riparian | | Terrestrial/Avian | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Nutrient Restoration Kootenai River | South Arm Fert. and Kok. Introductions / Tributary Enhancement | Conservation Aquaculture Sturgeon | Conservation Aquaculture Burbot | Aquatic system Biomonitoring | Habitat creation , modification, or restoration | Ecosystem function restoration flows (winter low, spring runoff peaking, sediment augmentation) | Flood plain reconnection, wetlands restoration | "Terracsosm" studies | Terrestrial Invert. surveys | Vegetation surveys | Small mammal surveys | Bird surveys |
| **2004** | Design | 1 | 1 | Evaluate | 1 | Assess | Hydrograph design | Local, small scale tests | Assess | Assess | 1 | Assess | 1 |
| **2005** | 1 | 1 | Evaluate | Evaluate | 1 | Evaluate | 1+fry bioassay | as opportunities | Design | Contingent | 1 | Contingent | 1 |
| **2006** | 1 | 1 | 1 | Evaluate | 1 | 1 | 1 | arise | 1 | Contingent | 1 | Contingent | 1 |
| **2007** | 1 | 1 | Evaluate | Contingent | 1 | 1 | 1 | Including: | 1 | Contingent | c | Contingent | c |
| **2008** | Review | Review | 1 | Contingent | 1 | 1 | 1 | restoration, | 1 | Contingent | c | Contingent | c |
| **2009** | 0 | Contingent | Evaluate | Contingent | 1 | Review | 1 | side channel | Review | Contingent | c | Contingent | c |
| **2010** | 0 | Contingent | 1 | Contingent | 1 | Contingent | 1 | artificial spawning | Contingent | Contingent | c | Contingent | c |
| **2011** | 0 | Contingent | Evaluate | Contingent | 1 | Contingent | Review | channel construction | Contingent | Contingent | c | Contingent | c |
| **2012** | 1 | Contingent | 1 | Contingent | 1 | Contingent | Contingent | Contingent | Contingent | Contingent | c | Contingent | c |
| **2013** | 1 | Contingent | Evaluate | Contingent | 1 | Contingent | Contingent | Contingent | Contingent | Contingent | c | Contingent | c |
| **2014** | 1 | Contingent | Review | Contingent | 1 | Contingent | Contingent | Contingent | Contingent | Contingent | c | Contingent | c |
| **.** | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | c | Contingent | c |
| **.** | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | c | Contingent | c |
| **2024** | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | Contingent | c | Contingent | c |

1=Annual implementation and evaluation, 0=No annual implementation but evaluation, "c"=contingent

## II. Aquatic Program Components

1. *Kootenai River experimental nutrient restoration* – The controlled addition of limiting nutrients to artificially de-nutrified aquatic systems is a well established, rigorous, yet rapidly emerging scientific discipline, with nearly 30 years of empirical history (Stockner 2003). Beginning with nutrient restoration in the North Arm of Kootenay Lake in 1992, the Kootenay Lake system provides a good example of the successes of fertilizing artificially denitrified waters. For example, downstream from Libby and Duncan Dams, Kootenay Lake was experiencing declines in productivity (nutrient levels) and fish populations during the 1980s. In response to these declines, the BC Ministry of Environment and BC Hydro initiated an experimental program to fertilize the North Arm of Kootenay Lake in 1992. By 1998, kokanee numbers in Kootenay Lake had jumped over 800% to 25-30 million. Combined kokanee spawning runs to Meadow Creek Spawning Channel and the Lardeau River increased from 270,000 in 1991 to 2.2 million in 1998. There are currently 30 to 35 million kokanee in Kootenay Lake, due largely to the nutrient restoration program and the presence of suitable kokanee spawning habitat, in the form of engineered habitat channels. The same ecological approach was applied to the South Arm of Kootenay Lake in 2004, and will be applied to the Kootenai River in Idaho, beginning in 2005. (Lead agencies: KTOI, IDFG).

2. *South Arm experimental nutrient restoration* – Following up on the success of the North Arm Kootenay Lake nutrient restoration program, a similar program began in the lake's South Arm to compensate for lost productivity and current ultraoligotrophy imposed by Libby Dam and the loss of the river's historical floodplain (Figures 1 and 2). (Lead agency: BC WLAP).

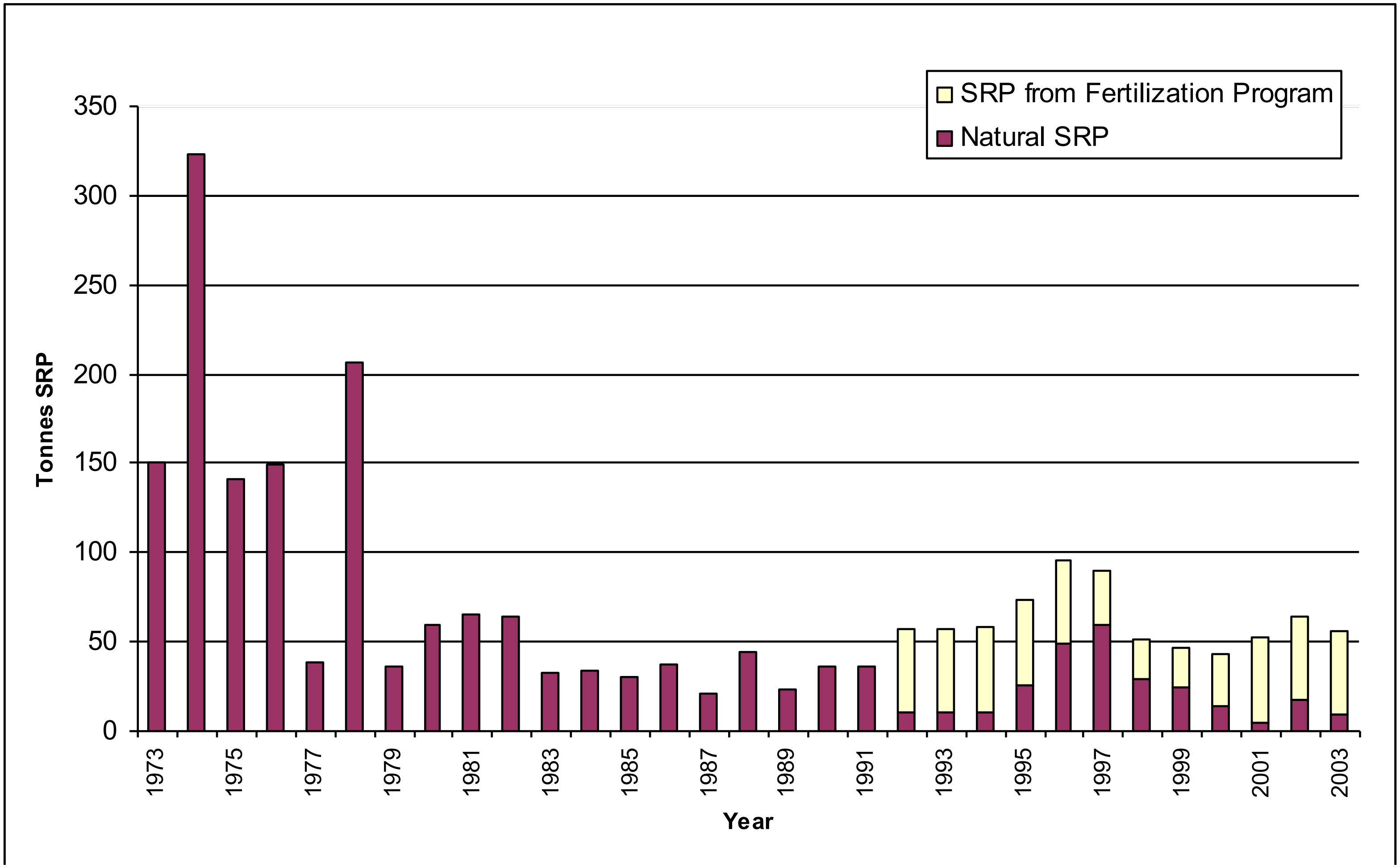
3. *Tributary stream restoration* – High quality tributary stream habitat within the Kootenai River Subbasin are paramount for survival of native resident and adfluvial fishes, riparian biological communities, and their supporting taxa. Consistent with this understanding, several tributary habitat improvement projects supported by BPA and the Bonneville Environmental Foundation funding are ongoing. Project proponents recognize the need to assess and pursue the benefits of expanding the scopes and scales of these and related tributary habitat enhancement projects. (Cooperating agencies: KTOI, IDFG, MFWP, BCWLAP).

4. *Conservation aquaculture, white sturgeon* – Started in 1989, the white sturgeon conservation aquaculture program is providing reliable annual recruitment, representation of current wild fish genetic diversity for the next generations, and the demographic base to maximize benefits of future mainstem habitat improvements designed to benefit natural spawning and recruitment. Currently, the conservation aquaculture program is the only program successfully contributing to demographic and genetic preservation of this endangered population (Lead agency: KTOI).

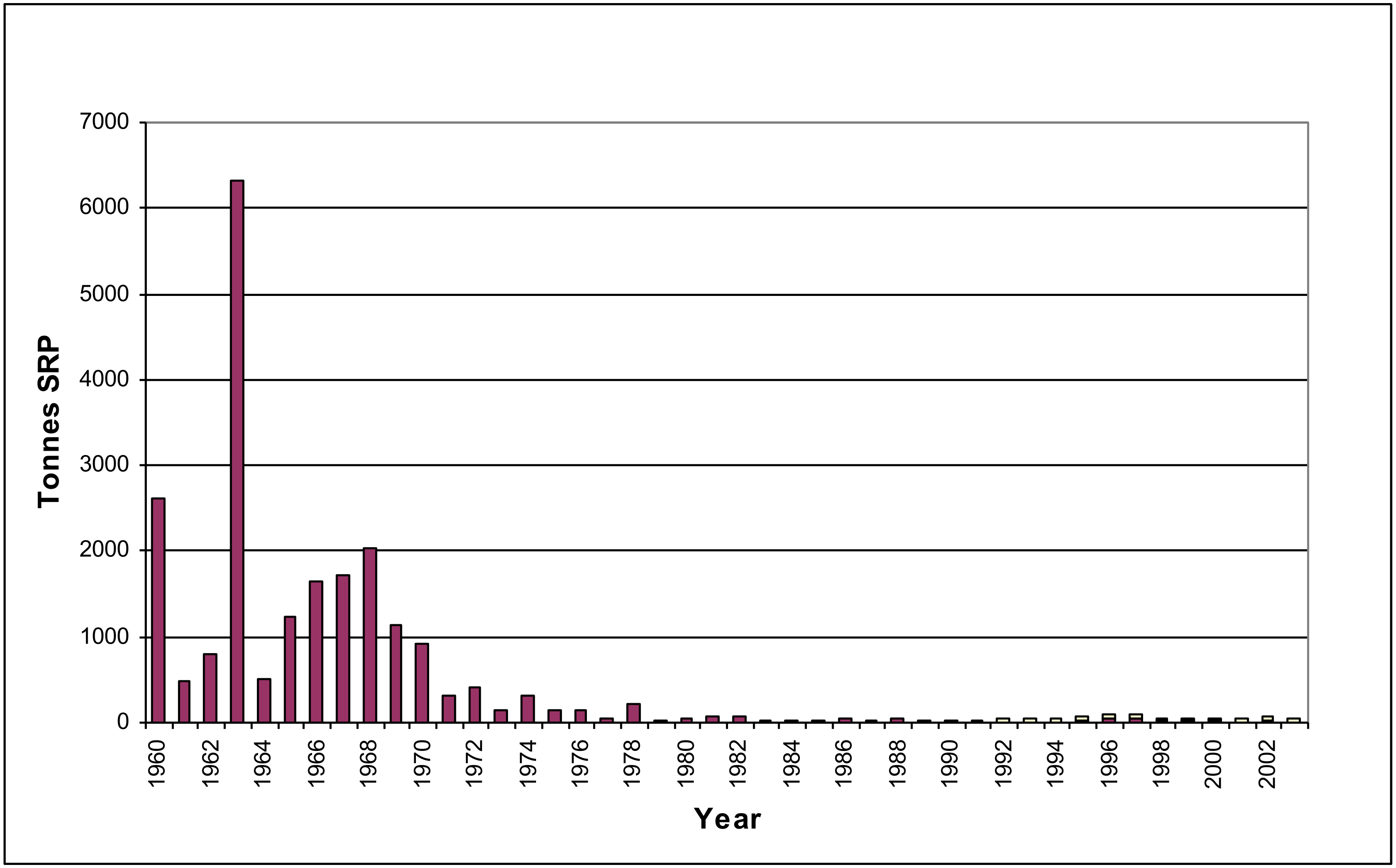
5. *Conservation aquaculture, burbot* – Modeled after success of the white sturgeon program (above), demographic and genetic requirements for burbot population

sustainability may be also targeted using conservation aquaculture. Initial success of experimental burbot conservation aquaculture occurred during the first year (2004) of research to develop techniques and facilities capable of reliably rearing burbot in captivity. (Lead agencies: KTOI, UI-ARI)

**Figure 1. Nutrient (soluble reactive phosphorous) loading to Kootenay Lake from the Kootenai River, 1973-2003. Libby Dam was completed in 1974.**



**in 1974. Elevated levels of phosphorous loading from the Kootenai River prior to the 1970s resulted in cultural eutrophication. Kootenay Lake nutrient restoration is indicated by the clear bars after 1991.**



6. *Aquatic biomonitoring* – Agency, tribal, and academic scientists have produced an ongoing biomonitoring program that evaluates water quality, and algal, aquatic insect and fish productivity in the Kootenai River from Kootenay Lake upstream to Wardner, BC. This program has annually documented baseline ecological conditions in the Kootenai River since the mid-1990s, more rigorously during the past four years, and will be used to evaluate experimental river nutrient treatments, relative to baseline conditions, prior to experimental nutrient restoration (Lead Agencies: KTOI, IDFG, BC WLAP).

7. *Habitat creation, modification, or restoration* – In response to extensive artificial alteration of the Kootenai ecosystem, innovative sturgeon projects including gravel/cobble additions over sand substrate, hydraulic manipulation structures, and spawning habitat, spawning and early life rearing channels, and natural-engineered hatchery systems are being considered for reestablishment of vital ecosystem functions. An array of additional projects are being currently being assessed to provide benefit for other fish and wildlife communities and the river's required supporting ecological functions (Tables 1 and 2) (Lead Agencies: USACOE, USFWS; cooperating agencies: KTOI, IDFG, MFWP, BCWLAP).

8. *Ecosystem restoration (normative) mainstem flows* – (All agencies) Libby Dam operation for flood control and power production has reversed the natural (pre-dam) Kootenai River hydrograph and has significantly altered downstream thermographs and water quality parameter values. All collaborators in the lower Kootenai River Subbasin have a vested interest in providing a more natural or normative river downstream from Libby Dam for a variety of ecological, social, cultural, recreational, and economic reasons, while sharing a vested interest in avoiding negative affects on flood control and power production.

## III. Riparian Program Components

1. *Floodplain reconnections, wetlands creation, riparian habitat function restoration* – (Lead agencies: KTOI, IDFG) Investigations and monitoring studies are currently underway in the Lower Kootenai River floodplain to determine the feasibility of reconnecting historical floodplain habitat with the main Kootenai River channel.

2. *"Terracosm" studies* – (Lead agency: KTOI) "Terracosms" are a land-based analogue for mesocosms that are medium-scale experimentally controlled systems used to quantify primary and secondary production and other ecological changes associated with experimental nutrient addition in aquatic systems. Unlike mesocosms, which simulate biological conditions in the water column of a river, terracosms are designed to measure the effects of water-borne nutrient levels on biological productivity over submerged floodplain habitat. The purpose of the terracosm experiments is to obtain valuable empirical data to more accurately quantify and understand the ecological changes that have occurred in Kootenai River following diking, channelization and impoundment. An associated digital

elevation modeling exercise essentially represents a large book keeping procedure to determine the magnitude of the floodplain losses. This, in turn is used to determine location, depth, and duration of floodplain inundation under pre- and post-development floodplain landscapes. An additional key step is to collect empirical data to determine the various productivity estimates from the vegetation groups that exist within the mosaic of riparian ecosystems along the Kootenai River. Some of the data (e.g. carbon leaf-fall per unit area, insect emergence) can be obtained from the literature, but requires validation to ensure the numbers accurately reflect the various measurable ecosystem flux rates that exist within the lower Kootenai River Subbasin. Terracosms and additional empirical measurements (i.e. leaf litter fall, leaf decomposition rates) are proposed to obtain these data (Table 2).

## IV. Terrestrial Program Components – To be developed

1. *Terrestrial invertebrate surveys*
2. *Vegetation surveys*
3. *Small mammal surveys Bird surveys*