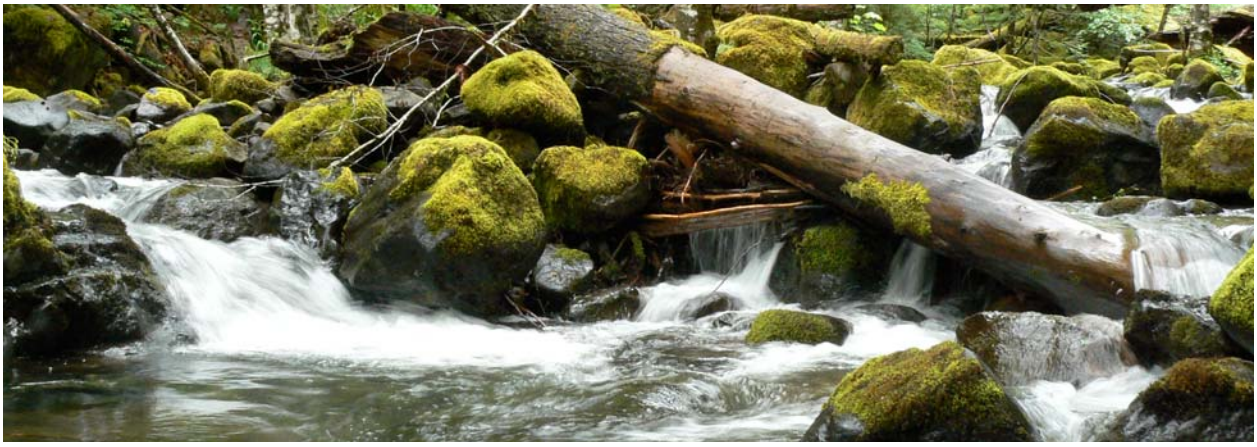
Aquatic and Riparian Effectiveness Monitoring Program

Interagency Monitoring Program – Northwest Forest Plan Area



2007 Annual Technical Report

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Aquatic and Riparian Effectiveness Monitoring Program
USDA Forest Service Pacific Northwest Regional Office
Bureau of Land Management Oregon State Office
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A copy of this report is available on our watershed monitoring website:
http://www.reo.gov/monitoring/watershed/

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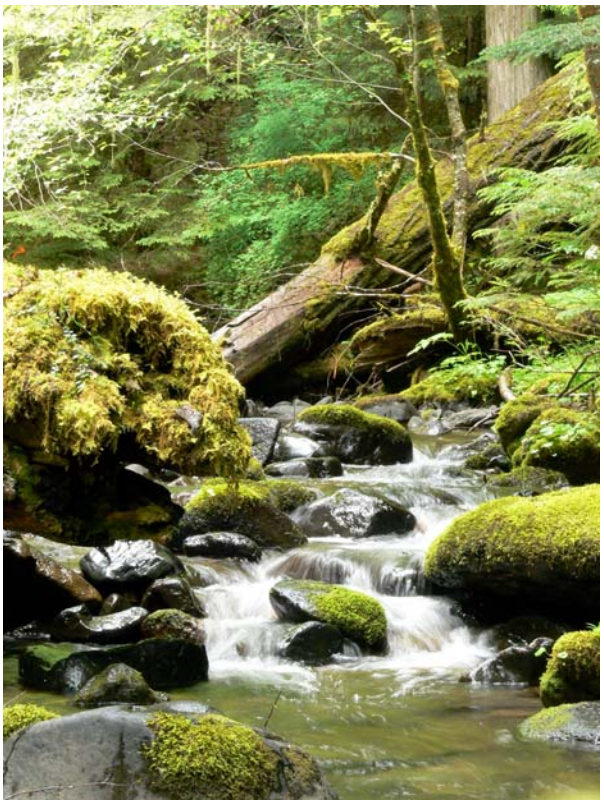
Executive Summary



The Aquatic and Riparian Effectiveness Monitoring Program (AREMP or the monitoring program hereafter) evaluates if the Northwest Forest Plan's Aquatic Conservation Strategy is maintaining and restoring watershed condition within the Plan area. The Plan provides management direction for 24 million acres of federal lands in western Washington and Oregon, and northern California.

Highlights of Aquatic and Riparian Effectiveness Monitoring Program (AREMP) accomplishments during the 2007 fiscal year include:

Responding to new direction from Interagency Executives:

- We'll now assess the condition of every sixth-field watershed in the Plan area that has at least 25% of the stream length in federal ownership (about 1,400 watersheds) using a combination of GIS, remote sensing, and field data. Previously, we used 250 randomly selected watersheds to make inferences about watershed conditions within the Plan area.
- Continued to align AREMP with the PacFish/InFish Biological Opinion monitoring program (PIBO) by standardizing/refining a core set of protocols and working with PIBO and local units to develop decision-support models in eastern Oregon and Washington.

Assisting local units in the use of decision-support models to:

- Identified key watersheds during the Forest Plan revision process.
- Determined fish sustainability based on species distribution and population trends, and habitat condition.
- Determined the likelihood of successfully reintroducing bull trout in the Clackamas River basin.

Continuing to refine the decision-support models used to assess watershed condition:

- Developed a landslide model to determine the topographic features associated with landslides and the effects of land management on landslide frequency.
- Determined what macroinvertebrate and amphibian metrics will be used in the models.
- Initiated a study to develop relationships between in-channel and upslope indicators to support a Geographic Information Systems (GIS)/remote sensing-based monitoring program.

Completing another successful field season:

- Collected stream data from 21 watersheds on physical, biological, and chemical attributes used to assess watershed condition as part of our normal field sampling program.
- Continued our quality control (QC) program by resurveying 26 QC sites and an additional 20 sites first surveyed in 2006 to enable us to use these data to detect changes in watershed condition.
- Participated in a pilot regional aquatic invasive species survey program.
- Utilized Student Conservation Association (SCA) interns as a successful component of the summer field staff.
- Completed a comprehensive review of the attributes we collect to determine whether to continue or modify sampling protocols.
- Stayed within our allocated budget. The cost of sampling 175 watershed sites, associated trend sites, and quality control sites was $5,890 per site. The average cost per watershed was $35,350.

Continuing our participation in the Pacific Northwest Aquatic Monitoring Partnership (PNAMP):

- Participated in analysis of data from a side-by-side protocol comparison test for in-channel physical attributes in the John Day Basin, OR conducted during summer 2005.
- Supported the establishment of a Lower Columbia River Recovery Area pilot where state and federal agencies will use a master sample design to determine sampling sites, establish common protocols, and share data for habitat status and trend monitoring.

Introduction

The purpose of this report is to provide an account of monitoring efforts in fiscal year 2007 (October 2006 - October 2007).

During 2007, the monitoring program worked toward or accomplished several key objectives. A complete discussion of each of these accomplishments is provided in subsequent sections. Updates are also provided for budget and personnel required to accomplish the tasks assigned to the monitoring program.

Background

The Northwest Forest Plan (hereafter referred to as the Plan), a management strategy applied to 24 million acres of federal land in the Pacific Northwest, was approved in 1994. The Plan includes an Aquatic Conservation Strategy that requires the protection, restoration, and monitoring of aquatic ecosystems under the Plan's jurisdiction (USDA-USDI 1994). The Aquatic and Riparian Effectiveness Monitoring Program (AREMP or the monitoring program hereafter) was developed to fulfill the monitoring component of the strategy.

The overall objectives of the monitoring program include assessment of the condition of aquatic, riparian, and upslope ecosystems; development of ecosystem management decision support models to refine indicator interpretation; development of predictive models to improve the use of monitoring data; providing information for adaptive management by analyzing trends in watershed condition and identifying elements that result in poor watershed condition; and providing a framework for adaptive monitoring at the regional scale (Reeves et al. 2004). Monitoring is conducted at the subwatershed scale (US Geologic Survey 6th-field hydrologic unit code [HUC]). These subwatersheds (hereafter referred to as "watersheds") are approximately 10,000-40,000 acres in size.

Accomplishments

Response to Interagency Executives

Implement a New Monitoring Strategy

AREMP is changing its study design in response to feedback received from managers, who need information at spatial scales that range from individual watersheds to administrative units, such as national forest or BLM districts, to the entire Northwest Forest Plan area.

AREMP personnel developed a Geographic Information Systems (GIS)/remote sensing-based monitoring program option that relies on continued field sampling to inform GIS analyses. This option will allow the program to evaluate every watershed with at least 25 percent federal ownership along the stream length (within each watershed) in the Plan area as frequently as data are collected or updated (about every five years) (Figure 1).

The GIS/remote sensing-based monitoring program option is based on using decision-support models to aggregate in-channel, upslope, and riparian attributes and calculate a watershed condition score. In-channel physical, chemical, and biological attributes are measured in the field at randomly chosen sites within randomly chosen watersheds throughout the Plan area; upslope and riparian attributes are measured for every watershed using GIS and remote sensing data.

To date, we have assessed all "federal watersheds" on the Olympic National Park, the Olympic, Gifford-Pinchot, and Willamette National Forests, and the Medford Bureau of Land Management District. We are working with researchers from the USDA Pacific Northwest Forest Sciences Laboratory and Oregon State University to use upslope and riparian data to make inferences about stream condition (see discussion below). Field data will be used to supplement the watershed condition assessments and validate the models used to assess stream condition.

Align AREMP with PIBO

Interagency executives directed the monitoring program to work with PIBO (PacFish/InFish Biological Opinion Effectiveness Monitoring Program, a large-scale federal monitoring program that focuses on the upper Columbia basin, and align the two programs so there is common way of reporting watershed condition across Oregon and Washington. Information about PIBO be found at http://www.fs.fed.us/biology/fishecology/emp/index.html)

Our approach is to develop decision-support models to assess watershed condition for the eastside of OR and WA that accommodate PIBO data. AREMP personnel modified an existing watershed condition model for use in the Okanogan, Wenatchee, Colville, Umatilla,

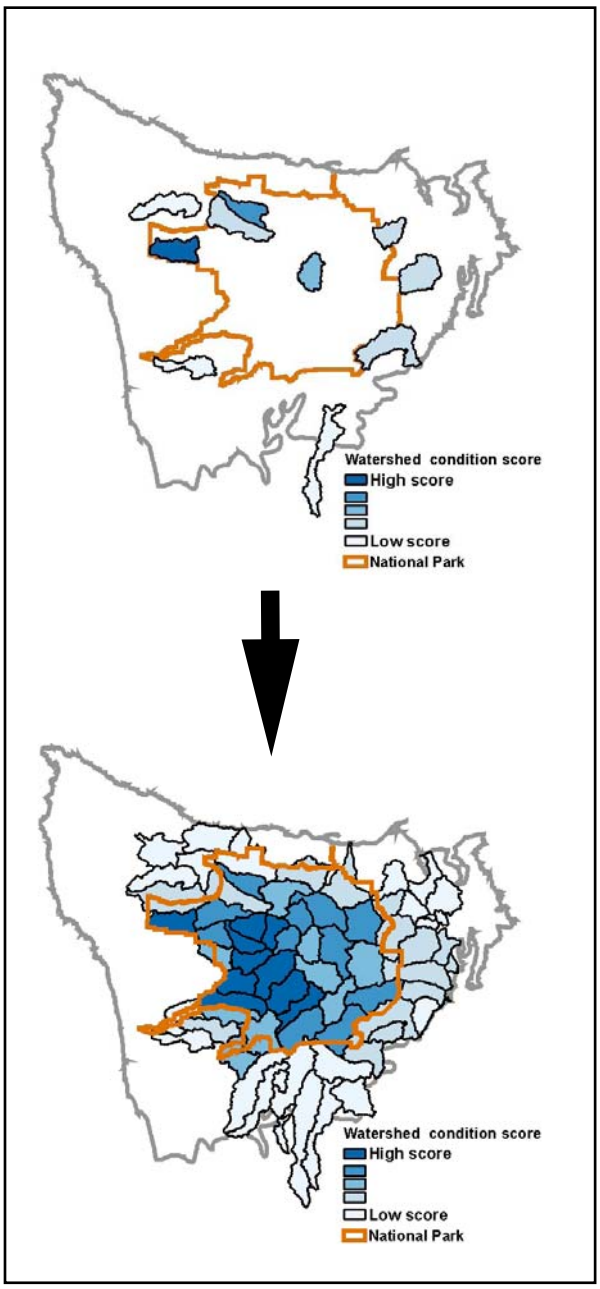


Figure 1. Example watershed condition assessment for the Olympic Peninsula , WA under past (above) and present (below) sampling designs. Figure 1 above shows an example from the 10-year assessment of the Northwest Forest Plan and includes 10 watersheds on the Olympic Peninsula out of the 250 watersheds sampled over the entire Plan area (Gallo et al. 2005). Figure 1 below shows the decision support model product using the GIS/remote sensing and field validation monitoring approach for all watersheds with federal ownership.

Wallowa-Whitman, and Malheur National Forests (NF).

This model will be used as a starting point for the AREMP-PIBO collaboration effort. Local experts from the Umatilla, Wallowa-Whitman, Ochoco, Deschutes, and Malheur NFs and the BLM will be invited to participate in a workshop in late January 2008 to review the existing model and modify it as necessary. The current model was designed to accommodate Forest Service Level II stream survey data. We will modify it to accommodate PIBO data during this workshop. This new model will then become the starting point for building models for other forests. The new models will need to be modified to account for ecological differences between the Forests and BLM districts.

Core attributes–The AREMP and PIBO agreed-upon core set of attributes was further refined in 2007 to standardize the way both programs measure dry channels (USDA 2005). The final 2007 field sampling protocol ("core protocol document") can be found at http://www.reo.gov/monitoring/report_show.php?show=watershed.

Assist Local Units

Forest Plan Revisions

Key watershed designations-Program personnel worked with specialists on the Okanogan-Wenatchee and Colville National Forests and with the forests in the Blue Mountains (Umatilla, Malheur, and Wallowa-Whitman) to apply decision-support models in their forest plan revisions. AREMP's watershed condition model is being used by these forests as part of the key watershed designation process. Key watershed determinations are requirements of a new Aquatic and Riparian Conservation Strategy (under development) that will be applied across Oregon and Washington (US Forest Service Pacific Northwest Region) only. The new strategy will be

part of each forest's plan, and will replace previous management plans such as the Northwest Forest Plan, PacFish, and InFish.

Sustainability analysis-The National Forest Management Act (NFMA) requires land management plans to provide for the ecosystem and species diversity of plant and animal communities based on the suitability and capability of the land area while meeting overall multiple-use objectives. An important aspect of Forest Plan revisions is to evaluate how Plans are providing for the continued sustainability of ecosystem and species diversity on the National Forest system lands. Also of concern is the capability of the plan area, consistent with overall multiple-use objectives, and the degree to which ecological conditions provide for species listed as threatened or endangered under the Endangered Species Act, species-of interest, or other species-of-concern.

Decision-support models were developed to show how FS lands contribute to self-sustaining, well-distributed population patterns that allow interaction within and across species populations, within the constraints of the species natural history and the capability of the plan area. This evaluation focuses on the amount, quality and distribution of habitat; the dynamics of the habitat over time, the species distribution (historic and current); information on species population trends and dynamics (if available); key biological interactions; and threats and limiting factors.

Bull trout reintroduction-The Mt. Hood National Forest is working with the US Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (ODFW), and researchers from the US Geological Survey (USGS) to reintroduce bull trout into the Clackamas River. AREMP personnel consulted on the project and built a decision-support model to document the decision process used to determine the suitability of an area for reintroduction and the likelihood of success. The model can be used for reintroduction of any species in any ecosystem. It evaluates data related to historic occupation of the species in the ecosystem, likelihood that the species is still present, natural recolonization potential, potential of habitat to support the reintroduction, threats, and impacts to donor stocks. A paper documenting the process will be submitted to Conservation Biology by the end of this calendar year.

Assessment of temperature problems- We initiated and provided a summary of hydrograph temperature data collected over the past five years to BLM and USFS regional water quality coordinators. These data will be shared with the Oregon Department of Environmental Quality and Washington Department of Ecology for assessment of temperature total maximum daily load (TMDL).

Decision-Support Model Refinements

In-Channel and Upslope Relationships

We are working toward developing relationships among the upslope and riparian attributes (e.g., vegetation, roads, and landslides) and in-channel conditions. When the relationships are developed, these upslope and riparian attributes will be used as surrogates for watershed condition. Field data are used to validate the relationships and ensure that the model results accurately reflect conditions on the ground.

The monitoring program has contracted a one year project (ending Dec. 31, 2007) with the Pacific Northwest Research Station in Corvallis and Oregon State University to develop the relationships between upslope/riparian and in-channel conditions. There are two goals for the project. First, we want to develop upslope/riparian and in-channel relationships in order to use existing GIS data to predict in-channel conditions in non-sampled watersheds. Secondly, if relationships are successfully developed, then we will evaluate the variance structure of the predicted in-channel conditions and recommend how to allocate field samples; i.e., how to best balance the number of sites sampled within watersheds with the number of sampled watersheds.

Landslide Analyses

The monitoring program is incorporating mass wasting into the next iteration of watershed condition assessments, which will be used in the 15-year evaluation of the Northwest Forest Plan in 2009. The assessment consists of extending the landslide models developed by Dan Miller of Earth Systems Institute for the Coastal Landscape Analysis and Modeling Study (CLAMS) to the extent of the Forest Plan and overlaying management activities to determine whether management activities affect landslide frequency. Landslide data were used to calibrate a GIS model that identifies areas within watersheds that have high potential for mass wasting. Adam Dresser (Six Rivers NF) collected data on landslide location from aerial photographs in 14 watersheds.

The CLAMS model is limited in that data from only one time period were used to calibrate the model; therefore the model predicts only probable landslide location and not the probability of debris flow. Therefore, in two watersheds, we used data from several time periods to include landslides and debris flows from multiple storm events so we could interpret results in terms of landslide rate, rather than just landslide density. This information allows us to speak directly to management impacts on frequency of landslide events and provide data to relate the effects of a single storm to the cumulative effects of many storm events. The models have been developed and the results are being incorporated into the decision support models used to evaluate watershed condition.

Metrics Derived from Amphibian and Macroinvertebrate Data

We are working with researchers from the Environmental Protection Agency to analyze macroinvertebrate data and select metrics for use in the decision support model. Analyses include determining which metrics are sensitive to management in forested systems, which serve as indicators of watersheds processes, and a redundancy analysis. A similar analysis is being conducted on amphibian data collected in the field.

Relative Bedload Stability

AREMP staff began exploring the feasibility of calculating relative bedload stability (RBS; Kaufmann et al. 1999) using the field data. Because the field component of AREMP is based largely on EMAP-style surveys, the attributes needed to calculate RBS are present in the dataset. RBS is currently under consideration by the Oregon Department of Environmental Quality as the Total Maximum Daily Limit (TMDL) for sediment. Additionally, the BLM is considering the metric for monitoring management activities.

Field Sampling Accomplishments

Twenty-one watersheds spread throughout the Plan area were sampled during 2007 (Figure 2). These watersheds were sequentially sampled from the subset of the 250 watersheds originally selected for monitoring the Northwest Forest Plan. The 250 watersheds were selected at random using Generalized Random Tessellation Sampling (GRTS) design, which guarantees a spatially balanced sample (Stevens and Olsen 2003, 2004). Watersheds had to contain a minimum of 25% federal ownership (USDA Forest Service, USDI Bureau of Land Management, or USDI National Park Service) along the total length of the stream (1:100,000 National Hydrography Dataset stream layer) to be considered for sampling in the monitoring plan. Twenty-six sites were resurveyed as part of the quality control program. Twenty sites from 2006 were also surveyed for trend purposes. All surveyed watersheds are listed in Appendix B.

During the 2007 field season, seven watersheds were dropped from the sample list for various reasons:

- One was dropped due to inaccessibility (crews were unable get into the watershed); *and*
- Six were dropped because there were not enough sites available to survey on federal lands.

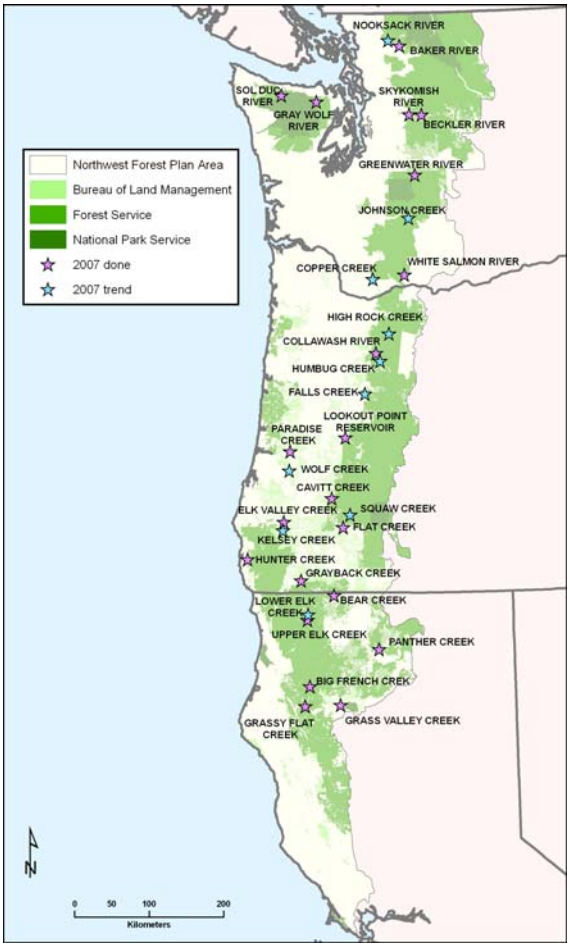


Figure 2. Map of the watersheds surveyed during 2007 summer field season. Watersheds coded in purple represent those in which initial surveys took place. Watersheds coded in blue indicate watersheds where a site was surveyed in 2006 to assess our quality control efforts and then was resurveyed in 2007 for use in detecting watershed condition trends.

Streamline AREMP's Stream Surveys

Monitoring program staff completed a comprehensive review of field protocols in 2007, which resulted in some attributes being dropped from our field collection, some attributes were modified, and many stayed the same. As part of the review process we considered elements such as: is the attribute used in the decision support models; is the attribute part of the core protocol document (described above); are there any savings – in time and money – that can be realized by the monitoring program if the attribute is dropped or measured with a different technique; and what does the monitoring program lose, with respect to the program goals, if the attribute is not measured. The refinement process was complex as the answer lies at the intersection between all of these questions. A summary of decisions made for each attribute and (or) protocol are in Table 1. The rational for the decisions is described in Appendix A.

Attribute	Action taken
Fish	Dropped from field surveys
Periphyton	Dropped from field surveys
pH	Dropped from field surveys
Aquatic amphibians	Changed from sampled to opportunistic sightings
Large wood	Changed to different measuring frequency
Bankfull width to depth (W:D)	Increase number of transects where W:D is measured
Dry stream channels	Are now measured
Terrestrial amphibians	No change
Macro-invertebrates	No change
Specific conductance	No change
Temperature	No change
Dissolved oxygen	No change
Photo documentation	No change
GPS	No change
Monument	No change
Site Length	No change
Pools	No change
Pool tail fines	No change
Substrate	No change
Slope	No change
Sinuosity	No change
Bankfull width	No change

Table 1. Summary of attribute protocol changes for the 2007 field season.

Abney Level Test Results

Field crews for the monitoring program conducted a methods comparison test in 2006 to determine whether the currently used laser rangefinder and electronic compass setup (akin to a surveyor's total station) should be replaced by Abney levels for the purpose of measuring stream gradient.

Thirty-seven randomly selected stream reaches throughout the Northwest Forest Plan area were surveyed using laser rangefinder and electronic compass setups and Abney levels. Stream gradients for the sampled reaches ranged from 0.7 to 44 % with a mean of 6.6 %. Two trials with each instrument were conducted at each site, if the values of the first two trials differed by greater than 10 % then a third trial was completed.

On average, it took each field crew approximately 25 minutes longer, per site, to measure the stream gradient with the Abney level than with the laser rangefinder and electronic compass setup. Unexplained differences were detected in gradients measured at individual sites with the two instruments, particularly at sites where stream gradient was less than 6 %. Average variation between the two trials for each instrument was 0.158 (coefficient of variation = 7.7 %) and 0.041 (coefficient of variation = 3.3 %) for the Abney level and laser setup respectively.

Based on time savings, greater measurement precision, and other benefits associated with measuring transect data (i.e., width and depth) and electronic data collection, we continued to use a laser rangefinder and electronic compass setup to measure stream gradient.

Quality Assessment Program

The monitoring program's Quality Assessment Program (QAP) includes several components. The data manager serves the key role of inspecting data for errors (both correctable and non-

correctable) and relaying mistakes back to the field crews to prevent further errors in data collection. The data manager is also responsible for inspecting calculated attributes (summarized raw data) for outlying errors. This information feeds into the data collection process at the point of protocol development/updating for the next field season.

The underlying sample design of the QAP that the monitoring program utilizes (both in the selection of watersheds and sites within watersheds) allows for repeat in-channel surveys in the same location. Initially resurveys were used for blind checks of crew measurements, i.e., between crew comparisons of attribute measurements at the same site. However, as a function of the design, we were able to extend the utility by resurveying a subset of sites in the following year for trend detection. These analyses are currently in progress and will incorporate the data collected from 2001 - 2007. The results will be posted on the monitoring programs website when they are completed (http://www.reo.gov/monitoring/report_show.php?show=watershed).

Aquatic Invasive Species Surveys

AREMP participated in a pilot regional survey effort to locate aquatic invasive species on federal lands. Protocols developed by Oregon State University Sea Grant College Program personnel were used to survey for eleven aquatic plants and animals identified as primary threats to northwest watersheds. Among the key species included were; New Zealand mudsnails, zebra mussels, quagga mussels, yellow flag iris, knotweed, hydrilla, Chinese mitten crabs, and four species of nonnative crayfish. Also, included were fifteen species of secondary concern.

Documentation and in-the-field training on species identification, data collection, and reporting was provided to AREMP field coordinators and crew leaders by Tania Siemens of Oregon State University Sea Grant Program. The pilot program was implemented at the start of the field season and did not interfere with AREMP field crews' ability to complete surveys in an efficient manner. AREMP personnel provided

feedback to Sea Grant personnel for improvements to be incorporated into future monitoring efforts such as, providing more training with live specimens and replacing opportunistic sightings with a more standardized protocol for surveying each reach.

Although none of the species of primary concern were detected by AREMP field crews, our data provides a baseline for detecting the future spread of aquatic invasive species.

Pacific Northwest Aquatic Monitoring Partnership

Support for the cooperative monitoring efforts between state, federal, and tribal agencies within Washington, Oregon, California, and Idaho – known as the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) continued. The monitoring program team lead continued as the lead of the Watershed Workgroup (a subgroup of PNAMP). AREMP staff participated in the following activities.

Protocol Manager

AREMP staff used Protocol Manager software to document existing field protocols and track changes to field protocols through time. As this was a pilot, the Protocol Manager software was not fully implemented and constructive feedback about the software was provided to PNAMP associates. This project is ongoing and a new version of the Protocol Manager software will be tested by AREMP staff during the winter of 2007-2008.

Interagency Side-by-Side Protocol Test

A workgroup consisting of state, tribal, and federal specialists continued their efforts to examine data collected using different protocols for commonly collected attributes. Data were collected by state, tribal and federal monitoring program survey crews during summer 2005 in the John Day basin (eastern-central Oregon) to meet the following objectives:

1) identify and recommend a core set of indicators (attributes) and their associated protocols that state, federal, and tribal monitoring programs use for assessing status and trends in watershed condition; 2) conduct a peer-reviewed experiment to determine which of the existing field protocols for each attribute distinguish the most different streams; 3) incorporate additional information into the recommendation of protocols, e.g., cost, precision, accuracy, sensitivity to trend, repeatability, and statistical review.

In parallel with developing a unified set of protocols, develop calibrations (crosswalks) for older protocols in order to preserve the value of legacy data where possible; and 5) recommend physical and chemical in-channel attributes and appropriate protocols for sampling. The data analysis of the protocol test is being conducted by Dr. Brett Roper (USDA Forest Service National Monitoring Coordinator), with an expected completion date during 2008.

The USDA Rocky Mountain Research Station is also analyzing data collected during intensive surveys of the same segments of stream to establish a baseline set of values from which to compare the results of the different protocols. Data collected using light detection and ranging (LIDAR) technology was also collected and will be compared to the intensively sampled stream data and to the agency/group collected data. Analyses are expected to be completed and presented in 2008.

Status and Trend Watershed/Stream Integrated Monitoring Program

The Watershed Workgroup held workshops in September 2006 and February 2007 to explore the possibility of creating an integrated state-tribal-federal monitoring program for watershed/stream status and trend monitoring efforts. The goal is, within 10 years, to create an integrated, interagency aquatic status and trend monitoring program to provide annual, statistically valid data on a set of agreed-upon stream, riparian, and upslope indicators of the condition of aquatic/riparian resources across the Pacific Northwest at statewide and finer scales of spatial resolution.

Although workshop participants were supportive of the concept, they felt several questions needed to be addressed before fully endorsing such a concept. Therefore, the workgroup endorsed using the Lower Columbia Recovery Area (Figure 3) as a demonstration area. AREMP personnel will participate in this effort since we have sample sites in this area.

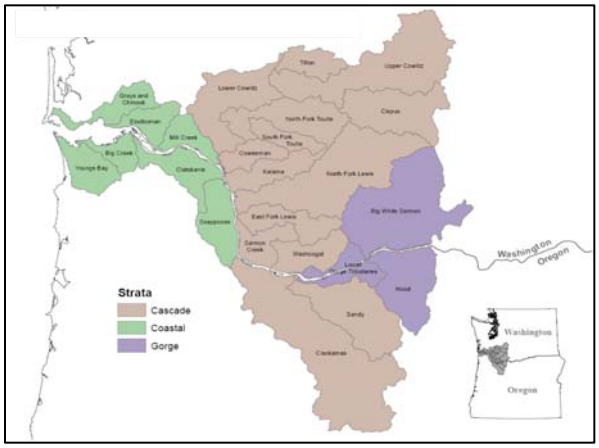


Figure 3. Lower Columbia River demonstration area.

Program Updates

Fiscal Year 2007 Budget

During the 2007 field season, the program employed 25 persons directly tied to the summer field work; seven personnel represent core staff (permanent and four-year term employees) and the balance represents temporary employees and SCA interns.

It cost $5,890 to sample each site. This cost is derived from taking our total budget and dividing by the number of sites sampled, and includes sampling trend sites and QA/QC sites as well as overhead and other non-field related costs. The cost to sample a watershed (based on sampling an average of 6 sites in each watershed) was $35,350.

Staffing Update

We consolidated our existing staffing structure by hiring a data manager/GIS specialist to replace our existing GIS technician position and our existing data manager position, whose appointments are expiring in late 2007. The new specialist will work to streamline data processing, i.e., combine spatial data and tabular data into one integrated geospatial-database.

Student Conservation Association Interns

Four Student Conservation Association (SCA) interns were hired as crew members during the 2007 field season. Compared to hiring GS-0404-05 Biological Science Technicians, there was a $40,000 cost savings to the program. We continued to collect high quality data and provided valuable work experience to the interns. Two of the GS-grade employees we hired in 2007 were SCA interns in 2006 and another GS-grade employee was a SCA intern in 2005. Overall, this was a very successful partnership and one we hope to continue in 2008.

Annual Watershed Reports and Data Available on Program Website

To facilitate the use of field and GIS data by local area managers, the program continues to place the annual Watershed Reports and associated data onto the monitoring program's website. Data from 2002 to 2006 are now available on the website. Data from the 2007 field season will be available on the site by the end of 2007. The current web page will be updated to show links to the reports and data. At the writing of this document, the reports will be posted at http://www.reo.gov/monitoring/reports.htm#watershed while the data will be posted under http://www.reo.gov/monitoring/maps.htm (this is subject to change depending on constraints of the website). Summarized data, rather than individual measurement data, are posted on the web, however measurement data are available by contacting the data manager, Lis Fano (541.750.7081), who will provide individuals with requested information.

GIS layers

AREMP now uses the latest version of a regional sixth-field HUC layer. Watersheds that meet the criteria of 25% federal ownership along the stream length have been selected and sorted into the seven aquatic provinces. Existing GIS data

have been clipped to the watershed boundaries and the current EMDS models have been run on them. The GIS data and EMDS models will evolve before the final analysis is done, but the "number crunching" process is now established.

Data Requests

In 2007, the monitoring program continued to provide data from our field surveys to local management units, Oregon Department of Fish and Wildlife, and other state and federal offices. The following are the filled data requests for 2007:

- Location points and photos of the foothill yellow-legged frog were sent to the Umpqua National Forest, Roseburg, Oregon. This was the first documented sighting of this species along the survey reach.

- Invasive flora species were sent to the Watershed/Aquatics Program, US Forest Service Pacific NW Region, and Samuel Chan Oregon State University Sea Grant College Program and Extension Service.

- Permit reports containing all captured fish and amphibian species were provided to National Oceanic Atmospheric Administration, USFWS, Californian Fish and Game, Washington Department of Fish and Wildlife, ODFW, Olympic National Park, and Mt. Rainier National Park.

- Macroinvertebrate results are being sent to UC Berkeley and Region 5 US Forest Service to assist in determining the effects of debris flows on stream ecosystems in the Klamath National Forest.

- Survey data are being sent to Mt. Baker/Snoqualmie NF.

- Thermograph data are being sent to Willamette NF Detroit District Area.

- Provided Lower Columbia Fish Recovery Board with AREMP 2007 field season HUC locations for the state of Washington.

- Photograph, thermograph and invertebrate data were supplied to the Washington Department of Fish & Wildlife.

- Other, non-specific data requests were directed to the AREMP data download website; http://www.reo.gov/monitoring/watershed/AREMP/latest/aremp.htm

Literature Cited

Gallo, K.; Lanigan, S.H.; Eldred P.; Gordon S.N.; and Moyer C. 2005. Northwest Forest Plan – the first 10 years (1994-2003): preliminary assessment of the condition of watersheds. Gen. Tech. Rep. PNW-GTR-647. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station 133 p.

Kaufmann, P.R; Levine, P.; Robison, E.G.; Seeliger, C.; and D.V. Peck. 1999. Quantifying Physical Habitat in Wadeable Streams. EPA/620/R-99/003. U.S. Environmental Protection Agency, Washington, D.C.

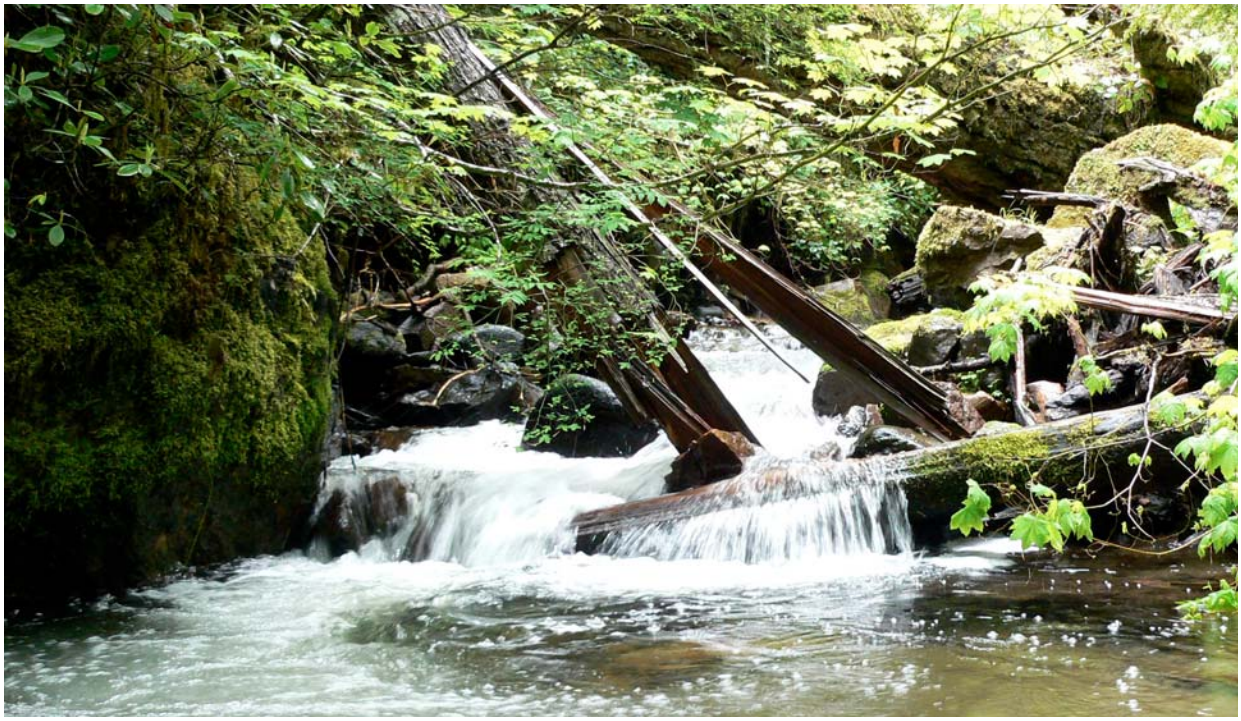
Reeves, G.H.; Hohler, D.B.; Larsen, D.P. [and others]. 2004. Aquatic and riparian effectiveness monitoring program for the Northwest Forest Plan. Gen. Tech. Rep. PNW-GTR-577. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 71 p.

Stevens, D.L., Jr.; Olsen, A.R. 2003. Variance estimation for spatially balanced samples of environmental resources. Environmetrics 14:593-610.

Stevens, D.L., Jr.; Olsen, A.R. 2004. Spatially-balanced sampling of natural resources. Journal of the American Statistical Association. 99:262-278.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl and standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [plus attachment A: standards and guidelines]. Available at http://www.reo.gov/library/reports/newroda.pdf. 74 p.

U.S. Department of Agriculture, Forest Service. 2005. Effectiveness monitoring for streams and riparian areas within the Pacific Northwest: stream channel methods for core attributes. Unpublished paper on file at: http://www.reo.gov/monitoring/watershed.htm or http://www.fs.fed.us/biology/fishecology/emp.htm. 18 p.



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Photos by Steve Lanigan, Hank Lavigne, Jeff O'Leary, Katie Clower, Jenine Toby, and Shawne Mohoric.

Appendix A – Overview of Changes to Field Protocol

Monitoring program staff completed a comprehensive review of field protocols in 2007, which resulted in some attributes being dropped from our field collection, some attributes were modified, and many stayed the same.

This appendix describes the the rational for changes, along with pertinent information about attribute protocols we considered changing, but that ultimately remained the same.

Biological Attributes

Fish

Fish presence is no longer surveyed using an electrofisher, starting in 2007. Although the Interagency Executives identified "What is the status and trend of fish populations?" as a high priority question, this is best answered by ongoing state efforts to monitor spawning fish, smolt production, and freshwater fish populations.

Fish presence is also of interest to NOAA (McElhany et al., 2006[1]), but they are most interested in the life history characteristics of listed salmon. Our sample design is not capable of collecting this information because we aren't sampling when most fish are spawning and we typically sample in wadable, headwater streams where anadromous fish spawning is unlikely to occur.

We explored using our fish presence data to derive a metric based on the movement of non-native fishes entering watersheds. However, we found a wide distribution of non-native fishes already exists throughout watersheds so tracking their movement was a mute point.

Bio-metrics associated with fish species, such as feeding guilds, native vs non-native, etc. could be used as part of our decision-support model, but given funding constraints, we are now only using macro-invertebrates and terrestrial (and incidental aquatic) amphibians to derive biometrics.

Dropping fish presence allows us to change from using four-person to three-person crews with a commensurate savings in personnel and vehicle/equipment costs. This change allows us to fund four field crews for the foreseeable future. If additional funding becomes available, we can sample more stream reaches. We now only record if we see fish, but make no attempt to identify fishes to genus and species.

Aquatic Amphibians

The collection of aquatic amphibians while electrofishing stream reaches is no longer being done. We document incidental and opportunistic sightings of aquatic amphibians and include these data when calculating biometrics-based on amphibian presence.

Aquatic amphibians collected consisted mostly of tailed frogs (*Ascaphus truei*) and Pacific giant salamanders (*Dicamptodon tenebrosus*). Pacific giant salamanders are relatively easy to see and correctly identify in streams because of their large size. The larval form of tailed frogs are commonly caught in our macro-invertebrates nets. Because tailed frogs and Pacific giant salamanders seemed to be found in our samples whenever we were in areas known to contain these species, they may be of limited value in differentiating between watershed conditions.

Terrestrial Amphibians

The program will continue surveying for terrestrial amphibians. Amphibians have been proposed as environmental indicator species partly because of their associations to late successional forests and sensitivity to management activities (Sheridan and Olson 2003). We also have an opportunity to create a large-scale species inventory, something that has not yet been accomplished for amphibians.

Habitat requirements of amphibians are still being determined within the scientific community. By combining our species information with the physical data we collect (bankfull width, water chemistry, substrate, and wood in particular), we have a powerful data set for examining habitats requirement for many species.

Macro-invertebrates – no changes

Periphyton

Periphyton were dropped from our field surveys, starting in 2007, because of funding constraints. Although the cost of collecting periphyton samples is minimal, we don't have sufficient funds to process the samples. We will reevaluate this decision if researchers determine that periphyton is a key attribute for describing watershed condition.

Water Chemistry

pH

The program stopped collecting pH data at each site in 2007. Currently, pH is not being used in the decision support model to assess watershed condition. pH was originally collected as contextual information regarding periphyton. Periphyton will no longer be collected due to budget constraints (see above). Also, in the past years pH has been problematic to accurately collect with the YSI water chemistry units used in field sampling. In watersheds surveyed during 2006, no pH data exist for 29 sites out of 208 (13.9%) total sampled sites. Issues with the meters have resulted in expensive repairs and significant time lost in the field with no final solution after extensive attempts to alleviate the problem. pH also requires daily calibration in the field and dropping this attribute will lead to measurable savings in salary compensation and equipment costs.

Specific Conductance

The program stopped measuring specific conductance at each site beginning in 2007. In previous years this information was used to determine appropriate electrofisher settings based on the water chemistry at each individual site. With the elimination of electrofishing from the field protocol, this information is no longer necessary.

Conductance – No changes

Temperature – No changes

Dissolved Oxygen – No changes

Weather

In 2007, the monitoring program stopped collecting information regarding weather conditions as part of the site observation data. It was determined that the information was no longer useful, because the program does not sample stream discharge and the data has not provided the project any information on data abnormalities over the years.

Habitat

Photo Documentation – No changes

GPS – No changes

Monument Site– No changes

Site Length – No changes

Pools – No changes

Pool Tail Fines – no change

Large Wood

In 2007, the monitoring program began measuring a different proportion of wood within the bankfull channel. Crews will measure the first 10 pieces of wood encountered and every 5th piece of wood up to and including the 35th piece of wood. All subsequent pieces of wood will be measured every 10th piece. This change in protocol still provides the program with the minimum number of measurements required to analyze wood data (i.e., volume and frequency). The program determined this was a feasible method to achieve 10% measured pieces and to save time measuring wood in streams that can potentially contain greater than 200 pieces of wood within the sample reach.

Substrate - no change

Stream Morphology

Slope - no change

Sinuosity – no change

Sinuosity demonstrates channel connectivity to the floodplain. It is also used for Rosgen channel typing. The results from the QAP indicate that the signal to noise ratios are variable between years but are >10 in all years except 2004. The initial and secondary survey plots indicate no significant difference between survey crews in four of the six years of data (the other two years appear to be influenced by one or two observations in which sinuosity was substantially different between the surveys). Because various scientific studies have demonstrated the affects of management activities on sinuosity, we will continue to measure it.

Bankfull Width to Depth

We increased the number of transects where depth measurements are taken (from 11 to 21). Bankfull width to depth is a ratio and therefore is subject to the influences of the numerator, denominator, and division of the two. The numerator (bankfull width, see below) appears to be reasonably acceptable with respect to detecting trend but not at indicating the actual bankfull width at a site (crews tend to disagree between 1 m and 3 m over the course of six years of study). The denominator (bankfull depth) is highly variable between years and in only one year has a signal to noise ratio been >4. The strongest relationship between the initial and secondary surveys occurred in 2001 when 11 transects and a minimum of 11 depth measurements were taken at each transect. Every year after that represents a reduction in the number of depth measurements taken at each transect and a decrease in the strength of the relationship between the initial and secondary survey. In 2006 we increased the number of depth measurements taken at each transect (from 11-15 in 2005 to 33 in 2006) and improved the performance of the relationship between initial and secondary surveys.

Bankfull Width – no change

After a review of the past five years of data, we decided not to change how we measure bankfull width. The results from the QAP indicate that bankfull width is not measured consistently between crews. A significant difference between

the initial and secondary surveys exists for four out of six years of data. However, a visual inspection of the data indicates that in three of the four years the difference between crews is driven by the single widest site (this is the influence of a single observation on the regression). The variance decomposition shows that the signal to noise ratios are variable between years and meet the >4 criteria given by Kaufman et al. (1999). Further, changes to the protocol such as the number of transects used to calculate average bankfull width and whether or not crews indicated bankfull elevation with a marker do not seem to have any impact on the results. The error and inconsistency are probably attributable to the difference in the elevation of the bankfull indicators (this is evident from the average bankfull depth calculations).

Dry Stream Channels

The monitoring program began to include sites with dry channels starting with the 2007 field season. This decision was based on emerging scientific research indicating the importance of some dry channels (to salmonids) and the potential to monitor global warming effects on the number of streams on public lands that go dry. Criteria to define a stream channel include the presence of bankfull indicators and evidence of a defined scoured channel. By including these channels, the number of sites per watershed and the number of watersheds that are surveyed increased. Certain attributes, e.g., residual pool depth and pool tail crest fines are not collected at dry sites.

Literature Cited

Rosgen, D.L. 1996. Applied River Morphology. Printed Media Companies, Minneapolis, MN.

Sheridan, C.D.; Olson, D.H. 2003. Amphibian assemblages in zero-order basins in the Oregon Coast Range. Canadian Journal of Forest Research. 33: 1452-1477.

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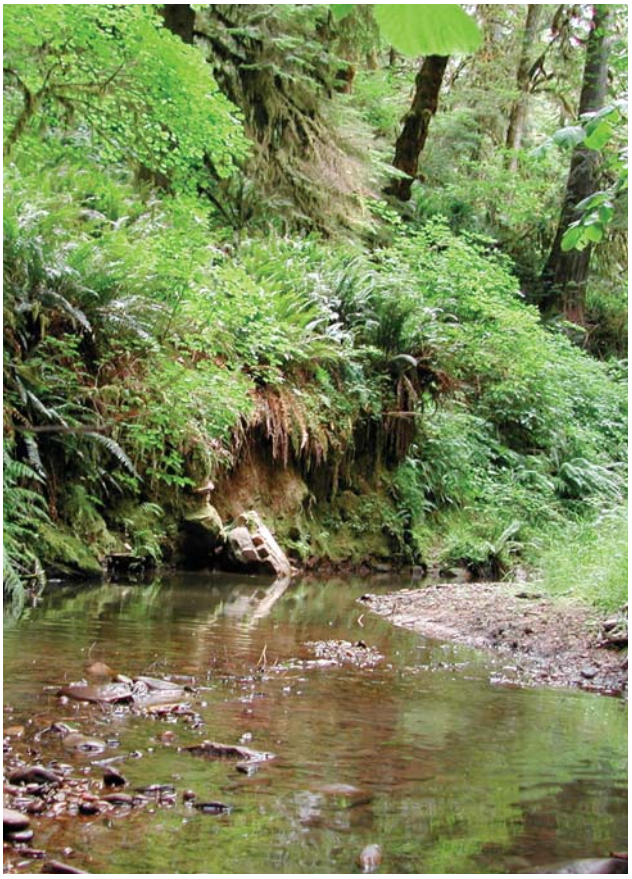
Appendix B – Watersheds surveyed in 2007

Appendix A-1. Watersheds surveyed in 2007 as original surveys with the number of sites surveyed in each watershed. QA/QC sites are where a second independent crew returned to sample the same stream reach to determine within crew measurement variability.

State	Province	Local Unit	6th Field HUC	6th Field HUC Name	County	# of Sites	# of QA/QC Sites
CA	Klamath Siskiyou	Klamath NF	180102060903	Bear Creek	Siskiyou	6	2
CA	Klamath Siskiyou	Klamath NF	180102111103	Big French Creek	Siskiyou	6	2
CA	Klamath Siskiyou	Shasta/Trinity NF	180102120406	Grassy Flat Creek	Trinity	6	
CA	Klamath Siskiyou	Shasta/Trinity NF	180102110603	Grass Valley Creek	Trinity	6	2
CA	Klamath Siskiyou	Klamath NF	180102090303	Lower Elk Creek	Siskiyou	6	
CA	High Cascades North	Shasta/Trinity NF	180200040303	Panther Creek	Siskiyou	6	
OR	Western Cascades	Umpqua NF	171003011106	Upper Cavitt Creek	Douglas	7	2
OR	Coast Range	Medford BLM	171003020803	West Fork Cow Creek/Elk Valley Creek	Douglas	5	2
OR	Klamath Siskiyou	Siskiyou NF	171003110303	Grayback Creek	Josephine	7	
OR	Western Cascades	Mt Hood NF	170900110101	Upper Hot Springs Fork Collawash	Clackamas	6	
OR	Franciscan	Siskiyou NF	171003120502	Lower Hunter Creek	Curry	7	2
OR	Western Cascades	Medford BLM	171003070504	Elk Creek/Flat Creek	Jackson	4	
OR	Western Cascades	Willamette NF	170900010702	Lookout Point Reservoir	Lane	8	2
OR	Coast Range	Coos Bay BLM	171003030401	Paradise Creek	Douglas	6	2
WA	Northern Cascades West	Mt Baker/Snoqualmie NF	171100090107	Lower Beckler River	King	5	2
WA	Olympic	Olympic NF	171100200304	Lower Gray Wolf River	Clallum	6	
WA	Northern Cascades West	Mt Baker/Snoqualmie NF	171100050806	Lower Baker River/Lake Shannon	Skagit	7	2
WA	Northern Cascades West	Mt Baker/Snoqualmie NF	171100090206	Lower South Fork Skykomish River	Snohomish	4	2
WA	High Cascades South	Gifford Pinchot NF	170701051004	Middle Little White Salmon River	Skamania	7	2
WA	Olympic	Olympic NF	171001010401	North Fork Sol Duc River	Clallum	6	2
WA	High Cascades North	Mt Baker/Snoqualmie NF	171100140105	Upper Greenwater River	Pierce	8	

Appendix A-2. Watersheds surveyed in 2007 as trend surveys. These are in addition to the number of sites originally surveyed in each watershed.

State	Province	Local Unit	6th Field HUC	6th Field HUC Name	Creek Code	County	# of Sites
CA	Klamath Siskiyou	Klamath NF	180102090302	Upper Elk Creek	CALEK	Siskiyou	2
OR	Western Cascades	Mt Hood NF	170900110304	High Rock Creek	ORHRK	Clackamas	2
OR	Western Cascades	Willamette NF	170900050203	Humbug Creek	ORHUM	Marion	2
OR	Klamath Siskiyou	Medford BLM	171003100405	Kelsey Creek	ORKSY	Josephine	2
OR	Northern Cascades West	Mt Baker/Snoqualmie NF	171100040301	Upper South Fork Nooksack River	WANOO	Whatcom	2
OR	Western Cascades	Umpqua NF	171003020203	Squaw Creek	ORSQW	Douglas	2
OR	Western Cascades	Willamette NF	170900060604	Trout Creek	ORFLS	Linn	2
OR	Coast Range	Roseburg BLM	171003030104	Wolf Creek	ORWLF	Douglas	2
WA	Western Cascades	Gifford Pinchot NF	170800020503	Copper Creek	WACOP	Skamania	2
WA	Western Cascades	Gifford Pinchot NF	170800040205	Johnson Creek	WAJHN	Lewis	2



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