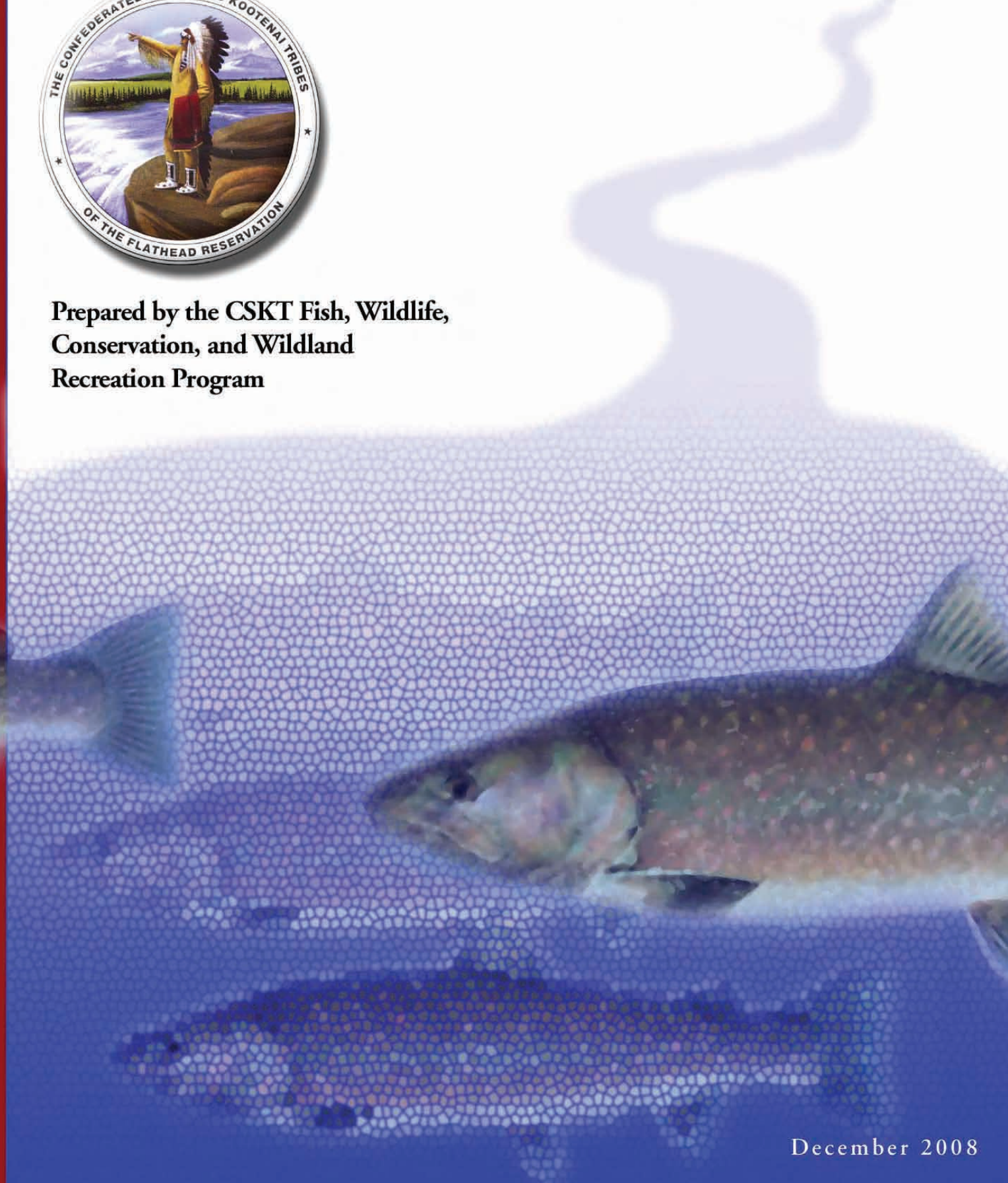
CONFEDERATED SALISH AND KOOTENAI TRIBES

# Jocko River Master Plan: Section 4

**A guide to ecological restoration activities in the lower main stem Jocko River corridor**

**Section 4: Monitoring and Data Needs**

**Prepared by the CSKT Fish, Wildlife, Conservation, and Wildland Recreation Program**



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**Jocko River Master Plan: A Guide to Ecological Restoration Activities in the Lower Mainstem Jocko River Corridor: Section 4**



**Contributors:**

**Confederated Salish and Kootenai Tribes**
Les A. Evarts
Craig A. Barfoot
Steven K. Klotezel
Seth V. Makepeace
Russel S. Sydnor

**Geum Environmental Consulting, Inc**
Sarah E. Flynn
Thomas G. Parker
Amy M. Sacry

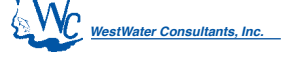
**River Design Group, Inc.**
Andrew T. Belski
Troy M. Brandt
Mathew S. Daniels
John M. Muhlfeld

**WestWater Consultants, Inc.**
Garret T. Decker

**Document Preparation:**

**CW Consulting**
David Rockwell



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# 4.0 Monitoring and Data Needs

Monitoring information is critical to the overall Jocko restoration effort because it can identify restoration implementation procedures that do not achieve restoration objectives, determine specific environmental responses to restoration activities, and reveal if restoration efforts are achieving broad goals. In this section we outline our approach to monitoring. We describe how we will use monitoring and adaptive management to continually reevaluate restoration strategies and techniques, and we explain how we will choose appropriate monitoring metrics to evaluate project performance and describe specific monitoring techniques.

As a first step, the Tribes' established and funded a multidisciplinary monitoring team to develop site-specific monitoring plans for each project and report the results as part of the annual reporting process. In these plans, the team will succinctly state the questions (all of which should be measurable) to be investigated. The questions will evaluate the physical, chemical, and biological responses of the restoration action at both the project and ecosystem scales to determine if it will meet established goals. Monitoring will be an ongoing activity, the results of which will be used to adaptively manage or guide out-year work to achieve the highest probability of success of future restoration projects.

*Monitoring will be an ongoing activity, the results of which will be used to adaptively manage or guide out-year work to achieve the highest probability of success of future restoration projects.*

## 4.1 Introduction

Adaptive management is an approach to managing restoration projects that allows for new information to be integrated into the restoration planning process to support changes in how projects are implemented. Restoration projects are implemented within natural systems, and natural systems are not completely predictable. Because of this inherent uncertainty, the interdisciplinary team must have the ability to adapt how they approach later project phases based on information learned during early phases. One of the most important benefits of adaptive management when conducting long-term projects is that it allows planners to experiment with more than one approach in order to determine the techniques that will best achieve project goals.

Adaptive management relies on monitoring programs to provide the data necessary to evaluate the existing condition of an ecosystem and compare it to the trajectory resulting from management or restoration efforts (Busch and Trexler 2003). Therefore, a monitoring program that can support adaptive management requires three types of monitoring:

- **Baseline monitoring** documents pre-project conditions and feeds into the restoration planning process. Baseline monitoring is also called ambient monitoring.

- Upon completion of restoration work, **implementation monitoring** documents work that was completed, serving as an as-built description of a project site.

- **Effectiveness monitoring** data is collected to determine how the site is responding to the restoration effort and if project goals and objectives are being met.

When combined, data from these three types of monitoring support adaptive decision-making. Subsection 4.1 describes the three types of monitoring in more detail.

The success of the monitoring program will depend on the development of clear project goals and objectives and easily measured, relevant metrics to evaluate if these have been met. Project goals, objectives and monitoring metrics should be clearly defined prior to implementation of a restoration project. Project **goals** reflect a clear consensus among the interdisciplinary team about which natural processes need to be restored at a particular site to reach the desired future condition (Section 3). **Objectives** indicate the progress of the system towards meeting project goals. They specify the expected structure, function, and appearance of the system within a certain timeframe after restoration has been completed. **Monitoring metrics** are the aspects of the system's structure and function that can be measured. Table 4.1-1 shows examples of the relationship among possible project goals, objectives, and metrics.

**Table 4.1-1.**
*Examples of the relationship among goals, objectives and monitoring metrics.*

| Goal | Objective(s) | Metric(s) |
|---|---|---|
| Restore connection between channel and floodplain | Raise bed and bankfull elevations by three feet | Channel cross-sections<br>Channel longitudinal profile |
| | Raise floodplain water table by one foot | Ground water monitoring wells |
| Convert disturbed grassland and wetland to native riparian shrubland | Establish 30 percent canopy cover of native shrubs within 5 years | Species survival<br>Experimental weed plot monitoring<br>Plant community transition matrix |
| Restore channel dimensions to reference conditions | Construct channel to design dimensions of 50 ft bankfull width and 3 ft depth at riffles with pool spacing of 200 feet | Channel cross-sections<br>Longitudinal profile |

A monitoring program that is well integrated with project objectives provides empirical data spatially and temporally relevant and useful across multiple disciplines. It provides repeatable data in a cost-effective manner and frequently updated results from experimental projects, allowing future projects to benefit from ongoing experimentation.

# 4.2 Types of Monitoring

## 4.2.1 Baseline Monitoring

Baseline or ambient monitoring assesses the existing condition prior to the implementation of restoration activities and serves as a benchmark against which to measure success. Baseline monitoring assesses long-term trends in watershed response that may be evident only after an extended period of time; ecological effects of a sequence of hydrologic events; or cumulative ecosystem response to a restoration activity. Examples of baseline monitoring include long-term instream temperature monitoring, geomorphic monitoring at established control and response reaches, or invertebrate or vertebrate biological community conditions. This type of baseline monitoring should be done at the watershed scale.

Baseline monitoring can also be completed for individual restoration projects. At this scale, baseline monitoring focuses on documenting the existing conditions at a site before restoration activities occur so that progress towards objectives can be measured.

## 4.2.2 Implementation Monitoring

Implementation monitoring is conducted to determine if the restoration program was completed as designed and to establish "as-built" project conditions. Implementation monitoring consists of documenting the completed restoration treatments and determining whether the implementation of the design was performed correctly. As-built data may be compared to the project design plans and the baseline condition. Additionally, implementation monitoring data form the foundation for future, post-project data comparisons.

## 4.2.3 Effectiveness Monitoring

Effectiveness monitoring is used to evaluate whether an implemented restoration project has achieved the desired goals established for the project. Project goals are related to and partially quantified using objectives defined prior to project implementation. Project objectives are written to be measurable and may include threshold values for ecological elements to determine achievement of the desired future condition (project goal). They may also include regulatory requirements set out in legal agreements (e.g., the ARCO settlement) and permit conditions. Objectives may be progressive, linking to measurements made during the establishment of the project to ensure that it will proceed to the desired future condition. For example, stability of bank treatments and the survival of planted materials can be examined periodically to determine if these features are trending to the desired condition.

Effectiveness monitoring is more time consuming than implementation monitoring, and so is more costly. To save time and money, monitoring may be completed on a portion of the project and extrapolated to the rest of the project.

If effectiveness monitoring determines that objectives are not being met, then an adaptive approach may be necessary to improve implementation efforts. A restoration initiative that fails to achieve intended results could be the result of improper assumptions relative to ecological conditions or the selection of invalid monitoring metrics. Good effectiveness monitoring forms the basis for adaptive management by helping to ensure that future projects avoid ineffective or problematic techniques.

# 4.3 Monitoring Techniques and Metrics

Choosing metrics that will effectively evaluate project goals and objectives is key to determining project success and gaining knowledge for future restoration projects. To ensure that appropriate metrics are selected, they must be directly linked to the goals and objectives of the project. Table 4.1-1 shows an example of linking objectives to project goals and monitoring metrics to objectives.

*Choosing metrics that will effectively evaluate project goals and objectives is key to determining project success and gaining knowledge for future restoration projects.*

Monitoring techniques and metrics should be scientifically based, relatively easily measured, sensitive enough to detect change, regionally adapted when necessary, have statistical validity, and provide direct feedback on performance of a system toward meeting the goals. Specifying bounds or limiting values for project objectives can aid in their selection.

Numerous protocols and methods are available to collect monitoring data. Specific projects and applications may require unique monitoring programs or the adaptation of a program to a specific situation. The following subsections include techniques and standard metrics for evaluating ecosystem responses to restoration activities. All are applicable to each of the three types of monitoring. They are described by discipline, although many cross multiple disciplines. The list serves as a summary of what might be used. The actual techniques and metrics will depend on specific project goals and objectives.

## 4.3.1 Geomorphic Monitoring Techniques and Metrics

Geomorphic monitoring involves the establishment of measurement reaches where channel geometry, planform, and substrate characteristics are measured on a recurrent basis. The intent is to document channel and floodplain response to restoration implementation and natural geomorphic or hydrologic events such as floods or pulse-sediment-loading events.

There are generally established protocols to complete this type of monitoring, many of which are reported in Harrelson et al. (1994). Table 4.3.1-1 shows examples of techniques and metrics that may be used during baseline, implementation, and effectiveness monitoring.

**Table 4.3.1-1.**
*Types, techniques, and metrics for geomorphic monitoring.*

| Monitoring Type | Monitoring Techniques | Monitoring Metrics |
|---|---|---|
| Baseline Monitoring | Channel cross section surveys<br>Channel longitudinal profile<br>Wolman pebble counts | Cross section dimensions<br>Channel slope<br>Channel substrate size |
| Implementation Monitoring | Channel cross section surveys<br>Channel longitudinal profile<br>Wolman pebble counts | Cross section dimensions<br>Channel slope<br>Channel substrate size |
| Effectiveness Monitoring | Channel cross sections<br>Channel Longitudinal Profile<br>Wolman pebble counts | Cross section dimensions<br>Channel slope<br>Channel substrate size |

## 4.3.2 Hydrologic Monitoring Techniques and Metrics

Stream flow measurement gauges are maintained throughout the Jocko Basin to support water management and, indirectly, the lower main-stem restoration effort. Stream flow gauges are maintained following U.S. Geological Survey protocols for gauging as summarized in Rantz et. al (1982). Stream flow measurements provide a daily time series of stream flow, as well as flood magnitudes. The results can be manipulated to provide metrics to address a wide range of questions.

Groundwater monitoring has been a component of the Jocko River Demonstration Project and a baseline groundwater platform is available for the lower maintstem floodplain above Valley Creek. Groundwater monitoring is a very intensive effort, and will only be completed for projects where the level of detail is warranted.

Table 4.3.2-1 documents the basic groundwater monitoring that has been completed for the two identified project areas.

**Table 4.3.2-1.**
*Monitoring types, techniques, and metrics for groundwater.*

| Monitoring Type | Monitoring Techniques | Monitoring Metrics |
|---|---|---|
| Baseline Monitoring | Shallow ground water wells<br>Stream gages<br>Dye tracers<br>Slug tests | Water depth, temperature<br>Direction of flow, synoptic seepage runs |
| Implementation Monitoring | None | |
| Effectiveness Monitoring | Shallow ground water wells<br>Stream gages<br>Dye tracer | |

## 4.3.3 Water Quality Monitoring Techniques and Metrics

Tribal resource management staff maintains two water quality measurement programs. Data from these programs will be incorporated into the decision making process for the Jocko River restoration efforts. Long-term water chemistry monitoring is maintained at the mouth of the Jocko River to document trends in water quality condition over time. Currently, the staff is completing a more focused assessment of water quality throughout the Jocko Drainage to allocate water quality loads to specific sub-watersheds. All water quality work is completed following sampling and analysis plans, quality assurance documentation, and rigorous quality control procedures. This broader effort may not scale down to individual restoration projects, but will document trends at broader spatial scales. Table 4.3.3-1 outlines water quality monitoring by monitoring type, technique, and metric.

**Table 4.3.3-1.**
*Monitoring types, techniques, and metrics for water quality.*

| Monitoring Type | Monitoring Techniques | Monitoring Metrics |
|---|---|---|
| Baseline Monitoring | Grab samples | Temperature<br>Sediment<br>Nutrients |
| Implementation Monitoring | Visual observations during construction | |
| Effectiveness Monitoring | Grab samples | Temperature<br>Sediment<br>Nutrients |

## 4.3.4 Floodplain and Wetland Functional Assessments

HGM Riverine assessments (Hauer et al. 2002) determine the functional status of the entire riparian-floodplain system. They evaluate floodplain functions based on variables measured in the field and determined from preexisting data. They focus on eight floodplain functions based on multiple variables (Section 2.1). Baseline HGM assessments are completed for all properties where restoration activities are proposed. Assessments of the restoration sites within the project area are completed prior to project implementation (baseline monitoring) and at set intervals after implementation to determine project success (effectiveness monitoring). Table 4.3.4-1 outlines the use of HGM monitoring.

**Table 4.3.4-1.**
*HGM monitoring types, techniques, and metrics.*

| Monitoring Type | Monitoring Techniques | Monitoring Metrics |
|---|---|---|
| Baseline Monitoring | HGM Riverine Assessment | 8 functional variables are assessed |
| Implementation Monitoring | None | |
| Effectiveness Monitoring | HGM Riverine Assessment | 8 functional variables are assessed |

HGM trends prior to and after restoration implementation are one of the primary ways of evaluating progress toward ARCO consent decree goals to restore or replace wetlands and riparian areas.

## 4.3.5 Biological Monitoring

Biological monitoring may be completed as part of baseline and effectiveness monitoring. Biological implementation monitoring may also occur if restoration techniques are directly targeted at improving habitat or other biological components of the ecosystem. It can cover a wide range of ecosystem components, including fisheries, macroinvertebrates, and wildlife. Vegetation monitoring may also fall under this broad category.

The goals of biological monitoring include tracking populations over time to determine how they or the communities in which they reside respond to restoration treatments. Results are compared to project goals and performance standards to determine if the project had the desired effects and met project requirements. Completing biological monitoring in restored and control reaches enables the practitioner to identify biological responses to restoration treatments versus area-wide biological fluctuations unrelated to the restoration effort. The following subsections highlight available biological sampling protocols.

### Fisheries

Fisheries monitoring can focus on multiple life stages of target species to determine how fish species are responding to restoration treatments. Redd counts evaluate spawning response. Snorkeling and electrofishing can be used to develop fish population estimates, species diversity, and habitat use. Quantifiable mark recapture or multiple depletion techniques can be used to track population response over time. Completing fisheries monitoring in treated and control reaches can help determine if fisheries responses are related to the restoration treatments or other processes operating at a larger scale. Table 4.3.5-1 outlines fish monitoring techniques.

**Table 4.3.5-1.**
*Monitoring types, techniques, and metrics for fish.*

| Monitoring Type | Monitoring Techniques | Monitoring Metrics |
|---|---|---|
| Baseline Monitoring | Redd counts<br>Electroshocking<br>Snorkeling<br>Kick net | |
| Implementation Monitoring | Documentation of As-built conditions | Metrics specific to project design |
| Effectiveness Monitoring | Redd counts<br>Electroshocking<br>Snorkeling<br>Kick net | |

### Aquatic Macroinvertebrates

Relative to fisheries monitoring, the sampling of aquatic macroinvertebrates is a lower-cost alternative for monitoring an aquatic system. Standard methods (e.g., Montana DEQ protocol) are employed to quantitatively sample aquatic macroinvertebrates. Sampling will focus on representative riffles where the greatest variety of species and number of individuals are typically found. Other habitat units may also be sampled. Establishing baseline aquatic macroinvertebrate communities is useful for comparing how quickly the communities recolonize sites following restoration work. Samples may be processed in-house or outsourced. Various metrics have been developed for relating aquatic macroinvertebrate communities to biological conditions.

### Birds, Wildlife and Amphibians

Other programs within the Confederated Salish and Kootenai Tribes have ongoing monitoring programs that track the status of birds, wildlife, and amphibians throughout the Flathead Reservation. When appropriate, data from these studies will be combined with monitoring data from Jocko River restoration projects as they become available.

## 4.3.6 Vegetation Monitoring

Vegetation monitoring is done to determine the effectiveness of planting, weed control, and site-prep techniques and to detect changes in floodplain communities in response to channel restoration. Valley-wide vegetation surveys can be tied to the channel cross sections established to measure the physical environment of the restored area and adjacent control areas. Permanent vegetation plots may be established throughout the floodplain in restored, enhanced, or preserved areas of the project and in adjacent control areas where no treatment was applied. The HGM assessments assess vegetation within the floodplain in the context of the overall floodplain function, but more detailed vegetation sampling should be completed in areas of seeding or planting to determine establishment and survival of plantings. These same surveys can be used to determine the presence and abundance of non-desired species such as noxious or exotic plant species. Table 4.3.6-1 outlines vegetation monitoring by type, technique, and metric.

**Table 4.3.6-1.**
*Monitoring types, techniques, and metrics for vegetation.*

| Type of Monitoring | Monitoring Technique | Metric |
|---|---|---|
| Baseline | HGM Assessments | 8 functional variables and cover types |
| Implementation | Photo documentation of as-built conditions | Photo points |
| Effectiveness | Survival plots | Survival<br>% cover herbaceous species<br>Recruitment of woody species<br>Weed species presence |
| | Experimental weed treatment plots | Survival<br>Plant volume<br>% cover weeds |
| | Bioengineering monitoring | Stem count<br>% cover stems<br>% biodegraded |

# 4.4 Additional Monitoring Considerations

In previous subsections we describe how the monitoring program should link directly to project goals and objectives, the types of monitoring that should be conducted, and possible monitoring techniques and metrics. Here we describe additional considerations that should be evaluated during the planning phase of a monitoring program. These include:

- a monitoring schedule,
- data storage,
- data review and reporting, and
- program personnel and budget.

Each of these is discussed in more detail below.

## 4.4.1 Monitoring Schedule

A monitoring program is carried out according to a systematic schedule that includes a start date, when each metric is to be measured, the frequency of measurements, and an end date. Timing, frequency, and duration depend on the metrics, performance standards, and uncertainty.

### Timing

A monitoring program is designed prior to implementing each restoration project. The design phase includes determining when monitoring should occur each year for each discipline. The driving consideration is the performance criteria outlined in the project objectives. Timing of sampling for each metric will vary by metric. For example, survival monitoring for vegetation is typically done late in the season. Cross section sampling is done during low flows after channel changes have occurred.

Biological monitoring occurs at the time most conducive to sampling the target species' use of the area.

### Frequency

Frequency of sampling refers to the period of time between samplings and is based on the expected change at the site. In general, "new" systems change rapidly and are monitored more often than older systems. As the system becomes established it is generally less vulnerable to disturbances, and monitoring can be less frequent. For example, annual monitoring during the first 3 years may be appropriate when survival of planted vegetation is the most variable. After that period, monitoring at intervals of 2 or more years may be appropriate. For channel changes, monitoring may be more appropriate at intervals of 2 years or after large flow events.

### Duration

Monitoring programs will last long enough to determine whether the project has met its objectives. A restored system should be reasonably self maintaining after a certain period of time. Fluctuations in some metrics will occur even in the most stable natural systems. It is important for the monitoring to extend to a point somewhere beyond the period of most rapid change and into the period when the system is stable.

## 4.4.2 Data Storage

Field notes are transferred to a computer database to maintain an archive of monitoring data that can be accessed for summarizing data, completing monitoring reports, and making future data comparisons.

## 4.4.3 Data Review and Reporting

Monitoring reports are completed annually or at the culmination of each monitoring period. Critically evaluating monitoring data is essential for gauging the effects of restoration actions. Reviewing and reporting data is key to adaptive management because it documents valuable information for future restoration projects and enables the team to evaluate the progress of a site toward its goals or desired future condition. The team can determine the success of the types of materials, structures, or experimental treatments implemented at a site and make midcourse adjustments if the site is not trending towards the desired future condition, such as planning for additional work and costs or adjusting monitoring techniques or metrics. Subsection 4.6 outlines a monitoring plan and annual report.

## 4.4.4 Personnel and Budget

An appropriate number of personnel and a sufficient budget will be available to implement and execute the monitoring program effectively.

## 4.5 Adaptive Management

Adaptive management is the process of evaluating whether goals and objectives for the project have been met. Adaptive management provides the opportunity for mid-course correction through evaluation and action. If it is determined that a standard has not been met, actions are implemented or changed to bring about the desired restoration goal. Examples of adaptive management techniques include: replacing or augmenting stream-bank treatments that have failed or replanting vegetation in restoration areas where survival has not met objectives as shown through monitoring results. The goal of using an adaptive management approach coupled with a clear monitoring plan is to reduce the number of failed projects by providing cause-and-effect input to the management process (Figure 4.5-1).


**Figure 4.5-1.**
*Adaptive management approach*

# 4.6 Site-Specific Monitoring Plans

Site-specific monitoring plans will be prepared during the restoration planning process (Section 3). This subsection presents an outline for such a plan, while Appendix C includes an example.

## 4.6.1 Site-Specific Monitoring Plan Outline

The following outline will generally be followed to develop a site-specific monitoring plan. Project goals, objectives, and monitoring techniques and metrics will be developed during the restoration planning process.

I. Introduction
   a. Project Description
   b. Project Goals, Objectives and Monitoring Metrics

II. Monitoring Overview – overview of monitoring techniques and metrics related to project objectives

III. Monitoring Schedule – overview of monitoring program schedule
    a. Frequency
    b. Timing
    c. Duration

IV. Methods-description of methods and techniques used
    a. Geomorphic
        i. Site locations
        ii. Schedule
    b. Hydrologic/Groundwater
        i. Site locations
        ii. Schedule
    c. Biological
        i. Site locations
        ii. Schedule
    d. Vegetation
        i. Site Locations
        ii. Schedule

V. Results (to be added to annually)
    a. Geomorphic
        i. Brief description or display of results
        ii. Statistical analysis used
    b. Hydrologic/Groundwater
        i. Brief description or display of results
        ii. Statistical analysis used
    c. Biological
        i. Brief description or display of results
        ii. Statistical analysis used
    d. Vegetation
        i. Brief description or display of results
        ii. Statistical analysis used

VI. Discussion (to be added annually)
    a. Highlight important trends or results
    b. Description of how ecosystem is trending towards or away from goals-desired future condition

VII. Recommendations (to be added annually)
    a. Specify actions that should be taken based on monitoring results
    b. Specify additional data needs or recommended changes in monitoring techniques

# 4.7 Literature Cited

For references to this section, go to the Literature Cited Section.