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PACFISH/INFISH Biological Opinion (PIBO): Effectiveness Monitoring Program Seven-Year Status Report 1998 Through 2004

Abstract

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The PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program was initiated in 1998 to provide a consistent framework for monitoring aquatic and riparian resources on most Forest Service and Bureau of Land Management lands within the Upper Columbia River Basin. This 7-year status report gives our funding sources, partners, and the public an overview of past activities, current business practices, products and publications, and future program directions. It is designed to increase accountability and summarize our accomplishments during the initial phase of the program.

Key words: PIBO, Effectiveness Monitoring, change detection, current condition, sampling protocol, budget

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PACFISH/INFISH Biological Opinion (PIBO): Effectiveness Monitoring Program Seven-Year Status Report 1998 Through 2004

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Commonly Asked Questions

1. **What is PIBO?** PIBO stands for the PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program. The program was initiated to evaluate the effect of land management activities on aquatic and riparian communities at multiple scales and to determine whether PACFISH/INFISH management practices are effective in maintaining or improving the structure and function of riparian and aquatic conditions. Our study area includes 20 USDA National Forests and nine USDI Bureau of Land Management (BLM) Field Units within the Interior Columbia River Basin.
2. **Who is PIBO?** We have seven full time Forest Service employees with backgrounds in fisheries, riparian ecology, geography, data management, and support services. We also employ up to 45 seasonal technicians. We are based in Logan, UT.
3. **How is the PIBO program funded?** The program is funded by Forest Service Regions 1, 4, and 6 and the Oregon/Washington and Idaho State Offices of the BLM. Funding for special projects has been provided by the Forest Service's Fish and Aquatic Ecology Unit and Stream Systems Technology Center, Forest Service Region 1, Oregon/Washington BLM, and the Salmon Challis National Forest.
4. **When will we begin reporting changes and trends in resource conditions?** In 2006 we will begin our second sampling rotation, when we resample sites initially sampled in 2001. Comparing these two sampling periods will allow us to begin describing changes in each attribute we measure. By 2010, approximately 1,000 stream reaches will have been resampled, giving us the ability to describe change between the periods of 2001 to 2005 and 2006 to 2010. Assessments of trends in resource conditions will begin in 2011, because a minimum of three samples are required for trend analyses.
5. **How is the PIBO-EMP working with other large-scale monitoring programs to develop compatible sampling methods and sampling design?** We have worked extensively with the Northwest Forest Plan – Aquatic and Riparian Effectiveness Monitoring Program (AREMP) to standardize sampling methods between our programs. Beginning in 2004 we will be using identical methods for a core set of physical habitat attributes and macroinvertebrate sampling. In 2005, we will be participating in a sampling protocol comparison study with other Federal and State monitoring programs.

6. **Is the PIBO program consistent with recommendations in the Forest Service Aquatic and Ecological Unit Inventory (AEUI) proposal?** Yes. The 2004 standardized sampling protocol developed with the AREMP program is consistent with the draft AEUI protocol for most attributes.
7. **Can the results be used to answer status and trend questions at smaller spatial scales (for example, individual Forests or BLM units)?** Results from sample size analyses suggest that we will be able to detect changes in resource condition at the scale of individual Forests and BLM Field Offices (35 to 90 sites) for many of the attributes we measure. Comparisons between reference and managed sites also support these results. We are beginning to work with Forest Planning teams to determine how our study design and data collection can be used to address their monitoring questions.
8. **What have we learned about the current condition of aquatic and riparian resources?** Analyses have focused on whether our sampling methods can detect differences in the resource condition between managed and reference sites. The assumption is that if the methods can detect differences, then they will be useful in detecting changes from current management practices. We found significant differences for eight of 12 physical habitat attributes and for macroinvertebrates, but no difference in riparian vegetation attributes. Analysis of PACFISH/INFISH Riparian Management Objectives suggest that several of the standards are unrealistic, especially wetted width:depth ratio and percent undercut banks. Stratification of the data by Regions or State Offices suggests that standards need to reflect local environmental factors.
9. **How can the data, summary results, reports, and publications be accessed?** Information about the project can be found on our Web page or by contacting us directly. Our Web site www.fs.fed.us/biology/fishecology/emp.html includes an overview of the program, sampling protocols, publications, and an employment page. We have also developed a second site where original and summarized data can be accessed for all stream reaches we sample. If you have further questions, please contact us at PIBO@fs.fed.us.
10. **Will PIBO become obsolete when Land Management Plans replace PACFISH and INFISH with new aquatic conservation strategies?** No. We use a probabilistic sampling design to nearly randomly choose sample sites. This approach is appropriate for assessing the effectiveness of aquatic conservation strategies (ACS). As question 7 above describes, our sample sizes should be adequate to assess the effectiveness of new ACS's as Land Management Plans are revised.

Introduction

The PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program was developed in response to monitoring needs addressed in the Biological Opinions for bull trout (U.S. Department of the Interior, Fish and Wildlife Service 1998) and steelhead (U.S. Department of Commerce, National Marine Fisheries Service 1998). It provides a consistent framework for monitoring aquatic and riparian resources within the range of the Pacific Anadromous Fish Strategy (PACFISH) and the Inland Fish Strategy (INFISH), and will determine whether land management practices are maintaining or improving riparian and aquatic conditions at both the landscape and watershed scales on Federal lands throughout the Upper Columbia River Basin.

The program began with a pilot study in 1998 on Forest Service lands within the Salmon River Basin of central Idaho. In 2000, the Interagency Implementation Team (IIT) expanded the pilot study to include Federal lands within the Interior Columbia River Basin. This includes Forest Service lands within PACFISH and INFISH (20 National Forests) and BLM lands that are within PACFISH or contain bull trout (10 Field Offices and Resource Areas). (Throughout this document we use the term "Field Units" to include Forest Service's Forests and Ranger Districts, and BLM Districts, Field Offices, and Resource Areas.) During the pilot study we focused on evaluating sample methods, addressing study design questions, and developing a centralized team to implement the program. The study design was finalized in the winter of 2000 (Kershner and others 2004b), and the PIBO Effectiveness Monitoring Program officially began in 2001.

This 7-year status report will give our funding sources, partners, and the public an overview of past activities, current business practices, products and publications, and future program directions. It is designed to increase accountability and summarize our accomplishments during the initial phase of the program.

Objectives and Study Design

The program goal is to determine whether PACFISH/INFISH management practices are effective in maintaining or restoring the structure and function of riparian and aquatic systems. The specific objectives are:

1. Determine whether a suite of biological and physical attributes, processes, and functions of upland, riparian, and aquatic systems are being degraded, maintained, or restored across the PIBO landscape.
2. Determine the direction and rate of change in riparian and aquatic habitats over time as a function of management practices.
3. Determine if specific "Designated Monitoring Area (DMA)" practices related to livestock grazing are maintaining or restoring riparian vegetation structure and function.

The study area contains 3,547 subwatersheds (sample units) with at least some Forest Service or BLM ownership. A generalized random tessellation stratified design (GRTS) was used to select subwatersheds to achieve a random, nearly regular sample pattern throughout the study area (Kershner and others 2004a). Approximately1,300 subwatersheds were selected for sampling during the first 5 years (2001 through 2005). Each of these subwatersheds will then be resampled on a 5-year rotation beginning in 2006 (table 1).

The subwatersheds were divided into two groups based on management history. A subwatershed was considered "reference" if it was not grazed by livestock in the last 30 years, road densities were less than

Table 1—The table displays the sampling design at full implementation where 250 subwatersheds would be sampled each year from 2001 through 2007. These sites will be resampled every 5 years. An additional 50 watersheds were selected for annual sampling (sentinel sites). The actual number of subwatersheds sampled at half implementation in 2001 and 2002, and full implementation in 2003 and 2004, are shown in parentheses.

Sampling design category	2001	2002	2003	2004	2005	2006	2007
Sentinel	50(38)	50(26)	50(48)	50(50)	50	50	50
Group 1	250(152)					250	
Group 2		250(106)					250
Group 3			250(233)				
Group 4				250(241)			
Group 5					250		

0.5 km per km^2, riparian road densities were less than 0.25 km per km^2, and there was no historic dredge or hardrock mining in riparian areas. All other subwatersheds were considered "managed."

Sample Site Selection

To address our first objective, we sampled an "integrator" reach in each randomly chosen subwatershed. These sites were chosen because they are the most likely location to show integrated effects from upstream management actions, and 83 percent of these sites are located in the most downstream response reach (defined as having a stream gradient less than 3 percent) on Federal land with the remaining sites (17 percent) at the downstream most transport reach (stream gradient between 3 and 5 percent) on Federal lands. The design also requires at least 50 percent Federal ownership upstream of the site. A suite of physical stream habitat attributes, riparian vegetation characteristics, and macroinvertebrate samples are collected at these sites.

To address our second objective, we randomly selected 25 reference and 25 managed integrator sites for annual sampling (sentinel sites).

Our third objective required us to sample a DMA within each selected subwatershed where cattle grazing occurs within the riparian area. The location of the DMA is determined by the Field Units and is used for annual "Implementation" monitoring (USDA 2003). This link between implementation and effectiveness monitoring provides an adaptive management feedback process. Only riparian vegetation, stream bank, and bankfull width measurements are collected at these sites.

Field Sampling Protocols

In 1997 an interagency team was convened to determine which physical and biological attributes should be measured to answer the program objectives (Kershner and others 2004b). The original sampling methods we used to measure the attributes came from a variety of sources. Since 1998 we have continued to evaluate and refine each of the methods based on feedback from field crews and results from quality assurance tests.

The stream habitat protocol includes methods for assessing channel cross-sections, gradient, habitat units, large wood, sinuosity, streambed substrate, streambank parameters, water temperature, and aquatic macroinvertebrates (Dugaw and others 2004). The riparian vegetation protocol describes methods for sampling the species composition along the greenline and across the riparian area (Coles-Ritchie and others 2004a,b). Both protocols for the 2004 field season can be downloaded from our Web site at www.fs.fed.us/biology/fishecology/emp.

Sampling Summary

The PIBO program has sampled within all 20 National Forests, three Resources Areas within Oregon/Washington BLM, and five of six Field Offices within Idaho BLM. During the pilot years from 1998 to 2000, 196 subwatersheds were sampled. Since the start of the first 5-year rotation in 2001, 783 subwatersheds have been sampled (table 2, fig. 1). Additional sites were sampled for protocol tests, annual quality control assessments, and for a variety of special projects. This information is summarized annually in reports tailored for each Forest and BLM Field Unit.

Table 2—Summary of all reaches sampled from 2001 through 2004. The sum of the number of subwatersheds is greater than the total due to multiple ownership in several subwatersheds. Similarly, the number of reaches is greater than the number of subwatersheds due to both integrator and DMA reaches within some subwatersheds.

Reaches location	Subwatersheds	Integrator reaches		DMA's
		Managed	Reference	
Region 1	288	211	77	17
Region 4	232	169	59	53
Region 6	184	162	14	80
BLM Idaho	50	26		34
BLM OR/WA	39	9		28
Total	783	577	150	212

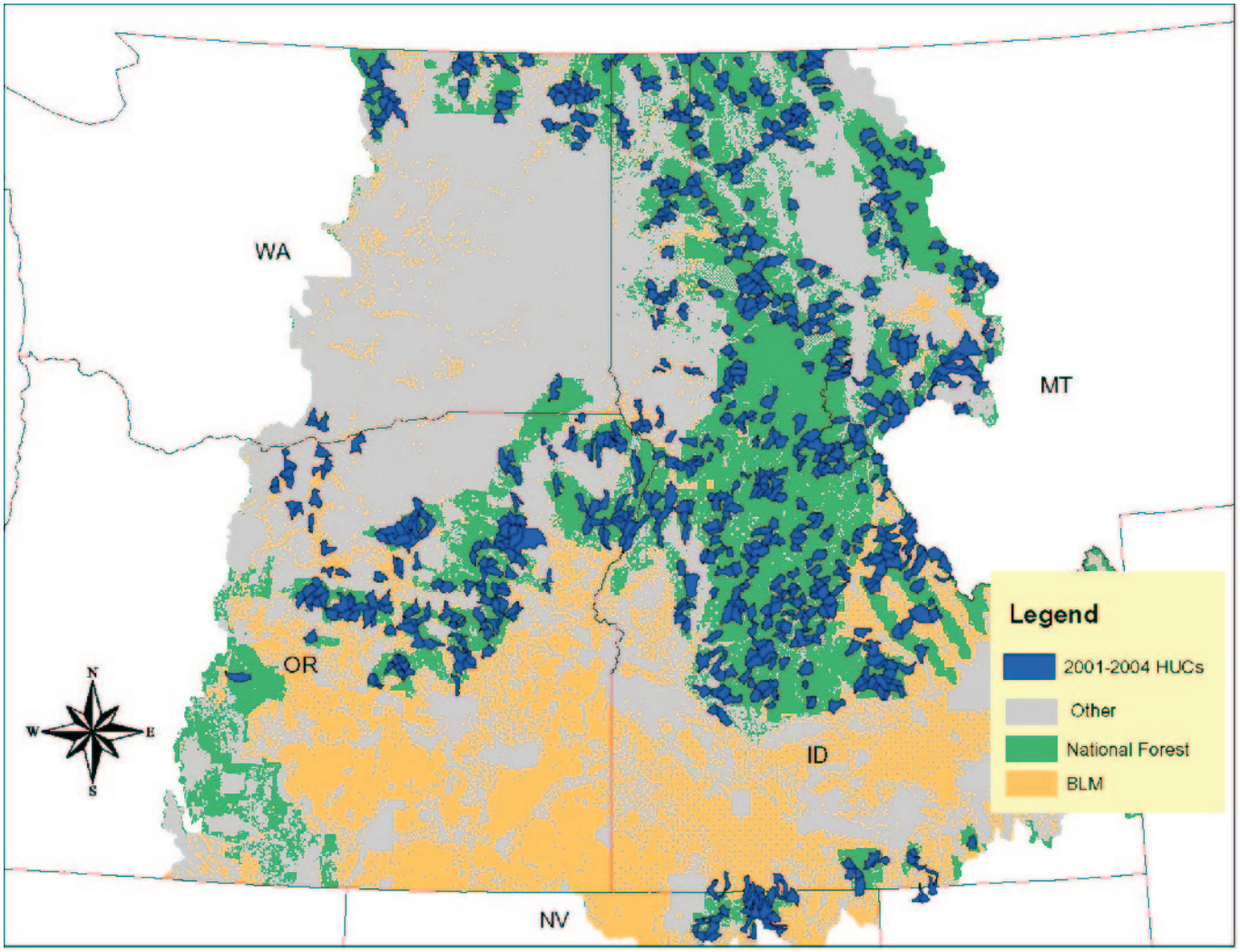


Figure 1—The figures show the study area and the 783 subwatersheds sampled between 2001 and 2004.

Detecting Change in Resource Condition

We will begin analyzing the dataset for changes in the conditions of aquatic and riparian resources (Objective 1) in 2006. This is the first year of the second rotation, when we begin resampling stream reaches initially sampled in 2001. We will summarize the change for nearly 250 sites each year until 2010. By this time about 1,000 stream reaches will have been resampled, giving us the ability to describe changes between the periods of 2001 to 2005 and 2006 to 2010. Assessments of trends in resource conditions will begin in 2011, since a minimum of three samples are required for trend analyses.

PIBO Program Resources

Funding for the program has steadily increased since 1998. In fiscal year 1998, we received $70,000 from Region 4 to initiate the program. The annual budget increased to $1,298,000 in fiscal year 2004, with the majority of funding coming from the three Forest Service Regions and two BLM State Offices (table 3). Additional funding has been provided through partnerships with the Forest Service Fish and Aquatic Ecology Unit, Forest Service Stream Systems Technology Center, Utah State University, BLM Washington Office, and individual Forests. Funding from partners has ranged from $0 to $75,000 annually, accounting for up to 6 percent of our budget.

Table 3—Funding levels by administrative unit for fiscal year 1998 through 2004, and estimated funding for fiscal year 2005. Amounts are in thousands of dollars.

Administrative unit	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
FS Region 1	0	0	$70	$168	$138	$380	$380	$390
FS Region 4	$70	$70	$70	$168	$168	$380	$380	$380
FS Region 6	0	0	$225	$168	$168	$365	$365	$365
ID BLM	0	0	$70	$70	$70	$70	$70	$70
OR/WA BLM	0	0	0	$72	$72	$72	$72	$72
Partnerships	0	$40	$40	$40	$15	$75	$31	$128
Total	$70	$110	$475	$686	$631	$1342	$1298	$1405

The annual cost for each Forest Service Region or BLM State Office was based on two criteria. The first was the percent of subwatersheds within the PIBO area managed by the Region/State. Subwatersheds with mixed ownership (BLM and Forest Service) were divided equally. The second factor was the percent of subwatersheds that are grazed. These criteria resulted in the three Regions funding about 90 percent of the program and the BLM about 10 percent.

In fiscal year 2003, approximately 91 percent of the funding was spent in direct support of monitoring activities and 9 percent was spent on indirect costs associated with support services and facilities (fig. 2). Salary and travel accounted for the majority of expenses (76 percent). We expect the proportion of funding in each category to remain constant, with the exception of partnership funds that fluctuate annually.

The program staffing consisted of 26 Federal person-years of effort in fiscal year 2003 (fig. 3). The staffing level within each job group has been changing as we approach the structure needed to implement the program efficiently. We expect the final structure to have a slightly greater emphasis on analysis and information management.

Analysis and Results

Evaluations of Sampling Methods

We conducted five studies to describe the repeatability (observer variability) associated with each sampling method, and the implications of this variability for detecting change.

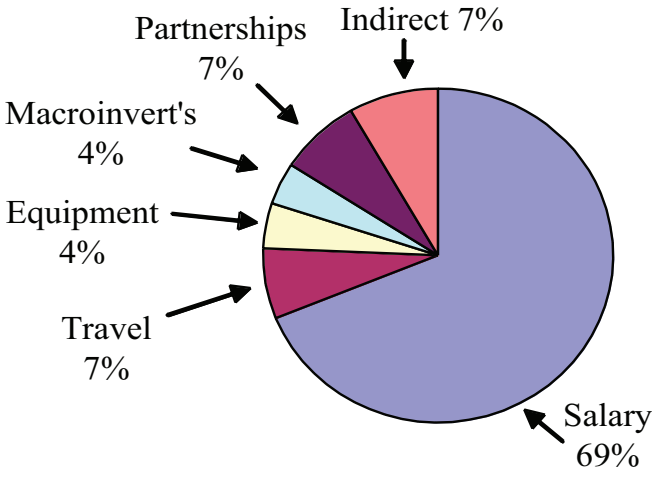


Figure 2—PIBO program expenditures, by category, fiscal year 2003.

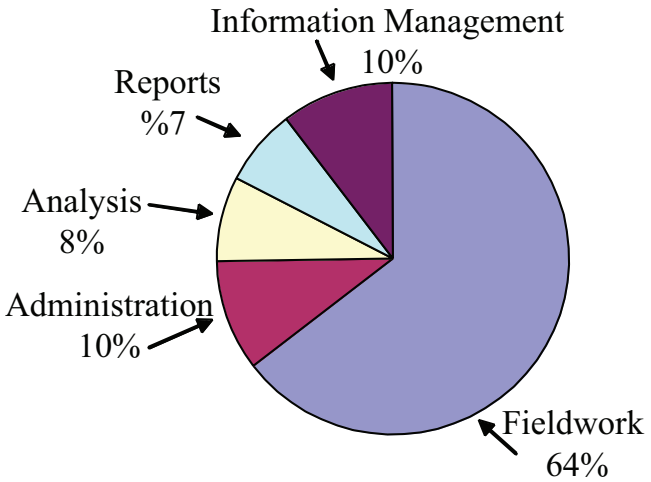


Figure 3—PIBO program employees, by job group, fiscal year 2003.

Repeatability of Physical Habitat Methods—In 2000 and 2001 we assessed the repeatability of stream reach measurements for each physical habitat and riparian vegetation attribute. The studies described the precision of individual measurement techniques, variability among crews (repeatability, fig. 4), sample sizes needed to detect changes, and temporal (seasonal) variation throughout the sampling season (Archer and others 2004, Roper and others 2002). As a result, the sampling methods were refined to improve repeatability and, in a few situations, resulted in switching to new methods.

Particle Count Methods—Our initial tests in 2000 resulted in poor repeatability of streambed particle counts. In an attempt to improve repeatability, we conducted several additional studies in 2001 to further define the sources of variability (Olsen and others, accepted). These studies led to changes in our sampling methods beginning in 2002.

Repeatability of Riparian Vegetation Methods—Initial tests of our riparian vegetation sampling methods showed that technicians had difficulty consistently describing vegetation community types. As a result, it would be difficult to detect changes until a major shift in the species composition occurred (Coles-Ritchie and others 2004a,b, fig. 5). In 2002 we tested a revised method, and in 2003 we switched to describing species cover (instead of community type cover) within systematically spaced plots. Preliminary results from quality assurance tests show that these changes improved repeatability, and provide more detailed information on species, percent cover, invasive species, and rare plants.

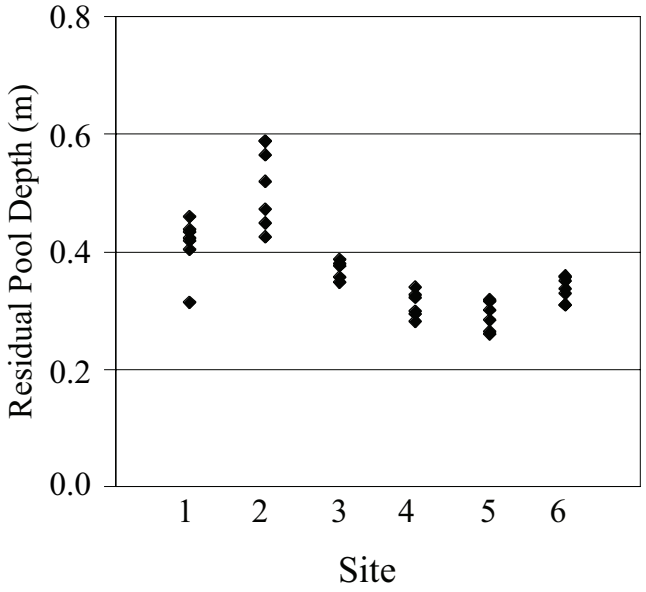


Figure 4—Average residual pool depths for six crews (symbols) at each of six stream reaches.

Plant Identification—In 2003 we tested the accuracy of plant identification by vegetation technicians in the field and the implications of misidentifications on vegetation analyses (Coles-Ritchie and Kelly, in prep.). The results have been used to improve training and modify species collection protocol.

Comparison of Particle Count Methods—In 2003 we compared differences in the estimates and precision of a transect based method and a habitat based method for measuring stream bed substrate (Archer and Roper, in press; fig. 6). Results from the two methods were similar, which convinced us to change our methods in 2004 to be consistent with other large-scale sampling programs.

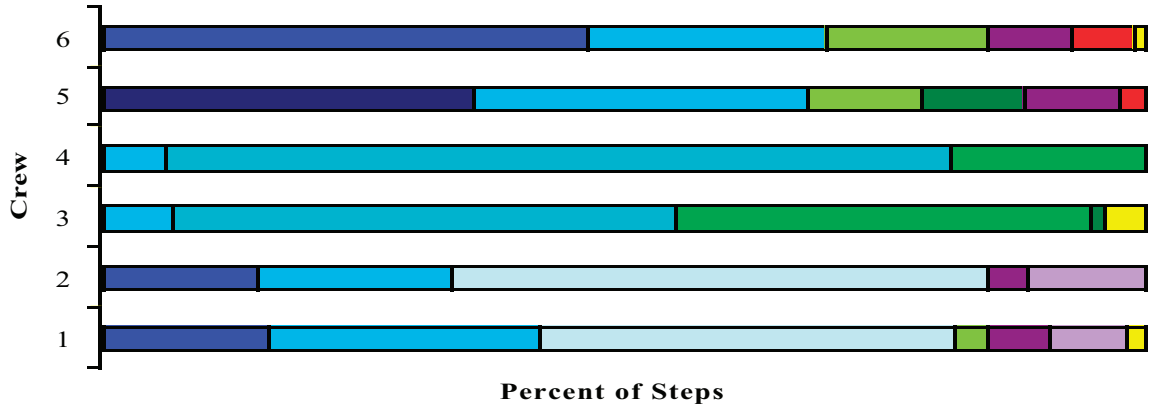
Comparisons of Resource Conditions in Managed and Reference Watersheds

Recent analyses have focused on whether our sampling methods can detect differences in the resource condition between managed and reference subwatersheds. The assumption is that if the methods can detect differences, then they will be useful in detecting changes from current management actions. The ability to account for environmental, spatial, and geomorphic differences between managed and reference sites was inherent to the approach. We addressed this using step-wise regression and analysis of covariance.

Comparisons between reference and managed sites were conducted separately for physical stream habitat attributes, riparian vegetation, and macroinvertebrates.

Physical Stream Habitat Attributes—We examined integrator sites from 62 reference stream reaches and 199 managed stream reaches. An unbalanced, incomplete block analysis of covariance was performed on each of the habitat variables using geology type as the block effect and bankfull width, stream gradient, and average precipitation as the covariates.

There were significant differences in most measures of stream habitat between reference and managed watersheds (table 4). The analysis of covariance was effective for comparing data across a large, relatively heterogeneous landscape where sample reach stratification may be impractical or sample sizes are limited. (Kershner and others 2004b).



Late Seral	Stability Rating	Wetland Rating
Y	9	93
Y	9	85
Y	9	93
Y	6	82
Y	8	83
Y	8	73
N	3	57
N	3	51
Y	8	49
Y	10	85
Y	10	78

Figure 5—The percentage of steps in each community type described by six technicians at Jack Creek. The stability, late successional, and wetland ratings are listed for each community.

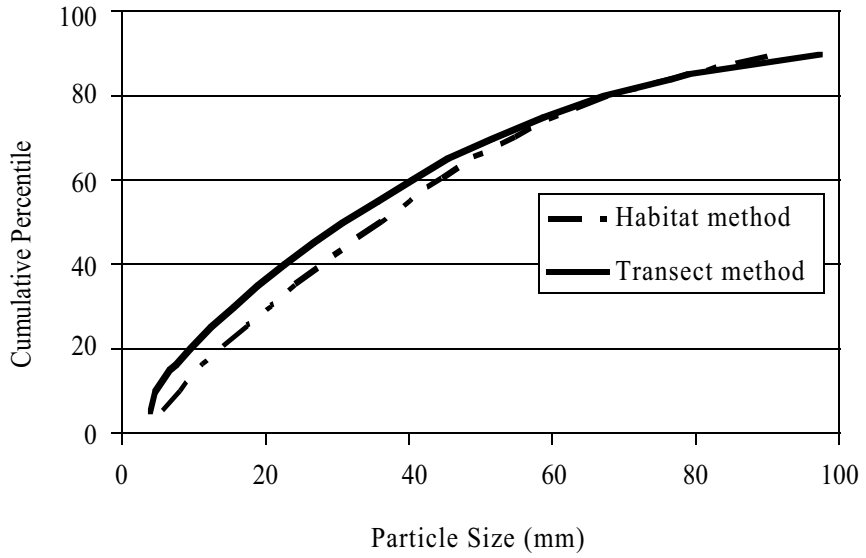


Figure 6—Particle count distributions for two methods used to characterize stream bed substrate. The difference in the median particle size (D50) was 4 mm.

Table 4—Unadjusted means and standard deviations of variables reported for reference and managed watersheds. Variables in bold were significantly different between reference and managed watersheds.

Dependent variables	Managed Mean (stdev)	Reference Mean (stdev)
Width to depth ratio*	**23.9 (12.7)**	**22.6 (13.7)**
Residual depth (m)	**0.33 (0.15)**	**0.41 (0.17)**
Percent pools	48.7 (20.4)	53.8 (21.5)
Bank stability (%)	**74.6 (18.3)**	**79.9 (16.8)**
Bank angle (°)	**108.6 (23.6)**	**93.7 (22.8)**
Undercut percent	**28 (18.1)**	**39.2 (18.1)**
Undercut depth (m)	**0.09 (0.07)**	**0.13 (0.07)**
Pool tail fines (%)	29.9 (27)	21.3 (22.7)
Riffle fines (mm)	24.9 (22.5)	24.7 (20.6)
D16 (mm)	10.8 (11.4)	10.2 (10)
D50 (mm)	**36.6 (27)**	**33.8 (29.1)**
D84 (mm)**	**83.1 (57.3)**	**79.1 (66.1)**

*Significant when streams were greater than 5 m wide
**Significant when streams were greater than 8 m wide

Riparian Vegetation—We examined stream reaches in both managed and reference subwatersheds to determine if we could detect differences in riparian vegetation attributes. In the first analysis, riparian vegetation was evaluated in relation to environment, management, and stream variables. Similarity indices and ordinations were used to compare all sites based on the relative cover of community types. Stream reaches were grouped into four riparian types: (1) conifer-alder forests, (2) wet sedge-willow sites, (3) dry-grazed sites, and (4) steeper-shrub sites. The dry-grazed sites were more impacted by management than the other riparian types. Precipitation and elevation explained the greatest amount of variance. These techniques found little difference between managed and reference sites across the entire study area (Coles-Ritchie 2004, chapter 3).

We also used a wetland rating system to evaluate riparian vegetation at a site. At the small scale, we compared wetland ratings inside and outside of riparian exclosures at 14 sites. Wetland ratings within exclosures were 12 percent higher than wetland ratings in adjacent outside exclosure sites (fig. 7).

At the larger scale, data from 325 riparian sites were evaluated using the wetland rating in relation to management, environment, and stream channel variables. There was no difference in the wetland rating between managed and reference sites (Coles-Ritchie 2004, chapter 4).

Macroinvertebrates—We compared aquatic macroinvertebrate information from integrator reaches within 59 reference and 186 managed subwatersheds. Data from reference reaches were used to build a multimetric and a multivariate model. The results from the multimetric model indicate that 37 percent of the managed reaches were biologically impaired. The multivariate model found 50 percent of the managed reaches to be impaired.

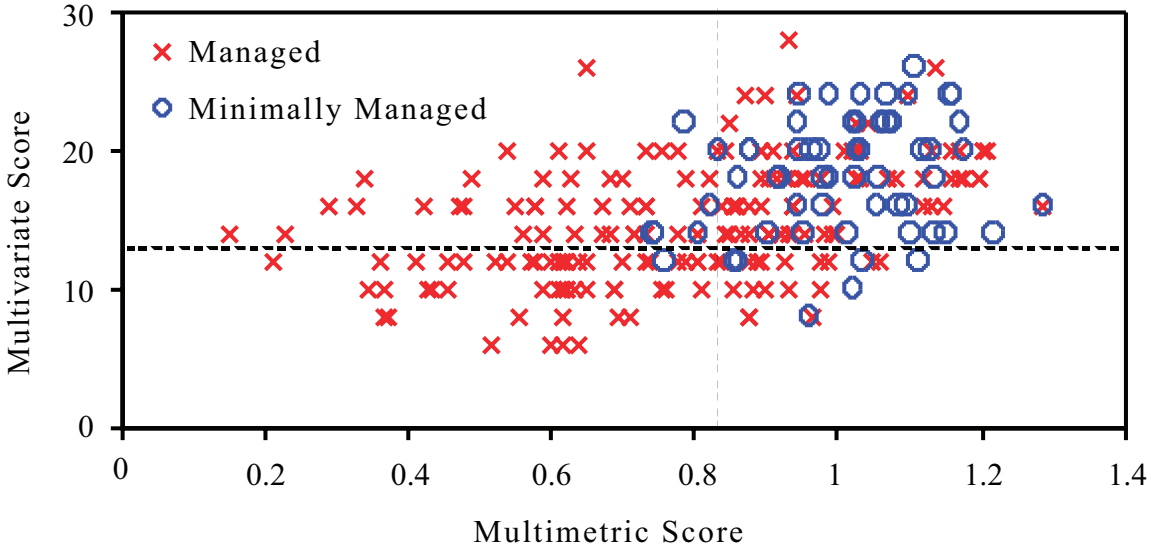


Figure 7—A plot of multimetric scores and multivariate scores for the 245 reaches evaluated in this study. The vertical dashed line indicates the score to the left of which only 10 percent of the minimally managed multimetric values occur. The horizontal dash line indicates the score below which only 10 percent of the minimally managed multivariate scores occur.

Interestingly, the two models agreed on the classification of reference reaches but were dramatically different when determining the impairment of managed sites (Roper and others, in prep.; fig. 8).

Summary—These analyses show that the effects of land management activities can be detected at the large scale for many physical stream habitat attributes and macroinvertebrates but not for riparian vegetation. The results support: (1) the need to address environmental differences between reference and managed sites, (2) the importance of using a wide variety of analytical techniques, and (3) the need for improved stratification techniques to make appropriate comparisons of conditions among sites (for example, between a Region or Forest).

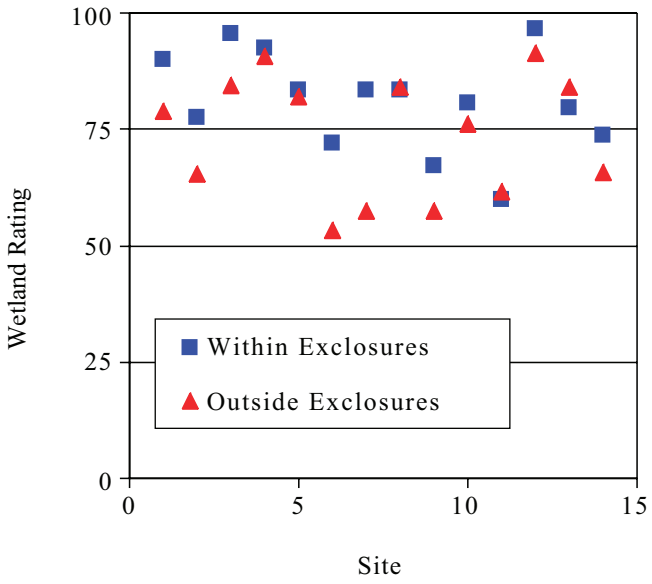


Figure 8—The greenline wetland ratings for 14 pairs of exclosure and outside exclosure sites. Community types were used to describe the vegetation cover and to calculate the wetland ratings.

Sample Size Analyses for Detecting Change

We used three approaches to test our ability to detect changes in resource condition. Our first approach used the total variance estimates from the method evaluation studies to calculate the number of sites needed to detect a change between two strata (see, for example, the reference and managed sites previously described; Archer and others 2004, Roper and others 2002). The other analyses looked at detecting changes between two time periods. Sample sizes are given for all three approaches (Roper and others 2003, table 5). Of the three approaches, the resampling design (table 5, last column) most closely approximates the PIBO study design.

The sample size estimates suggest: (1) that given a sample size of 1,300 sites, we should be able to detect small changes for most stream habitat attributes; (2) that at the scale of an individual Forest (where we will sample from 35 to 90 sites), we should be able to detect a 20 percent change for at least half of the attributes; and (3) that at the scale of an individual District it is unlikely we will detect meaningful changes.

Table 5—Sample size estimates for detecting a difference of at least 20 percent, with a type I and type II error rate of 0.1. Numbers listed are the number of samples required in each strata or time period.

Stream habitat attribute	Two strata	Number of sites needed to detect differences between: Time 1 and time 2 when sites are randomly chosen	Time 1 and time 2 when the same sites are resampled
Gradient (%)	226	211	34
Sinuosity	14	27	7
Bank angle (°)	22	20	9
Undercut depth (m)	81	157	46
Bank undercut (%)	98	101	57
Bank stability (%)	4	20	17
Bankfull width (m)	66	47	15
Width: depth ratio	79	60	32
D50 (mm)	193	271	87
Percent fines	198	333	61
Percent pools	17	53	17
Residual pool depth (m)	27	102	19

PACFISH/INFISH Riparian Management Objectives

The PACFISH and INFISH documents described Riparian Management Objectives (RMO's) for physical stream habitat attributes and water temperature so that they would be used as interim standards until completion of the Interior Columbia Basin Ecosystem Management Planning document. A number of concerns have surfaced regarding the RMO's, including: (1) the "one size fits all" approach to setting standards, (2) unrealistic descriptions of healthy stream channels, and (3) sampling methods were not described. To address these issues we used data from 357 sites and looked at the percent of time that RMO's were met (table 6).

Our results suggest several of the standards are unrealistic, especially wetted width:depth ratio and percent undercut banks. Stratification of the data by Region suggests that standards need to be tailored to local environmental factors. For example, 77 percent of reference sites in Region 1 (N=32) met the large woody debris standard compared to only 44 percent in Region 4 (N=43). This suggests that factors such as precipitation, forest type, and so forth may need to be incorporated when developing standards. We are currently working on developing appropriate standards for each RMO.

Livestock Designated Monitoring Areas (DMA)

We will begin analyzing data from DMA sites in 2004. These analyses will focus on describing the relationships between effectiveness monitoring (EM) data and the implementation monitoring (IM) information collected by the Field Units at these sites. This will provide a link between implementation monitoring objectives and the resource conditions that result from management under these guidelines. At the large scale, we will address the following questions:

1. Is the condition of sites that meet IM objectives different than those that do not?
2. Is the trend in resource condition different at sites that meet IM objectives versus those that do not?
3. What is the relationship between the type of IM monitoring (bank alteration, residual stubble height, and so forth) and the resource condition?

At the scale of a single site, local specialists may use the information to validate or change annual use standards or grazing management within their allotments.

Data Management and Distribution

Data Management

The technology used to enter field data and the development of a database has been an evolving process. As of 2003, all field data were entered into data recorders (physical habitat) or handheld computers (riparian vegetation). This information was imported directly into a Microsoft Access database. After the field season, each data set is run through a series of quality assurance queries to identify outliers, typing errors, and missing values. The final step is to calculate reach level summary values for each attribute.

Annual Reports

Each year we produce 25 versions of a summary report. These include a report for each of the 20 National Forests, three Forest Service Regions, and two BLM State Offices (Anderson and others 2004, fig. 9). Each annual report contains an overview of the program; study design and methods; overview of what's new; maps of sample locations by BLM State, Forest Service Region, or Forest; graphical display of the results for

Table 6—Summary of the percent of reaches throughout the study area that met or exceeded PACFISH/INFISH Riparian Management Objectives (RMO's).

Variable	RMO's	Managed N=265	Reference N=92	All N=357
Pools / mile	Varies	78%	67%	75%
Wetted W:D ratio	<10	1%	2%	1%
% undercut banks	>75	3%	16%	5%
Bank stability	>80	82%	84%	82%
LWD / mile	>20	46%	59%	50%
Max. temp.(spawning habitat)	60° F	25%	53%	32%
Max. temp. (rearing habitat)	64° F	43%	69%	49%

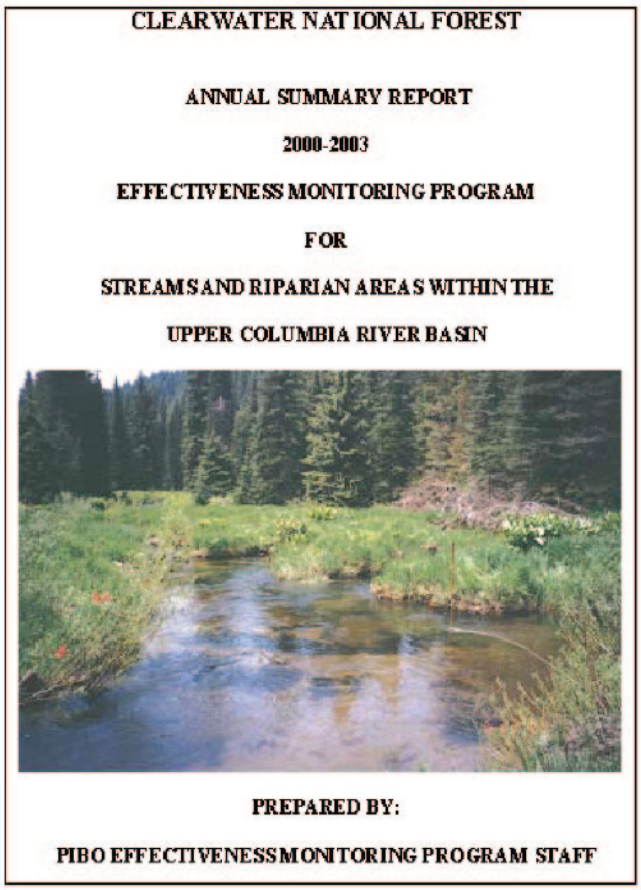


Figure 9—Example of an annual report.

most variables; and data tables with summary values for each attribute at each site. The reports are distributed during our spring meetings with each Field Unit.

Compatibility with NRIS Water and Terra

We began working with Natural Resource Information Systems (NRIS) Water Module in 2003 to move our physical stream habitat data into the NRIS system. The data migration will be completed by fall 2005. New information will be placed in each Forests NRIS database annually. We are also working toward migrating riparian vegetation data into the NRIS Terrestrial Module.

PIBO-EMP Web Site

Information about our program can be found on our Web site at www.fs.fed.us/biology/fishecology/emp. The website includes an overview of the program, sampling protocols, annual reports, publications, and an employment page. If you have additional questions, please contact us at PIBO@fs.fed.us.

Data Access Web Site

We frequently receive requests for site specific data, data summaries for a Forest or group of Forests, or attribute information for collaborative research projects. To provide quick and easy access to this information, we developed a Web site where all summary information and original data can be viewed and downloaded. We also hope to add all photographs and reach description pages by summer 2006. This information can be accessed through a "Data Access" link on the PIBO Web site.

Interaction with Forest Service and BLM Staff

Annual Meetings

We interact with the Forest Service Regions, BLM State Offices, and Field Units through Field Unit visits, on demand presentations, professional society meetings, and the Web site. Each spring we visit each Forest Supervisor's Office and BLM District / Field Office where we give a presentation about the program, distribute reports and publications, discuss logistics for the coming field season, and receive feedback about the program and the products we produce. We have made the following additions based on this feedback:

1. We now summarize water temperature data to determine "impairment" under the Clean Water Act. Information on impairment criteria was gathered from the five State regulatory agencies.
2. In 2003 we began collecting plant species data. This allows us to report on the presence or absence and percent cover for sensitive, threatened, or endangered species, and State-designated weed species.
3. The Western Bio-Monitoring Center developed a predictive model that provides a water quality score for each site based on the macroinvertebrate assemblages (RIVPAC's Model). We provide the results from this model as one approach to summarizing the invertebrate composition at each reach.

Monitoring Coordination Meetings

At the request of the Regional Executives, we participated in seven monitoring coordination meetings with various Field Units in 2001 and 2002. The goal was to identify redundancy and compatibility between the IM and EM programs, and the monitoring conducted by the Field Units. Findings were compiled, reviewed by the Field Units, and reported to the executives.

Regional Teams

We interact with the Regional and State Offices through the IIT and IM task team. We also participate in other task teams such as the R4 and ID BLM Stubble Height team and the R1 Streambank Alteration Team, and we attend numerous Regional and State meetings for resource specialists each year.

Professional Society Meetings

We give presentations at range, fisheries, geomorphology, water quality, and vegetation related professional society meetings each year. These meetings provide contact with other monitoring programs and Forest Service and BLM personnel throughout the country.

Partnership Projects

Recently we began working with the Field Units to address additional aquatic monitoring needs. These have included one-time sampling of additional sites, evaluating sampling methods for implementation monitoring, and long-term additions to our annual sampling.

Lost River Ranger District—The Lost River Ranger District of the Salmon-Challis National Forest needed current condition information on grazing DMA's for an environmental impact statement. The Salmon-Challis National Forest provided funding for us to collect bank stability, greenline successional status, and woody regeneration information at 20 sites.

Oregon BLM—The OR/WA BLM provided funding in 2003 to sample 16 additional subwatersheds in southeastern Oregon. Subwatersheds were chosen by Resource Area personnel, and we selected sample reaches following our normal protocol for integrator reaches. Reports were produced and distributed to each Resource Area.

Forest Service Region 1 Streambank Alteration Team—In 2003, we worked with Region 1 personnel conducting a study that compared the bank alteration estimates, observer variability, and the effect of training associated with three streambank alteration methods (Heitke and others, in review; fig. 10). Results will be used to develop a single sampling method with a known level of precision. Funding was provided by the National Fish and Aquatic Ecology unit, Region 1, and our program.

Idaho BLM Priority Sites—In 2004 we will begin sampling 10 additional stream reaches annually on Idaho BLM lands. These stream reaches are considered high priority areas by the Field Offices and will be resampled every 3 years. Funding will be provided by the BLM State Office.

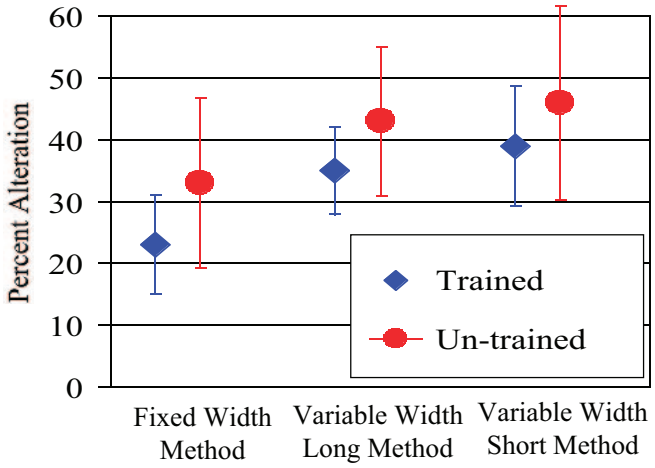


Figure 10—The figure shows the mean percent alteration estimate, standard deviation of observer variability, and the effect of training on alteration estimates and observer variability for three streambank alteration sampling methods.

Interaction with Other Monitoring Programs

Standardizing Sampling Methods

We have worked extensively with the Northwest Forest Plan – Aquatic and Riparian Effectiveness Monitoring Program (AREMP) to standardize sampling methods between our programs. Beginning with the 2004 sampling season, we began using identical sampling methods for a core set of physical stream habitat attributes and macroinvertebrates. This will allow us to combine data and answer aquatic monitoring questions over a larger geographic area. These methods are also consistent with the current Forest Service Aquatic Ecological Unit Inventory protocol.

Comparison of Riparian Vegetation Sampling Methods

We worked with the Forest Service Terrestrial Ecological Unit Inventory Team (TEUI), the Environmental Protection Agency (EPA) Environmental Monitoring and Assessment Program (EMAP), and the Forest Service Forest Inventory and Analysis (FIA) Program, to identify similarities and differences

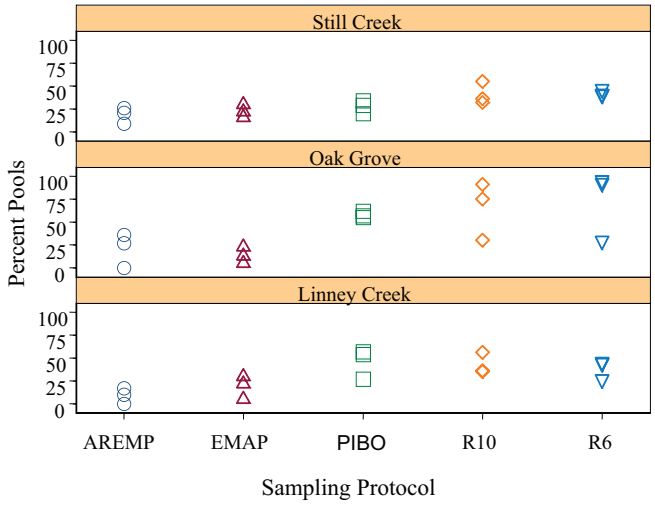


Figure 11—Estimates of protocol means and measurement precision for percent pool habitat on three streams in Oregon. Symbols represent reach means for each crew.

among the riparian vegetation sampling methods. Data were collected using four methodologies at 23 sites within the John Day River basin in 2003. This information will help us move toward a standardized national riparian vegetation sampling methodology.

Comparison of Physical Habitat Sampling Methods

In 2002 we participated in a study that compared six physical habitat protocols used by the Forest Service and EPA (fig. 11). The results identified the strengths and weaknesses of the sampling methods used by each program (Whitacre 2004). This information also provided the framework for integration with the AREMP program.

In 2005, we will participate in an expanded study being coordinated by the Pacific Northwest Aquatic Monitoring Partnership. This study includes seven monitoring programs, and results will provide a basis for standardizing sampling methods among programs.

Interagency Teams

We participate in a variety of interagency teams addressing monitoring and ESA listed species. These include the Bonneville Power Administration /U.S. Bureau of Reclamation - Research Monitoring and Evaluation program, Pacific Northwest Aquatic Monitoring Partnership, Forest Service Aquatic and Ecological Unit Inventory Team, and informal workgroups with other large-scale monitoring programs.

Future Direction and Study Questions

We plan to have a well developed and comprehensive monitoring program by the end of the first sampling cycle. To achieve this goal we will focus on the following issues.

Sampling Method Assessments

Methods for measuring channel shape at a reach scale vary considerably among monitoring programs. We are working with a graduate student to evaluate whether four commonly used methods accurately characterize the sample reach.

Another graduate student is assessing the costs and benefits of adding a fish sampling component to our program.

We are also investigating the ability of our vegetation sampling method to adequately detect the presence or absence, and measure the abundance of, noxious weeds within the riparian area.

Smaller Scale Monitoring Questions

We are currently working with the Blue Mountain Forest Planning Team to determine whether some Land Management Plan monitoring questions can be answered by our program.

We are also working to describe the relationship between riparian vegetation and streambank attributes such as bank stability, bank angle, and the percent of undercut banks in streams representing a variety of channel types and geomorphic conditions.

Assessing Change Detection

We are continuing to evaluate how to best define current conditions, deviation from reference condition, and the appropriate strata to use in these analyses.

We have a joint proposal with the Geospatial Technical Center to assess the feasibility of using remote sensing to consistently describe both natural and human caused disturbance upstream from sample sites. We will then focus on describing relationships between reach level data and watershed scale disturbance.

Additional Questions

We are continuing to work with other large-scale monitoring programs to develop standardized sampling methods and analytical techniques so that data can be combined across multiple programs.

Our program has been conducting additional projects and assignments at the request of the Field Units. We are currently assessing how to best integrate these projects and produce quality products that are usable to multiple groups while still meeting our original mission.

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We are extremely grateful for our interactions with technical experts outside the program. We acknowledge the dedication of the Interagency Team that developed our Monitoring Plan and who continue to support our program. We also thank Dave Turner, Tony Olsen, and Phil Larsen for their guidance in developing our study design and with data analysis. Our interaction with other monitoring programs has greatly improved our understanding of monitoring. So, thanks to everyone with the AREMP, EMAP, FIA, IDEQ, ODEQ, ODFW, and WDE programs.

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Figure 12—The 2003 summer field technicians and staff.

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