Kootenai River Habitat Restoration Project Master Plan

Chapter 5 – Adaptive Management and Monitoring

Kootenai Tribe of Idaho
July 2009

Chapter 5: Table of Contents

Chapter 5: Figures

Chapter 5: Tables

5 Adaptive Management and Monitoring

This chapter describes the Adaptive Management and Monitoring program for the Kootenai River Habitat Restoration Project. The Adaptive Management and Monitoring program is a long-term decision-making framework that provides a formal way to incorporate effectiveness monitoring data related to specific restoration treatments, monitoring information from other related programs, and other new information that may become available. As part of later design phases, this adaptive management and monitoring program will be refined and tailored to address the specific restoration treatments and implementation scenarios that are selected.

5.1 Overview

The Adaptive Management and Monitoring program will be guided by the Kootenai River Habitat Restoration Project goals:

- Restore physical habitat by reducing the negative effects to river and floodplain ecological processes caused by river response to the altered landscape.
- Restore native vegetation by establishing stream bank and floodplain conditions that sustain plant community development processes.
- Restore aquatic habitat conditions that support sustainable populations for all life stages of native fish.
- Create opportunities for river and floodplain stewardship in the community.

The purpose of the Kootenai River Habitat Restoration Project Adaptive Management and Monitoring Plan is to provide a framework to:

- Evaluate the effectiveness of the implemented habitat actions in terms of achieving the project goals;
- Identify project maintenance needs;
- Identify any potential unforeseen negative impacts on infrastructure, public and private lands, flood control management, focal species, and habitat;
- Support decisions to modify restoration treatments; and
- Refine or modify restoration treatments that might be implemented in later phases of the project.

An important corollary purpose of the Adaptive Management and Monitoring Plan is to establish links to other existing adaptive management and monitoring programs. For example, it will be important to orchestrate effective coordination with the broader scale Kootenai River Adaptive Management Plan[1] monitoring associated with the Fish and Wildlife Service Biological Opinion

---

[1] In 2004, the Kootenai Tribe along with numerous scientific and management stakeholders participated in a multi-agency adaptive management workshop to develop a long-term adaptive management framework for the Kootenai River ecosystem. The resulting 20-year adaptive management framework included aquatic, riparian and

regarding the effects of Libby Dam Operations on the Kootenai River White Sturgeon, Bull Trout and Kootenai Sturgeon Critical Habitat (Libby Dam BiOp) (USFWS 2006, clarified in 2008) as clarified, monitoring associated with the Kootenai Tribal Sturgeon Hatchery and the Tribe's aquaculture program, and the Kootenai River White Sturgeon Recovery Implementation Plan and Schedule (Kootenai Tribe of Idaho 2005), and other Kootenai subbasin fish and wildlife programs as partially listed in Section 1.1.4 of this Master Plan.

Because the Kootenai River Habitat Restoration Project focuses on overcoming limiting factors related to habitat, the Adaptive Management and Monitoring program will emphasize collection and evaluation of data that determines whether habitat goals and objectives are being achieved. As described in previous chapters, project goals and associated limiting factors are grouped into categories of morphology, riparian vegetation and aquatic habitat, and the project goals are based on these groupings. These limiting factors were selected because they can be most directly addressed by restoration treatments outlined in this Master Plan. Similarly, metrics related to morphology, riparian vegetation and aquatic habitat are most likely to be sensitive to changes resulting from restoration treatments. Therefore, the adaptive management and monitoring program includes metrics that link directly limiting factors, and these links are shown in Table 5-1. While one of the purposes of the Kootenai River Habitat Restoration Project, as described in Chapter 1, is to improve habitat for aquatic focal species, this adaptive management and monitoring program does not specifically include metrics related to the biological response in terms of focal aquatic species populations. This is because those metrics are being monitored as part of other, concurrent monitoring and evaluation programs. Because the links between habitat metrics and aquatic focal species are important, this Adaptive Management and Monitoring Plan specifically includes information about related monitoring and evaluation programs (see Table 5-3 and Section 5.5).

Chapter 2 (particularly Section 2.6 Aquatic Habitat Limiting Factors) describes the links between aquatic focal species and the limiting factors included in this Master Plan. Monitoring and evaluation activities conducted through other programs will provide links between the Kootenai River Habitat Restoration Project and biological response within the Kootenai River ecosystem. As the project moves into subsequent design phases, it will be necessary to develop formal mechanisms to ensure the social and cultural context is being considered adequately. Collectively, the information gathered through the coordinated adaptive management and evaluation programs will contribute to addressing and resolving data gaps associated with a broad range of ecosystem functions necessary for sturgeon and other aquatic focal species. In subsequent phases of the Kootenai River Habitat Restoration Project, this Adaptive Management and Monitoring program will be expanded and refined to explicitly define how these efforts will be coordinated so that a broad range of necessary data and information is effectively shared among the different programs.

---

terrestrial/avian components and is described in the 2005 *Draft Kootenai River Adaptive Management Plan* (Walters et al. 2005).

5.2 Adaptive Management and Monitoring Program

The following sections describe the conceptual approach to the Kootenai River Habitat Restoration Project Adaptive Management and Monitoring program. As noted previously, the details of this program will be refined during the preliminary design phase of the project.

Adaptive management can be defined as incorporating the scientific method into a management framework to resolve specific problems. Adaptive management is based on the premise that informed, deliberate experimentation is the most reliable means of understanding and addressing complex problems in resource systems. Moreover, the adaptive management approach incorporates the development and comparison of alternative models based on multidisciplinary collaboration as the basis of management, experimental design, and monitoring of the resource system (Holling 1978; Walters 1986). This differentiates adaptive management from a more traditional trial-and-error or learn-as-you-go management approach (Hilborn 1992, Halbert 1993).

When applied to the large scale Kootenai River Habitat Restoration Project, adaptive management will provide a necessary framework for managing the entire restoration project, and linking it to related natural resource management programs. Adaptive management will encompass all stages of restoration, including planning and design, implementation, monitoring and maintenance.

A restoration design that incorporates adaptive management is the result of an interdisciplinary process that is focused on increasing knowledge about the ecosystem and its habitat, and how restoration treatments can overcome limiting factors. Knowledge is increased by collecting design-specific data, analyzing the data and applying information and experience gained from previous restoration projects; and from monitoring and evaluating the current project. Restoration design must be an iterative process that includes feedback loops that allow interpretations of monitoring results to serve as inputs in an ongoing process where designs are refined; it is not a linear process with a pre-determined or fixed end point. Figure 5-1 illustrates the restoration design process where information from early restoration phases feeds back into later phases of design and implementation (note that Figure 5-1 illustrates only the design process not the larger process that will be used to adaptively implement the project). This allows for project designs developed in later phases to incorporate effectiveness monitoring data from previous phases, resulting in the most effective restoration treatments being included as part of later restoration designs.

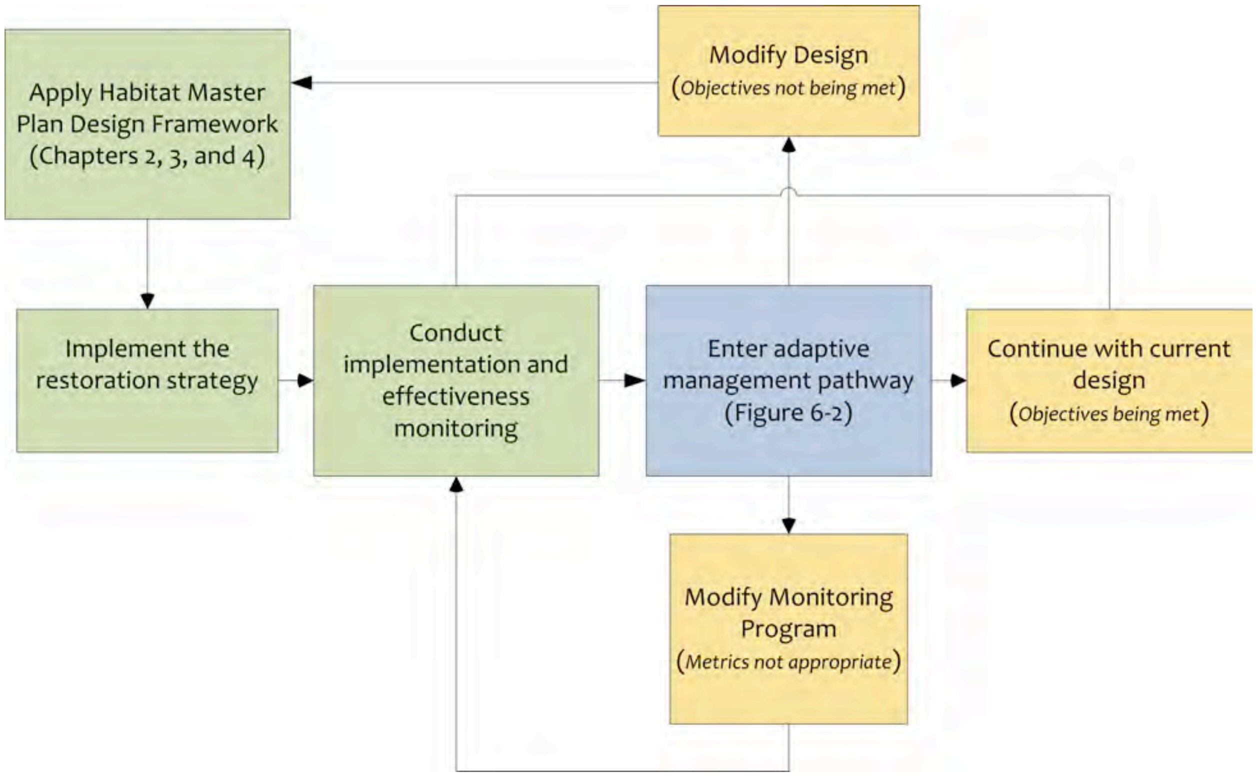

Figure 5-1. Restoration design process.

The Adaptive Management and Monitoring program provides a mechanism to make the design process adaptable and accountable, and to determine whether habitat restoration goals are being achieved. Table 5-1 illustrates how restoration goals are described in terms of limiting factors, restoration strategies and quantifiable objectives to support the adaptive management and monitoring program.

Following is a summary of the Adaptive Management and Monitoring program's components:

- **Goals** are described in terms of limiting factors related to morphology, riparian vegetation and aquatic habitat (and constraints related to river stewardship) that must be overcome to restore habitat; **restoration strategies** are identified to overcome limiting factors, and **objectives** are quantifiable ways to determine whether limiting factors are being addressed by treatments (see Chapter 3). In this document, some objectives include placeholders for thresholds that will be developed during the next phase of the design process and subsequently used to determine whether success criteria are being met.
- Once preliminary designs are completed for a project reach, **success criteria** will be developed based on either quantitative or qualitative criteria developed as part of the design. Success criteria provide a way to explicitly state and measure the expected outcomes of restoration treatments within both short-term and long-term time frames. Examples of success criteria are included in Table 5-2. The associated monitoring

program must include ways to measure these criteria in a manner that is quantifiable, repeatable and accurate.

- To accomplish this, **metrics** will be selected for each success criteria. Monitoring metrics are ways of measuring criteria; for example, size class distribution is a metric for sediment-transport and feet per year is a metric for lateral bank erosion. Proposed metrics are included in Table 5-1; these will be refined and potentially augmented during the preliminary design process.

Table 5-1. Limiting factors, strategies, objectives and metrics by four goal categories.			
Limiting Factors/ Constraints	**Restoration Strategy Components**	**Quantifiable Objectives [1]**	**Proposed Metrics**
Morphology			
River and floodplain response to altered flow regime and altered hydraulics	Establish channel dimensions that are sustainable given the morphological setting and governing flow and sediment regimes	▪ Construct a meandering gravel-bed channel with side channels in the Braided Reaches ▪ Construct a confined gravel-bed channel in the Straight Reach ▪ Excavate floodplain adjacent to the channel in the Meander Reaches	▪ Channel width ▪ Channel depth ▪ Channel slope ▪ Particle-size distribution
River and floodplain response to altered sediment supply and sediment-transport conditions	Gradually reduce sediment supply and transport competence in a downstream direction in order to promote deposition of sediment on the floodplain in the Braided Reaches and reduce deposition of sediment on the channel bed in downstream reaches	▪ Provide floodplain surfaces in the Braided and Straight Reaches that will store X tons of sediment over X years ▪ Provide river and floodplain sediment-transport conditions in the Braided and Straight Reaches that deposit X tons of sediment on the floodplains and less than X tons of sediment in the channel annually	▪ Change in volume and area of depositional surfaces ▪ Particle size distribution ▪ Scour and fill depth on point bars ▪ Channel width ▪ Channel depth
Loss of floodplain connection	Establish channel and floodplain connection at mean annual peak flow where feasible given constraints from river and floodplain management	▪ In the Braided and Straight Reaches, create X acres of new floodplain surfaces at elevations that correspond to river stage at 30,000 cfs ▪ In the Meander Reaches, connect X acres of floodplain surfaces at elevations that correspond to river stage at 30,000 cfs	▪ Channel profile ▪ Bank height ratio ▪ Observations of hydrologic connectivity

Table 5-1. Limiting factors, strategies, objectives and metrics by four goal categories.

Limiting Factors/ Constraints	Restoration Strategy Components	Quantifiable Objectives [1]	Proposed Metrics
Accelerated bank erosion and reduced boundary roughness	Establish bank vegetation; increase channel roughness	▪ Within identified bank treatment areas, lateral bank migration is 0 ft per year for first five years while vegetation is becoming established ▪ Within identified bank treatment areas, less than 10% of bank length moves laterally less than 1 ft between years 5 and 10 ▪ Within identified bank treatment areas, less than 30% of bank length moves laterally less than 1 ft between years 10 and 20	▪ BEHI ratings ▪ Bank profiles ▪ Bank erosion rates
Riparian vegetation			
Lack of surfaces that support riparian recruitment	Increase floodplain areas with suitable substrate and elevation relative to the water table in order to support riparian vegetation recruitment and establishment	• In Braided Reach 1, create X acres of new floodplain surfaces • In Meander Reach 1, X acres of floodplain is (surface) connected to the river at 30,000 cfs including X acres with sand/gravel/cobble substrate • In Meander Reach 1, X acres of floodplain has hydrology in the rooting zone sufficient to support hydrophytic vegetation	• Hydrologic connectivity • Groundwater depth • Canopy cover of plants • Area and stability of depositional surfaces
Lack of outer bank vegetation	Establish bank vegetation	• Within identified bank treatment areas, X live willow and shrub stems per square foot on bank face by year 3 • Within identified bank treatment areas, 80% canopy cover of native shrubs by year 5	• Stem counts • Proportional abundance of native vegetation types • Canopy cover
Frequent scour/deposition of floodplain surfaces	Increase stability/longevity of floodplain surfaces	• Maximum x% change in footprint of point bars per year over three years (allows some movement, but not complete annual redistribution of point bars)	• Area of depositional features and change in position over time
Altered hydroperiod	Increase floodplain areas with appropriate elevation ranges relative to the water table to support native tree and shrub species	• Link this objective to a design table that represents proportional abundance of elevation patches per unit area	• Groundwater depth • Wetland indicator status of plant species

Table 5-1. Limiting factors, strategies, objectives and metrics by four goal categories.

Limiting Factors/ Constraints	Restoration Strategy Components	Quantifiable Objectives [1]	Proposed Metrics
Invasive weeds	Reduce weed cover so weeds do not limit recruitment and establishment of native plant species	• Weed canopy cover is less than 10% by year five	• Canopy cover invasive species • Weed mapping
Lack of native seed sources	Establish nodes of diverse, native vegetation within the Straight Reach and Meander Reaches	• Link this objective to design plant pallets that include a list of species by layer and target density/canopy cover over short, medium and long-term timeframes	• Native plant species canopy cover and diversity as measured by number of species by life form
Lack of nutrient sources for primary productivity and limited carbon storage (reduced primary productivity)	Increase amount and diversity of native vegetation and wetlands within the Meander Reaches	• Targets would be established for each project design	• Combination of vegetation metrics and other metrics from the Tribe's Operational Loss Assessment
Aquatic habitat			
Insufficient depth for Kootenai sturgeon migration preference	Provide depth conditions for normal Kootenai sturgeon migration and spawning behavior in Kootenai sturgeon migration reaches	• Provide intermittent depths of 16.5 to 23 ft or greater in 60% of the area of rocky substrate from RM 152 to RM157 during peak augmentation flows	• Channel depth • Libby Dam BiOp monitoring completed by others
Insufficient velocity for Kootenai sturgeon spawning preference	Provide velocity conditions for Kootenai sturgeon spawning and embryo/free-embryo incubation and rearing in Kootenai sturgeon spawning reaches	• Provide velocities of 3.3 ft/s and greater in approximately 60% of the area of rocky substrate from RM 152 to RM157 during post-peak augmentation flows	• Flow velocity • Libby Dam BiOp monitoring completed by others
Lack of coarse substrate for Kootenai sturgeon egg attachment and larval hiding	Provide substrate conditions for Kootenai sturgeon embryo/free-embryo incubation and rearing in Kootenai sturgeon spawning reaches	• Place coarse substrate (X mm) in approximately X miles of the Meander Reaches at the locations of known spawning behavior, general corresponding with pool tailout locations in Meander Reach 1	• Particle size measurements and distribution • Libby Dam BiOp monitoring completed by others
Lack of cover for juvenile fish	Increase instream and bank cover by constructing instream structures and establishing bank vegetation	• Create dense vegetation bank cover for approximately X% of the Braided Reaches, X% of the Straight Reach and X% of the Meander Reaches	• Canopy cover of bank vegetation and density of instream cover

Table 5-1. Limiting factors, strategies, objectives and metrics by four goal categories.			
Limiting Factors/ Constraints	**Restoration Strategy Components**	**Quantifiable Objectives** [1]	**Proposed Metrics**
Lack of pool-riffle complexity	Increase hydraulic habitat complexity by establishing ratios of pool and riffle habitat that are appropriate for the morphological setting	• Establish X% pool/glide habitat and X% riffle/run habitat in all reaches	• Pool and riffle habitat lengths by reach
Simplified food web from lack of nutrients	Increase nutrient availability	• Reference nutrient addition program and reference other goals/objectives aimed at increasing ecosystem productivity	• Combination of metrics and other Kootenai Tribe monitoring and evaluation metrics from Operational Loss Assessment
Insufficient pool frequency	Establish pool frequency that is appropriate for the morphological setting	• Establish pool frequency of one pool per unit length corresponding to 5 to 7 bankfull widths	• Pool spacing
Lack of fish passage into tributaries	Establish fish passage at known barriers on tributaries within the project area	• Remove fish passage barriers on tributaries	• Depth and velocity criteria for target species
Lack of off-channel habitat for rearing	Increase availability of off-channel habitat for native aquatic species	• Create X acres of off-channel habitat that is connected to the mainstem at X cfs. This could be linked to a design table that specifies how habitat should be distributed in terms of wetland systems/classes	• Area of off-channel habitat features • Observations in off-channel areas
Altered water quality	Identify and reduce point source pollutant inputs into Kootenai River and tributaries	• Identify specific opportunities to reduce pollutant inputs	• Turbidity • Chemical analysis
River stewardship			
Dam controlled flow, regime	Develop habitat actions that are compatible with modified regimes and work with Libby Dam managers so operations support habitat restoration efforts	• Verify that coordination is happening	• Documented coordination

Table 5-1. Limiting factors, strategies, objectives and metrics by four goal categories.

Limiting Factors/ Constraints	Restoration Strategy Components	Quantifiable Objectives [1]	Proposed Metrics
Dam controlled sediment regime	Develop habitat actions that are compatible with modified regimes and work with Libby Dam managers so operations support habitat restoration efforts	• Verify that coordination is happening	• Documented coordination
Dam controlled thermal regime	Develop habitat actions that are compatible with modified regimes and work with Libby Dam managers so operations support habitat restoration efforts	• Verify that coordination is happening	• Documented coordination
Dam controlled nutrient regime	Develop habitat actions that are compatible with modified regimes and work with Libby Dam managers so operations support habitat restoration efforts	• Verify that coordination is happening	• Documented coordination
Floodplain land use	Coordinate with landowners and grazing lessees to explore development of grazing management plans that allow floodplain vegetation to develop	• Verify that coordination is happening	• Documented coordination
Bank armoring	Coordinate with appropriate parties to maintain, modify or remove bank armoring to support channel, riparian and floodplain ecological processes according to specific habitat actions	• Verify that coordination is happening	• Documented coordination
Levees and diking districts	Coordinate with diking districts and other affected parties to maintain, modify or remove levees to support channel, riparian and floodplain ecological processes according to specific habitat actions	• Verify that coordination is happening	• Documented coordination

Table 5-1. Limiting factors, strategies, objectives and metrics by four goal categories.			
Limiting Factors/ Constraints	**Restoration Strategy Components**	**Quantifiable Objectives [1]**	**Proposed Metrics**
Transportation Corridors	Develop habitat actions that are compatible with existing infrastructure; and work with owners to mitigate for potential impacts to infrastructure from project actions	• Verify that coordination is happening	• Documented coordination
Backwater influence from Kootenay Lake	Work with B.C. and other entities to explore and identify potential modifications to Kootenay Lake level management and design habitat actions that would complement those potential changes to Lake level management	• Reduce the backwater influence on X miles of river by lowering the backwater elevation by X feet during flows greater than X cfs	• Backwater elevation
Urban development adjacent to river	Design habitat actions that do not place urban infrastructure at risk, and create riparian buffers to separate city from river where possible by working with Bonners Ferry and landowners	• Establish riparian buffers for X feet of river frontage based on results of coordinating with landowners	• Documented coordination • Length of riparian buffer

[1] Where thresholds are not specified, they are indicated with an 'X' and will be developed during later design phases.

Table 5-2. Conceptual success criteria for adaptive management in the context of short-term and long-term time frames.		
Metrics	**Short-term success criteria* (0-15 years)**	**Long-term success criteria* (15+ years)**
Morphology		
Channel width/depth ratio	Channel dimensions are within 20% of design	Channel dimensions are within 20% of design
Hydrologic connectivity	Floodplain is accessed at flows > 30,000 CFS	Floodplain is accessed at flows > 30,000 CFS
Particle size distribution	Substrate meets distribution criteria by reach	Natural processes maintain appropriate particle size for design habitat
Bank erosion rates	Bank erosion <0.5 foot/yr	Bank erosion < 1 foot/yr
Lateral bank movement	Lateral bank movement < 0.5 foot/yr	Lateral bank movement < 1 foot/yr
Bank height ratio	BHR between 1.0 to 1.4	BHR between 1.0 and 1.4
Sediment volume	Floodplain surfaces in the Braided and Straight Reaches store X tons of sediment over X years	Floodplain surfaces in the Braided and Straight Reaches store X tons of sediment over X years
Scour and fill depth	Scour/fill depth is X feet/event by reach	Scour/fill depth is X feet/event by reach
Riparian vegetation		
Proportional abundance of native vegetation types	Floodplain vegetation types > 70% of target distribution	Floodplain vegetation types > 80% of target distribution
Canopy cover	Native species canopy cover > 80% of total	Native species canopy cover > 90% of total
Invasive species canopy	Invasive species < 20%	Invasive species < 10%
Stem counts	X live willows/sq ft by year 3	X live willows/sq ft by year XX
Groundwater depth	X acres of floodplain has sufficient root zone hydrology to support wetlands	X acres of floodplain has sufficient root zone hydrology to support wetlands
Hydrologic connectivity	X% of floodplain is accessed at flows > 30,000CFS	X% of floodplain is accessed at flows > 30,000CFS
Weed mapping	Weed canopy cover < 10% by year 5	Weed canopy cover does not increase above 10%
Point bar footprint	Max of X% change/yr over 3 years	Max of X% change/yr annually
Aquatic habitat		
Mean channel depth/velocity Particle size/distribution	Channel dimensions are within 20 % of design	Healthy channel is maintained by natural processes
Pool/riffle habitat length	Substrate meets distribution criteria by reach	Substrate meets distribution criteria by reach
Species population/ Proportional distribution	Habitat proportions are within 10% of design Increase in species diversity and population	Habitat proportions are within 10% of design Target species populations are healthy and naturally maintaining
Movement/migration	Barriers removed	Tributaries accessed by target species
Bank canopy cover	X% of banks in each reach have dense canopy cover	X% of banks in each reach have dense canopy cover
River stewardship		
Metrics are tied to degree of coordination and outcomes	Success criteria linked to amount and quality of communication with landowners and agencies	Success criteria tied to numbers of cooperative projects initiated

*Success criteria will be refined during subsequent design phases and may include biological components.

The conceptual success criteria described in Table 5-2 are split into short-term and long-term time frames. Short-term success criteria focus on whether specific restoration treatments and actions are responding as expected at the scale of the particular treatment or action. At this scale, thresholds that determine success are linked to quantitative criteria that will be developed during the design process. In some cases, long-term success criteria are similar to short-term success criteria, except different thresholds may be used to define success. For example, when restoring native vegetation to a recently disturbed surface, it is more likely that weeds will colonize that surface. As soils develop and native plants occupy more niches over the long-term, it is reasonable to set a lower threshold for weed cover in terms of how success is defined. In other cases, long-term success criteria may be broader and focus on whether limiting factors are being addressed and whether the ecosystem is responding to changes in habitat conditions caused by the restoration project. In addition to being different for different timeframes, some success criteria must be flexible due to the variable nature of a river and floodplain ecosystem. Because we define restoration as creating conditions that will sustain ecological processes, it is necessary to acknowledge that ecological processes are dynamic and will result in changes, particularly during the first few years after a project is constructed. For example, in the case of a constructed channel, some lateral erosion and deposition is desirable as the channel makes slight adjustments to local hydraulic and sediment-transport conditions. If success criteria for the short-term time frame are expressed as variation around a mean design value, this will allow room for natural adjustments without automatically triggering maintenance actions or unnecessary or inappropriate redesign.

Success criteria values and ranges represent expectations about how the ecosystem will respond to restoration treatments. Exceeding these values and ranges triggers a management response that is described in more detail in Section 5-4. Management responses may include reconsidering success criteria, increasing monitoring intensity, performing a maintenance action, or redesigning some aspect of the project. In practice, monitoring data should be reviewed both in the office and in the field by an adaptive management team consisting of experts and managers who represent the relevant scientific disciplines. Evaluating monitoring data in the context of the ecosystem makes it possible to observe ecological processes that are difficult to capture numerically. This contextual interdisciplinary review is necessary is necessary for the decision-making process described in Section 5-4 to be effective.

In addition to success criteria directed at habitat, additional criteria may be developed for biological populations as part of later design phases. As noted previously, it will be necessary to coordinate with other related restoration efforts like those described in the Draft Kootenai River Adaptive Management Plan (Walters et al. 2005) so appropriate links are made between habitat actions and other management programs aimed at restoring Kootenai sturgeon and other native populations.

5.3 Monitoring Program

This section describes the monitoring framework for the Kootenai River Habitat Restoration Project. The purpose of this section is to describe how monitoring data will be used to evaluate the success of the project and provide information to support the adaptive management decision-making process.

Three types of monitoring are necessary to establish the integrated monitoring program. These include baseline, implementation, and effectiveness monitoring.

- **Baseline** monitoring documents the pre-restoration condition.
- **Implementation monitoring** (also called as-built monitoring) documents the restoration project as completed.
- **Effectiveness monitoring** addresses whether project objectives are being met, determines maintenance needs, and provides inputs into decision pathways.

5.3.1 Baseline Monitoring

Baseline monitoring data include data collected to support development of this Master Plan, data that will be collected in the future to support subsequent design work, and other data collected as part of related projects. These data reflect the pre-restoration condition of habitat in the Kootenai River project area, and provide a basis for documenting changes that result from implementing restoration actions. Monitoring and adaptive management plans for specific projects will include a comprehensive list of data sets that apply to each project.

5.3.2 Implementation or As-built Monitoring

Once a project phase has been constructed, a detailed as-built survey will be conducted to document the completed restoration project. During the as-built survey, permanent monitoring stations will be established for the purpose of conducting effectiveness monitoring. The exact location of permanent monitoring stations will be determined as construction proceeds. Similar to construction, as-built documentation will occur in phases following completion of each project reach or phase.

The following information and data may be collected as part of the as-built documentation:

- Detailed aerial (LiDAR), ground, and bathymetric topographic surveys of the channel and floodplain for use as base maps for project monitoring.
- Aerial photographs of the project reach.
- Ground photographs of the project reach.
- Longitudinal profile and channel cross-sections with as-built stationing.
- Channel substrate composition
- Resource-grade GPS surveys to create maps documenting revegetation treatment areas and vegetation cover type extents.
- Resource-grade GPS survey to create maps to document structure locations
- Resource-grade GPS surveys to create as-built wetland maps

5.3.3 Effectiveness Monitoring

Effectiveness monitoring is designed to measure progress toward achieving project goals and objectives in terms of success criteria, determine maintenance needs and provide input into determining whether the site exhibits a trajectory towards or away from achieving project goals and objectives. This monitoring effort will focus on collecting data necessary to calculate the monitoring metrics established to quantify success criteria for the project. The following sections describe how the effectiveness monitoring plan will be developed and implemented including: monitoring methods, monitoring locations, level of effort, and monitoring schedule and frequency. More detailed adaptive management and monitoring plans will be developed during the preliminary and final design phases. How the data are collected for effectiveness monitoring, and how those data will be used to make decisions regarding project success, and determine corrective actions and maintenance needs is described in Section 5-4.

5.3.3.1 Monitoring Methods

Subsequent design phases will include specific monitoring methods that explain how each metric will be evaluated, and as noted above, additional metrics may be added. Methods may be included as an appendix that can be easily separated from the plan and used as a field reference. Specific monitoring methods will be determined for each phase of restoration depending on the specific restoration treatments that are implemented.

5.3.3.2 Monitoring Locations, Level of Effort, Timing and Frequency

Monitoring locations will be identified during the design phase and as the as-built survey is completed. The sampling intensity (level of effort) will be determined according to the parameter that is being measured and will vary depending on the particular monitoring method. Table 5-3 provides an example of the number of sampling sites, anticipated sampling locations, timing and sampling frequency for each monitoring metric.

Table 5-3. Example of potential monitoring sampling locations, effort, timing and frequency.

Example Metrics	Sampling Locations	Total Samples / Sampling Event	Timing	Scheduled Frequency*
Morphology				
Channel width/depth ratio	At cross-sections	Depends on Reach Length	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Hydrologic connectivity	Entire restoration area	One	During peak flow	Years 1, 2, 3, 5, 10, 15, etc.
Particle size distribution	All riffles and point bars and according to existing monitoring and evaluation efforts	Up to 5 per reach and per existing monitoring and evaluation efforts	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Bank erosion rates	Outer bends where bank stabilization structures are installed and at all channel cross-sections	Depends on Reach Length	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Lateral bank movement	Outer bends where bank stabilization structures are installed and at all channel cross-sections	Depends on Reach Length	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Bank height ratio	Points along longitudinal profile	Depends on Reach Length		Years 1, 2, 3, 5, 10, 15, etc.

Table 5-3. Example of potential monitoring sampling locations, effort, timing and frequency.				
Example Metrics	**Sampling Locations**	**Total Samples / Sampling Event**	**Timing**	**Scheduled Frequency***
Sediment volume	Entire floodplain surface	One	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Scour and fill depth	Point bars	3 to 5 per bar	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Riparian Vegetation				
Proportional abundance of native vegetation types	Entire project area	One	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Canopy cover	Sampling plots	Per monitoring plan	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Invasive species canopy	Sampling plots	Per monitoring plan	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Stem counts	All bioengineering structures	Per monitoring plan	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Groundwater depth	Within wetlands	Paired wells/wetland	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Hydrologic connectivity	Entire restoration area	One/Peak Flow Event	During peak flow	Years 1, 2, 3, 5, 10, 15, etc.
Weed mapping	Sampling plots	Per monitoring plan	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Point bar footprint	All point bars	One/Peak Flow Event	After Peak Flow	Years 1, 2, 3, 5, 10, 15, etc.
Aquatic Habitat				
Mean channel depth/velocity	At cross-sections	Depends on Reach Length		Years 1, 2, 3, 5, 10, 15, etc.
Particle size/distribution	At cross-sections	Depends on Reach Length		Years 1, 2, 3, 5, 10, 15, etc.
Pool/riffle habitat length	Entire length of longitudinal profile	Depends on Reach Length	After peak runoff	Years 1, 2, 3, 5, 10, 15, etc.
Species population/ Proportional distribution	Entire restoration area	Per related monitoring and evaluation efforts	Per existing protocols	Years 1, 2, 3, 5, 10, 15, etc.
Movement/migration	Tributaries TBD and in Kootenai River Mainstem	Per related monitoring and evaluation efforts	Per existing protocols	Years 1, 2, 3, 5, 10, 15, etc.
Bank canopy cover	At cross-sections	Depends on Reach Length	Growing season	Years 1, 2, 3, 5, 10, 15, etc.
Turbidity	Above and below project extents	Per related monitoring and evaluation efforts and specific	Peak runoff, release flows, construction protocol	Years 1, 2, 3, 5, 10, 15, etc.

Table 5-3. Example of potential monitoring sampling locations, effort, timing and frequency.				
Example Metrics	**Sampling Locations**	**Total Samples / Sampling Event**	**Timing**	**Scheduled Frequency***
		restoration plan		

* Significant floods and other disturbances may trigger additional monitoring events (e.g., drought, ice jams, and unseasonal flow events exceeding bankfull). Related monitoring and evaluation programs will be referenced as part of project-specific monitoring plans.

5.4 Framework for Making Adaptive Management Decisions Based on Monitoring Data

Implementing large-scale ecosystem restoration requires building in mechanisms to address the uncertainty that is inherent within natural systems. To address this uncertainty, the Adaptive Management and Monitoring program includes a decision-making framework for interpretation of effectiveness monitoring data and other information that becomes available. To support this, the Kootenai Tribe will initiate efforts to identify and convene an interdisciplinary adaptive management and monitoring team for the Kootenai River Habitat Restoration Project prior to initiation of the preliminary design phase. This team will include representatives from key management agencies (co-managers), a range of necessary disciplines (e.g., fish and plant biologists, hydrologists, etc.) and other experts in the field of restoration. This team will coordinate to critically review monitoring data and other project-related information (in the office and in the field) so team members can interpret monitoring results in the context of developing ecosystem functions and processes. Through this framework, it will be possible to determine whether the implemented restoration actions(s) are meeting project objectives based on success criteria, which corrective measures may be necessary, whether maintenance is necessary, and whether monitoring methods and/or success criteria should be modified.

5.4.1 Interpreting Monitoring Results for Decision-Making

At a coarse scale, data generated during monitoring will point toward one of three conclusions related to whether project objectives are being met: 1) restoration project is meeting objectives, 2) restoration project is trending toward meeting objectives, or 3) restoration project is either not meeting objectives or trending toward not meeting objectives. The third conclusion may be reached for several reasons:

- Incorrect implementation of restoration action(s) or incorrect underlying restoration assumptions.
- Site conditions (e.g., anticipated hydrology not occurring, substrate does not support desired plant community).
- Non-project related factors (e.g., prolonged drought, other climatic variability, floods, invasive species and land use impacts).

- Insufficient time has elapsed since implementation (e.g., channel bed may not have become fully armored, flows have not been sufficient to move or deposit sediment, or hard-coated seeds may not have germinated).
- Ineffective monitoring program (e.g., inappropriate data collection methods, sampling regime, sampling locations not capturing variability, or data analysis).

The interdisciplinary adaptive management and monitoring team will interpret monitoring data, and conclusions about the success of restoration projects will be made using professional judgment in the context of this framework. Once a conclusion has been reached, the team will evaluate causes and uncertainties related to data interpretation, including ensuring that the monitoring data are appropriate and support conclusions, and that the correct conclusion has been reached. The adaptive management team will then identify the appropriate action related to that conclusion. Table 5-4 describes three types of monitoring data interpretations and related decisions and actions. Figure 5-2 outlines the decision-making framework that leads to one of the three data interpretations.

Table 5-4. Adaptive Management Decision-making Framework.

Interpretations of Monitoring Data	Decisions and Actions
Restoration project is meeting objectives based on values of success criteria	▪ Evaluate monitoring program (continue, reduce, eliminate some metrics, verify that metrics are appropriate)
Restoration project has not yet met objectives, but data appears to show trend toward meeting objectives	▪ Evaluate monitoring program (continue, reduce, modify, eliminate some metrics) ▪ Evaluate whether rates of progress toward objectives are appropriate ▪ Develop plan to address rate of progress if necessary ▪ Implement plan as new habitat action and evaluate within this framework
Restoration project appears that it will not meet objectives	▪ Evaluate causes ▪ Assess monitoring program to determine if appropriate data are being collected to determine and evaluate causes and effectiveness of restoration project or treatment ▪ Evaluate whether success criteria are appropriate ▪ Develop plan to address problems ▪ Implement plan and monitor results

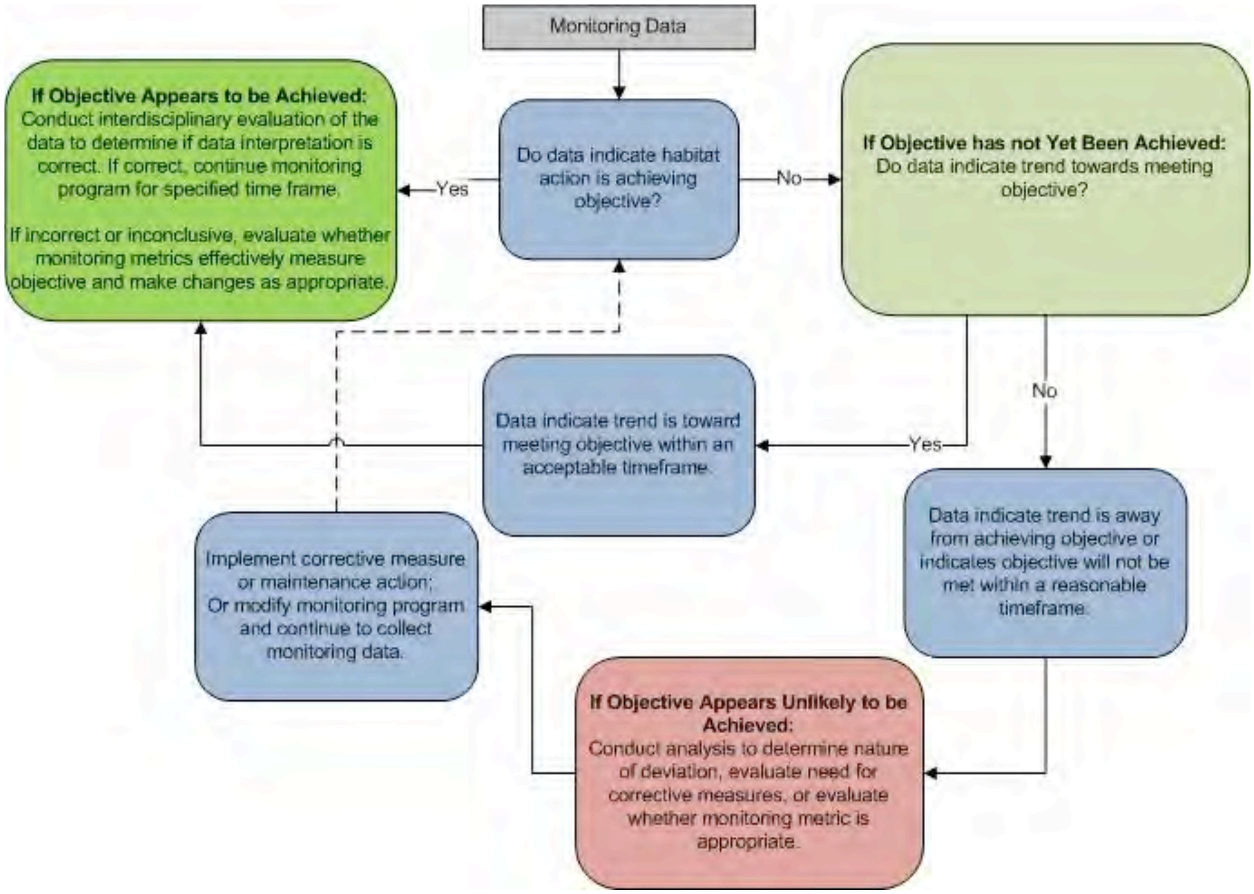

Figure 5-2. Adaptive management decision pathway

5.4.2 Interpreting Monitoring Results to Modify Future Restoration Designs

While effectiveness monitoring data will be used to evaluate and potentially modify restoration projects that have been designed and implemented, these data will also be used to guide restoration designs for subsequent project phases. One use of monitoring data may be to modify existing restoration treatments. For example, if a material used in a restoration treatment fails to withstand a high flow event that is within the design criteria for that treatment, a stronger or different material might be used in the design for later project phases. Alternatively, if a restoration treatment or combination of treatments does not appear to be addressing a limiting factor, future designs may adaptively replace that treatment with an entirely different treatment.

5.4.3 Interpreting Monitoring Results for Routine Maintenance Needs

In addition to monitoring project effectiveness, monitoring will be used to determine maintenance needs for the project, in addition to any unforeseen negative impacts on infrastructure. Some maintenance needs will occur annually regardless of monitoring results, such as watering planted material and controlling weeds; others will occur as a direct result of interpreting monitoring data or observations made during monitoring, such as repairing a damaged structure. The decision framework shown in Figure 5-2 will be used to evaluate monitoring induced project maintenance needs.

5.4.4 Detecting Data Trends

Interpreting data and determining trends will be an important component of the Monitoring and Adaptive Management Plan due to the inherent variability and various timeframes associated with restoring altered ecological systems. Trend analysis requires evaluating data collected at specified intervals over a specified period in order to determine the magnitude and direction of change. The amount of data needed to conduct a trend analysis will depend on various factors, such as the type of data being collected or the expected response time. For some metrics, such as those that address plant community structure, a minimum of several years of data are typically needed to detect and characterize trends.

5.5 Links to Other Restoration and Monitoring Programs

While the Kootenai River Habitat Restoration Project will have its own monitoring program aimed at evaluating effectiveness of restoration actions in terms of objectives and time frames described in this document, several other monitoring and restoration programs have already been established through existing, related projects that make it possible to track biological and habitat components that may vary over longer time frames and larger geographic scales. As described above, the Adaptive Management and Monitoring Program associated with this Master Plan focuses on metrics that are sensitive to changes in habitat that result from restoration treatments. While that information will be most appropriate for evaluating how effective particular combinations of restoration treatments are at overcoming limiting factors, it will be necessary to link to information from other monitoring and evaluation programs to understand the effects of the Kootenai River Habitat Restoration Project on aquatic focal species populations and other ecological components of the ecosystem.

Monitoring will be closely linked to the Tribe's proposed conservation aquaculture program that will spawn, rear and release Kootenai River white sturgeon and burbot to the reaches of river targeted for habitat restoration. Habitat and population monitoring will be critical to guide the scale of aquaculture production at both the Kootenai River Hatchery and at the new Twin Rivers Hatchery. While the hatcheries may be successful at reintroducing fish to the river, a self-sustaining population is unlikely to be restored unless habitat is suitable to support all life stages.

Table 5-5 provides a summary of existing monitoring programs and associated data that are being collected, and that would be incorporated into the adaptive management decision-making process related to the Kootenai River Habitat Restoration Project. Much of the information contained within this table is drawn from more detailed descriptions of monitoring activities in both the Libby Dam BiOp (USFWS 2006), as clarified, and the *Kootenai River White Sturgeon Recovery Implementation Plan and Schedule* (Kootenai Tribe of Idaho 2005). A summary of these monitoring approaches and associated metrics is given below.

Biological Monitoring

Several agencies monitor Kootenai River White Sturgeon. Within Idaho, the Kootenai Tribe and Idaho Fish and Game (IDFG) track and measure population dynamics, movement patterns, spawning habits, and genetic variability. The British Columbia Ministry of Environment (BCMoE) is collecting analogous data in Kootenay Lake.

Population health and distribution are also being monitored for other focal fish species, including burbot, redband trout, bull trout, and westslope cutthroat trout. Monitoring of all focal fish species relies on combinations of gillnetting, seining, electrofishing, and snorkeling to generate population estimates. Movement and migration tracking is monitored through sonic/radio telemetry tagging.

Avian and mammal populations are also monitored throughout the Kootenai subbasin by a number of agencies. The Kootenai Tribe samples both terrestrial and aquatic invertebrates to record species composition, abundance, and richness as part of its Operational Loss Assessment project.

Integration of these biological data for Kootenai sturgeon and other fish, avian, mammalian and invertebrate species will provide community-based ecological baseline conditions against which to measure biological and ecological response to the habitat restoration project actions.

Hydrology monitoring

Channel depth, current velocity, and bank height have been measured by the U.S. Geological Survey (USGS) in order to understand the effects of managing flow from Libby Dam. Montana Fish Wildlife and Parks and the U.S. Army Corps of Engineers (USACE) monitor total dissolved gas (TDG) events associated with flow management at Libby Dam.

The Kootenai Tribe performs monthly water quality monitoring during the summer and water temperature data are collected by the USACE and USGS.

Off-channel/vegetation monitoring

Kootenai Tribe has recently established a 5-year interval bioassessment and survey of vegetation, canopy cover, and bank stability for riparian areas within the floodplain. These data are being used to develop food web and habitat suitability models. The Tribe is also performing tributary biological productivity evaluations and experimental nutrient additions in conjunction with IDFG and other collaborators in order to assess overall ecosystem health.

This combination of biological, hydrologic and vegetation monitoring will complement targeted effectiveness monitoring described in this chapter. An important preliminary task of the interdisciplinary adaptive management and monitoring team will be to better define how information from related monitoring and evaluation programs will be integrated into the Kootenai River Habitat Restoration Project.

Table 5-5. Related Monitoring and Evaluation Programs.

Ecosystem and Population Components	Monitoring Description/Methods	Monitoring Metrics [1]	Monitoring Location(s)	Lead Entity
White Sturgeon				
Population health	Gillnetting, beach seining, and snorkeling employed to generate population	Growth, survival, length, weight, condition factor, age class structure	Mainstem index sites	IDFG

Table 5-5. Related Monitoring and Evaluation Programs.				
Ecosystem and Population Components	**Monitoring Description/Methods**	**Monitoring Metrics [1]**	**Monitoring Location(s)**	**Lead Entity**
	estimates, locations, growth and mortality rates, age-class distribution			
	Gillnetting, setlining, angling to determine size and structure of population	Catch rate information	River and Lake	IDFG, BCMoE
Genetic variability	Mitochondrial DNA, nuclear, and DNA marker analysis	Variability, diversity, and genetic distance measures	System-wide	Kootenai Tribe
Migration/ Movement	Radio/Sonic telemetry of movement and timing. Emphasis on monitoring response to experimental flow increases	Locations, movement measures	Mainstem ID, MT, B.C.	IDFG
Spawning/Early life stages	Sample juveniles in order to monitor viability of released sturgeon. Sonic tracking to determine movement throughout system	Location, CPUE,	River and Lake	IDFG, Kootenai Tribe, MFWP, BCMoE
	Installation of artificial substrate mats. Monitor spawning conditions and response to flow alterations	Location, CPUE, flow, temperature, embryo stage	River, ID, MT	IDFG
Other Species				
Trout	Radio telemetry, drift nets, screw caps, snorkeling to monitor movement, tributary sources, habitat preferences	Locations, movement measures of habitat, depth, substrate, flow, temperature	River	IDFG
	Electrofishing, hoop netting population estimates, response to normative flow efforts, gamefish monitoring	Species abundance	MT below of Libby Dam, Koocanusa Reservoir; Westside tributaries in ID	IDFG, Kootenai Tribe, MFWP
Burbot	Generate population estimates, monitor movement, and perform chemical blood tests	Population abundance, PSD, recruitment magnitude and frequency	Kootenai and Goat rivers, B.C. Kootenai River, ID, Boundary and Deep creeks, ID	IDFG
	Monitor spawning and rearing of fluvial burbot	CPUE, with 1/2m net tows and light traps	River and tributaries, downstream from Libby Dam	IDFG, MFWP
Aquatic Invertebrates	Macroinvertebrate sampling and taxonomy, algal community composition	Standard macroinvertebrate sampling metrics	Libby, MT – Porthill, ID; Westside tributaries in ID	Kootenai Tribe
Mammals	Mammal population assessments are performed by state agencies throughout the Kootenai basin			MFWP, IDFG, Kootenai Tribe
Terrestrial Invertebrates	Terrestrial invertebrates sampled at ~60 sites from Libby Dam Tailrace to Porthill	Standard invertebrate metrics	500-year Kootenai River floodplain, MT & ID	Kootenai Tribe

Table 5-5. Related Monitoring and Evaluation Programs.				
Ecosystem and Population Components	**Monitoring Description/Methods**	**Monitoring Metrics** [1]	**Monitoring Location(s)**	**Lead Entity**
			Subset of 60 of the 160 bird sites (below); BPA mitigation sites	
Avian community	Avian data collected from Libby Dam Tailrace downstream to Porthill	Standard avian metrics	500-year Kootenai River floodplain, MT & ID; 160 sites	Kootenai Tribe
Vegetation community	Field surveys and aerial imagery assessments	Standard vegetation metrics	160 field sites and aerial imagery entire 500 year floodplain from Libby dam to ID/B.C. border 500-year floodplain; BPA mitigation sites	Kootenai Tribe
Vegetation community	Field surveys and aerial imagery assessments	Standard vegetation metrics	160 field sites and aerial imagery entire 500 year floodplain from Libby dam to ID/B.C. border 500-year floodplain; BPA mitigation sites	Kootenai Tribe
Hydrology				
Flow/Channel dynamics	Monitor and evaluate sturgeon larval abundance in response to flow change		Downstream from Libby Dam	IDFG
	Determine minimum flow for sturgeon spawning and rearing		Downstream from Libby Dam	IDFG
	Monitor permanent stream form and maintain sediment monitoring stations		Monitoring stations at Wigwam River, Grave Creek	MFWP
	Measure depth, velocity, bank elevation for use in development of Increased flow model. Substrate sampling		Downstream from Libby Dam	USGS/USACE
Water quality	Chemical analysis samples, staff gage, thermographs		Mainstem ID, MT,B.C.	
	TDG monitoring in response to increased flow events		Three areas in proximity to Libby Dam	MFWP/USACE
	Temperature monitoring		Mainstem, tributaries	USGS/USACE
	Water quality monitoring of nutrient levels, metal and chemical levels	NH_3, NO_2, SRP, TP, SRP, TN, NO_3+NO_4	Mainstem, tributaries	Kootenai Tribe
Off-Channel				
Tributary	Evaluate tributary biological productivity (algae, flora, fauna) to assess ecosystem	Chlorophyll biomass and accrual rates, algae, periphyton, phytoplankton,	Westside Kootenai River tributaries in ID	Kootenai Tribe

Table 5-5. Related Monitoring and Evaluation Programs.				
Ecosystem and Population Components	**Monitoring Description/Methods**	**Monitoring Metrics [1]**	**Monitoring Location(s)**	**Lead Entity**
Habitat	Evaluate biological conditions using HEP, HSE, IEI ranking	HEP, IBI, IEI	Kootenai and Columbia basins; BPA mitigation sites	Kootenai Tribe
	Monitor and evaluate integration of riparian/riverine floodplain food web models via RDRT/AEA	HEP, IBI, IEI	System-wide	Kootenai Tribe
	Map stream contours, assess bank stability, vegetation survey, canopy cover, bioassessments, staff-gage recalibration	HEP, Habitat (type, quality, relative abundance, value), stream morphology, migration rate, sediment-transport, morphology, sediment characterization	System-wide	Kootenai Tribe
Connectivity	Use biological productivity data to determine areas of necessary or potential floodplain connectivity	Trophic structure in floodplain and tributaries compared w/mainstem	Westside floodplain tributaries, BPA mitigation sites; system-wide	Kootenai Tribe

[1] Where metrics are not specified, they will be developed during later design phases.

To best utilize and share data among these related efforts, standard and accessible data storage and sharing tools are needed. The next section describes a data storage system that will be used to support the Adaptive Management and Monitoring program.

5.6 Data Storage

Monitoring data will be stored with the Kootenai Tribe or other designated entities in standard database(s). Data tables will be structured to avoid redundant data and to ensure consistent data formats among sampling events. Prior to the first sampling event, the interdisciplinary adaptive management and monitoring team will work together to develop consistent data naming conventions, table structures, and other coordination items that will facilitate data collection, transmission, sharing, and analysis.

Existing data management system

The Kootenai Tribe of Idaho Fish and Wildlife Monitoring Database was established in 2000 as a means of managing monitoring data collected through the 1994 Ecosystem Restoration Project, which covers approximately the same geographic area as the KRHRP. This online relational database may provide a template for the construction of a data management system capable of storing and synthesizing the volume of data that will need to be collected to support the Adaptive Management and Monitoring program.

The Tribe's database currently houses information pertaining to water quality and discharge levels, macroinvertebrate and algae, and the status of several fish species. A list of the data currently housed within this database is given in Table 5-6.

Table 5-6. Kootenai Tribe's Fish and Wildlife Database data and metrics.

Category	Monitored metrics
Water	▪ Discharge ▪ Temperature ▪ Metals content ▪ Chemical content
Fish species	▪ Weight ▪ Length ▪ Effort ▪ (Rep, K)
Macroinvertebrate, algae species	▪ Taxonomic richness and abundance ▪ Community composition % ▪ Functional groups
Avian	▪ Species ▪ Common name ▪ Abundance ▪ Distance ▪ Direction ▪ Time ▪ Wind ▪ Sky ▪ Temperature
Invertebrates	▪ Abundance ▪ Class ▪ Order ▪ Family ▪ Common name ▪ Foraging guild ▪ Diet ▪ Foraging habitat ▪ Reproductive structure ▪ Trophic level

Monitoring data in the Tribe's database is searchable by several attributes including monitoring site, collection date, species, and monitoring metrics. Data can be listed, sorted, searched, censored, viewed and exported on a case-by-case basis for individual queries, or summarized in tabular or graphical form for a designated time frame.

In order to support the Kootenai River Habitat Restoration Project, the existing database will need to be modified or expanded so it can support the KRHRP. Specifically, the database and associated interface will need to accommodate data that evaluates channel morphology, riparian vegetation, aquatic habitat and potentially stewardship related actions.

If the design team determines that the existing database does not have an adequate structure to encompass and disseminate the body of information that will be collected through the KRHRP adaptive management and monitoring program, it will be necessary to construct a new data management system. For the system to be a useful tool for adaptive management, it will need to be easy to enter or import new data into the system quickly in formats that are compatible and comparable with existing data. Ideal characteristics of the adaptive management data system include:

- Standard templates for data collection and data entry or import into the system;
- Automated integration of new data sets, including error checking and data validation rules;
- Integration of a spatial data component so effectiveness monitoring data can be readily displayed on maps and put into the context of restoration projects and associated as-built documentation;
- Built-in analysis functions to allow calculation of metrics based on raw data;
- Flexible query tools so the data management system can be used as a decision support tool;
- Database to store lessons learned from previous restoration projects that can be applied to future restoration design phases; and
- Managed levels of access so different functions are available to design team members, managers, interdisciplinary adaptive management and monitoring team members, other co-managers and potentially members of the public.

The data management system will be designed and built during the preliminary and final design phases so it is functional before the first restoration project begins.

5.7 Summary

The Adaptive Management and Monitoring Program outlined in this Master Plan is intended to be a starting point for developing more refined and targeted adaptive management and monitoring components during subsequent design phases.

Prior to preliminary design, an interdisciplinary adaptive management and monitoring team will be convened by Kootenai Tribe to further develop this program. Once specific restoration treatments and implementation scenarios are designed within the different project reaches as part of restoration project sequencing, effectiveness monitoring will be tailored to those treatments and scenarios.

Information from related monitoring and evaluation programs will be included as part of evaluating Kootenai River Habitat Restoration Project progress over time, and a data management system will be developed to store information so it is accessible and can be easily integrated.

In addition to supporting decisions about specific restoration treatments and implementation scenarios, data collected as part of the adaptive management and monitoring program will support reporting requirements related to environmental compliance, which includes permitting. The next chapter describes the environmental compliance and permitting components of the Kootenai River Habitat Restoration Project.