Independent Multidisciplinary Science Team (IMST)

State of Oregon

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October 9, 2006

Tom Byler
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Dear Tom:

Enclosed please find a copy of the Independent Multidisciplinary Science Team's (IMST) synthesis report on the *Watershed and Aquatic Habitat Effectiveness Monitoring: A Synthesis of a Technical Workshop*. The workshop was jointly organized and held by the IMST and Oregon Watershed Enhancement Board on April 18 and 19, 2006.

This report summarizes results of the workshop and synthesizes findings and recommendations by workshop participants. We made every effort to ensure that the report reflects the outcome of the workshop without bias from the IMST. Copies of the report will be sent to the workshop participants and it will also be posted on IMST's web site later this month. As you know, the IMST will provide a separate report(s) on key issues relating to restoration effectiveness monitoring, as discussed with you and your staff.

Please do not hesitate to contact us if you have any questions regarding this report.

Sincerely,

Nancy Molina
IMST Co-Chair

Carl B. Schreck
IMST Co-Chair

encl.

cc with enclosures
Greg Sielglitz, OWEB
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IMST

Watershed and Aquatic Habitat Effectiveness Monitoring:

A Synthesis of A Technical Workshop

IMST Technical Report 2006-1

Released October 9, 2006

Independent Multidisciplinary Science Team
Oregon Plan for Salmon and Watersheds
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Disclaimer: *The workshop was jointly held by the Independent Multidisciplinary Science Team (IMST) and the Oregon Watershed Enhancement Board (OWEB). This is a synthesis of workshop notes to reflect the collection of ideas and concepts discussed on the days of the workshop. It does not necessarily reflect the opinions of the IMST, OWEB or any individual workshop participant. This report does not include recommendations by the IMST to OWEB or any other Oregon Plan partner requiring responses as directed by Oregon Revised Statute 541.409. The mention of trade names or other products does not constitute endorsement or recommendation for use.*

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Report Preparation
This report was written by: Kathy Maas-Hebner, Oregon State University and Lead IMST Technical Support and the members of the IMST, Nancy Molina, Neil Christensen, Michael Harte, Bob Hughes, Vic Kaczynski, Carl Schreck, and Carl Yee. The draft report was reviewed by Greg Sieglitz and Tom Byler. Reviewer comments were reviewed by the IMST and incorporated as appropriate. The draft report was discussed at the August 22, 2006 IMST public meeting and adopted at the September 27, 2006 IMST public meeting.

Table of Contents

Executive Summary

On April 18 and 19, 2006, the Independent Multidisciplinary Science Team (IMST) and the Oregon Watershed Enhancement Board (OWEB) jointly convened a technical workshop in Corvallis, Oregon on effectiveness monitoring of aquatic habitat and watershed restoration activities. The immediate goal of the workshop was to create an opportunity for monitoring experts and practitioners (scientists, local watershed representatives, and resource specialists) to exchange ideas about effectiveness monitoring of restoration efforts. The longer-term goal for the workshop was to provide background material for the IMST to organize scientific information regarding effectiveness monitoring for ecological restoration activities. OWEB could then use that guidance to evaluate the effectiveness of its restoration programs and to better allocate resources to activities that further the goal of the Oregon Plan for Salmon and Watersheds. This report is a synthesis of the workshop discussions and will be the foundation of an independent report prepared by the IMST that will provide OWEB with:

- Pros and cons of various protocols and methods;
- Identification of broad information gaps and research needs;
- Concepts and tools for aggregating data and answering questions at larger scales; and
- Opportunities to increase scientific rigor, scope of inference, etc.

Four work groups were designated for breakout discussions based on broad categories of restoration objectives drawn from the 2003-2005 Oregon Plan Biennium Report[1] and lists of restoration projects, activities and objectives from OWEB's *Oregon Watershed Restoration Inventory*. Each work was given the same set of questions aimed at addressing the State of Oregon's need to achieve scientific rigor in its effectiveness monitoring programs and to answer questions on restoration effectiveness at the basin, regional, and statewide scales.

The work groups found that focusing on individual project and activity types proved problematic and the work groups grappled with how to measure and determine overall effectiveness of project types without clear short- and long-term restoration goals and objectives. Participants indicated that an overarching restoration strategy is needed at the state level to provide context for the work occurring at local levels. Individual projects may be effective in some places but the participants felt that the real question was "Is the aggregation of all the smaller projects effective for the meeting the goals of the Oregon Plan?" Restoration needs to focus on long-term solutions that address natural processes and ecosystem functions not on short-term fixes that do not contribute to long-term solutions.

For the most part, work groups did not directly address the questions presented to them; however, several common issues were identified including:

- The terms "restoration", "effectiveness", and "effectiveness monitoring" have not been adequately defined and articulated as to what they mean to OWEB's program and to the Oregon Plan.
- Monitoring and restoration need to be integrated across disciplines and across landscape units of concern. Aquatic and terrestrial efforts need to be better integrated. Restoration

[1] Oregon Watershed Enhancement Board (OWEB) 2005. 2003-2005 Oregon Plan Biennial Report, Volume 1. Oregon Watershed Enhancement Board. Salem, OR.

and monitoring designs are integrated, not separate processes. A strategic state-wide restoration and monitoring plan is needed. Restoration projects and activities include a "science element" as they each have null and alternative hypotheses. Effectiveness monitoring must be designed properly to determine which hypotheses should be accepted and which one should be rejected.

- Statisticians are needed to advise OWEB on experimental designs, sample sizes, and how to incorporate existing data sets into an effectiveness monitoring program. Designs need to address projects already in place as well as future projects. Statisticians should be brought into the process at the beginning not at the end when data are being analyzed.
- Geographical and temporal scale issues bring considerable difficulty to monitoring efforts, data analysis and interpretation. The technical and analytical tools for scaling small-scale project level data up to larger watershed scale are not yet available.
- Sufficient numbers of readily available control and reference sites are required for assessments and statistical analysis. Adequate baseline data are also needed and should be a required element in restoration and monitoring plans.
- Standardized data collection protocols and methods must be used; otherwise the data are not useful in integrated analyses of restoration effectiveness. Data management is also a critical component for monitoring.
- A centralized data center is needed to provide the means for sharing, integrating, and analyzing data. Linked databases need to be created that include information on watershed and site assessments, project restoration goals and objectives, procedures and methods used, data collected, data format, quality assurance and quality control procedures used, and reporting methods.
- Roles for agencies, watershed groups, OWEB grant holders, and others need to be determined and clearly articulated. State-wide and regional coordination of restoration and monitoring efforts is needed.
- Education and technology transfer needs to occur to provide technical assistance to watershed groups to provide them with the knowledge and skills to properly implement restoration activities, collect data, and conduct effectiveness monitoring so the data can be integrated at larger scales. Educating the public and policy makers on the importance of effectiveness monitoring is also needed.

Introduction

On April 18 and 19, 2006, the Independent Multidisciplinary Science Team (IMST) and the Oregon Watershed Enhancement Board (OWEB) jointly convened a technical workshop in Corvallis, Oregon on effectiveness monitoring of aquatic habitat and watershed restoration activities (see Agenda, Appendix 1). OWEB provided funding for the workshop under its Effectiveness Monitoring Program. The immediate goal of the workshop was to create an opportunity for monitoring experts and practitioners (scientists, local watershed representatives, and resource specialists) to exchange ideas about effectiveness monitoring of restoration efforts. The longer-term goal for the workshop was to provide background material for the IMST to organize scientific information regarding effectiveness monitoring for ecological restoration activities. OWEB could then use that guidance to evaluate the effectiveness of its restoration programs and to better allocate resources to activities that further the goal of the Oregon Plan for Salmon and Watersheds (Oregon Plan). This report is a synthesis of the workshop discussions and will be the foundation of an independent report prepared by the IMST that will provide OWEB with:

- Pros and cons of various protocols and methods;
- Identification of broad information gaps and research needs;
- Concepts and tools for aggregating data and answering questions at larger scales; and
- Opportunities to increase scientific rigor, scope of inference, etc.

The IMST and OWEB conducted the workshop with a limited number of invited participants (Appendix 2) to ensure productive discussions. Participants were chosen based on expertise and experience in Oregon and represented knowledge of coastal, western, central and eastern Oregon watersheds and aquatic ecosystems. Not all interested restoration groups could be represented as invited participants other experts attending the workshop as audience members were given the opportunity to participate in work group sessions as time allowed and are represented in the synthesis.

Invited speakers were asked to present information to provide participants with a common frame of reference and to be a catalyst for ensuing discussions (see Appendix 3 for speaker abstracts). In addition to the speakers, a small poster session was held the evening of April 18th to allow monitoring practitioners an opportunity to showcase some of their work (see Appendix 4 for poster abstracts).

Prior to the workshop, all invited participants were sent a general questionnaire to determine what types and what levels of monitoring they involved. The questionnaire was used to understand the general backgrounds and experiences participants brought to the workshop discussions. Twenty-four responses were received (total of 44 sent out) and summarized (Appendix 5) by participant affiliations grouped as university, federal and state agencies, and non-governmental organizations (which included watershed groups and consultants).

Report Methods and Format

The aim of this report is to provide a synthesis of the workshop deliberations, including question and answer sessions after individual talks and during workshop debriefings. One facilitator and two note takers were present in each workgroup. This report synthesizes the flip-chart notes, generally written by the facilitator, and the handwritten or typed notes taken by the note takers. IMST members used their own notes to check the accuracy of the synthesis. Additional or supplemental information has not been incorporated into the discussion material. Therefore some sections may be incomplete or vary in the level of detail.

This is a synthesis of workshop notes to reflect the collection of ideas and concepts discussed on the days of the workshop. It does not necessarily reflect the opinions of the IMST, OWEB or any individual workshop participant. This report does not include recommendations by the IMST to OWEB or any other Oregon Plan partner requiring responses as directed by Oregon Revised Statute 541.409. The mention of trade names or other products does not constitute endorsement or recommendation for use.

This report presents:

1. description of the work groups and discussion process;
2. synthesis of workshop discussions including a broad framework for restoration and monitoring programs;
3. synthesized answers to workshop questions; and
4. appendices documenting the workshop proceedings, pre-workshop questionnaire, and materials provided to participants.

Work Groups and Discussion Process

Four work groups were designated for break out discussions based on broad categories of restoration objectives drawn from the 2003-2005 Oregon Plan Biennial Report[2].

- The *Fish and Aquatic Habitat* group was based on objectives related to channel complexity, fish passage, diversion screens, biological and assemblage/community integrity, fish population health, and chemical habitat/water quality related to aquatic biota. The focus of this group was to include all aquatic biota in large and small streams and estuaries.
- The *Hydrology and Watershed Function* group was grouped around the main objectives based on stream flow, hydrologic regimes, wet meadow and wetland function, upland water infiltration and percolation, and irrigation efficiency.
- The *Water Quality* group was based on objectives such as reduced sediment loads, decreased water temperatures, decreased nutrient inputs, increased dissolved oxygen, and other factors considered under the total maximum daily load (TMDL) process.
- The *Upland and Riparian Area Condition* group focused on integrating many of the vegetative and soil factors that affect hydrological and instream conditions of individual watersheds. The broader objectives of this group included channel and floodplain reconnection, rechannelizations, improved meandering, streambed aggradation, stream shading, bank stability, upland infiltration and percolation, and decreased upland runoff and erosion.

[2] Oregon Watershed Enhancement Board (OWEB) 2005. 2003-2005 Oregon Plan Biennial Report, Volume 1. Oregon Watershed Enhancement Board. Salem, OR.

The work groups were provided with a set of questions (Appendix 6) intended to facilitate synthesis of available information from both research and anecdotal experiences. The questions were developed by a steering committee over a 9-month period with informal feedback from various agencies, groups, and individuals. The overall context of these questions was to address the State of Oregon's need to achieve scientific rigor in its effectiveness monitoring programs and to answer questions at basin, regional, and statewide scales. The steering committee aimed to order the questions in a hierarchy so that later questions built on the earlier answers. As a foundation for the questions, OWEB presented the work groups with a list of restoration activities and objectives broken out by the four work group topics (Appendix 7). The list of projects was from OWEB's *Oregon Watershed Restoration Inventory.* The Inventory is used by OWEB to track projects and activities at the site-level to establish the type of restoration efforts in place and where they occurred. The Inventory includes work funded by OWEB and other sources. OWEB desired feedback from the work groups as to the effectiveness of the project types listed in the Inventory and if there were appropriate ways to group the projects or activities for analyses.

Synthesis of Work Group Discussions

Discussion Approach and Focus on Projects

Focusing on individual project and activity types proved problematic for each of the four work groups. The work groups grappled with how to measure and determine overall effectiveness of project types without clear short- and long-term restoration goals and objectives. The lists of activities are tactics used in restoration not strategies. Participants indicated that an overarching restoration strategy is needed at the state level to provide context for the work occurring at local levels. Individual projects may be effective in some places but the participants felt that the real question was "Is the aggregation of all the smaller projects effective for meeting the goals of the Oregon Plan?"

The work groups also indicated that the projects and activities cannot be looked at separately by aquatic biota/habitat, water quality, hydrological or terrestrial groupings. All are interrelated; therefore monitoring and restoration need to be integrated across disciplines and across the landscape units of concern. Aquatic and terrestrial ecosystems are integrated and restoration efforts need to do a better job integrating the processes connecting them. Participants also indicated that the complexity of issues involved in watershed functions and land uses greatly hinder answering the questions presented to the groups. Each work group indicated that an implicit requirement for restoration is that processes occurring within watersheds are fully understood. Currently, watershed processes are not fully understood, particularly how disturbances affect conditions and natural restoration processes. Restoration also needs to focus on long-term solutions that address natural processes and ecosystem functions not on short-term fixes that do not contribute to long-term solutions.

Other Monitoring Programs as Possible Templates

A key sentiment among work group members was that sound programs and information are already available and Oregon should not spend time reinventing the wheel. OWEB should review, adopt and adapt those practices to fit Oregon's situation and needs. The comprehensive monitoring plan and effectiveness monitoring protocols prepared by Washington's Salmon Recovery Funding Board were strongly recommended by each group (Appendix 8). In the evaluation process, OWEB would need to determine to what extent Oregon watersheds are sufficiently similar to Washington watersheds to be able to use the strategies and protocols. OWEB would also need to build upon the protocols listed by Washington. For example, Washington's documents are focused on salmonid habitat so similar protocols would need to be developed for water quality, hydrology, and upland conditions. OWEB needs to determine the extent Oregon can rely on Washington's work if Oregon chooses a smaller before-after-control-impact (BACI) design approach.

Participants did not make a comprehensive list of other programs at the federal, state, and local levels (e.g. watershed councils), but three were mentioned as sound templates for OWEB to evaluate. The Fire Effects Monitoring and Inventory System (FireMon) at the US Forest Service's Fire Science Lab in Missoula, Montana shows the intensity of different monitoring concepts, suites of parameters (e.g. plants, soil), a walk-through questionnaire (including budget), and has information about many different parameters including core parameters. US EPA's Quality Assurance Project Plans may be useful as templates and can be used like a strategic monitoring plan that includes vision, objectives, data management, etc. The work the University of California, Davis is doing for the California Department of Fish and Game's salmonid effectiveness monitoring program was also suggested.

Scientific Elements in Restoration and Effectiveness Monitoring

Restoration projects and activities include a "science element" as they each have null and alternative hypotheses. For example, a null hypothesis (H_o) could state "adding large wood to a stream will not increase the number or depth of pools" while the alternative hypothesis (H_a) would be "adding large wood to a stream significantly increases the number and depths of pools". Effectiveness monitoring must have an exploration aspect and be designed properly to determine which hypotheses should be accepted and which ones should be rejected. This will address a basic objective for monitoring: to learn how organisms and ecosystems respond to restoration efforts.

Similar to research, restoration project implementation or treatment application, effectiveness monitoring designs, data sampling, and statistical analyses must be rigorous and defensible. The objectives and methods for projects and activities need to be clearly stated, documented and testable. Adequate replication of projects and activities and experimental controls are also needed to increase rigor and the range of inference. Restoring ecosystems, similar to ecological research, requires multidisciplinary concepts and approaches.

Monitoring Design, Sampling, and Analysis

Participants expressed concerns about separating the restoration planning process from the monitoring planning process because restoration designs and monitoring designs are integrated, not separate, and should not be done piecemeal. Participants suggested a top-down approach using statewide goals to create an overarching monitoring design. Objectives need to be measurable, quantifiable, and repeatable. The design should strengthen the conclusions. It was also apparent from work group discussions that participants did not feel that "restoration", "effectiveness", and "effectiveness monitoring" have been sufficiently defined and articulated as to what they mean to OWEB's program and the Oregon Plan. "Restoration" is often used to imply a return to historical/pre-European settlement conditions, function, and/or process rates, but ecosystems are not static and "historical conditions and rates" may not be attainable for centuries, if at all.

Control and reference sites[3] are required for proper comparison and analyses and need to be identified and set aside for the specific purpose of serving as a comparison to treated sites. References sites do not have to be "pristine" but should represent properly functioning conditions and cover the range of variability that occurs in Oregon watersheds. Controls should represent the wide range of degraded conditions encountered in Oregon watersheds. The controls should be similar to treated sites before treatment and represent what may occur if restoration steps are not taken. More control sites may be needed than treated sites. The use of experimental study designs like before-after-control-impact (BACI), Walter staircase, and rotating panel designs mentioned by the *Fish and Aquatic Habitat* work group require adequate controls.

Statisticians are needed to help determine experimental designs, sample sizes, and how to incorporate existing data sets. Statisticians should be brought into the process at the beginning of the program design process not at the end when data are being analyzed. The experimental design could include sites that are intensively monitored and sites that are less-intensively monitored. The less-intensively monitored sites could be part of a rotating panel design. The purpose would be to add statistical power to allow conclusions to be drawn about changes in the monitored systems over time.

Project performance is contextual, the context has to be established and clearly articulated. The context should also include natural and anthropogenic constraints that challenge analysis and interpretation. The constraints need to be well documented.

The designs need to address projects already in place as well as future projects. This requires a strategic state-level restoration plan. A technical review team could then review smaller scale designs and determine if and how they fit into the larger design framework. Scale issues must be incorporated into the design—watershed level restoration effectiveness can only be evaluated if watershed level activities were implemented. The rotating panel design is not appropriate for use at small (reach) scales. Restoration actions based on limiting factors for specific watersheds may confound the aggregation of watersheds because limiting factors differ across the landscape and by spatial scale.

Standardized or compatible data collection protocols and methods should be used; otherwise the data are not useful in integrated analyses. Issues related to compatible and consistent data collected over time and across groups are long-term concerns. Data protocols need to be accurately cited within monitoring plans and any variations clearly documented and justified. Standardized protocols and data collection could be required by the funding agencies. Training and quality assurance on field protocols and tools to assure consistent and rigorous data collections were recommended by participants. It was cautioned that latitude is needed to allow protocols to "evolve" with time through an oversight group or person so that data collected using old and new protocols can be calibrated, integrated and aggregated over time.

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[3] Control and reference sites are often used interchangeably, however, in this document control and reference sites are considered to be different. Reference sites represent the desired conditions of properly functioning ecosystems at a particular stage of development or successional stage. Reference sites often are minimally disturbed, or least disturbed, by anthropogenic activities. Control sites are used in the context of experimental designs and are similar to the sites being restored; control sites represent what would happen over time if no action were taken.

OWEB will need to determine which portions of existing data were collected correctly and can be aggregated into larger data sets. Participants indicated that using a top-down design approach does not mean that existing data are not valuable—they can be used, they just won't be as robust as data collected under the final monitoring design.

A unique category of projects referred to as "random acts of kindness" was identified by participants. Projects that fall under this category may have started out with good intentions but, may not have been placed strategically, the project type was incorrect for the site or to meet objectives, or environmental or societal constraints and perceived risks prevented a project from being implemented for maximum effectiveness. OWEB needs to determine how these projects should be included within the larger restoration and monitoring framework.

Data also need to be periodically reviewed. Similar to scientific research, monitoring data must stand up to scrutiny. A suggestion was to either have consultants conduct an independent review or agencies conduct an in-house review every five years to determine if the projects were effective at the appropriate scale.

Scale Issues and Integration

Each group acknowledged the difficulties that geographical and temporal scales bring to monitoring, data analysis, and interpretation. Basically, if the State's long-term goal will be to make watershed scale evaluations of restoration efforts, then the actions and monitoring need to be conducted at the watershed scale. OWEB needs to look at the landscape level first and develop broad goals and hypotheses; different goals will be needed for the different systems across Oregon. Then OWEB can develop broad landscape level objectives that can be applied to smaller scales as a nested hierarchy (i.e. develop goals and objectives for the region, then watersheds, followed by streams and lastly stream reaches). The broader landscape objectives should be compared to objectives of projects already implemented as well as future projects. The monitoring must match the scale of the project but the project must match the scale required for restoration.

Some participants felt that it is not yet known how to take small-scale projects across a watershed and scale up to larger watershed scales because technical and analytical tools for doing this are not yet available. Presently Oregon can do site monitoring or paired watershed monitoring. OWEB and the State of Oregon should consider broadening the intensively monitored watershed approach to evaluate the effectiveness of combinations of project types known to be effective and to determine if the collective skills needed to restore watersheds are available. Intensively monitored watersheds may be paired or not paired with other watersheds. It was suggested by one group that watershed councils could be responsible for intensively monitored watersheds (which tend to be the size of 6th field HUCs[4] or sub-watersheds ranging 15–60 square miles) and would be able to respond to local needs. Coordination is needed to insure that the same tools and protocols are used across watersheds. Stable funding is also needed.

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[4] HUC =Hydrologic unit code. HUCs and watersheds are often used interchangeably but, not all hydrologic units are true watersheds. Hydrologic units have unique codes and are drainage areas that are delineated so as to nest into a multi-level hierarchical drainage system; they may encompass portions of more than one watershed, or not entirely encapsulate one entire watershed.

Status and trends monitoring can reveal larger influences on ecosystem or population recovery, but it must be done along with intensively monitored watersheds to determine restoration effectiveness. OWEB needs to take advantage of existing status and trends monitoring and combine it with an effectiveness monitoring program. The State of Oregon should also build and implement a state-wide status and trends monitoring program that scales down from a state-wide level down to 4th field HUCs (sub-basins averaging 700 square miles) within which the complex of restoration/protection efforts can be evaluated across the multiple interested parties.

All work groups acknowledged that assessments have occurred through watershed organizations, federal and state agencies, private organizations, and the Northwest Power and Conservation Councils' sub-basin planning process. Objectives of the assessments vary with the different groups. Prior to integration into the larger framework, it must be determined if the evaluation processes used by these different groups were appropriate, done correctly and can be integrated into the larger framework. Goals vary from project to project and not all objectives for similar projects are mutually compatible. The groups' objectives also must be evaluated before data can be integrated into the larger framework.

Participants indicated that someone must synthesize all the data at larger scales, beyond individual watersheds. If human impacts vary in intensity across the landscape the response signal(s) may occur at larger landscape scales. That information could then be applied to local watersheds. The large-scale information/signals/indicators need to be integrated by a larger entity at the state or regional level. It may not be possible to determine the contribution of individual projects to large-scale responses, unless the projects were conducted at the appropriate scale to influence the response.

OWEB Database

Several workshop participants felt that the *Oregon Watershed Restoration Inventory* currently maintained by OWEB may be sufficient to track the numbers of projects installed and the amount of funds spent on projects but it may not provide specific means to determine effectiveness of activities at any scale, including the project scale. Participants saw a need for OWEB to develop and maintain a separate database from the grants program to track more pertinent information on restoration benefits to watershed structure, functions and processes. Such a linked database would include information on assessments completed, restoration goals and objectives, clear documentation of procedures and methods used, data collected, data format, quality assurance and quality control procedures used, and reporting methods.

A Centralized Data Center

Each work group touched upon the need to have a centralized data center, most likely maintained at the state-level by an agency and coordinated with regional efforts (e.g. PNAMP). Such a data center is necessary to help maintain quality assurance and quality control of data that are entered into the database. The center would require qualified data analysts and statisticians to provide structure to the databases and to periodically review the data entered. The data center would be more than a data repository; it should provide the means for sharing, integrating and analyzing the data.

Models as Tools
Each work group mentioned various models available as tools to use in restoration efforts and to determine if responses to restoration activities are moving in a positive direction. It was emphasized that models are not meant to replace proper monitoring but to assist the process. Available models and related information on use, appropriate application and limitations need to be compiled so that they can be used more effectively. Specific models mentioned by the workgroups are listed in the *Synthesized Answers to Workshop Questions* section.

Predictive models can be used to estimate area within a watershed that must be treated before a detectable response will be seen. In cases where long-time frames are required before a system level response may be detected (e.g. tree plantings achieving canopy closure over a stream and reducing stream temperatures), the models could be run with real data collected after restoration has occurred to help assess whether or not a positive, negative, or neutral trend is occurring in response to restoration activities. This is a useful tool but it does not replace on the ground monitoring.

The Fish and Aquatic Habitat Work Group indicated that more watershed scale predictive models need to be developed and validated. Intensively managed and monitored watersheds are needed to mechanistically test various models. For model validation, the monitoring must occur at the scale at which the models are designed to work at. Other participants indicated that models need to be developed to evaluate suites of restoration activities used within watersheds.

Funding
All groups indicated the importance of adequate and sustainable funding for a successful effectiveness monitoring program. A monitoring program needs to be funded adequately to work properly. Poor monitoring can give false impressions to practitioners, stakeholders, and policy makers. Poor monitoring is worse than no monitoring. The required amount of funding for a rigorous monitoring program needs to be compared to the potential funding level; then critical decisions can be made to adjust the program and the risks of doing so in determining whether or not goals and objectives can be reached.

Key Elements for Developing Strategic Restoration and Effectiveness Monitoring Programs

Over the course of the discussions, the work groups touched upon the elements that are needed to create and manage a good effectiveness monitoring programs. Participants consistently emphasized that restoration and effectiveness monitoring are integrated and should not be viewed as separate processes. An overarching and strategic restoration and monitoring program needs to be developed that indicates where the smaller scaled operations fit into the larger program. All the elements mentioned by participants are necessary for the larger program and for the smaller components nested within it.

Defining Terms:

- Define effectiveness monitoring – There is still a need to adequately define and adopt a definition for effectiveness monitoring and how it relates to scale, projects, watersheds, various objectives, and the State of Oregon. Other types of monitoring (compliance, implementation, validation, status and trends, etc.) also need to be defined and how they are interrelated to one another and to effectiveness monitoring.
- Define restoration – Restoration is the goal, but, "restoration" needs to be clearly defined and articulated, otherwise the pieces of the story cannot be put together and interpreted. Is the goal restoring watershed and ecological function which is a long-term goal or is it to solve an immediate problem that is a short-term goal and may not be a long-term "fix" to the underlying problems?
- Desired future condition/function – The desired future condition or functions for each landscape unit restored (e.g. stream reach, watershed, prairie, forest, meadow, estuary) must be determined and well articulated. The desired future condition is the long-term goal and provides context for restoration activities.

Accountability and "success"

- Determine at what scales accountability is needed – At what level is accountability required; at the individual project level, statewide program level, or both? The level of accountability must be determined and incorporated into the goals of the monitoring program. The monitoring purpose, audience, and technical and social outcomes must be specified to provide context for the monitoring and to determine the measures and endpoints of success.
- Measures of success and restoration effectiveness – The parties involved in restoration and monitoring must agree on how results will be reported and what is meant by "success" or "effective restoration". Ratings like "good", "medium", or "bad" must be defined and used consistently for policy makers and the public. We should consider replacing the term "success" with terms such as "positive trend", "no change in trend" and "negative trend", etc. because we may never find agreement on what "success" is. Determining trends will require adequate baseline data.

  Criteria indicators for determining effectiveness include water quality, water quantity, hydrological regimes, invasive species, channel morphology, fish populations (listed and not listed species), landscape condition (upland, riparian vegetation characteristics), as well as social and economic measures. Long-term predictors are needed, e.g. not just fish numbers but measures of biological and genetic fitness.
- Rigor – Need to determine the "appropriate" level of rigor and risk of committing Type I or Type II errors. What is the risk of saying we are right when we are actually wrong? What is the risk of saying we're wrong when we are not wrong? The program may not need to show significant changes at alpha levels of 0.01 or 0.05, but it needs to be repeatable.

Roles and Coordination

- Determine roles – Roles for agencies, watershed groups, OWEB grant holders, and others must be well defined and clearly articulated. This allows for realistic expectations for all involved and for "ownership" in the restoration and monitoring processes.
- Restoration and monitoring coordinators – Basin level and state-wide coordinators are needed to insure that consistent, high quality implementation of projects and associated monitoring are occurring through time and across watershed groups and agencies.

  Coordinators would also ensure that technical assistance is provided where needed. Watershed councils and others must be provided specific recommendations for implementing restoration projects/activities and monitoring so that the information and data obtained from the groups can be integrated and scaled up.

  Agencies also need statewide and regional coordination of efforts and standardization of protocols. This will allow agencies to better use financial and staff resources, share and integrate agency data and to better incorporate data collected by watershed groups.
- Regional coordination – OWEB and the State of Oregon need to coordinate with other groups including PNAMP, CSMEP, EMAP and others. Broader scale coordination within the region will allow better use of monitoring resources, information exchange on tools and techniques and an opportunity to integrate data at larger geographical scales. Larger scale effort such as PNAMP, CSMEP, and EMAP need to be connected to local watershed and sub-basin efforts and vice versa. Coordination with neighboring state monitoring programs also adds benefits.
- Example programs – Participants indicated that some watershed council operations or other restoration programs could serve as key examples and work with neighboring groups as mentors. This would allow the state to focus monitoring on key watersheds and allow larger groups to assist adjacent groups in developing restoration and monitoring programs.

Restoration Approach

- Assessment – Prior to implementing restoration activities, it should be determined how the watersheds should function under natural conditions (e.g. through reference sites[5]). From there it should be determined what is creating the current watershed conditions, habitat and water quality environments. The assessment should provide the context for the restoration objectives, help insure that the activities have positive effects, and make sense within the larger picture. The assessments must address watershed condition over time, via a series of assessments conducted over time.

  Assessments should include limiting factors analysis in order to determine priority restoration needs and to make conclusions from monitoring efforts useful. If limiting factors are not addressed first then restoration activities may not have the intended results. This could result in identifying a sound restoration practice as not being an effective practice.

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[5] Control and reference sites are often used interchangeably, however, in this document control and reference sites are considered to be different. Reference sites represent the desired conditions of properly functioning ecosystems at a particular stage of development or successional stage. Reference sites often are minimally disturbed, or least disturbed, by anthropogenic activities. Control sites are used in the context of experimental designs and are similar to the sites being restored; control sites represent what would happen over time if no action were taken.

- Goals for restoration and effectiveness monitoring – Goals for restoring or maintaining ecosystem functions, physical processes, and other higher order processes are needed as the basis for both restoration and effectiveness monitoring. Rather than install project after project with no strategic plan, tools and techniques to restore function must first be developed and evaluated. Restoration and monitoring should focus on causes not problems and be tailored to specific watersheds.

  Restoration and monitoring goals are interrelated and should be developed at the same geographical and temporal scales. Effectiveness monitoring should be done along with implementation and compliance monitoring; they are not entirely separate processes. A considerable amount of variation occurs with project implementation and without knowing how implementation occurred, one cannot determine effectiveness. All monitoring needs to be clearly articulated in overall restoration plans. Restoration plans should also include societal values and constraints that may affect overall effectiveness.

- Determine scales for restoration and monitoring – Most work groups indicated that restoration and monitoring need to be designed at the appropriate watershed scale (e.g. 6^{th} field HUC or sub-watershed (15–60 square miles for hydrology; 5^{th} field HUC or watershed (60–375 square miles) for water quality; 6^{th} field HUC or broader (60–375 square miles or more) for aquatic biota).

  Temporal scales required for restoration must also be determined. Results do not happen overnight. Reasonable timeframes for restoration must be determined and well articulated to stakeholders. Timeframes will vary by the structures and functions being restored and by watershed.

- Goals, objectives and restoration alternatives – Goals and objectives for restoration need to be developed as well as possible restoration activities to meet the goals and objectives. Objectives need to be clearly tied to assessments and measurable. Restorative "fixes" need to be identified and proposed based on assessments and the information within the toolbox. Project plans need to include quantitative prediction of expected changes, measurable effects, and where they are expected to occur, so that effectiveness can be assessed. Essentially, Workshop Questions 3–8 (Appendix 6) should be answered for each project or activity.

- Restoration sequence – The most important consideration in sequencing restoration activities may be to identify and target limiting factors, however, the root causes must be identified and restored first (e.g., riparian vegetation and upland vegetation may need to be established to reduce channel widening and incision rates (long-term processes) before large wood is placed to create instream habitat (short-term structural change)).

- Implementation – Particular projects or activities vary greatly in their implementation and maintenance. How a project or activity was implemented and later maintained needs to be tracked and well documented. This information can assist practitioners in determining why a particular project had positive, negative, or neutral effects. This information is also necessary to aggregate data and conduct appropriate data analysis and interpretation.

Technical Assistance and Education

- Toolbox – A toolbox should be created that includes accepted restoration and best management that can be applied to a spectrum of watershed scales and conditions. The tool box should be organized to allow practitioners to match their watersheds and current conditions of concern to similar watersheds. This could be done through stratification by watershed size, ecological characteristics, and suite of problems. The toolbox could be built on the existing work of Washington's Salmon Recovery Funding Board, but OWEB needs to determine to what extent Oregon watersheds are sufficiently similar to Washington watersheds. The toolbox should, when possible, include circumstances when an activity or project is not an appropriate first choice or when other functions should be restored first. Not every activity or project type is appropriate everywhere.

  One group indicated that the current manuals being used by watershed groups are often out of date. Tools in the toolbox need to be periodically assessed and updated. The toolbox needs to be comprised of well-articulated technical strategies and common lessons and could be distilled and developed from sources such as:
    a) scientific and technical documents in applied natural resource fields;
    b) comprehensive literature and technical reviews;
    c) existing best management practices literature and manuals;
    d) manuals and documents created by OWEB and Washington's Salmon Recovery Funding Board, as well as from other states; and
    e) case studies of what worked where and what didn't work and why.

- Outreach and Education – Managers and practitioners need to know how to use the toolbox and how to apply the tools appropriately. Technical assistance should be provided to promote the use and understanding of existing databases and other technical resources (e.g. GIS data layer, remote sensing data), statistical designs, data collection methods, quality assurance/quality control measures, analytical methods, and interpretation of results. Conceptual and on-the-ground training are needed. Education is also important so that the public and decision makers understand and support monitoring as a key component in restoration efforts.

Monitoring

- Monitoring – Monitoring specifics need to be well articulated, including what parameters are to be monitored to see if the "conventional wisdom" contained in the toolbox actually works in the target watershed. The following is not an exhaustive list for monitoring, but are points made by workshop participants. Many of these are discussed in more detail in the preceding section, *Synthesis of Work Group Discussions*.

  a) The broad-scale monitoring strategy should include project implementation, effectiveness monitoring and trend monitoring at representative reaches.

  a) Statistical consulting is needed to help determine experimental design and sample size and how to incorporate existing data. References sites should be identified to represent the variation of conditions across the landscape. Control sites similar to treated sites need to be identified and more may be needed than treated sites and left untreated. These are critical first steps, not the last steps.

b) Not all projects need to be monitored. Those that are most likely to produce detectable changes should be monitored. Projects should be randomly selected from appropriate categories and those that were properly designed based on assessments and properly implemented and documented.

c) Monitoring strategies and sampling have to address issues of spatial scale and temporal variability.

d) Indicators linked to endpoints of interest that are responsive to stressors and have high signals and low environmental “noise”, etc. need to be determined. Indicators that will give the earliest response as well as those that are expected later also need to be determined.

e) Standardized and compatible data collection protocols/methods should be used across agencies and watersheds; otherwise the data are not useful in integrated analyses. Data protocols need to be accurately cited within monitoring plans and any variations clearly documented and justified. Standardized protocols and the data collected should be required by the funding agencies.

f) Reporting requirements, data and metadata documentation, data validation and storage must be coordinated at the state level.

g) Data management is a critical key component of monitoring strategies. This includes adequate documentation (i.e., metadata), quality assurance and quality control.

h) A standard format for reporting geographic information is needed. Presently various groups may use lat/long, GIS coordinates, township-range or a combination of formats.

i) Baseline data should be a required element in restoration and monitoring plans in order to assess overall impacts of restoration activities. The monitoring needs to account for outside causes and aggregated effects (e.g., changes in land use, climatic variations, ocean conditions or commercial harvest impacts on anadromous stocks) that can affect results.

Synthesized Answers to Workshop Questions

One of the main goals for the workshop was to provide fairly detailed technical information on issues related to effectiveness monitoring and detection of ecosystem responses to restoration activities. This information was then to be used as a foundation for future effectiveness monitoring documents IMST will be preparing for OWEB. As noted earlier, the format of listed projects and objectives provided by OWEB (Appendix 7) were problematic to the participants and the work group discussions did not directly address many of the workshop questions (Appendix 6). In an attempt to determine if the desired information was actually provided in a round about way, the IMST and its staff used the notes and flip charts from each work group discussion and the original questions to place the information within a common structure. This format will facilitate IMST's work and help to determine what steps are needed to fully answer the questions or how the questions should be reworded. **These "answers" should not be viewed as definitive responses by the participants since most work groups did not directly address the questions.** Several work groups created examples to illustrate approaches to effectiveness monitoring and these are included in this section without additional elaboration, so the information may be incomplete.

As a starting point, workshop participants were provided lists of restoration activities by OWEB related to each work group's theme, with the intent that the work group would use the activities list to focus their discussions. The work groups had similar reactions and comments to the first question: *1) Review the list of restoration activities and objectives associated with this work group topic (provided by OWEB in Appendix 7). a) Are these appropriate for the work group discussion?*

Discussion of the lists generated the following observations and opinions among participants:

- Projects and objectives should be geared toward holistic, watershed-scale processes (such as sediment or nutrient dynamics) and higher-level outcomes; it was difficult to promote a holistic view from a simple list of projects. Some examples of functional restoration objectives (from the Water Quality workgroup) were:
    - Increasing hydrological retention watershed-wide
    - Increasing channel complexity
    - Increasing floodplain connectivity
    - Improving riparian condition
    - Decreasing pollution loading
    - Increasing groundwater contact
    - Mimicking the natural hydrograph
- A definition of "restoration" is needed to understand the utility of the activities listed.
- In restoration planning, the desired outcomes need to be determined first, then the proper tools can be chosen to achieve them.
- For the Fish and Aquatic Habitat work group, the list could be improved by focusing on other species in addition to salmonids

As indicated above, the following sections organize the work group discussion notes along the lines of the workshop questions provided to the work groups. In some cases there were no pertinent comments or observations from a work group on a particular question, and in those cases, the question is not included in the text.

Fish and Aquatic Habitat Work Group: Workshop Question Synthesis

1) Review the list of restoration activities and objectives associated with this work group topic (provided by OWEB in Appendix 7).

b) *Are there other activities not included in the list?*

Other objectives not listed for some projects/activities were added by the group.

- Culvert removal/ replacement to alleviate barriers to wood and sediment transport.
- Dam removal to restore sediment transport processes.
- Large wood placement to facilitate sediment sorting and/or enhance nutrient retention.
- Increased channel sinuosity, which requires erosion of some stream banks, has the opposite objective of increased stream bank stabilization.
- Estuarine enhancement to accommodate tidal flux (e.g. culvert and dike removal in a slough to enhance nutrient flux and sediment transport and deposition.

The work group did not focus on this question and only one additional activity was mentioned:

- Hatchery fish – supplementation; mitigation to create a fishery to alleviate harvesting pressure on wild fish.

2) In your experience, which of the activities discussed in Question 1 have been shown to be effective either through research or long-term effectiveness monitoring programs, and which are still experimental?

There are no activities that universally work. Some activities will work at certain scales but may not at broader scales. Other fish and non-fish species besides salmonids should be considered.

We need to learn from the past and the failures need to be evaluated. For example, weir installation—depending on area, will or will not work to meet objectives. One needs a hypothesis of what might be the problem in the stream based on knowledge of stream processes. Then a clear objective and hypothesis must be stated.

This all goes back to clearly defining "restoration". We need to clearly articulate long-term goals such as removal of species from listing under federal or state endangered species acts or maintaining viable sport and/or commercial fisheries. Restoration approaches at the project level are different than at the larger scales, there are some overlaps but it is not clear where it occurs within OWEB's list.

5) For each activity discussed above:

a) *What are the key effectiveness monitoring questions you would use to determine success? How would restoration objectives and monitoring questions differ at the project/site and watershed scales?*

The objective of monitoring is to learn. Questions need to be designed to learn how, when, and why a response to restoration occurs.

Are there regionally and state-wide sufficient or sustainable populations and distributions? Maintaining sustainable and viable populations of species of concern would be higher in the hierarchy than the goal of maintaining habitat.

Monitoring questions and designs will differ for community or assemblage monitoring and population monitoring.

For the questions listed in 5(a), at what scales (geographic and temporal) would you conduct your monitoring and/or your analysis?

To determine the minimum scale to assess objectives you have to start with your data needs. What is the relevant scale to collect those particular data? Objectives must have a measurable endpoint.

b) *What biotic and/or abiotic factors or field variables would you measure? What magnitude of change in these factors would have to occur before a significant response could be detected in the monitoring data?*

Responses may not be directly observed so proper indicators need to be identified and tied back to the desired response. It must also be determined how good and how reliable the indicators are in representing the responses.

One must be cautious of sampling problems such as "cherry picking sites" (i.e., not truly representative of the average site) and poor indicators e.g., misuse of pool to riffle ratio; carcass counts may not translate to the number of redds; migrant numbers may not translate into number of smolts.

c) *Where (relative positions within watersheds or basins) and how often (given the likely variation in response) would you collect your data? Are there analytical tools that would help answer this question?*

Some questions can be answered using remote sensing. It was mentioned that The Nature Conservancy and the Army Corps of Engineers have developed a model to assess the impacts of multiple actions on stream flow. Other models mentioned include Pisces software and Aqua Halo.

6) Restoration effectiveness is often monitored/or proposed to be monitored by individual activities or at small local scales. Is this the optimum way for testing whether the Oregon Plan objectives are being met?

No. Within the context of larger objectives you still need to measure at the watershed scale. The Oregon Plan does not outline specific measurable, quantifiable, and repeatable objectives.

If not, what is a better model?

Better model testing is multi-scale not single-scale.

a) *Are there logical monitoring groupings by type of restoration activity, or by location?*

Grouping monitoring by restoration activity in not the best approach, they should group by objectives. It may also take more than one type of activity to meet the restoration objective. Some projects can be used to meet different objectives but not necessarily the same objective everywhere. Focus on objectives to establish context of activities—the environmental setting is the context, grouping by objective ultimately groups restoration by water body/location.

At what scales? There may be groupings at smaller scales, but one needs to start with the larger landscape and move down to smaller scales. From the larger landscape, develop objectives that can be applied to smaller scales. Then the groupings may be more obvious. It is the objectives that dictate the monitoring that is employed.

b) *Could the intensity (density of sample points) or frequency of monitoring be varied if activities were grouped in some way?*

Yes, but a hierarchy needs to be established to combine the data among the groups.

7) How do you design sampling schemes that account for:

a) *Land use effects (urban, agriculture, forestry, rangeland), and*

b) *Climatic and precipitation variability (e.g., drought, El Nino events, floods), or ocean conditions, or other unanticipated variables that may influence the effectiveness of restoration projects?*

Members of the work group suggested looking at Chris Jordan's (NOAA Fisheries, Newport Research Station) work as an example. Certain landscapes may have a signal and try to connect it to the local watershed scale. Use index of broad landscape features, but still need to be connect to smaller scales.

The Work Group's Process

The Fish and Aquatic Habitat Work Group, as with other groups, did not directly answer all the questions, instead they developed a few examples to demonstrate monitoring processes and key issues that need to be addressed. Following are their hypothetical examples.

Example 1. Oregon Coastal Coho — Recovery of an evolutionary significant unit (ESU) or population; achieve healthy populations that are sustainable and viable.

Objectives should be population based at the landscape level, e.g. double the current spawner abundance. Concerns and issues need to be identified: 1) main problem is at the landscape scale but needs to be evaluated at a smaller scale; 2) local variation will occur in response to actions and requires monitoring; 3) monitoring program must have a component to test uncertainty at the proper scale; and 4) must determine the projected restoration impact to reach the objective. This is where models come in.

Structuring the monitoring program includes incorporating information from life cycle monitoring sites. Life cycle monitoring sites could also be used as the "before" in a before-after-control-impact (BACI) design. A metric of performance to drive the monitoring planning should be chosen, e.g. total population of coastal coho spawners over time. The effect of actions on population viability needs to be estimated, e.g. water quality impacts. Also the relationships between actions and responses that are known and not known need to be determined. The projected impact of restoration activities to reach the goal is needed and can be accomplished with predictive models.

Limiting factors need to be prioritized. Actions needed to address each limiting factor must be identified. Assumptions and uncertainties related to the actions need to be tested and monitored. Also, need to determine at what extent a signal is expected to be detected.

Rolling up small scale results to answer large scale questions

1. From an OWEB funding perspective, increasing the actual fish numbers is not important, what is important is showing that habitat has improved (addresses root causes), because responses in fish numbers are not expected to occur within the timeframe of the study.
2. Anadromy is complex and affirms the importance of determining cause and effect. Monitoring needs a control to fully understand the effect(s) of actions.
3. Monitoring occurs at a local level to understand cause and effect of restoration actions. Then the larger scale is examined (across species management units) for mitigation. For example:
   - Assumptions—the model used is correct and not all large wood projects are created equal;
   - Context—wood placement occurred during a period of generally low flow winters.
   - Hypothesis—large wood projects need high flow events to affect channel structure.
   - Key point—spatial and temporal aspects are important and need to be known to interpret monitoring information. Seasonal variation is important in order to validate effectiveness.
4. Results can not be applied generically to all landscapes.

Example 2. Coquille River System — Coho have life history type that uses "rice paddy" areas downstream and is genetically driven rather than density driven.

Key points to consider for monitoring:

1. Variation in phenotypes is important to monitoring.
2. Need to incorporate life history of animals, but we tend to compartmentalize them (e.g. summer and winter steelhead are one species) but there are gradations of life histories not distinct groupings.
3. Fish patterns are inconsistent and unpredictable, therefore pre-treatment data are critical. For example, if adult fish returns have increased then downstream movement of fry are expected and should be detected.
4. Need to connect the entire watershed to life history diversity. Need to understand life history type within and between watersheds.
   - When, why and where are fish moving? Life history of organism must be considered.
   - Fish movement may or may not be density dependent. Need to understand these and the limiting factors in order to design an appropriate monitoring program.
   - Need a broad understanding of all projects implemented across the landscape, requires implementation monitoring and knowledge of those that worked.

- Need to connect the entire watershed to life history diversity. Need to understand life history type within and between watersheds.

5. Large sampling issues exist—Need to capture variation in time and space and can use a rotating panel design. This facilitates aggregation (concept for "Master Pull" being developed by Phil Larsen at US EPA) but for this to work, embedded random samples must be overlaid. The concept is that many projects can be rolled up if they are using points from "Master Pull".

Hydrology Work Group: Workshop Question Synthesis

1) Review the list of restoration activities and objectives associated with this work group topic (provided by OWEB in Appendix 7).

b) Are there other activities not included in the list?

Artificial wetland construction should not be lumped with wetland restoration.

The group added the following additional activities to the list:

- aquifer recharge
- retention basins
- rip rap removal
- dam removal
- irrigation management
- channel complexity

2) In your experience, which of the activities discussed in Question 1 have been shown to be effective either through research or long-term effectiveness monitoring programs, and which are still experimental?

The group did not feel that it was their job to determine if these activities work. However, there was discussion on whether or not large wood placement was always useful. Disagreements were voiced as to whether or not juniper removal would increase water availability and if it would make a difference at the watershed scale.

6) Restoration effectiveness is often monitored/or proposed to be monitored by individual activities or at small local scales. Is this the optimum way for testing whether the Oregon Plan objectives are being met?

No.

a) Are there logical monitoring groupings by type of restoration activity, or by location? At what scales?

The activities need to be based on objectives. A strategy needs to be defined. Is restoration the goal or is it sustainability.

Key principles

Work group participants reviewed four general principles and a matrix presented by participant Jim Wigington (US EPA). The group agreed with both the principles and the matrix.

1. Water quantity and flow regime can exert a powerful direct influence on aquatic ecosystems.
2. Hydrology (water quantity and flow regime) can have a strong influence on streams that can mask restoration of aquatic habitats, etc.
3. The nature of desired restoration practices (and their effectiveness) for water quantity and flow regime varies with landscape setting, inherent attributes of the watershed, the nature of the damage/disturbance to the watershed, the mixture of land uses, and the size of the watershed.
4. Basic data on water supply and flow regime needs to be considered when monitoring and evaluating restoration effectiveness.

The table below would allow restoration and monitoring practitioners to summarize known information and compare it across various sized watersheds.

Watershed size	Ecoregion(s)	Land Use	Specific Problem	Restoration Activity	Response Time Frame	Monitoring Strategy
1 km^2						
10 km^2						
100 km^2						
1,000 km^2						
10,000 km^2						
100,000 km^2						

The Work Group's Process

The Hydrology Workgroup chose to not address the list of individual questions as presented but prepared two case studies, one for eastern Oregon and one for western Oregon, to provide a framework to approach hydrological restoration and monitoring effectiveness at the 6th field HUC (15–60 square miles) scale . The group indicated that models can be used as tools but are not a substitute for monitoring. These two hypothetical case studies are included below:

Hypothetical Eastern Oregon Example-Hydrology Work Group

Watershed scale: 6th field HUC/sub-watershed

Assumptions:

1. Water over-appropriated; irrigation withdrawals have a large impact on water flow and volume.
2. Rural landscape.
3. Riparian areas are stressed.
4. Channel morphology has been altered.
5. Hydrographs have been altered. Hydrographs in lowland areas may be more altered than in the uplands.
6. Watershed has high road density.
7. Endangered species present; Endangered Species Act and Clean Water Act must be taken into account.

Approach:

1. Assess land use and land cover of the watershed.
2. Develop a point of diversions map including wells and diversion gates. Need to know subsurface hydrology.
3. Reference available water assessments.
4. Identify system stressors.
5. Define restoration goals.
6. Identify restoration actions based on options and overall strategy.
7. Develop monitoring strategy (pre- and post-implementation, and long-term, experimental design, determine existing data).

8. Calculate water budget pre- and post- project implementation.
9. Monitoring and implementation strategy including quality assurance/quality control standard operating procedures, database management, GIS.
10. Conduct analysis and reporting

Problem: Inadequate water supply
Restoration Actions:
1. Irrigation water management
    - measuring devices in the river; upstream and downstream
    - measuring devices out of the river (capacity rods and physical staff gage)
2. Floodplain restoration
    - rip rap removal
    - vegetation management
    - levee removal
    - livestock off-channel watering sites
    - consider bank profiling
    - consider roads and infrastructure removal or addition (e.g., riparian exclosures)
    - channel realignment, self-sustaining

Effectiveness Monitoring Actions:
1. Monitor annually for changes in water budget.
2. Monitor annually for water quality such as temperature (maybe 4x / year, seasonally) but response likely to be decadal. Do very detailed measurements on 10-year intervals.
3. Monitor riparian extent and quality at 10-year intervals
4. Channel morphology monitoring: refer to State of Washington for existing protocols/EMAP[6]. Use remote sensing (e.g., green LIDAR, aerial photos) at 10-year intervals and after every 100-year event. Qualitative photo annual checks on morphological changes.
5. Measure gradient, channel confinement, and sinuosity every 6- to 10-years

[6] The US Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP).

Hypothetical Western Oregon Example- Hydrology Work Group

Watershed scale: 6th field HUC/sub-watershed, coastal

Assumptions:

1. Forested uplands and agricultural lowlands with some urban areas.
2. Riparian areas are dominated by red alder
3. Impacted by roads. High road density. Culverts are of concern.
4. Endangered Species Act and Clean Water Act issues present.
5. Good coho habitat present.
6. Lowland and tidal areas under private management with simplified instream structure (low density of large wood, levees present, rip-rapped banks)
7. Loss of floodplain connectivity.
8. Loss of wetlands.
9. Loss of estuarine habitat.
10. Urbanization effects (flow changes, excess nutrients, solid wastes, commercial discharges, septic tanks, etc.).

Approach:

1. Assess land use and land cover of the watershed.
2. Develop a point of diversions map including wells and diversion gates. Need to know subsurface hydrology.
3. Reference available water assessments.
4. Identify system stressors.
5. Define restoration goals.
6. Identify restoration actions based on options and overall strategy.
7. Develop monitoring strategy (pre- and post-implementation, and long-term, experimental design, determine existing data).
8. Monitoring and implementation strategy including quality assurance/quality control, standard operating procedures, database management, GIS.
9. Conduct analysis and reporting

Problems: Road density, road surface drainage, culvert drainage and fish passage, excess sediment and runoff including mass wasting and debris flows.

Restoration Actions:

1. Improve road and road surface drainage by encouraging industrial forest legacy road assessments and upgrade roads under use.
2. Replace or remove culverts to improve fish passage.
3. Reduce road density by decommissioning roads.
4. Implement sediment control procedures.
5. Mitigate road related mass wasting and debris flows.
6. Increase and improve channel complexity (see FISRWG) by:
    - increasing gravel recruitment
    - placement of large wood
    - recruit large conifers within riparian areas (upland forested areas)
    - manage lowland riparian vegetation to increase bank stability

- o Restore floodplains by removing or decreasing the density of levees, rip-rap, tide gates, and dikes, and managing invasive riparian plant species.
- o Restore tidal and freshwater wetlands to increase water storage.

Effectiveness Monitoring Actions:

1. Monitor for decreases in road density with pre- and post-treatment assessments.
2. Monitor all sediments (channel, bedrock, and fine sediments) in 5- to 10-year intervals. Expect to see reduction in fine sediments over a longer time than coarser sediments. Track substrate composition (i.e. fines, gravels, and imbededness) in 5- to 10-year intervals.
3. Estimate flow regime and hydrograph pre- and post-treatment.
4. Monitor riparian condition using EMAP protocols and remote sensing (green LIDAR) in 5-year intervals.
5. Monitor stream channel characteristics with longitudinal cross sections (EMAP protocols).
6. Floodplain monitoring similar to that listed in eastside example except that 5-year intervals would be used.

Water Quality Work Group: Workshop Question Synthesis

1) Review the list of restoration activities and objectives associated with this work group topic (provided by OWEB in Appendix 7).

b) Are there other activities not included in the list?

The group added the following activities to the list:

- Riparian buffers
- Riparian vegetation management and fencing
- Improve flow regime (more natural hydrograph)
- Source control of fertilizer and agricultural chemical use
- Public education (e.g. effect of advertisements, polls of use of chemicals)
- Non-native species control
- Groundwater protection
- Built environments (e.g. septic tanks)
- Recreation management (e.g. campgrounds)
- Coordinated information and data management;
- How-to fixes (sources), storm water, forest practices, best management practices, permitting and construction, stewardship.

2) In your experience, which of the activities discussed in Question 1 have been shown to be effective either through research or long-term effectiveness monitoring programs, and which are still experimental?

Individual projects may be successful but may not contribute to the overall restoration of watershed functions. Additionally, effectiveness monitoring should include effectiveness of protection and conservation of key watershed components not just restoration activities.

The Work Group's Process

The Water Quality Work Group chose two example activities (riparian plantings and livestock grazing management including riparian fencing and rotations) to address portions of Questions 3 and 4 concerning geographic and temporal scales, measured parameters and sampling locations (see following two tables). Key components that would also be a part of these examples include:

- Pre-diagnosis through assessment is a critical first step.
- Treatments are assumed to come from toolbox or predictor model and there are enough to use probabilistic sampling.
- As you move up in scale, it becomes more difficult to connect individual projects to cause of changes.
- Identifying and using a control basin for comparison.
- Use models in parallel to the sampling to help detect trends; it may be unlikely that sustained long-term monitoring will occur to see on the ground results. Work group identified models for temperature (e.g. Heat Source), nutrients (e.g. SPARROW by USGS) and erosion and sediment transport (e.g., Soil-Water Assessment Tool (SWAT), Revised Universal Soil Loss Equation 2 (RUSLE2), Spatially Explicit Delivery Model (SEDMOD), Agricultural Non-Point Source (ANAGNPS), MIKE 11, Hydrological Simulation-Fortran (HSPF)).

- Models cannot be used to assess effectiveness but can help decide whether a project is/was worth doing.
- A different "program" is needed to characterize watershed integrity; this won't result from effectiveness monitoring.
- Core vs. supplemental indicators should be considered (e.g. turbidity as a surrogate for sediment) but linkages need to clearly established and validated.

Example 1. Riparian Tree Planting

Water Quality Parameter	Geographic Scale	Variables Measured	Time Frame[1] (dependent on tree species, size of stream, & size of planting)	Location for Measurements
Temperature	Project/site/reach	tree survival	1-5 year intervals for 15 years	treated site and control reach
		tree growth	1-5 year intervals for 15 years	treated site and control reach
		canopy closure	1-5 year intervals for 15 years	treated site and control reach
		stream shading	1-5 year intervals for 15 years	treated site and control reach
		stream temperature (optional)	continuous- seasonal low flows	upstream & downstream of project and control reach
	Sub-watershed[2]	stream temperature	continuous-seasonally	at integrator site or longitudinally
		extent of treated area; length and width	1-5 years, after new projects added; end at 10 years	
		stream flow[3]		
		climatic variables[3]		
	Watershed (*sum of all effects*)	stream temperature		at integrator site or longitudinally
		extent of treated area; length and width		
		stream flow[3]		
		climatic variables[3]		
Sedimentation	Project/site/reach	bank stability	yearly	at bank of project site
		turbidity[4]	flow related; storm event sampling and water management triggers	above and below project site
	Sub-watershed[2, 5]	turbidity[4]	continuously through flow changes	integrator sites (same as temperature)
		substrate/% fines	? not indicated by group	

[1] Work group put a time limit on effectiveness monitoring, feeling that long-term monitoring is not likely to be sustained.
[2] Workgroup indicated that the monitoring design comes into play at the sub-watershed scale; approximately 10,000–40,0000 acres also referred to as a 6th field HUC.
[3] Other variables that should be monitored to help explain observations.
[4] Turbidity is used as a surrogate for sediment.
[5] Sampling for effectiveness of riparian plantings on sedimentation at the sub-watershed scale could be done through a probabilistic design, if it is coupled with a stratified approach or paired watersheds.

Example 2. Livestock Grazing Management (includes grazing rotations and riparian fencing)

Water Quality Parameter	Geographic Scale	Variables Measured	Time Frame	Location for Measurements
Temperature	Project/site/reach	channel width to depth ratio		treated site and control reach
		stream shading		treated site and control reach
		canopy closure		treated site and control reach
		stream temperature	continuous-seasonal low flows	upstream & down stream of project and control reach
	Sub-Watershed[1]	stream temperature	continuous-seasonally	at integrator site or longitudinally
		extent of treated area; length and width	1-5 years, after new projects added; end at 10 years	
		*stream flow		
		*climatic variables		
Sedimentation	Project/site/reach	bank stability	yearly	photo points at bank of project site
		turbidity	annually, not event based	above and below project site
E. coli	Project/site/reach (grab samples)	*E. coli*	low flows and high flows- intensive sampling needed because of high variability	on allotment and control;
	Sub-Watershed[1]	*E. coli*	low flows and high flows- intensive sampling needed because of high variability and to be able to detect change at this scale.	combine with run-off (storm) sampling for background to determine source
Nutrients	Project/site/reach (grab samples)	Total nitrogen; total phosphorous; periphyton	high sampling frequency-30 samples during summer low-flows and CAFO[2] like sites during winter high-flows	above and below project site
	Sub-Watershed[1]	Total nitrogen; total phosphorous; periphyton	high sampling frequency-30 samples during summer low-flows and CAFO[2] like sites during winter high-flows	
		Biological Oxygen Demand & pH	diurnal change & degree of fluctuation	
		diatoms		

[1]Workgroup indicated that the monitoring design comes into play at the sub-watershed scale; approximately 10,000–40,0000 acres also referred to as a 6th field HUC.
[2]CAFO = confined animal feeding operations

5) For each activity discussed above:

a) *What are the key effectiveness monitoring questions you would use to determine success? How would restoration objectives and monitoring questions differ at the project/site and watershed scales?*

   We need to consider dropping the term "success" and use terms such as "positive trend", "no change in trend" and "negative trend", etc. because we may never find agreement in what "success" is. Determining trends will require adequate baseline data.

b) *For the questions listed in 5(a), at what scales (geographic and temporal) would you conduct your monitoring and/or your analysis?*

   Water quality monitoring needs to be done on watershed or larger scales.

c) *What biotic and/or abiotic factors or field variables would you measure? What magnitude of change in these factors would have to occur before a significant response could be detected in the monitoring data?*

d) *Where (relative positions within watersheds or basins) and how often (given the likely variation in response) would you collect your data? Are there analytical tools that would help answer this question?*

   DEQ is drafting a watershed assessment manual which will be helpful in describing some protocols, data formatting, statistical analysis, and reporting for a number of "core indicators" such as temperature, sediment, etc.

6) Restoration effectiveness is often monitored/or proposed to be monitored by individual activities or at small local scales. Is this the optimum way for testing whether the Oregon Plan objectives are being met? If not, what is a better model?

Water quality monitoring needs to be done on watershed or larger scales. Ambient water quality monitoring should not be done for individual projects, however, monitoring at the site scale may be important in some point-source like instances such as a clear-cut.

a) *Are there logical monitoring groupings by type of restoration activity, or by location? At what scales?*

   Activities need to be organized by function such as controlling sediments or nutrient inputs.

Upland and Riparian Area Condition Work Group: Workshop Question Synthesis

1) Review the list of restoration activities and objectives associated with this work group topic (provided by OWEB in Appendix 7).

b) Are there other activities not included in the list?

The group added the following activities to the list:

- noxious weed and invasive species management
- riparian thinning, particularly in westside forests
- forest health including prescribed fire, fuels management, thinning, particularly eastside forests
- vegetative buffers (restoration and enhancement)
- wetland protection
- protection and conservation easements
- riparian area maintenance

2) In your experience, which of the activities discussed in Question 1 have been shown to be effective either through research or long-term effectiveness monitoring programs, and which are still experimental?

The objective statements provided by OWEB (listed with the activities in Appendix 7) do not reflect ecological process-based, higher level outcomes. The desired future conditions must be determined prior to stating objectives. Appropriate indicators are needed. Without proper context, the objectives by themselves do not have much meaning.

At some point most the activities listed by OWEB and the participants have been shown to be effective within proper contexts. The concern is being able to understand which tool to use and where, as all can be misused or used at the wrong scale. A question was brought up as to whether there was currently adequate science behind the effectiveness of juniper removal as a restoration activity.

Example Approach for Riparian Plantings

The work group decided to work through an example restoration activity, riparian planting, to address the questions posed to them.

3) With regard to placement of restoration activities,

a) *Where in a watershed or river basin would the group expect these restoration activities to be most effective (e.g., lower or higher stream orders; upper of lower terrestrial areas of the watershed)?*

Riparian plantings to reduce or maintain stream temperatures are most effective when the goal is to keep water from warming, not cooling already warmed water. Upper reaches of watersheds may be most effective, but there may be exceptions such as in the Deschutes basin where plantings may be more effective in lower reaches than upper reaches because of cool water inputs. Areas of salmonid spawning and rearing, or shallow water habitats that need shading are appropriate.

Effectiveness is also tied to being able to establish appropriate buffer widths that are based primarily on stream size and aspect, but may be restricted by landowner objectives and cooperation.

One must determine site potential and locate projects or activities based on site specific information. Regional teams have place-based information to apply to determinations for project/activity sites.

b) *How can one determine the amount of landscape that would have to be treated over time in order to see a basin-wide response to restoration activities?*

Models such as Heat Source used for the TMDL process or the model SHADOW developed by USDA Forest Service, Pacific Norwest Region. Other suggestions included thermal credit tools and USFS ecological site guides (to assess site potential). If basin-scale responses are desired then basin-scale treatments are needed.

c) *Are there regional or ecoregional differences in the applicability of specific restoration activities?*

Group indicated that ecoregional differences would be expected but did not elaborate on it.

4) With regard to the site or system-wide responses one would expect to see as a result of the restoration activities being discussed:

a) *What responses would be expected? Is there a particular order that the responses would occur?*

1) Increased shading of the channel; then

2) Water quality improvement/water temperature decreases

b) *Where (with respect to the placement of a restoration activities) would the different responses be detected (e.g. at the site treated, upstream/downstream, sub surface, etc., please be as specific as possible)?*

At the restoration site

c) *At what geographic scales would the response be detected (e.g. stream reach, sub-basin, basin, watershed, etc.)?*

At the reach scale

d) *After implementation of an activity, when would you expect a response to be detected (e.g. months, years, centuries, unknown with our current state of knowledge)?*

Months to years, it depends on the species used and channel size and morphology.

5) For the activity discussed above:

a) *What are the key effectiveness monitoring questions you would use to determine success? How would restoration objectives and monitoring questions differ at the project/site and watershed scales?*

1) Is plant growth survival and growth adequate to meet objectives?

2) Is the level of canopy closure or shade moving in the right directions? or

Have you achieved the desired shade levels? Canopy closure occurs within a pre-specified time frame.

3) Is cover for fish being provided?

4) Is shade influencing stream temperature?

5) Are we achieving desired shade trends?

A good monitoring plan must have short-term surrogates to measure and tied to long-term validation monitoring. Are the trends moving in the right direction to meet the end goal?

b) *For the questions listed in 5(a), at what scales (geographic and temporal) would you conduct your monitoring and/or your analysis?*

1: In arid/semi-arid areas monitor at 1 year, 5 year, and 10 year timeframes (group did not specify for westside plantings). Timing of temperature response is hard to predict and may range in years to decades, other environmental factors must be taken into account.

2: Plant growth and survival would be measured at the site.

Stream temperature changes detected at the reach scale, downstream from planting. But need to obtain baseline data prior to implementation for comparison.

c) *What biotic and/or abiotic factors or field variables would you measure? What magnitude of change in these factors would have to occur before a significant response could be detected in the monitoring data?*

For plants measure growth, height, diameter, survival. Determine canopy closure and shade levels over stream channel.

6) Restoration effectiveness is often monitored/or proposed to be monitored by individual activities or at small local scales. Is this the optimum way for testing whether the Oregon Plan objectives are being met?

No.

a) *Are there logical monitoring groupings by type of restoration activity, or by location? At what scales?*

Participants suggested that the activities could be grouped based on monitoring components:

1. Riparian plantings and vegetation management including thinning
2. Livestock grazing management including off-site watering, riparian fencing, cross fencing, livestock rotations
3. Passive restoration including conservation easements, acquisitions, protection, vegetative buffers
4. Road management/surface drainage improvements including road decommissioning
5. Agricultural practices including wind breaks, no-till crop systems, terracing, sediment control basins, vegetative buffers.

b) *Could the intensity (density of sample points) or frequency of monitoring be varied if activities were grouped in some way? What are the potential pros and cons?*

- Start with modeling
- Use a subset of project monitoring to assess model validity and effectiveness
- Good spatial controls (e.g., paired watersheds) must be set up to account for other variables including climate, weather patterns, land use patterns, stream flow, elevation, soils, topology, etc. Be opportunistic for information sources.
- Gather information and rerun the model.
- Develop a program for failure analysis
- Measure the same parameters as used by the model. If a high uncertainty exists at the project level, it demands significant investment for data collection. Monitoring and evaluation are; intensive site level monitoring at smaller scales and possible use of models at the watershed level.
- Photographs can be a good tool for capturing visual information and interpreting results.
- Identify key areas and partnerships across the state to focus effectiveness monitoring efforts.

Appendices

Appendix 1: Agenda

IMST/OWEB Effectiveness Monitoring Workshop
April 18 & 19, 2006
LaSells Stewart Center
Oregon State University
Corvallis, Oregon

Tuesday, April 18

8:30	Welcome – Nancy Molina (Co-Chair, Independent Multidisciplinary Science Team
8:35–8:45	Introduction – Why the conference and the importance of effectiveness monitoring to the Oregon Plan – Michael Carrier (Governor's Natural Resource Office, State of Oregon, Salem)
8:45-9:05	Effectiveness monitoring and the Oregon Plan– Greg Sieglitz (Oregon Watershed Enhancement Board, Salem, OR)
9:05-9:30	Setting the stage: Progress toward comprehensive monitoring in Washington - Steve Leider (Governor's Salmon Recovery Office, State of Washington, Olympia, WA)
9:30-9:55	Washington Salmon Recovery Funding Board Reach Scale Effectiveness Monitoring Program – Jennifer O'Neal (Tetra Tech EC, Bothell, WA)
9:55–10:10	BREAK
10:10–10:35	Importance of scale, sampling design, and statistics – Don Stevens, Jr. (Department of Statistics, Oregon State University, Corvallis, OR)
10:35–11:00	Adaptive Monitoring for Watershed Condition Assessments in the Northwest Forest Plan area – Steve Lanigan (USDA Forest Service, Pacific Northwest Region, Portland, OR)
11:00–11:25	Monitoring and evaluation of data in a west-side watershed council – Jon Souder (Coos Watershed Association, Charleston, OR)
11:25-12:25	LUNCH
12:25–12:50	Monitoring and evaluation of data in an eastside watershed council–Bob Bower (Walla Walla Watershed Council, Milton-Freewater, OR)
12:50 –1:15	The Nature Conservancy Monitoring Program: Lessons learned and tools – Allison Aldous (The Nature Conservancy, Portland, OR)
1:15–1:30	Public Comment

1:30–1:40	Explain workgroup sessions and expectations desired outcomes prior to dividing up (Nancy Molina, Co-Chair IMST)
1:40–3:00	Workgroup session #1
3:00–3:10	BREAK
3:10–5:00	Workgroup sessions #2
5:00–5:30	Steering committee/facilitators debriefing meeting
5:00–6:00	RECEPTION and POSTER SESSION
6:00–6:25	Building Science and Accountability into Community-based Restoration - Todd Reeve (Bonneville Environmental Foundation, Portland, OR)
6:25–6:50	Evaluating Habitat Restoration for Pacific Salmon: Results of Case Studies and Guidance for Monitoring Design - Martin Liermann National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA)
6:50–7:15	Intensively Monitored Watersheds vs. Intensively Manipulated Watersheds: How to apply the "limiting factor, engineering solution, biological response" approach to restoration at the watershed scale – Chris Jordan (NOAA Fisheries, Newport Research Station, Newport, OR)

Wednesday, April 19

8:30–9:00	Summary of Tuesday working group discussions (Lead by facilitators)
9:00–9:10	BREAK
9:10–12:00	Workgroup sessions #3
12:00–12:30	LUNCH
12:30–2:40	Workgroup sessions #4
2:40–2:50	BREAK (drinks & snacks)
2:50–4:00	Summary Session – all work groups meet in lecture hall
4:00–4:45	Open Microphone/Public Comment:
4:45–5:00	Wrap up: Nancy Molina and Greg Sieglitz and facilitators.

Appendix 2: Workshop Participants

Fish and Aquatic Habitat Work Group

Facilitator: Marcia Sinclair

Invited Participants:

Phil Kaufmann	US Environmental Protection Agency
Stan Gregory	Department of Fisheries and Wildlife, Oregon State University,
Gordon Reeves	US Forest Service, Pacific Northwest Research Station
Hiram Li	USGS-NBS Oregon Cooperative Fishery Research Unit
Judy Li	Department of Fisheries and Wildlife, Oregon State University
Jeff Rodgers	Oregon Department of Fish and Wildlife
Rachel Hoffman	Tillamook Estuaries Partnership
Jim Ruzycki	Oregon Department of Fish and Wildlife
Al Doelker	USDI Bureau of Land Management
Deborah Konnoff	US Forest Service, Pacific Northwest Region
Cindy Thieman	Long Tom Watershed Council
Martin Liermann	NOAA Fisheries, Northwest Fisheries Science Center
Rick Hafele	Oregon Department of Environmental Quality
Wayne Hoffman	Mid-Coast Watershed Council

IMST Members Present:

Carl Schreck	Independent Multidisciplinary Science Team
Vic Kaczynski	Independent Multidisciplinary Science Team

Note Takers:

Nancy Gramlich	Oregon Department of Environmental Quality
Erin Gilbert	Oregon Department of Fish and Wildlife

Others/ Audience Participants:

Guillermo Giannico	Department of Fisheries and Wildlife, Oregon State University
Mark Grenbemer	Oregon Watershed Enhancement Board
Paul Wagner	Keith Wolf Associates (KWA) Ecological Sciences, Inc
Christopher Currens	ABR, Inc. Environmental Research and Services
Shannon Hubler	Oregon Department of Fish and Wildlife
Jesse Schwartz	Confederated Tribes of the Umatilla Indian Reservation
Russell Scranton	NOAA Fisheries, Northwest Regional Office

Hydrology and Watershed Function Work Group

Facilitator: Paul Hoobyar

Invited Participants:

Coby Menton	Grande Ronde Model Watershed
Allison Aldous	The Nature Conservancy
Jeff McDonnell	Department of Forest Engineering, Oregon State University
John Runyon	Adolfson & Assoc.
Jim Wigington	US Environmental Protection Agency
Mike Furniss	US Forest Service, Pacific Northwest Research Station
Mike Mulvey	Oregon Department of Environmental Quality
Chris Jordan	NOAA Fisheries, Northwest Fisheries Science Center
Bob Bower	Walla Walla Watershed Council

IMST Member(s) Present:

Carlton Yee	Independent Multidisciplinary Science Team

Note Takers:

Jeni Gatherum	Oregon Watershed Enhancement Board
Becky Miller	Oregon Watershed Enhancement Board

Others/Audience Participants:

Tom Shafer	Oregon Watershed Enhancement Board
Rachel Burr	Oregon Department of Environmental Quality
Kimberly Schoenk	Oregon Water Trust
Ivan Camacho	Oregon Department of Environmental Quality
Denise Lofman	Tillamook Bay Watershed Council
Brad Houslet	Confederated Tribes of the Warm Springs Reservation
Kevin O'Brian	Applegate Watershed Council

Upland and Riparian Area Condition Work Group

Facilitator: Mike Schnee

Invited Participants:

Wayne Elmore	US Bureau of Land Management (retired)
Leslie Bach	The Nature Conservancy
Tim Deboodt	OSU Extension, Crook County
Ryan Houston	Upper Deschutes Watershed Council
Kelly Burnett	US Forest Service, Pacific Northwest Research Station
Sandy DeBano	Department of Fisheries and Wildlife, Oregon State University
Sam Chan	Oregon Sea Grant, OSU
Bob Beschta	Dept. of Forest Engineering, Oregon State University (emeritus)
Steve Lanigan	US Forest Service, Siuslaw National Forest
Gregg Riegel	US Forest Service, Deschutes National Forest
Jim Cathcart	Oregon Department of Forestry
Jon Souder	Coos Watershed Association
Matt Swanson	South Coast Watershed Council

IMST Members Present:

Nancy Molina	Independent Multidisciplinary Science Team
Neil Christensen	Independent Multidisciplinary Science Team

Note Takers:

Audrey Hatch	Oregon Department of Fish and Wildlife
Larry Whitney	Oregon Department of Environmental Quality
Larry Marxten	Oregon Department of Environmental Quality
Leyla Arsan	Department of Fisheries and Wildlife, Oregon State University
Susan Morré	Department of Forest Science, Oregon State University

Others/Audience Participants:

Chris Vogel	Applegate Watershed Council
Jo Morgan	Oregon Department of Fish and Wildlife
Betsy Parry	Habitat biologist, independent
Douglass Fittering	Oregon Watershed Enhancement Board
Hugh Barrett	CRS Consulting
Don Stevens	Department of Statistics, Oregon State University
Jennifer O'Neal	TetraTech
Jennifer Weikel	Oregon Department of Forestry
Kathy Maas-Hebner	Department of Forest Science, Oregon State University

Water Quality Work Group

Facilitator: Rick Bastasch

Invited Participants:

Lesley Jones	Upper Deschutes Watershed Council
Phil Larsen	US Environmental Protection Agency
Greg Pettit	Oregon Department of Environmental Quality
Stewart Rounds	US Geological Survey
Trish Carroll	US Forest Service, Pacific Northwest Region
Shaun McKinney	USDA Natural Resources Conservation Service
Paul Measeles	Oregon Department of Agriculture
Sherri Johnson	US Forest Service, Pacific Northwest Research Station
Keith Wolf	Keith Wolf Associates (KWA) Ecological Sciences, Inc

IMST Member(s) Present:

Michael Harte	Independent Multidisciplinary Science Team

Note Takers:

Bobbi Riggers	Oregon Watershed Enhancement Board
Doug Drake	Oregon Department of Environmental Quality

Others/Audience Participants:

Steve Hanson	Oregon Department of Environmental Quality
Jordan Palmeri	Oregon Department of Environmental Quality
Sandy Lyon	Partnership for the Umpqua Rivers
Jason Frederickson	Tenmile Lakes Basin Partnership
Todd Shaw	Confederated Tribes of the Umatilla Indian Reservation
Pat Oman	Oregon Watershed Enhancement Board
Jamie Sheahan	Yamhill Basin Council
Ken Bierly	Oregon Watershed Enhancement Board

Appendix 3: Plenary and Evening Session Presenters' Abstracts

Allison Aldous
The Nature Conservancy
Portland, OR

<u>The Nature Conservancy Monitoring Program: Lessons Learned and Tools</u>
The Nature Conservancy has an active monitoring program for species and ecosystems to evaluate the effectiveness of conservation strategies as well as to identify and prioritize future activities. Monitoring projects are identified and prioritized during conservation planning, and tracked using an MS Access® database that is distributed to field stewards throughout the state. In addition, we have an adaptive management schedule whereby all monitoring activities are reviewed on a biennial basis.

Bob Bower
Walla Walla Basin Watershed Council
Milton-Freewater, OR

<u>Monitoring and evaluation of data in an eastside watershed council</u>
The Walla Walla Basin Watershed Council (WWBWC) is located in Northeastern Oregon, in a bi-state watershed where the Walla Walla River converges with the Columbia River in Washington. The WWBWC has been active in the area of effectiveness monitoring over its 12 year history in a number of areas.

The WWBWC continues to be the lead effectiveness-monitoring entity for a landmark bi-state USFWS-Irrigation District Flow Agreement (2000 to present) that re-watered a segment of the Walla Walla River that had been dry for over a hundred years. The WWBWC along with Oregon Department of Environmental Quality co-developed a temperature model for a temperature TMDL (2005) on the mainstem Walla Walla River. This process garnished a wide variety of baseline conditions and reference site information for long-term effectiveness monitoring including channel complexity, water quality, hydrologic regime, improved meandering and channel complexity, stream shading and water temperatures. Temperature and flow models developed during this TMDL process are currently used by the WWBWC as management tools to help prioritize activities, and assess potential benefits of various restoration actions for ESA fish species and TMDL implementation.

The WWBWC has also been utilizing Oregon Water Resource Department (OWRD) historical and WWBWC baseline flow and ground water information to identify a dropping water table in near-river shallow aquifer and spring-creek system. This information led to the WWBWC working with a local irrigation district to design, build and operate the first aquifer recharge project under OWRD's new limited license process in the state of Oregon. This particular project demonstrates an excellent example of applied-solutions type of approach to restoration that watershed councils are often the most likely to apply. Baseline and trend monitoring information provided guidance for an on-the-ground solution. We are now monitoring the effectiveness of the project as it raises the water table in wells and flows in spring branches within a few mile radius of the project site.

The WWBWC has also been involved in variety of other effectiveness monitoring areas including fish passage (fish telemetry studies) and diversion (seepage runs and measuring devices), biological and community integrity (pre/post Walla Walla River conditions macroinvertebrates sampling) and irrigation improvements (diversion meters and stream gauging).

The WWBWC has only been successful in its effectiveness monitoring work by creating and fostering strong partnerships with the above listed agencies as well as Oregon State University, Oregon State University Extension Service, Washington State University, United States Geological Survey, Oregon Department of Fish and Wildlife, the Confederated Tribes of the Umatilla Indian Reservation, Washington Department of Fish and Wildlife, Washington Department of Ecology, Walla Walla Watershed Alliance, Hudson Bay District Improvement Company, Walla Walla River Irrigation Districts, Gardena Farms No. 13 Irrigation District, Natural Resource and Conservation Service, Walla Walla County Conservation District and Umatilla County Soil and Water Conservation District, and of course the landowners.

Chris Jordan
NOAA- Fisheries, Newport Research Station
Newport, OR

Intensively Monitored Watersheds vs. Intensively Manipulated Watersheds: How to apply the "limiting factor, engineering solution, biological response" approach to restoration at the watershed scale

The basic premise of the Intensively Monitored Watershed (IMW) program is that the complex relationships controlling salmon response to habitat conditions can best be understood by concentrating monitoring and research efforts at a few locations. Focusing efforts on a relatively few locations enables enough data on physical and biological attributes of a system to be collected to develop a comprehensive understanding of the factors affecting salmon production in freshwater. As such, an IMW is a logical method for achieving the level of sampling intensity necessary to determine the response of salmon to a set of management actions; but at what spatial scale is the IMW concept the most effective? For the IMW approach to be applied in the context of restoration action effectiveness monitoring, some form of treatment-control contrast is needed. Does this imply that multiple replicate IMWs are needed, or that treatment-control subwatersheds are defined within a single IMW, or is the IMW approach limited to some form of temporal or BACI design? Under any of these scenarios, the primary goal of an IMW based restoration strategy would be to demonstrate the restoration actions effectiveness. However, we know that evaluating biological responses to large-scale restoration actions is complicated, requiring an understanding of how these actions interact to affect habitat conditions and how system biology responds to these habitat changes. So perhaps IMWs are most effectively applied to restoration planning as natural laboratories best suited to generating hypotheses to support restoration and monitoring strategies.

Steve Lanigan (presenter) **and Jon Martin**
USDA Forest Service, Pacific NW Region, Resource Planning and Monitoring
Portland, OR

Adaptive Monitoring for Watershed Condition Assessments in the Northwest Forest Plan area

The Aquatic and Riparian Effectiveness Monitoring Program (AREMP) recently completed a preliminary 10-year assessment of watershed condition in the Northwest Forest Plan area. Some of the key lessons we learned about monitoring include:

- The decision support models used to assess watershed condition were an effective tool;
- targets or measurable objectives should be identified prior to monitoring efforts;
- “thresholds” are needed to indicate when management actions need to be changed;
- compliance (“did we follow standards and guidelines”) and activities (“where and when did an action take place?”) monitoring should be closely linked to effectiveness monitoring;
- there are lots of GIS data, but it’s currently difficult to compile them all into Plan area coverages;
- managers want monitoring programs to address both short- and long-term questions about the effect of management actions on watershed condition at different scales;
- agencies need to be thinking about how to address questions that will be asked in 5 – 10 years;
- it’s important to keep executives “in the loop” about monitoring activities, because of high personnel turnover;
- scientific credibility is absolutely critical, and
- we’re still seeking the “proper balance” between using intensively sampled in-channel attributes, and using upslope and riparian GIS and remote sensing data.

Steve Leider
Governor’s Salmon Recovery Office, State of Washington
Olympia, WA

Setting the Stage: Progress Toward Comprehensive Monitoring in Washington

Washington State has made progress toward developing and implementing a comprehensive salmon recovery and watershed health monitoring effort within the last decade. Listings of salmon, trout and steelhead that occurred across much of the state in the 1990s lead to creation of the organizational structure now being used in the state for salmonid restoration and recovery. This included legislative recognition of the importance of monitoring. In 2002, the state completed a Comprehensive Monitoring Strategy (CMS) and Action Plan, largely based on an earlier report from the state’s Independent Science Panel (ISP). Drawing upon ongoing advice from the ISP the CMS addressed various types of monitoring (i.e., implementation, status and trends, reach-scale and watershed-scale effectiveness and validation monitoring), and recommended high priority actions. Effectiveness monitoring was among the highest priorities. In 2003, the Salmon Recovery Funding Board (SRFB) began implementing the effectiveness monitoring recommendations contained in the CMS, by providing initial funding for watershed-scale monitoring (intensively monitored watersheds) and later, made a major change in approach to SRFB effectiveness monitoring at the project-scale. To continue to improve coordination, in 2004, by Executive Order the Governor's Forum on Monitoring was created. Collectively, these efforts substantially increase our ability to show progress and improve accountability, but much work remains to be done. Challenges include making the myriad complexities of monitoring understandable to lay audiences, and finding an affordable balance between technical rigor and relevance at the local scales with the extensive and diverse needs at regional and statewide scales.

Martin Liermann (presenter) **and Phil Roni**
Northwest Fisheries Science Center, National Marine Fisheries Service
Seattle, WA

<u>Evaluating Habitat Restoration for Pacific Salmon: Results of Case Studies and Guidance for Monitoring Design</u>
Over the last decade our program has been involved with effectiveness monitoring of several types of habitat restoration including: placement of large woody debris, boulder weirs, engineered logjams, dam removal, nutrient addition as well as whole watershed restoration. These studies have used various study designs, but have generally shown localized improvements in habitat and increases in juvenile salmon abundance following habitat restoration. Using the results of these studies we provide some basic recommendations for monitoring design. In particular, with recent emphasis shifting towards watershed-scale effects of restoration, we use data from these and other studies to estimate the level of replication needed to detect a fish response using a before-after control impact design (BACI). Finally, we discuss the trade offs between spatial and temporal replication, and costs of watershed-scale effectiveness monitoring.

Jennifer O'Neal (presenter) **and Bruce Crawford**
Tetra Tech EC
Bothell, WA

<u>Washington Salmon Recovery Funding Board Reach Scale Effectiveness Monitoring Program</u>
The Washington State Salmon Recovery Funding Board (SRFB) was created by the state legislature in 1999 and since then has funded more than 695 projects and spent more than $241 million in state and federal funds toward salmon recovery. There is a need for the SRFB, as well as state and federal government, to have accountability for the effects of these expenditures. It is not economically feasible to monitor the long-term success of every project funded, so projects were grouped into monitoring categories of which a subset were monitored. The results from this monitoring are expected to provide information about the probable effectiveness of other projects in the same category. Monitoring categories include: fish passage, in-stream structures, riparian plantings, livestock exclusions, constrained channels, channel connectivity, gravel placement, and diversion screening restoration. The intent of the monitoring was to test whether habitat targeted for restoration had been improved, and for some projects, whether local stream reach abundance of salmon and steelhead had increased. Where structures were part of habitat improvement, engineering specifications were also tested for effectiveness in meeting design criteria over time.

The type of statistical test used for analysis varied by project type. Seven categories (fish passage, in-stream structures, riparian plantings, livestock exclusions, constrained channels, channel connectivity, gravel placement) are being tested using a Before After Control Impact (BACI) experimental design. Because there are no control areas established for Habitat Protection Projects, change over time will be assessed using regression analysis and a non-parametric statistical approach.

Field sampling indicators and field sampling techniques were adopted from U.S. Environmental Protection Agency's (EPA's) Environmental Monitoring and Assessment Program (EMAP) (Peck 2003). Each of the nine project types had a specific protocol adapted from EMAP that was used to collect data on attributes designed to detect changes in habitat, fish populations, or ecological status expected to result from project implementation. Summary statistics calculated from the field data were entered into the PRISM database maintained to track SRFB-funded restoration projects across the state. A paired t-test for BACI projects was used to test for changes between control and impact reaches before and after implementation. For Habitat Protection Projects, summary statistics will be tracked for change over time using either regression or non-parametric statistical methods.

The data presented in this presentation represent preliminary findings from the first 2 years of data collection. Any indications of change need to be viewed both within the context of the project and the longer-term perspective that will be developed over the life of the monitoring program.

Todd Reeve
Bonneville Environmental Foundation
Portland, OR

Building Science and Accountability into Community-based Restoration

In 2004, the Bonneville Environmental Foundation (BEF) reviewed the results of its first five years of watershed restoration funding in the Pacific Northwest states of Montana, Idaho, Oregon, and Washington. We examined completed restoration projects, interviewed watershed managers, and reviewed past project proposals to determine if BEF's conventional one to two-year grants were promoting accountable, scientific, and watershed-scale restoration. Our evaluation indicated that BEF's short-term funding was likely to promote site-specific interventions and discourage rigorous, sustained monitoring and a watershed-scale approach. In an effort to advance accountable and increasingly effective restoration, BEF developed and is now applying an experimental long-term funding approach.

Greg Sieglitz
Oregon Watershed Enhancement Board
Salem, OR

Effectiveness Monitoring and the Oregon Plan

The Oregon Plan for Salmon and Watersheds was initiated in 1997 as a broad based effort of citizens, local watershed groups, the State of Oregon, and federal agencies to restore healthy salmonid populations and watersheds. The Oregon Watershed Enhancement Board's (OWEB) monitoring program is an integral part of the Oregon Plan and includes information management and distribution, coordination of Oregon Plan monitoring, effectiveness monitoring of restoration actions, and grant program feedback. The OWEB Effectiveness Monitoring Program is staffed by a coordinator and will review western juniper (*Juniperus occidentalis*) removal and irrigation efficiency; will solicit independent review of OWEB funded restoration projects for effectiveness; help implement watershed scale evaluation of projects; and conduct alternatives futures modeling and analysis. The rest of the presentation introduced the audience to the goals of the workshop and briefly defined types of monitoring being conducted for restoration activities. (Abstract prepared by IMST staff)

Jon A. Souder
Coos Watershed Association
Charleston, OR

Monitoring and Evaluation of Data in a West-side Watershed Council

The Coos Watershed Association, founded in 1993, began simple monitoring of its restoration projects in 1997. Since that time—during implementation of approximately 300 restoration projects—monitoring has been inculcated into the organization's adaptive management culture. The three pillars that provide the foundation for this monitoring include collection of basic data, use of baseline watershed assessments, and application of standard protocols. During this time, they have progressed from site-specific project-effectiveness to a more rigorous approach of implementation, program-effectiveness, and validation monitoring at multiple scales. Monitoring needs have resulted in the development of analytical tools for riparian silviculture, road surveys, and coastal wetlands. Results have been compiled into three peer-reviewed program-effectiveness monitoring reports covering fish passage and in-stream complexity, riparian restoration, and road sediment reduction.

Don L. Stevens, Jr.
Oregon State University, Statistics Department
Corvallis, OR

Importance of Scale, Sampling Design, and Statistics

One of the important issues in effectiveness monitoring is how to take information from a few well-studied sample applications, and extend or scale-up to regional applications. The issue is strongly related to the change of support problem (COSP) considered in geostatistics. Similarly, the modifiable area unit problem (MAUP) is concerned with the influence of aggregation and scaling on the relationship of two (or more) variables. In this talk, I'll discuss the influence that aggregation and scaling can have on apparent relationships, and suggest some techniques to counter that influence. I'll also review some design principles for selecting sites to test the effectiveness of restoration activities.

Appendix 4: Poster Abstracts

Kyle Abraham, Jennifer Weikel, Jim Cathcart, Liz Dent
Oregon Department of Forestry
Salem, OR

<u>Riparian Function and Stream Temperature: Monitoring the Effectiveness of Oregon Department of Forestry's Protection Rules and Strategies.</u>
Streamside riparian areas have long been studied for their importance in providing stream shade, high quality aquatic habitat, and maintaining water quality standards. In Oregon, harvest units associated with fish-bearing streams require specific vegetation retention standards (Private land uses OAR 629-640-0100; State Forests use the Northwest Oregon State Forest Management Plan) The forest practices monitoring section of the Private and Community Forest Program, Oregon Department of Forestry (ODF) has been monitoring stream temperature since 1994 and riparian stand structure and function since 1996. Early ODF stream temperature studies compared stream temperatures and conditions upstream of harvest units to stream temperatures and conditions downstream of harvest units to evaluate the effectiveness of current rules in meeting Department of Environmental Quality (DEQ) water quality standards. This approach did not adequately address the effectiveness questions due to a lack of pre-treatment (pre-harvest) data. This study uses a before-after control-impact (BACI) study design to evaluate the effectiveness of the Forest Practices Act and the State Forest Management Strategies in maintaining stream temperature and for providing adequate large wood. The BACI design allows for a period of pre-harvest data collection to calibrate the stream conditions followed by a period of post-harvest conditions with which to compare.

The specific monitoring questions for this study include:

1. Are the riparian rules and strategies effective in meeting DEQ water quality standards regarding anti-degradation of stream temperature and the water quality standard?
2. Are the riparian rules and strategies effective in maintaining large wood recruitment to streams, downed wood in riparian areas, and shade?
3. What are the trends in riparian area regeneration?
4. What are the trends in overstory and understory riparian characteristics and how do they along with channel and valley characteristics relate to stream temperature and shade?

Results from an analysis of the pre-harvest data are highlighted.

Tim Deboodt[1], Michael Fisher[2], John Buckhouse[3], and John Swanson[4]
[1]OSU Crook County Extension Service, Prineville, OR
[2]Central Oregon Community College, Bend, OR
[3]OSU Department of Rangeland Ecology and Management, Corvallis, OR
[4]USDI Bureau of Land Management, Prineville, OR

<u>Camp Creek Paired Watershed Juniper Control/Water Quantity Monitoring Project</u>
A paired watershed study was established in 1994 to analyze the impacts of western juniper encroachment on streamflow quantity and quality. The project is located in the Camp Creek drainage, a tributary of the Crooked River, Deschutes River Basin. Research indicates that the

encroachment of western juniper inhibits water retention and storage as well as altering the timing of release of groundwater. This phenomenon is of great importance in eastern Oregon due to western juniper dominated systems increasing from an estimated 420, 000 acres in 1934 to 6,000,000 acres today.

Monitoring since 1994 has established similarities and differences between the two watersheds. Baseline data collected annually in each watershed includes streamflow, vegetation parameters, precipitation, and soil movement. Additional monitoring added in 2004 includes depth to ground water, volume of spring flow, weather parameters, snow depth accumulation and soil moisture. Preliminary analysis of pre-treatment groundwater data shows the two watersheds to be similar in timing of groundwater movement and springflow, but different in volume and duration of springflow. In the fall of 2005, western juniper was cut in one watershed (approximately 120 hectares). Monitoring of both watersheds will continue through June 2008. Analysis of post-treatment data will be conducted to assess changes in water relationships between the two watersheds that are a result of the treatment.

Paul Jacobsen
Oregon Department of Fish and Wildlife
Corvallis, OR

Instream Enhancement and Assessment: What do we know so far

Overwintering habitat likely limits freshwater survival of coho salmon in Oregon (Oregon Coastal Coho Assessment 2005). Large wood, historically present in large quantities in most coastal basins and in the Willamette Valley (Sedell and Luchessa 1982), is now often absent or found in low volumes due to a variety of reasons, including stream cleaning, logging practices, and agricultural activities. Adding large wood to streams can increase habitat complexity and pool area, improving overwintering survival of several salmonid species (Nickelson et al, 1992, Solazzi et al, 2000, and Johnson et al, 2004). We conducted aquatic habitat surveys in 85 stream reaches in Western Oregon. Large wood was then added to each reach in complex jams. Repeat surveys conducted one or two years after wood additions indicate that the number of large wood pieces, wood volume, and the number of "key" wood pieces increased. Post-treatment surveys did not detect changes in other parameters such as pool area or channel substrate. We expect such changes to occur over a time scale of five to fifty years. Accordingly, long-term monitoring of modified reaches is necessary to fully characterize the effect of large wood addition on coho overwintering habitat.

Lesley Jones
Upper Deschutes Watershed Council
Bend, OR

Restoration effectiveness monitoring in priority watersheds of the Deschutes Basin

The complex issues in the Deschutes Basin are illustrative of watershed restoration challenges across Oregon. In particular, highly regulated flows have resulted in impaired water quality and a need for extensive instream flow restoration. The effectiveness of basin-wide efforts to improve water quality via instream flow restoration is of interest to natural resource decision makers who apply limited budgetary resources toward achieving balance between out of stream irrigation demands and instream ecological needs. The Upper Deschutes Watershed Council Water Quality Monitoring Program (UDWC program) prioritizes watersheds based on restoration activities, evaluates the status and trends of multiple water quality parameters that are expected to change upon restoration, and provides water quality analyses to help refine preliminary flow restoration targets. Through these services, the UDWC program provides the technical tools needed by natural resource decision makers to achieve future watershed restoration across the Deschutes Basin.

Michael P. Mulvey and Aaron N. Borisenko
Oregon Department of Environmental Quality, Watershed Assessment Section
2020 SW Fourth Avenue, Suite 400, Portland OR 97201

An Assessment of the Chemical, Habitat and Biological Condition of Wadeable Streams in the Lower Columbia Region of Oregon

We conducted a two-year study of the biological, chemical and habitat quality of first through third order, wadeable streams in the Oregon portion of the Lower Columbia basin. We surveyed 54 randomly selected streams and 17 non-random reference streams in 2003 and 2004 during June, July, August and September using the US EPA Environmental Monitoring and Assessment Program wadeable streams protocol. This region includes the spawning and fresh water rearing habitat of several anadromous salmonids that are listed or being considered for listing as threatened under the Endangered Species Act. It also contains Portland, Oregon's largest city.

We found that the most extensive stressors in wadeable streams were high levels of fine sediment, high turbidity, and warm water temperatures. These stressors impair 30 to 40% of the wadeable stream miles. Water temperature, fine sediment, phosphorus and turbidity were on average significantly higher across the region relative to high-quality reference sites. Although we found stream habitat simplification and alteration were less extensive (<10%), when present these stressors were significant risk factors to the biological integrity of the aquatic vertebrate and macroinvertebrate communities. Habitat simplification and alteration were indicated by decreased amounts of large woody debris habitat, increased proportion of glide habitat, and reduced stream shade relative to reference sites.

We also compared our findings to the 2002 303d List of Water Quality Limited Streams which was compiled using non-randomly selected data. Overall, the 303d List greatly underestimated both the extent and the types of impairment present relative to the probabilistic stream assessment data.

Russell Scranton
Herrera Environmental Consultants Inc.
Portland, OR

The Application of Geographic Information Systems for Delineation & Classification of Tidal Wetlands for Resource Management of Oregon's Coastal Watersheds

Oregon 's tidal wetlands resource managers needed an improved GIS layer for management of existing tidal wetland habitat and areas considered for tidal wetland restoration. A reconnaissance project was initiated, whereby interpretations of remote sensing data, the National Wetland Inventory, Oregon Estuary Plan Book and additional management tools were used to create a Tidal Wetland data layer, as an ArcGIS Geodatabase, for Oregon 's coastal estuaries. This data set classifies existing tidal wetland status for evaluation based on (1) the hydrogeomorphic (HGM) classification, adopted nationally and by the State of Oregon and (2) habitat classification based on the Oregon Estuary Plan Book and National Wetland Inventory classification system. The classification "restoration consideration areas" was developed for lands where restoration of tidal circulation might be geotechnically feasible pending further investigations. Additional groundwork and validation of the data's classifications is recommended before this interpretation is used as an official reference for resource management.

This project was also developed to provide a GIS base layer, which when combined with supplementary data sets, would enhance the ability of resource mangers and citizens to prioritize tidal wetland restoration efforts and evaluate the ecological integrity of restored and natural tidal wetlands. Further development of the data set may enhance management of Goals 16 and 17 of Oregon's Statewide Planning Goals Guidelines and aid in management of non-point source pollution and the prioritization of habitat restoration for Oregon Coastal Coho Populations for addressing existing limiting factors. Resource managers and the public will be able to view and interpret this data layer and supporting documentation online at the Oregon Coastal Atlas.

Appendix 5: Summary of Responses to Pre-workshop Survey

Prior to the workshop steering committee asked 44 invited workshop participants to answer the following questions:

1. If you are currently involved in effectiveness monitoring (of any kind, not just for restoration), briefly list the policies, programs, requirements or other authorities that guide your monitoring. What are the approximate funding amounts and sources for your monitoring?
2. What restoration activities are you involved with, and what objectives are they meant to accomplish (relate to the list of objectives provided below where possible)? At what scales of space (site, reach, segment, watershed, etc.) and time are these activities performed?
3. What methods (sampling designs, indicators, and effectiveness criteria) have you used to monitor those restoration activities? What are the objectives of this monitoring, and what questions are you trying to answer? How would you categorize this monitoring in terms of implementation, effectiveness, validation, or assessment? What is the duration and frequency of your monitoring? What are the factors that limit the frequency and duration?

The answers from this survey were summarized in three broad affiliation categories by Courtney Shaff, OWEB, and Kathy Maas-Hebner, OSU:

Affiliation Category	Number of Responses Received
Universities (Land Grant & Sea Grant)	5
State and Federal Agencies	13
Non governmental organizations	6

Non-governmental organizations included watershed groups, conservation groups, and consultants providing services to the non-governmental organizations. The compiled information is contained on the following pages and describes the various backgrounds and experiences workgroup participants have with effectiveness monitoring.

Notable differences among the groups include scales and time frames of monitoring, funding sources, and overall contributions made to monitoring. The most common constraints identified by the three groups were inadequate funding and limited staff. Some non-governmental organizations also indicated a lack of available technical expertise needed to carry out effectiveness monitoring programs.

Overall contributions to monitoring efforts also differ by group. Agency, university and extension staffs provide technical assistance in statistical designs, data integration and analysis, protocol and sampling procedure to one another and to non-governmental organizations. Through research efforts, universities and agencies increase the body of knowledge of natural processes, the recovery of populations, and the physical components of habitats used for restoration and monitoring. Non-governmental organizations work with technical consultants and partner with other organizations and companies to increase available resources and may provide data to state and/or federal agency monitoring programs.

State and Federal Agencies

State and federal agency responses indicated that agencies often conduct monitoring to determine the effectiveness of programs or management actions, as well as measuring the effectiveness of individual actions/projects or cumulative effects of actions. The scales of agency monitoring efforts vary from specific sites or projects to large river basins. The duration of monitoring is determined by objectives and can range from a single day to several decades. Monitoring by agency management sectors is often driven by state and federal reporting requirements, rules, and legislation. Agencies may also be directly involved with monitoring related to research and or status and trends of natural resources.

Types of monitoring

- Permit compliance/implementation
- Assessments/inventories
- Status and trend
- Effectiveness
- Validation

Geographic scales

- Site – permit compliance
- Reach
- Segment
- Watershed
- Basins (e.g., Columbia River, Klamath River, Deschutes)

Funding sources

- BPA
- Federal and State funds
- Permit fees
- State and federal grants
- Sport fish restoration funds
- PCSRF
- BLM
- NOAA Fisheries
- USFS
- OWEB

Sampling procedures and protocols used are often standardized/established and published and used across multiple regions state-wide (or in the case of federal agencies nation-wide). <u>Some examples of protocols used include</u>: ODFW methods for aquatic inventories and monitoring; Rosgen stream classification; rangeland health; digital photography.

<u>Other contributions to effectiveness monitoring include</u>: agency staff providing technical assistance in statistical designs, data integration and analysis, developing protocols, and sampling procedures.

Through research, state and federal agencies increase the body of knowledge on natural processes, the recovery of populations, and the physical components of habitats.

Examples of projects include: Monitoring of water quality to determine the effectiveness of the implementation of plans and rules. Monitoring of projects funded by the Salmon Recovery Funding Board to determine project level and project type effectiveness. Project types include livestock exclusion, fish passage, and in stream habitat.

Major factor limiting monitoring: Funding, staff availability, time

Universities, land grant

Effectiveness monitoring at land grant universities is related to specific research and extension programs or cooperative research agreements made with management agencies targeting specific actions or cumulative effects of restoration actions. Geographical scales range from site to large river basins. The duration of monitoring varies by specific research or extension objectives from one year to several decades.

Types of monitoring

- Assessments
- Effectiveness
- Validation

Geographic scales

- Site
- Reach
- Segment
- Watershed
- Basins (e.g., Columbia River, Klamath River, Deschutes)

Funding sources

- State and federal grants
- ODEQ
- EPA
- National Science Foundation
- BPA

Sampling procedures and protocols used are often standardized/established and published and used across multiple regions state-wide (or in the case of federal agencies nation-wide). Sampling procedures can range from basic (e.g., snorkel surveys) to complex and equipment intensive.

Other contributions to effectiveness monitoring include: developing protocols and sampling procedures conducting research and effectiveness monitoring for agencies. Through research land grant universities (as well as other universities) increase the body of knowledge on natural processes, the recovery of populations, and the physical components of habitats.

Examples of projects include: Long-term monitoring of conservation easements to determine the effectiveness of restoration actions in addressing project objectives, such as improved water quality. Before and after monitoring of a stream re-channelization project in order to determine its effectiveness in improving biological and community integrity of the stream. ODF is using effectiveness monitoring if the Oregon Forest Practice Rules are maintaining stream temperatures in the Oregon Coast Range. A paired watershed study is being conducted in eastern Oregon to determine the effectiveness of using western juniper removal to alter streamflow quantity and quality.

Major factor limiting monitoring: Funding and staff and/or graduate student availability

Non-Governmental Organizations

Non-governmental organizations are involved in different levels and types of effectiveness monitoring which often depend on the size and structure of the organization. The scale the monitoring is conducted at varies from specific sites or activities to the watershed level. The duration also varies by organization and monitoring objectives from ≤ 5 years to a decade or more. Effectiveness monitoring is often driven by reporting requirements of grantors as well as adaptive management objectives and the need to demonstrate effectiveness of individual restoration projects or groups of projects to stakeholders and volunteers.

Types of monitoring

- Implementation
- Effectiveness
- Validation

Geographic scales

- Project/site specific
- Reach
- Watershed

Funding Sources

- DEQ 319
- USFWS Jobs in the Woods
- OWEB
- Siskiyou RAC (Title II)
- Oregon Community Foundation
- ODFW's R&E
- In-kind Donations
- SWCDs
- EPA
- Private grants/donations

Sampling procedures and protocols vary from basic, less equipment intensive methods (e.g., visual estimates, photo points) to detailed, scientifically rigorous data collection. Some examples of protocols used include: EPA EMAP, Photo Point Monitoring, ODFW Spawner Survey Methods, Coastal Lowlands Riparian Silviculture Manual, and Water Quality Monitoring: Oregon Plan for Salmon and Watersheds.

Examples of projects include: Long-term water quality monitoring related to TMDL implementation. Long-term effectiveness and validation monitoring are being used to determine the effectiveness of road improvement projects at reducing sediment inputs adjacent streams. Long-term temperature monitoring is being used to determine the effectiveness of riparian planting and bank stabilization on maintaining and lowering stream temperatures. Effectiveness of fish passage projects at passing the intended species and lie stages

Other notes: Many groups work with technical consultants and partner with other organizations and companies to increase resources.

Major factors limiting monitoring: Funding, staff, technical expertise.

Appendix 6: Workshop Questions for Work Groups

I. Setting the groundwork on restoration activities conducted in Oregon

1) Review the list (provided by OWEB) of restoration activities and objectives associated with this work group topic.

a) Are these appropriate for the work group discussion?

b) Are there other activities not included in the list?

c) General discussion on restoration objectives.

2) In your experience, which of the activities discussed in Question 1 have been shown to be effective either through research or long-term effectiveness monitoring programs, and which are still experimental?

3) With regard to placement of restoration activities,

a) Where in a watershed or river basin would the group expect these restoration activities to be most effective (e.g., lower or higher stream orders; upper of lower terrestrial areas of the watershed)?

b) How can one determine the amount of landscape that would have to be treated over time in order to see a basin-wide response to restoration activities?

c) Are there regional or ecoregional differences in the applicability of specific restoration activities?

4) With regard to the site or system-wide responses one would expect to see as a result of the restoration activities being discussed:

a) What responses would be expected? Is there a particular order that the responses would occur?

b) Where (with respect to the placement of a restoration activities) would the different responses be detected (e.g. at the site treated, upstream/downstream, sub surface, etc., please be as specific as possible)?

c) At what geographic scales would the response be detected (e.g. stream reach, sub-basin, basin, watershed, etc.)?

d) After implementation of an activity, when would you expect a response to be detected (e.g. months, years, centuries, unknown with our current state of knowledge)?

II. Monitoring questions, parameters/criteria and scales

5) For each activity discussed above:

a) What are the key effectiveness monitoring questions you would use to determine success? How would restoration objectives and monitoring questions differ at the project/site and watershed scales?

b) For the questions listed in 5(a), at what scales (geographic and temporal) would you conduct your monitoring and/or your analysis?

c) What biotic and/or abiotic factors or field variables would you measure? What magnitude of change in these factors would have to occur before a significant response could be detected in the monitoring data?

d) Where (relative positions within watersheds or basins) and how often (given the likely variation in response) would you collect your data? Are there analytical tools that would help answer this question?

III. Sampling and sampling design considerations

6) Restoration effectiveness is often monitored/or proposed to be monitored by individual activities or at small local scales. Is this the optimum way for testing whether the Oregon Plan objectives are being met? If not, what is a better model?

a) Are there logical monitoring groupings by type of restoration activity, or by location? At what scales?

b) Could the intensity (density of sample points) or frequency of monitoring be varied if activities were grouped in some way? What are the potential pros and cons?

7) How do you design sampling schemes that account for:

a) Land use effects (urban, agriculture, forestry, rangeland), and

b) Climatic and precipitation variability (e.g., drought, El Nino events, floods), or ocean conditions, or other unanticipated variables that may influence the effectiveness of restoration projects?

8) If we want to use project level monitoring data to answer more integrated questions at larger scales, what are some of the key issues in sampling design that arise?

IV. Ongoing research and research needs
(These questions will be addressed if time allows)

9) What research or effectiveness monitoring studies are in progress that may help to further answer any of the previous the questions?

10) What kind of research is underway (or could be initiated) that would help improve the ability to roll up site-scale restoration monitoring data into a watershed, landscape, regional, and/or state-wide evaluations?

Appendix 7: OWEB Restoration Projects and Objectives

Examples of Aquatic Habitat Restoration Activities and Objectives

Restoration Activities	Restoration Objectives
Culvert removal/ replacement/ retrofitting	
	Increase/improve fish passage
	Improve/increase spawning habitat
	Improve/increase rearing habitat
Dam removal	Increase/improve fish passage
	Improve/increase spawning habitat
	Improve/increase rearing habitat
Fish ladder installation/improvement	
	Increase/improve fish passage
	Improve/increase spawning habitat
	Improve/increase rearing habitat
Large wood placement	
	Improve/increase stream structure and complexity
	Improve/increase gravel recruitment
	Improve/increase spawning habitat
	Improve/increase rearing habitat
	Improve/increase pools
	Improve/increase over-winter habitat
	Improve/increase summer habitat
	Improve/increase streambank stabilization
	Improve/increase refuge cover
	Improve/increase slow water habitat
Estuarine enhancement	Improve/increase rearing habitat
Weir installation	Improve/increase pools
	Improve/increase slow water habitat
	Improve/increase gravel recruitment
Off-channel habitat	Improve/increase off-channel habitat
	Improve/increase slow water habitat
	Improve/increase refuge cover
	Improve/increase rearing habitat
Nutrient enrichment	
	Increase primary production
	Increase food availability for juvenile salmonids

Examples of Watershed Condition and Hydrology Restoration Activities and Objectives

Restoration Activities	Restoration Objectives
Floodplain restoration	Improve/increase stream interaction with floodplain Improve/increase upland storage capacity
Juniper clearing/control	Improve/increase upslope stability Improve/increase upland water storage capacity Decrease erosion Decrease stream sedimentation Decrease run-off
Large wood placement	Improve/increase stream structure and complexity Improve/increase gravel recruitment Improve/increase pools Improve/increase streambank stabilization Improve/increase slow water habitat
Road/ surface drainage improvement	Decrease erosion Decrease stream sedimentation Decrease run-off
Wetland construction/ enhancement/ restoration	Improve/increase upland storage capacity Improve/increase net area of wetland Decrease stream sedimentation

Examples of Water Quality Restoration Activities and Objectives

Restoration Activities	Restoration Objectives
Wetland construction/ enhancement/ Restoration	Improve/increase upland storage capacity
	Improve/increase net area of wetland
	Improve/increase wetland connection to surrounding area
	Decrease stream sedimentation
Irrigation efficiency	Decrease run-off
	Decrease stream temperature
	Improve/increase stream flow
Juniper clearing/control	Improve/increase upland water storage capacity
	Decrease erosion
	Decrease stream sedimentation
	Decrease upland run-off
Off-channel livestock watering	Decrease stream sedimentation
	Decrease erosion
	Decreased nutrient input
Instream water enhancement	Improve/increase stream flow
Grazing management	Decrease stream sedimentation
	Decrease erosion
	Decreased upland run-off
Road/ surface drainage improvement	Decrease erosion
	Decrease stream sedimentation
	Decrease upland run-off
Sediment control basins	Decrease stream sedimentation
	Decrease run-off

Examples of Upland and Riparian Function Restoration Activities and Objectives

Restoration Activities	Restoration Objectives
Livestock grazing management	
	Decrease stream sedimentation
	Decrease erosion
	Improve/increase streambank stabilization
	Improve/increase native plant species composition
Off-channel livestock watering	
	Decrease livestock access to stream
	Decrease stream sedimentation
	Decrease erosion
	Improve/increase streambank stabilization
	Improve/increase native plant species composition
Noxious weed control	
	Improve/increase wildlife habitat
	Improve/increase upslope stability
	Improve/increase native plant species composition
	Decrease erosion
Riparian fencing	
	Decrease livestock access to stream
	Decrease stream sedimentation
	Decrease erosion
	Improve/increase streambank stabilization
Riparian planting	
	Improve/increase shading
	Improve/increase wildlife habitat
	Improve/increase native plant species composition
	Decrease erosion
	Improve/increase streambank stabilization
	Improve/increase large wood recruitment
Streambank erosion control	
	Decrease stream sedimentation
	Decrease erosion
	Improve/increase streambank stabilization
Juniper removal/clearing	
	Improve/increase native plant species composition
	Decrease erosion
	Decrease stream sedimentation
	Decrease run-off

Examples of Upland and Riparian Function Restoration Activities and Objectives, Continued

Restoration Activities	Restoration Objectives
Road/ surface drainage improvement	
	Decrease road access Decrease road density Decrease erosion Decrease stream sedimentation Decrease run-off
Cross-fencing	
	Increase native plant composition
Livestock rotation	
	Increase native plant composition
No till agriculture	
	Decrease erosion Decrease stream sedimentation Decrease run-off
Terracing	Decrease erosion Decrease stream sedimentation Decrease run-off
Sediment control basins	Decrease erosion Decrease stream sedimentation Decrease run-off
Windbreaks	Decrease erosion Decrease stream sedimentation Decrease run-off
Range seeding	
	Improve/increase native plant species composition Decrease erosion Decrease stream sedimentation Decrease run-off
Upland tree planting	
	Improve/increase native plant species composition Improve/increase wildlife habitat Improve/increase upslope stability
Wetland construction/ enhancement/ restoration	Improve/increase upland storage capacity Improve/increase net area of wetland Decrease stream sedimentation

Appendix 8: Effectiveness Monitoring Documents produced by Washington's Salmon Recovery Funding Board

Monitoring Strategy and Action Plan Documents

Monitoring Oversight Committee. 2002. Executive Report: The Washington Comprehensive Monitoring Strategy and Action Plan for Watershed Health and Salmon Recovery. Volume 1 of 3. Salmon Recovery Board, Olympia, Washington.

Monitoring Oversight Committee. 2002. Comprehensive Strategy: The Washington Comprehensive Monitoring Strategy and Action Plan for Watershed Health and Salmon Recovery. Volume 2 of 3. Salmon Recovery Board, Olympia, Washington.

Monitoring Oversight Committee. 2002. Action Plan: The Washington Comprehensive Monitoring Strategy and Action Plan for Watershed Health and Salmon Recovery. Volume 3 of 3. Salmon Recovery Board, Olympia, Washington.

Washington Protocols

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Fish Passage Projects (Culverts, Bridge, Fishways, Logjams, Dam Removal, Debris Removal). Report MC-1. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of In-Stream Habitat Projects (Channel reconfigurations, deflectors, log and rock control weirs, roughened channels, and woody debris removal) Report MC-2. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Riparian Planting Projects. Report MC-3. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Riparian Livestock Exclusion Projects. Report MC-4. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Constrained Channels (dike removal/setback, riprap removal, road removal/setback/ and landfill removal). Report MC-5. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Channel Connectivity, Off Channel Habitat, and Wetland Restoration Projects. Report MC-6. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Spawning Gravel Projects. Report MC-7. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Instream Diversion Projects (irrigation diversion dams, water treatment plants, pipes, ditches, headgates, hydropower penstocks). Report MC-8. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.

Crawford, B.A. 2004. Protocol for Monitoring Effectiveness of Habitat Protection Projects (land parcel biodiversity health). Report MC-10. Washington Salmon Recovery Funding Board. Interagency Committee for Outdoor Recreation. Olympia, Washington.