Vision

The aquatic environment in the **Flathead and Kootenai subbasins** is linked to the mainstem Columbia through the operation of the Federal Columbia River Power System (FCRPS). The **goal** for the Flathead and Kootenai River Subbasins is to restore and protect the abundance, productivity, and diversity of biological communities and habitats, particularly those containing native fish and wildlife populations. Establishment of normative environmental conditions in the rivers and reservoirs affected by the operation of the FCRPS is essential to accomplish this goal.

Fluctuating reservoir elevations and stream flows resulting from system operation directly affect the aquatic environment and associated riparian and wetland habitats. The abundance, productivity and diversity of fish and wildlife species inhabiting the headwaters of the Columbia River are controlled by their ecosystems. There is a need to operate dams to restore and maintain normative hydrologic conditions (conditions that mimic natural processes and minimize impacts on fish and wildlife). To achieve this, headwater storage projects need to be operated consistent with the variable flood control strategy (VARQ) and Integrated Rule Curves (IRC). Specifically, there is a need for reservoir refill to promote biological productivity in the reservoirs. Downstream, there is a need for a gradual ramp-down of river flows after the spring runoff to maintain stable discharges, especially during the biologically productive summer months, to benefit native species.

The following biological objectives represent an established multi-species, habitat-based plan to restore normative functions in the Columbia River headwaters, consistent with mainstem operations called for in the NMFS and USFWS 2000 Biological Opinions. These operational mitigation measures are a portion of the overall mitigation plans in the Flathead and Kootenai subbasins (Fraley et al. 1989; MFWP and CSKT 1991,1993; MFWP, CSKT and KTOI 1998). Associated projects targeting habitat restoration and fish passage improvements were not included herein, unless directly pertinent to mainstem Columbia operations.

Biological Objectives
The following objectives and strategies were excerpted from the Flathead and Kootenai Subbasin Summaries and mitigation plans. Action measures promote the ecological conditions needed to support fish and population characteristics (capacity, abundance, productivity and life history diversity) and are needed to achieve the vision.

Objective 1 Restore populations of native fish and wildlife to self-sustaining levels capable of supporting harvest.

Self-supporting fish populations need to be protected or reestablished in areas where their habitat can be maintained or restored. Natural colonization of restored habitats should be encouraged where possible. Where wild stocks have been extirpated, an appropriate source population could be replicated through imprint planting of genetically compatible eyed eggs or fry. Various techniques for reestablishing wild runs need to be evaluated through rigorous comparisons of effectiveness and risk.

The construction and operation of Libby Dam caused the following fisheries losses that must be mitigated (MFWP, CSKT and KTOI 1998):
Replace the annual loss of 15,000 trout and 377,000 mountain whitefish from the river inundated by Libby Reservoir.
Replace the annual loss of 57,000 juvenile *Oncorhynchus spp* from inundated tributaries.
Replace the annual loss of 5,990 juvenile *Oncorhynchus spp* from tributaries blocked by new road construction to accommodate the reservoir.
Replace the annual loss of 2,100 juvenile westslope cutthroat trout from the Kootenai River downstream of Libby Dam.
Increase burbot in the Kootenai river to replace a loss of an approximate 90 percent reduction in the burbot fishery.

White sturgeon are now endangered and bull trout are designated threatened under the Endangered Species Act (ESA). These populations need to be restored to sustainable numbers to allow delisting these species.
Replace 175 km of the Kootenai River and 134 km of tributary stream habitat lost to inundation by Libby Reservoir.
Replace 25 km of adfluvial trout habitat was blocked by road construction when new roads were built around the reservoir to accommodate filling the pool.

The construction and operation of Hungry Horse dam resulted in the following fisheries losses that must be mitigated (Zubic and Fraley 1987; MFWP and CSKT 1991):
Replace a minimum annual loss of 65,000 juvenile westslope cutthroat trout.
Replace an annual loss of 250,000 juvenile bull trout
The loss statement also identifies the loss of 100,000 adult kokanee. Since experimental stocking could not restore the kokanee population, the implementation plan calls for replacing this loss using native trout species.
Replace the loss of 78 miles of river and tributary habitat lost due to inundation by Hungry Horse Reservoir.

Strategy 1. Restore normative conditions in the seasonal pattern and stability of river discharges and reservoir conditions.

The IRCs provide seasonality of flow in downstream reaches that are consistent with the Normative River Concept (ISAB 1997, 1997b). Figure 1 shows the influence of dam regulation on daily flow fluctuation downstream of a storage project. Flow fluctuation increases the width of the varial zone that becomes biologically unproductive.

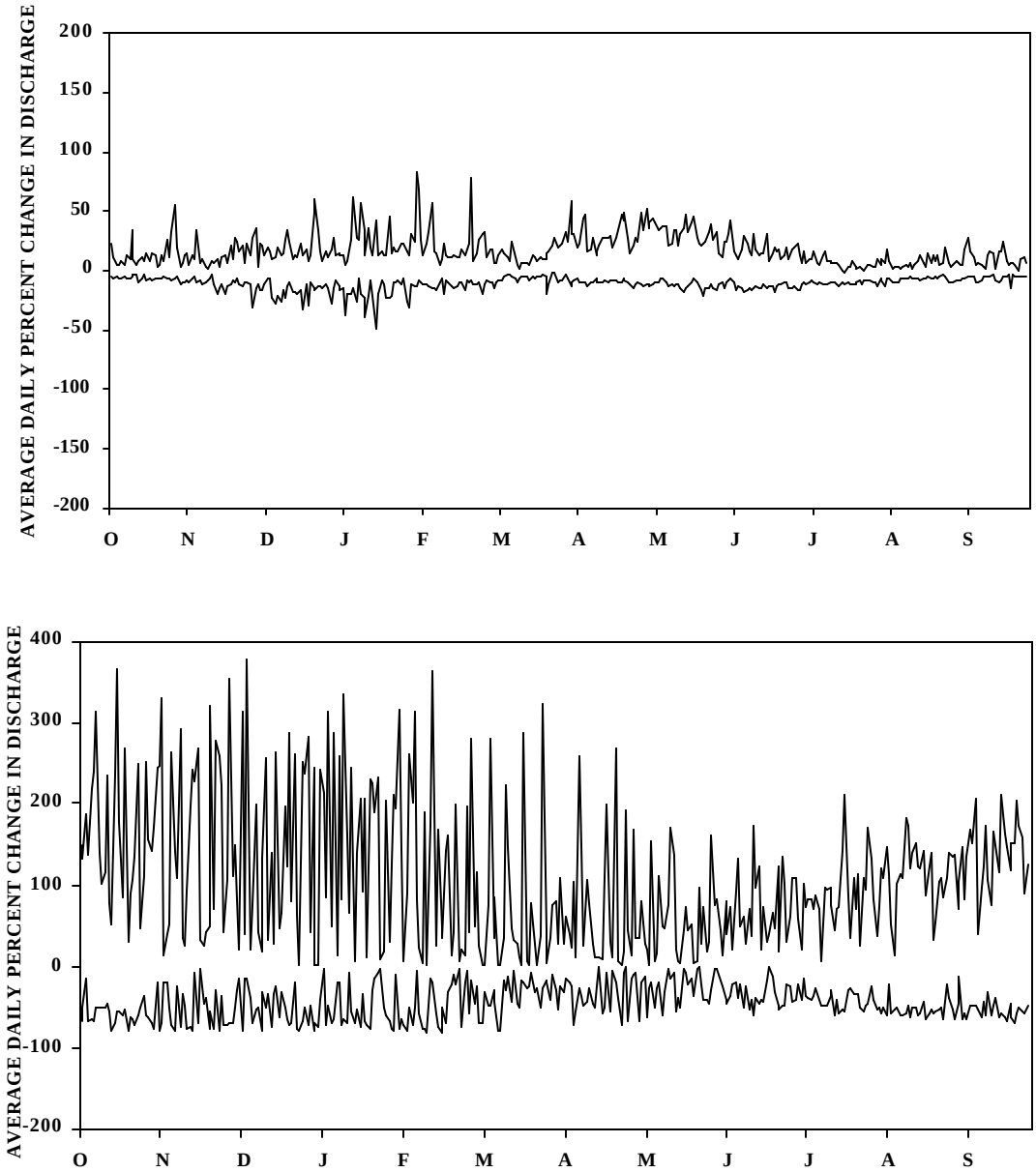

Figure 1. Range in daily change in discharge of the Kootenai River from water year 1952 through 1971 (top) and below Libby Dam from water years 1975 through 1995 (bottom) *in* Hauer 1996.

Strategy 2. Operate dams to provide reservoir operations that are consistent with VARQ and IRC concepts by 2002.

The USFWS and NMFS 2000 Biological Opinions on the operation of the FCRPS called for the variable flow, flood control strategy (VARQ). VARQ is crucial to create a naturalized spring runoff (within flood constraints) while simultaneously protecting resident fish in Hungry Horse and Libby Reservoirs (ACOE 1999, Marotz et al. 1999). During less than average water years, VARQ allows dam operators to store more water prior to runoff and produce a more naturally shaped dam discharge hydrograph. River flows can be augmented during spring without compromising reservoir refill probability. Reduced duration and frequency of deep reservoir drawdown protects aquatic food production in the reservoirs, assuring an ample springtime food supply for fish (Marotz et al. 1996). Improved reservoir refill aids resident fish migrations into spawning tributaries and increases the frequency of years in which water is available for summer flow augmentation.

The more naturally shaped hydrograph and stable flows protect biological production in the rivers downstream of the dams during the productive summer months. The naturalized spring freshet resorts and cleans river sediments and helps restore nutrient cycles and floodplain function. Normalized river flows benefit all species of special concern in Montana, then flows continue downstream to aid anadromous salmon smolt migration in the lower Columbia River.

Strategy 3. Reduce the frequency of refill failure (to within five feet of full pool) at Hungry Horse and Libby Reservoirs as compared to historic operation.

Increased refill frequency improves biological production in the reservoirs during the warm months. At full pool, the reservoirs contain the maximum volume and biological productivity for fish growth and a large surface area for the deposition of terrestrial insects, an important summer fish food component, from the surrounding landscape (May et al. 1988). Refill timing also assures that passage into spawning and rearing habitats in tributaries is maintained for the threatened bull trout that begins its fall spawning run in July. Another species of special concern in Montana, the westslope cutthroat trout, ascends the spawning streams during April and May when the reservoirs are near the annual minimum elevation.

The timing of reservoir refill should be varied depending on water availability. The IRCs contain a variable reservoir refill date to avoid forced spills at the dams. The reservoirs can refill earlier during dry water years, but should refill later during high water years to avoid the use of the spillways, which cause problems associated with gas supersaturation and abrupt changes in water temperature.

Strategy 4. Implement seasonal flow windows and flow ramping rates in the Flathead and Kootenai Rivers downstream of the storage reservoirs.

Instream Flow Incremental Methodology studies in the Flathead and Kootenai Rivers have provided empirical evidence for seasonal flow limitations and ramping rates. Preliminary results, including tiered flows for white sturgeon and allowable ramping rates, were included as terms and conditions in the USFWS 2000 BiOp on Kootenai white sturgeon and bull trout. Since that writing, MFWP has compiled additional empirical evidence to expand and refine the earlier results.

The USFWS 2000 BiOp states that the white sturgeon tiered flows should be refined by October 1, 2001. The intent was to develop a mathematical formula, based on water availability, to define the required volume to be released from storage at Libby Dam to meet flow targets at Bonners Ferry, ID (USFWS 1999, 2000). Table 1 shows that the tiered flows in the BiOp differ from the original plan adopted by the White Sturgeon Recovery Team in their Recovery Plan. The trigger points dividing the

various "tiers" were reduced, while the volumes to be released increased slightly. This situation will increase the number of years that Libby Reservoir will fail to refill, thus reducing the annual volumes available for summer flow augmentation. The table assumes that unregulated flows between Libby Dam and Bonners Ferry were correctly calculated by the ACOE. Recent analyses of the data referred to as Bonners Locals show that the calculated volumes do not match empirical data. Thus the release volumes shown in column two may have been over-estimated and the difference between the two scenarios may be greater than shown.

Table 1. Comparison of the original sturgeon tiered flow approach to the tiered flows published in the USFWS 2000 Biological Opinion on the operation of the Federal Columbia River Power System.

Original Tiered Flows		Biological Opinion Tiered Flows	
Inflow Forecast (MAF)	Release Volume (MAF)	Inflow Forecast (MAF)	Release Volume (MAF)
< 5.031	Sturgeon Flow Not Requested	< 4.80	Sturgeon Flow Not Requested
5.031<forecast<6.337	0.39*	4.80<forecast<6.00	0.4
6.337<forecast<7.075	0.49	6.00<forecast<6.70	0.5
7.075<forecast<8.5	0.68	6.70<forecast<8.10	0.7
8.5<forecast<9.5	1.16	8.10<forecast<8.90	1.2
> 9.5	1.55	> 8.90	1.6

* Volume to be released from Libby Reservoir was calculated based on the flow target at Bonners Ferry, ID minus estimated mean local inflow from unregulated sources between Libby Dam and Bonners Ferry within each tier. Volumes are preliminary, pending ongoing analysis.

The calculation of tiered flows during spring for white sturgeon and summer for bull trout should use a conservative inflow forecast, assuming the lowest 25th percentile precipitation (rather than average). NMFS and USFWS agreed to meet with Montana to develop a mathematical formula for defining minimum summer flows based on water availability. This agreement has not as yet been fulfilled.

Strategy 5. Maintain minimum flows in the Flathead and Kootenai Rivers. The minimum flow in the South Fork Flathead River has a sliding scale (See Marotz and Muhlfeld 2000).

The minimum flow in the Flathead River is 3,500 cfs and 4,000 cfs in the Kootenai River. During the power emergency of 2001, the Flathead River minimum flow was reduced to 3,200 cfs. The USFWS 2000 BiOp specifies higher flows during the summer for bull trout. We concur with the sliding scale, flow strategy for bull trout as specified (USFWS 2000).

Strategy 6. Reduce runoff forecasting error by increasing the number of snow monitoring sites and improved remote-sensing technology.

Forecasting error results in verifiable deviations from planned dam operations. Improved forecasting capability would remove some of the uncertainty in annual dam operations.

Strategy 7. Re-vegetate the top 20 feet of the varial zone in Hungry Horse and Libby reservoirs (where possible in low gradient areas).

This action is called for by the USFWS 2000 BiOp (USFWS 2000). The reservoir varial zones are neither terrestrial or aquatic habitats and are biologically unproductive. Revegetating the top 20 feet of the varial zone with flood tolerant vegetation would stabilize erosion and benefit fish and wildlife.

Objective 2 Protect, restore, and enhance riparian/wetland habitat above and below Hungry Horse and Libby Dams, meeting the annual goals set forth in management and mitigation plans.

There is a need to reconnect access to spawning and rearing habitat that has been blocked by human-caused barriers (Knotek et al. 1997). Levees, culverts, diversion dams and man-caused landslides have blocked fish passage into spawning and rearing habitats. Improving fish passage into existing habitat is a cost-effective tool to replace habitat lost during the construction and operation of the hydropower system. In the Kootenai River, deltas have accumulated at the mouths of tributaries because regulated flows are insufficient to remove and resort deltaic deposits. These efforts are consistent with the maintenance of genetic integrity in fish species and protection of threatened, endangered, and senstive plant and animal species. Fish and wildlife restoration measures should be integrated to promote connectivity of aquatic and terrestrial habitats.

Strategy 1. Restore in-channel habitat structure, function, and complexity.

Fish require suitable habitats for natural production and survival through all life stages. Regulated river flows have resulted in substrate imbeddedness. Cobbles and gravels clogged with sediment need to be flushed periodically to improve the productive capacity of the rivers. Imbedded sediments reduce insect production becausefine sediments prevent insects from using the surface and interstitial spaces between gravel and cobble as habitat. Clean cobbles are also used as security habitat for trout. Juvenile bull trout are especially dependant on unimbedded cobble substrates. Possible treatments include stream bank stabilization, riparian re-vegetation, and agitation of embedded gravels to remove silts and fine sands.

Channelized or dyked river reaches need to be restored to natural form and function. This can be accomplished passively by restoring normative flow regimes and by using biotechnical approaches to restore the river to a stable channel form. Restoring bankfull flows for at least 48 hours at a frequency of 2.5 years would aid channel maintenance and normative sediment dynamics. Stream restoration measures may include placing large rocks, woody debris, and bank stabilization structures in the river to restore the appropriate channel morphometry. Options are being explored by IDFG and KTOI to restore spawning substrate for the endangerd Kootenai white sturgeon.

Strategy 2. Restore riparian and wetland habitats and floodplain function.

Riparian and wetland areas have the greatest influence over the biological health of the watershed. They provide security cover for fish and terrestrial wildlife, habitat and food for insect production, and woody debris that creates channel diversity and pocket water for spawning gravel deposition. Ground cover vegetation and riparian canopy in the riparian zone traps sediments produced from adjacent land areas. There is a need to identify and protect the best available remaining riparian and wetland habitats through the use of conservation agreements and land acquisitions and a need to modify the activities that are causing the degradation of impacted areas or that are preventing the ecosystem from recovering. Riparian and wetland vegetation needs to be restored and protected through fencing and re-vegetation projects.

Strategy 3. Complete an operational impact assessment and develop plans to mitigate for any impacts that the operations of Hungry Horse and Libby Dams may cause to the development and successional trends of riparian wildlife habitats and their associated aquatic

components, in cooperation with ongoing fisheries mitigation activities.

Terrestrial habitat lost due to inundation by Hungry Horse and Libby Reservoirs is being addressed through the Montana Wildlife Trust Fund. Operational losses have not been quantified or mitigated.

Objective 4 Maintain temperatures within the tolerance range of native fish species.

Strategy 1. Operate selective withdrawal devices at Hungry Horse and Libby Dams to mimic the natural thermal regime in the rivers downstream.

Deploy continuous recording thermographs at important points along the river to monitor water temperatures in relation to the tolerance range of native fish species. Empirically correlate fish growth and survival at critical life stages with water temperature. Adjust the annual thermal regime using selective withdrawal for maximum benefit of native fish species. Thermal modeling is ongoing and results could best be compiled in a longitudinal thermal model (an extension of the existing discharge temperature model).

Strategy 2. Improve riparian and in-stream habitat using stream channel and riparian habitat restoration methods.

Flow ramping during the summer can influence water temperature by intermittently inundating solar heated substrates. Flow fluctuations caused by dam operation displaces riparian vegetation (removing shade) in the varial zone, influencing solar input. Stabilizing summer flows would enhance reestablishment of riparian vegetation in the varial zone.

Objective 5 Meet the TMDL goal for reduction in phosphorus.

There is a need to address all significant point and non-point sources of water pollution in the system. Reductions in water quality can lower the overall resilience of aquatic environment and keep fish and wildlife populations from recovering. Standards for total maximum loading of nutrients (TMDL), thermal pollution, and gas saturation need to be enforced (Stanford et al. 1997).

Strategy 1. Support new techniques for bank stabilization as alternatives to the standard riprap material. These new techniques would serve as landowner demonstration models for the reduction of sediment to the mainstem and lake.

Strategy 2. Protect critical wetland and riparian habitats through acquisition or conservation easements. Identify and rank all high priority areas and establish purchase/protection mechanisms.

Strategy 3. Work with the Focus Watershed Coordination projects in the Flathead and Kootenai drainages to identify site-specific wetland/riparian restoration projects and to coordinate with landowners, agencies, and other funding sources.

Scientific Foundation

The above objectives and tasks represent actions related to main stem operations that will create desirable habitat and help recover fish and wildlife populations in the headwaters while recovery actions for anadromous fish continue in the lower Columbia River.

System dam operation affects environmental conditions above and below the dams. Quantitative biological models of the reservoirs (HRMOD and LRMOD) were constructed using empirical physical and biological data linked to dam operation (Marotz et al. 1996, 1999; Skaar et al 1996). Conditions in the reservoirs resulting from various dam operation scenarios can be assessed beginning with the hydrologic mass balance and thermal structure and extending from primary producers through tertiary trophic levels.

The rivers downstream were modeled using a modified form of Instream Flow Incremental Methodology (IFIM) that quantifies the total availability of various habitats under differing dam operation relative to seasonal habitat selection by fish species and life cycle stage. The empirical models, combined with field verification provide the basis for IRCs, seasonal river flows and flow ramping rates (Marotz and Muhlfeld 2000; Muhlfeld et al. 2001a, 2001b).

The hierarchy of the models begins with water availability in the headwaters and works downstream. Monthly inflow forecasts are input to calculate reservoir drawdown and refill targets, and/or dam discharge schedules. Water availability in the Flathead and Kootenai subbasins varies somewhat independently from the main stem Columbia River; the subbasins might be wet or dry compared to the whole Columbia Watershed. Dam discharge is regulated by the physical characteristics of catchments/dams and downstream flood constraints. Flows from unregulated sources are added enroute downstream. Flow peaks are dampened by river friction and downstream catchments, water travel times and hyporheic interactions. Hydrologic calculations in HRMOD and LRMOD end at the outlet of Flathead Lake and Kootenay Lake, respectively. The Montana models can share input and output with system models to assess basin-wide operations (SOR EIS 1995).

Biological hierarchies in the models extend from primary production (based on Carbon-14 uptake at depth), through secondary producers (zooplankton production by genus and entrainment loss, benthic Dipteran standing stocks and emergence relative to reservoir operation, terrestrial insect deposition by Order) and fish growth (kokanee at Libby and westslope cutthroat at Hungry Horse). The influence of dam operation on other species can be inferred from the physical measures (reservoir elevations and river flows) and trophic responses. The IRCs contain a tiered strategy for spring flow augmentation for white sturgeon and stable summer flows for bull trout (USFWS 2000, Marotz et al. 1999).

Habitat forming processes affected by reservoir elevations and river flows include erosion and sediment deposition, nutrient cycling and plant succession. Under natural flow conditions, flushing flows sort bottom sediments, creating unimbedded cobbles that benefit benthic insect production and fish security cover. Fine sediments are deposited along the river margins and on the tails of islands, providing nutrients and soils for riparian vegetation. Unnatural flow fluctuations disrupt these habitat forming processes, resulting in a larger varial zone that is biologically unproductive (Hauer et al. 1994, 1997). Unnatural seasonal flows and flow fluctuations also affect burbot spawning behavior (Paragamian 2000). Terrestrial plants are less likely to take root in a fluctuating system. Fine sediments that would normally become stabilized by shoreline vegetation are more easily eroded into the river channel.

Action Measures

We recommend actions for the river's mainstem and the tributary subbasins that are consistent with the framework elements already adopted. The Council adopted the IRCs in 1995. The white sturgeon recovery team unanimously adopted the IRCs into the Recovery Plan (USFWS 1999) and many of the components (e.g. VARQ flood control, sliding reservoir refill dates and stabilized summer flows for bull trout) were included in the 2000 BiOps from NMFS and USFWS. Data in support of the recommendations are included in the federal documents and court documents (State of Montana v. United States Army Corps of Engineers and U.S. Bureau of Reclamation, Ninth Circuit No. 99-35407).

The State of Montana strongly supports the proposed implementation of VARQ. This will help to provide additional water in both Libby and Horse that will help provide a more equitable balance between the needs of salmon, bull trout, sturgeon and resident fish. We also support the implementation schedule proposed that would implement VARQ at Hungry Horse during 2002 and Libby in 2003 (following in one year to allow time for consultations with Canada and finalization of environmental documents).

Impacts in the rivers below Libby and Hungry Horse Dams should be mitigated by planning a steady draft from July through September when flows in the Columbia River are augmented for anadromous fish recovery. We suggest that the standard be a 10 foot draft rather than 20 feet. This strategy helps to avoid the most severe impacts caused by a second, unnatural flow peak in August that occurred in past attempts to meet anadromous flow targets. The double-peak drafting strategy caused significant, and in our view, unnecessary impacts on bull trout and other resident fish and aquatic resources.

The top 20 feet of Libby and Hungry Horse Reservoirs should be revegetated as per the USFWS 2000 BiOp.

The impact of dam operation on terrestrial wildlife in the Flathead and Kootenai Rivers should be assessed and mitigated.

Experimental Design for Monitoring and Evaluating Long-term Objectives

The tiered flow approach for recovering the endangered Kootenai white sturgeon is an experimental design to mimic annual changes in water availability and provide sampling variation in river flow and temperature (USFWS 1999). Comparisons with observed spawning events and subsequent measures of survival will allow researchers to examine conditions needed for natural reproduction and recruitment to the white sturgeon population. Changes in the tiered flow approach between the original and those presented in the USFWS 2000 BiOp have prompted a review to be completed by October 1, 2001. Work has begun to develop a mathematical formula to determine flow volumes based on reservoir inflow forecasts and reservoir capacity. Empirical measures of sturgeon survival, and other species of special concern including bull trout, will ultimately shape the tiered discharge volumes into an annual hydrograph suitable for natural white sturgeon reproduction.

The USFWS 2000 BiOp requires similar research on the effects of flow ramping rates on bull trout. We have proposed a mathematical formula for stable flows during summer based on water availability. The minimum flows and ramping rates established by the BiOp will be evaluated using IFIM methodology and radio telemetry to collect data on bull trout distribution, movements, and habitat use through weekly ground, boat, and aerial surveys. The experimental design allows researchers to examine the effectiveness of seasonal flow limits and ramping rates by comparing total habitat availability at various flows with habitat selection within critical life stages within each target species. Sampling involves tracking diel movements during critical flows at minimum (winter) and maximum temperatures. IFIM and telemetry are being simultaneously applied to other species of special concern including westslope cutthroat trout and redband.

The scientific approach involves monetoring at the micro- and mesohabitat levels in the treatment and control areas, with periodic sampling at the macrohabitat or subbasin level. Specific monitoring strategies, including pre- and post-treatment sampling, has been designed for each completed and ongoing mitigation project (generally the strategies involve site-specific habitat measures, photo points, migrant trapping and population assessments). These activities are combined with watershed level, long-term, time-series indices for habitat and fish populations to evaluate direct and indirect effects of projects. Annual population monitoring includes population estimates, age/growth measurements and redd counts. Habitat quality is assessed by McNeil method of streambed coring in 33 tributaries (to assess juvenile bull trout rearing habitat quality) and by substrate scoring in 21 tributaries; conduct annual migratory cutthroat and bull trout redd counts in 45 index tributary reaches to monitor adult runs. Cutthroat and bull trout juveniles are quantified in 31 tributaries annually.

MFWP is monitoring the effectiveness of selective withdrawal at Hungry Horse Dam on the Flathead River ecosystem and Libby Dam in the Kootenai River. River temperatures are monitored at six locations in the Flathead River system and at Libby Dam on the Kootenai River. Macrozoobenthos diversity and abundance and fish growth rates have been examined over time. Research is ongoing to assess the abundance, distribution, and food habits of predator fish species (lake trout, northern pike) in the Flathead River to determine if selective withdrawal and river flows can be managed to improve conditions for native fish species.

This monitoring program is maintained through a cooperative effort with other agencies. Details can be found in project proposals, project reports and peer reviewed publications. Raw data are stored at the FWP headquarters in Kalispell and the regional office in Libby. Data are electronically stored and available upon request. Quality control safeguards are in place for the management and storage of data through imbedded error checking programs and subsequent analysis. There are restrictions on access and use of certain data sets prior to review and/or publication.

Power Supply Considerations.

These recommendations for operating the FCRPS were designed to meet the needs of fish and wildlife with minimal impacts to power supply needs and system flood control in the northwest region. Power analyses have been completed by BPA (Wright 1996; Also see model simulations by Roger Schiewe and Craig Larson).

The Council might consider more inter-regional energy transfers, energy conservation and alternative energy technologies to resolve the region's power supply problems. Additional transmission associated with Hungry Horse and Libby Dams would have the added fisheries benefit of stabilizing river flows when electrical storms cause grid interruptions.

The Council should incorporate costs associated with damages to fish and wildlife resources and losses to past mitigation investments when the power supply impacts of proposed operations are evaluated. Economic analyses should not externalize costs associated with losses to ecosystem health.

The Council can conclude that it is adopting a fish and wildlife program that truly does protect, mitigate and enhance fish and wildlife, while continuing to assure the region an adequate, efficient, economical and reliable power supply, when fish and wildlife show a positive trend. Projects should address approved loss statements and ultimately develop a measurable system for evaluating progress.

Thank you for the opportunity to comment. If you require more information, please contact Brian Marotz, Fisheries Program Officer, Montana Fish, Wildlife & Parks, Kalispell, Montana (406) 751-4546.

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