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James G. Hallett and Margaret A. O’Connell  
Biology Department, Eastern Washington University  
Cheney, WA 99004

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# Abstract

The abstract should consist of one paragraph (up to 500 words) that concisely states why and (generally) how the study was done, as well as what the results were and what they mean. They should also include any lessons learned. The abstract should not simply outline the contents or present the methods in detail. Citations should not be presented in abstracts, and acronyms should be used sparingly. Detailed statistical results should be reserved for the main text. Because abstracts tend to be more widely read than complete papers, authors should make them concise, clear, and applied.

# Introduction

The introduction should provide context for the work being reported. In doing so, it should present a general overview of previous literature and previous work on the subject to guide the reader to the report’s purpose and importance. When applicable, the introduction should include a brief description of the study area to provide geographic and biological context. Relationships between the purpose of the work and strategies for habitat restoration, predation, or hatchery and hydrosystem operations should be described. Do not provide an exhaustive history of the project. *The type of RM&E being conducted must be identified (research, status and trend monitoring, or action effectiveness). For research projects and action effectiveness projects, include hypotheses, related uncertainties, and a timeline for your study including the start and anticipated end date.*

Ecological restoration projects have been initiated world-wide with the goal of recovering damaged or degraded ecological systems, increasing the resilience of biodiversity, and providing ecosystem services ([Wortley et al. 2013](#_ENREF_33)). Assessment of such projects is essential for improving their implementation and justifying their costs, but comprehensive monitoring and evaluation have rarely been incorporated into projects ([Suding 2011](#_ENREF_31)). The need for assessment of restoration activities conducted under the Albeni Falls Plan led to development of a monitoring plan for terrestrial ecosystems (AFIWG 2001). This program was designed to compare managed mitigation lands with a reference ecosystem describing the desired future condition (Aronson et al. 1995, Clewell and Aronson 2007). The reference characterizes the desired physical environment, biological composition and structure, and flows of materials and organisms across the boundaries of the ecosystem to be restored.

Monitoring and evaluation are now recognized as essential components in the conduct of ecological restoration for projects and programs in the Columbia Basin by the ISAB ([2011](#_ENREF_20)). This is an important step forward, but requires that monitoring and evaluation be done appropriately ([Hallett 2013](#_ENREF_13)).

Prior to initiation of a restoration project, its goals and objectives need to be clearly defined. Typically a reference model is created that describes the desired future condition ([Aronson et al. 1995](#_ENREF_2), [Clewell and Aronson 2007](#_ENREF_5)). The reference ecosystem provides a model for planning, implementing, and evaluating a restoration project ([Ruiz-Jaen and Aide 2005](#_ENREF_27)). The reference characterizes the desired physical environment, biological composition and structure, and flows of materials and organisms across the boundaries of the ecosystem to be restored. In addition to representing ecosystem form and function, the reference may also include the anticipated ecosystem services or societal benefits of the restoration. The form that a reference model takes will vary with the context and scope of the project ([Clewell and Aronson 2007](#_ENREF_5)). The steps necessary to begin restoring a project area towards the reference condition comprise the implementation plan. The specific objectives determine the type and scope of monitoring required to assess project outcomes. Because individual projects are developed in response to degradation that has taken place under different conditions and contexts, these objectives may vary. Objectives typically include attainment of one or more ecological attributes ([Society for Ecological Restoration International Science & Policy Working Group 2004](#_ENREF_29)), but also social and cultural needs ([Hallett et al. 2013](#_ENREF_17)). Implementation of ecological restoration is typically subject to a variety of constraints including resource limitations, logistics, jurisdictions, and available expertise. When coupled with the variability typical of ecological systems, the outcomes of ecological restoration may be uneven. Although success in restoration is not guaranteed, monitoring and evaluation during implementation increase the likelihood of success by determining when changes in implementation are required.

In general, this approach has been adopted by the five members of the Upper Columbia United Tribes (UCUT) for ecological restoration on mitigation and tribal lands under their management. In this report, we discuss the development of a regional monitoring and evaluation program to provide assessment of a varied set of projects. Our approach compares the status of mitigation sites undergoing restoration with sets of reference conditions. Because restoration may take many years to achieve a particular target condition, intermediate results can be used to inform managers so that implementation might be altered if necessary. In the following, we review the objectives of ecological restoration and selection of reference model, outline the field and analytical approaches, summarize the sampling to date, consider some preliminary findings, and discuss data dissemination.

# Objectives of ecological restoration

The goals and objectives of ecological restoration should be clearly defined and measurable ([Hobbs and Norton 1996](#_ENREF_18), [Clewell and Aronson 2007](#_ENREF_5)). The nine ecological attributes that underlie the objectives of most projects involve the form, function, and stability of the ecosystem to be restored ([Society for Ecological Restoration International Science & Policy Working Group 2004](#_ENREF_29), [Hallett et al. 2013](#_ENREF_17)). For the projects under this monitoring program, the key attributes are that the restored area (1) has an *assemblage of species characteristic of a reference ecosystem and which provides appropriate community structure*, and (2) *consists of indigenous species to greatest possible extent*. Other attributes, which are not examined explicitly by monitoring at this time, concern the functioning of the restored system and its stability and resilience (i.e., can it maintain itself over time and sustain normal periodic stress events). We do assume that steps are taken to eliminate potential threats to the restored system, which can include, for example, modifying grazing regimes and controlling invasive species. The Tribes also have some overarching cultural values that are reinvigorated by restoration. These include restoration of culturally significant species, enhancement of landscape aesthetics, and increased hunting and fishing opportunities. Attainment of social attributes is also outside of the scope of our monitoring at the present time.

Nonnative plants species are a significant problem in disturbed or degraded habitats. Nonnative species include noxious species as well as nonnative plants that do not act invasively. Invasive or noxious species are organisms that have life-history characteristics that allow them to outcompete native species. This may result in reduced biodiversity and ecosystem services. Degraded ecosystems are highly susceptible to invaders, and management for invasive species are economically costly. Annual costs to control invasive species in the U.S., for example, are approximately $138 billion (Bryson and Carter 2008). Ecological restoration efforts are being implemented regionally to reduce disturbance and restore native flora and fauna.



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As part of this effort, we examined the composition and distribution of grass and forb species in the Inland Northwest using data from a long-term monitoring program. Our objectives were to first characterize the composition of the nonnative flora, and the relative importance of these species to the overall flora. Second, we asked how the composition of areas undergoing ecological restoration (mitigation sites) compares to sites that reflect a desired future condition (reference sites).

Following the Wildlife Category Review process, the ISRP reported that the UCUT Wildlife Monitoring and Evaluation Program (UWMEP) met scientific criteria ([ISRP 2009-17](http://www.nwcouncil.org/fw/reviews/2010/wildlife/isrp2009-17/)). Based on ISRP recommendations, the Northwest Power and Conservation Council asked that the ISRP provide further review of the project and its applicability to other geographical areas after 3 years of implementation. We presented a report of progress last year providing discussion of the analytical approach to assessing ecological change. This report was reviewed by the ISRP in October 2013. They concluded again that the UWMEP meets scientific review criteria. Specifically the ISRP said that: “The progress report meets the ISRP’s previous qualifications from the Wildlife Category Review by providing a very good summary of analytical approaches and a thoughtful and rigorous preliminary analysis of data. The ISRP believes this wildlife M&E approach can be used in other areas. However, if the use of the approach is expanded to other areas, the ISRP recommends that the sponsors develop a companion document where the analytical approaches are explained in more detail. This companion document can be provided to the ISRP during the next review process.”

# Methods

The methods section describes what was done, where it was done, and when it was done. Authors should provide a high-level description of the methods, accompanied by relevant links to protocols in [MonitoringMethods.org](https://www.monitoringmethods.org/). Well-designed maps can reduce the need for detailed descriptions of study sites as part of the overall methods section. Projects with metric and indicator data for each protocol can provide those in a separate appendix at the end of the report.

## Monitoring locations

The Albeni Falls Work Group (2001) used a stratified-random sampling design to determine the location of points for monitoring. The protocol mapped a geo-referenced grid (200-m spacing) onto each mitigation property using GIS. Grid points were sequentially numbered and represented potential monitoring sample points on mitigation areas that could then be randomly selected by use of a random numbers generator. The 200-m spacing is equal to the preferred sample point separation for breeding bird point-count stations ([Huff et al. 2000](#_ENREF_4)), and yields one potential sample point for every 4 ha of habitat. Closer grid-point spacing would decrease the probability that data from adjacent sample points are independent and increase the risk of double counting birds when using point-count sampling techniques. Sites managed by the Kalispel Tribe were selected with this technique in 2004.

Additional sites were added at Big Meadows and Indian Creek in 2014.

Fig. 1. Locations of reference and permanent points on lands managed by the five Upper Columbia United Tribes. Reference sites were located on BLM and Turnbull NWR.

Fig. 2. Locations of permanent points sampled on lands managed by the Kalispel Tribe in Washington in 2014.

Fig. 3. Locations of permanent points sampled on lands managed by the Kalispel Tribe in Idaho in 2014.

Table 1. Reference sites sampled for eight habitat types. None of these sites were sampled in 2014.

Table 2. Habitats and number of sampling sites for mitigation units managed by the Kalispel Tribe. Complete sampling could not be conducted on the Big Meadows property north of Priest River because of agricultural activity.

## Vegetation sampling

Composition and structure of the vegetation are typically the first things to be addressed in terrestrial ecological restoration projects. In some cases, soil amendments or other changes to the physical environment might be necessary before this can proceed. Vegetation provides the template for inclusion and maintenance of wildlife species by directly providing requisites such as food, cover, perches, and nests, and indirectly through its effects on ecosystem functioning and microclimate. The goal of vegetation sampling was to collect comparative information on herbaceous vegetation, shrubs, and trees on both reference and mitigation points. Our methods for vegetation sampling have not yet been published at MonitoringMethods.org, but should be available there in 2015. We summarize them here.

Frequency and percent cover of ground vegetation and substrate features were measured. Unless precluded by plant condition (e.g., seedling), all plants were identified to species. Ground vegetation and substrate were measured using a 20 x 50-cm plot placed at the center of each site point and on alternating sides of a 32-m transect radiating in each of the cardinal directions from the sampling point for a total of 33 plots. Species of herbaceous vegetation and substrate features (e.g., rock, litter) were recorded and assigned to 1 of 6 cover categories (Daubenmire 1959). The height (to nearest cm) of the tallest vegetation rooted in the plot was measured at three points along the midline of the plot frame. In tall marsh vegetation, the plot frame used is 3-sided (open on 1 of the 50-cm sides) to be able to slide the plot into the vegetation rather than placing over the vegetation. Instead of cover class, the number of stems of cattails and bulrushes were recorded.

Shrubs were measured along the same 32-m transects used for cover measurements. A 2-m belt was used and species and size (length x width x height) of each shrub were recorded. Number of trees by species and diameter at breast height (DBH) size class were recorded within 16 × 16-m plots centered on each reference or mitigation point in 6 size classes. Number of standing dead trees (i.e., snags) was recorded by size class and stage of decay.

## Vertebrate sampling

Full details of sampling procedures for larval amphibians, birds, and small mammals are available at MonitoringMethods.org ([Hallett and O'Connell 2013c](#_ENREF_3), [b](#_ENREF_2), [a](#_ENREF_1)).

Scientific collecting permits were approved by the Idaho Department of Fish and Game. Required annual reports were provided to both agencies in February 2015. Environmental compliance requirements of the Bonneville Power Administration were met. Approval by the Eastern Washington University Institutional Animal Care and Use Committee was renewed.

# Results

It is preferable to present detailed results in tables, figures, and graphs, especially when numerical precision is important. The interpretation and application of the results should be explained in the Discussion/Conclusion section below. Results should be presented in biologically meaningful terms and should be organized by topic and species, including by ESU, DPS, or MPG as appropriate. Data illustrating time trends should be displayed in cumulative figures and include relevant previous data. Summary data should not be refined to the point that the reader cannot verify the analyses or use the information for other purposes. Raw data and instructions for how to access data sets should only be included in the appendices. When presenting the results of statistical tests, please report the type of test, sample or effect sizes, and the significance level (P-value). The discussion of results should be included in the Discussion/Conclusion section.

Field work was conducted from June through September 2014. Relative to previous years, we had very large sample sizes for amphibians and small mammals (Table 2). Full analysis of these data will be provided in our next annual report. Data summaries are now available online (see next section).

Table 3. Number of records obtained and number of species identified for each species group in 2014.

Add Table 2

# Discussion/Conclusion

A good discussion provides broad syntheses and stresses the relevance of the findings, including the benefit to fish and wildlife. Authors should indicate the importance of their work and how it relates to current knowledge. If issues during implementation of your work significantly impacted results, discuss those here. Please also highlight lessons learned from your project that could inform future RM&E work on a local and regional scale. Informed speculation is acceptable as long as it is clearly identified as such. Authors should avoid merely restating their results and/or (re)summarizing the literature. *For research and action effectiveness projects, please be sure to state whether hypotheses were accepted or rejected and whether your results addressed any critical uncertainties.*

# Adaptive Management & Lessons Learned

*In order to emphasize the application of results to management actions, adaptive management and lessons learned have been distinguished as a separate section from the Discussion/Conclusion section.*

Please explain how your results could be used by fish or wildlife managers to inform [program strategies](http://www.cbfish.org/ProgramStrategy.mvc/ProgramStrategiesIndex), including habitat restoration, predation, or hatchery and hydrosystem operations. Describe how your results could be applied at the watershed, subbasin, and Columbia Basin scale. Finally, please discuss how your results will be shared with other resource managers.

# Acknowledgements

Ray Entz, Matt Berger (Kalispel Tribe), provided support for work conducted on the lands under their management. Kristi Kimmet managed the field work and data entry. Adam Gebauer, Dylan Timmins, and Kim Quayle conducted much of the field work. Scott Price conducted the bird surveys. Funding was provided by the Bonneville Power Administration.

# References

Hallett, J. G. and M. A. O'Connell. 2013a. Amphibian Surveys Using Minnow Traps. Monitoring Methods 1296.

Hallett, J. G. and M. A. O'Connell. 2013b. Breeding Bird Surveys Using Point Counts. Monitoring Methods 1295.

Hallett, J. G. and M. A. O'Connell. 2013c. Small Mammal Surveys Using Removal Trapping. Monitoring Methods 1293.

Huff, M. H., K. A. Bettinger, and et.al. 2000. A habitat based point-count protocol for terrestrial birds, emphasizing Washington and Oregon General Technical Report PNW-GTR-501 U.S.D.A Forest Service, Pacific Northwest Research Station, Portland, OR.

Author(s) last name or Organization(s), Title, Publication Date, Publisher, Volume/Edition, Page #.

# Appendices

## A.1: Data sets or products:

All of the data collected between 2002 and 2014 are available in summarized form on the Geospatial Database Viewer created by the Kalispel Natural Resources Department (<http://gis.knrd.org/knrdgisviewer/>). The data viewer provides filters for restricting data to, for example, specific mitigation units or years, and displays the locations of sampling points. Data can be exported in summary form or raw data tables can be requested online.

Data tables are refreshed after field data have been examined and updated. This is usually several months after field work has been completed because of the time required to ensure correct species identification of plants and small mammals. The most recent implementation of the Geospatial Database Viewer now incorporates new data within 1 week from the time it is uploaded to our SQL database.

We have been working with the data consultants in charge of managing the Geospatial Database Viewer to increase the analytical tools available online. This year, the first of several stages was completed by incorporating the database extensions using the R programming language. As development proceeds, more informative summary tables, as well as additional tools for analysis and graphical display, will become available.

AFIWG. (Albeni Falls Interagency Work Group). 2001. Monitoring and Evaluation Plan for the Albeni Falls Wildlife Mitigation Project.