PACIFIC NORTHWEST AQUATIC MONITORING PARTNERSHIP

2016 Annual Report

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Executive Summary

The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) continued to promote integration of monitoring resources and development of tools to support monitoring in 2016. Improved coordination and integration of goals, objectives, and activities among Pacific Northwest monitoring programs is essential to improving the quality and consistency of monitoring in the region.

PNAMP operates through inter-organizational teams to make progress on a variety of projects identified to support partner needs and PNAMP goals. These teams are largely ad hoc and formed for the specific purpose of achieving the objectives of the identified projects. For each project, the PNAMP Coordination Team identified interested Steering Committee (SC) members and subject matter experts to form the working teams that provide guidance and leadership. In addition, the teams acted as an intermediate between the larger group of interested participants and the SC, thus maintaining the concept of better SC/participant exchange. The PNAMP Coordination Team continued to facilitate dialog among experts to move forward with ongoing and new projects. In addition, the Coordination Team continued their efforts to track in-kind contributions of time from participants at meetings, workshops, and other PNAMP hosted events; in 2016 this estimate amounted to 4,281 hours by 101 organizations.

In 2016, PNAMP focused on projects related to data management, integration of monitoring, monitoring design, species and watershed monitoring, and technologies to advance monitoring. PNAMP advanced its coordination goals and objectives for these topics by hosting workshops, work sessions, and meetings. Steering Committee members and subject matter experts participated in these meetings to exchange information about their own programs, coordinate existing projects, and initiate new tasks. The following list highlights some of PNAMP's accomplishments in 2016:

- Improved bilateral communications among Intensively Monitored Watershed (IMW) stakeholders to ensure IMWs outcomes (tools, results, and guidance) are valuable to policy-makers and managers by planning and facilitating a two-day workshop with more than 70 participants in Portland, OR on November 1-2.
- Continued work to improve regional coordination for data sharing and reporting of habitat indicators by planning and facilitating a series of stakeholder meetings, 62 people from 34 organizations participated in the project.
- Furthered goal of coordinated data management and exchange to support improved assessment reporting of salmon and steelhead populations in the Columbia River Basin by planning and hosting the annual Coordinated Assessments Workshop in Portland, Oregon on April 28 with 50 attendees from 23 agencies. Also facilitated bi-weekly Core Team phone calls.
- Helped finalize an integrated status and trends monitoring strategy for the Lower Columbia region that will enhance regional coordination and inform the 2018 Municipal Stormwater NPDES Permits in Southwest Washington. This was accomplished by planning and facilitating a series of meetings between municipal stormwater managers and habitat monitoring practitioners in Southwest Washington.
- Continued to coordinate development of a standard taxonomic effort agreement for the Pacific Northwest to facilitate the sharing of macroinvertebrate data.
- Forged new partnerships and expanded use of the MonitoringResources.org web tools through outreach to new national scale monitoring efforts at BLM and USGS. Explored the concept of a facilitated monitoring network beyond the Pacific Northwest by hosting a two-day workshop in Fort Collins, Colorado on October 12-13. The workshop was attended by 30 people from 12 different organizations.

- Served as project manager for the development of MonitoringResources.org tools to support monitoring design creation and documentation, site management, and reporting of sample locations and dates.
- Provided six on-site trainings related to the use of MonitoringResource.org tools for Upper Columbia United Tribes, Nez Perce Tribe, and BPA subject matter experts; trainings ranged from 4-25 people in size.
- Presented a six-part webinar series on MonitoringResources.org functionality (MonitoringResources.org overview, Monitoring Explorer, Site Manager, Sample Designer, documenting protocols and methods, and tool integration). There were over 60 participants across all webinars with many individuals attending multiple webinars.
- Increased documentation of monitoring by promoting and managing the MonitoringResources.org protocol and method library (with 977 protocols and 1,688 methods in the system at the end of 2016).
- Moderated the MonitoringResources.org community forum to discuss protocols and methods.
- Maintained the PNAMP.org website for better information discovery and delivery.

PNAMP's work on these tasks supports our partner's Research, Monitoring, and Evaluation (RM&E) coordination needs, including action agencies' responsibilities for the Federal Columbia River Power System Biological Opinion and the Northwest Power and Conservation Council Fish & Wildlife Program (FWP) strategies for more standardized and coordinated regional monitoring. Specifically, management of online tools to support consistent and detailed documentation for projects, supporting metadata for datasets, conducting method reviews to develop and promote best practices, coordinating data management and exchange to support improved assessments and reporting in the Columbia River Basin, and demonstrating benefits of an integrated status and trend monitoring process are all activities that have and will continue to support FWP strategies as well as PNAMP's partners' strategies. Products resulting from PNAMP's work include online tools to document details about projects' study designs, methods, protocols, and metrics; an application to create metadata records for datasets; data exchange standard for four Viable Salmonid Population (VSP) indicators; tools for VSP prioritization; data exchange standard for monitoring locations and the associated metadata; and guidance for implementing data management and sharing.

Although there was a great deal of progress made in 2016, PNAMP projects will always benefit from increased participation from the PNAMP steering committee members, subject matter experts, and community stakeholders. In particular the MonitoringResources.org web applications, the Monitoring Metadata Exchange (MMX) standard, and the regional habitat indicator data sharing activities would all benefit from additional practitioner engagement and lead to improved RM&E coordination.

Lastly, in addition to specific project tasks, PNAMP continued to emphasize communication as a tool to support collaboration and provided a forum where monitoring practitioners and policy staff could interact and exchange information. PNAMP operates by open, inclusive processes and all meetings and documents are readily accessible on the PNAMP website.

The opportunity provided by the PNAMP forum to allow its partners and participants to collectively focus on issues, results, and future needs related to monitoring increases coordination and collaboration and leads to increased effectiveness and efficiency of aquatic resource monitoring on a regional scale.

Introduction

Federal, state, tribal, local, and private aquatic monitoring programs in the Pacific Northwest have evolved independently in response to different organizational mandates, jurisdictional needs, issues and questions. Planning and coordination of monitoring activities have evolved slowly, but steadily. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) became a formal institution in 2004, charged with providing a forum for coordination of aquatic monitoring efforts in the region. The geographic area of this coordination includes the Pacific Northwest region from Northern California to Canada where participating entities are implementing monitoring efforts. Currently, 19 federal, state, tribal, and regional entities are signatory partners of the PNAMP charter (Appendix A).

The guiding principles behind PNAMP are that monitoring will be improved if all programs:

- use consistent monitoring approaches and protocols
- follow a scientific foundation
- support monitoring policy and management objectives
- collect and present information in a manner that can be shared

These goals require considerable effort and commitment to collaboration by many entities and individuals. PNAMP strives to provide the forum where this collaboration can occur and to facilitate the exchange among subject matter and policy experts that is necessary to accomplish these goals. Although we are always supportive of more participation, we believe PNAMP has a representative mix of participants to address these goals.

The different mandates driving monitoring and subsequent management, policy, and reporting responses require collaboration with other regional and national organizations as well as many individual participating organizations. Regardless of the complexity involved, PNAMP believes that support of coordination and collaboration based on the four guiding principles is important for a successful regional monitoring network.

PNAMP's organizational structure includes a Steering Committee made up of representatives from all organizations that are signatory to the Charter (link to PNAMP Charter page), staff (aka Coordination Team) to serve as coordinators and facilitators for specific topics of interest, and subject matter experts participating in working teams that focus on specific project tasks.

The PNAMP Steering Committee, Coordination Team, and participants share the responsibility to work together to accomplish our goals efficiently and consistently. We encourage those in the region who seek assistance with aquatic resource monitoring issues to contribute to PNAMP. Coordination of complex topics with many partners takes time and hard work. Because PNAMP is a voluntary organization, our progress is directly correlated to participation. Support and open communication are essential for PNAMP to be able to respond to needs of the region. We need to hear from both subject matter and policy experts on what is needed for better coordinated aquatic resource monitoring.

Steering Committee Activities

The PNAMP Steering Committee (SC) provides the science-policy interface between the executive partners and project work teams, and are responsible for communicating their respective organizations' work and needs to PNAMP, as well as delivering PNAMP progress and challenges to their organizations. The SC directs

the activities of the Coordination Team and helps obtain resources needed to accomplish projects. The SC provides assistance to PNAMP initiatives by participating in the formulation, development, and review of recommendations for activities of PNAMP work teams and integrating these activities with their own organizational activities. By promoting communication among organizations, the SC strives to assure that monitoring plans and information are coordinated across the Pacific Northwest.

The SC is made up of representatives from the signatory partners (Appendix A). There are also several "courtesy members" that are invited to participate in SC meetings. Courtesy members are entities that are considering becoming a formal partner; their participation helps them understand the opportunities, responsibilities, and benefits of signatory membership. Courtesy members in 2016 included: Great Northern LCC, Kootenai Tribe of Idaho, Nez Perce Tribe, Nisqually Tribe, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, Puget Sound Partnership, Regional Coordinator for Yakama Nation Fisheries, Shoshone-Bannock Tribes, and Sitka Technology Group. PNAMP is always working to expand membership and increase participation from our partners; we feel it benefits the leadership of the Steering Committee and aids PNAMP in better serving its partners and the region.

In 2016, the Steering Committee met in January, May, October, and held a special session in December focused on the IMW Workshop follow-up. The purpose of these meetings was to track the progress of activities, discuss how new tasks or projects align with PNAMP's goals, and offer guidance when necessary. SC members also report these meetings are a valuable opportunity to network with their peers, who are responsible for monitoring activities in their respective agencies and tribes. These meetings also facilitated information exchange between SC members and work team leads. SC meetings were facilitated by the PNAMP Coordinator and the Coordination Team prepared materials before the meetings and notes following the meetings.

Coordination Team Activities

The PNAMP Coordination Team is employed by the U.S. Geological Survey (USGS), Northwest Region Executive Office. In 2016, the PNAMP Coordination Team included a Coordinator (Jennifer Bayer), and three staff biologists (Amy Puls, Becca Scully, and Megan Dethloff). During the course of the year, two additional staff biologists, Sheryn Olson and Sam Cimino, joined the coordination team.

The Coordination Team's goals are to facilitate the transfer of information within PNAMP and across all relevant organizations, support relationships between science and monitoring, and promote communication among organizations to help assure that monitoring plans and information are coordinated across the Pacific Northwest. The Coordination Team works to initiate and facilitate the development, presentation, and distribution of products aimed at heightening understanding of PNAMP topics, successes, and challenges, and to serve as a clearinghouse for PNAMP activities and products.

The Coordination Team is responsible for administrative requirements of PNAMP activities (e.g. logistical support for meetings, record keeping, and maintenance of participant information). At least one member of the Coordination Staff serves as a lead or co-lead for all PNAMP projects to ensure the project progresses in a timely manner. The PNAMP Coordinator serves as the director of the organization, and is responsible for fiscal, reporting, staffing, and day to day management of PNAMP activities

In 2016, organizational support was provided by developing and negotiating fiscal support with government and non-government entities and managing budgets and associated contracts with those entities. Required progress reporting regarding the Coordination Team's activities (within PNAMP) and PNAMP activities to interested external parties was completed. The Coordination Team continued to seek appropriate outlets for communicating PNAMP's work beyond required progress reporting. The Coordination Team represented PNAMP at several external meetings, workshops, and conferences in 2016. In addition, the Coordinator conducted briefings at meetings and for individual organizations and their executives regarding PNAMP activities throughout the region as requested.

The PNAMP website (www.pnamp.org) remained a vital communication tool to provide information about PNAMP events and projects, and increase the availability of biological and natural resources information at the regional and national level. While the content of the website was maintained by PNAMP staff, technical support and hosting of the website was provided by Sitka Technology Group through November and by the US Geological Survey after that. Although the website has served PNAMP well since 2010, the site could use improvements; however, PNAMP would need additional funding to make updates to the design and usability of the site.

In addition to the pnamp.org website, the Coordination Team also managed development of MonitoringResources.org as described in the MonitoringResources.org Project below.

In-Kind Contributions

PNAMP is a dynamic, growing association of state, federal, and tribal partners and includes a variety of participants from other organizations. Projects are supported by PNAMP staff and inter-organizational working teams, who are almost entirely supported by in-kind contributions from their respective organizations. While managing projects in this volunteer-based environment is challenging, the results are very rewarding.

It is important to us to acknowledge the generosity of in-kind contributions from participants. Over the years, the Coordination Team has tried various ways to track in-kind contributions. We have found it to be relatively easy to track meeting hours and assign in-kind contributions based on attendance at PNAMP meetings and estimates of meeting prep or drive time. For 2016 we calculated 4,281 hours of in-kind contributions of time from 101 participating organizations (Appendix B). Table 1 shows in-kind contributions by topical category, and illustrates how using meeting time to represent participation is imperfect. The 22 hours of in-kind time recorded for meetings related to macroinvertebrate data sharing doesn't reflect the numerous hours taxonomists spent outside of meetings developing the taxa lists for the standard taxonomic effort. Figure 1 shows in-kind contributions by organization type for 2010 through 2016. The spikes in in-kind contributions in 2014 and 2016 were the result of the two-day IMW workshops held those years that were attended by a large number of people. While tracking meeting participation is an imperfect measure of in-kind contributions, it remains our best option. It is much harder to track time contributed outside of meetings. The Coordination Team asks task leads and participants to track hours spent on PNAMP activities during the year, but not many do. Because we are not able to come up with an accurate assessment of these hours in 2016, we are not reporting any estimates here. The Coordination Team plans to continue requesting in-kind estimates from participants in the future.

Table 1. Estimated hours contributed to PNAMP meetings by topical category. Hours were estimated for each meeting attendee for every PNAMP meeting from January 1 to December 31, 2015. For teleconferences the meeting duration was used to estimate the contribution of time from each participant. For in-person meetings contributions were calculated as 1.5 times the meeting duration to help account for travel and prep time. Hours were then grouped by topical category.

Project or Topical Category	Total Hours
Intensively Monitored Watersheds	1345.00
Coordinated Assessments	665.5
Lower Columbia Habitat Status & Trends Monitoring	477.75
Monitoring Resources	437.50
Regional Habitat Indicators	436.00
Enterprise Tools for National Monitoring (USGS)	420.75
Steering Committee Meeting Series	250.50
Outreach and Communication	97.50
Large River Monitoring Forum (USGS)	83.00
Data Management and Sharing Best Practices	45.50
Macroinvertebrate Data Sharing	22.00

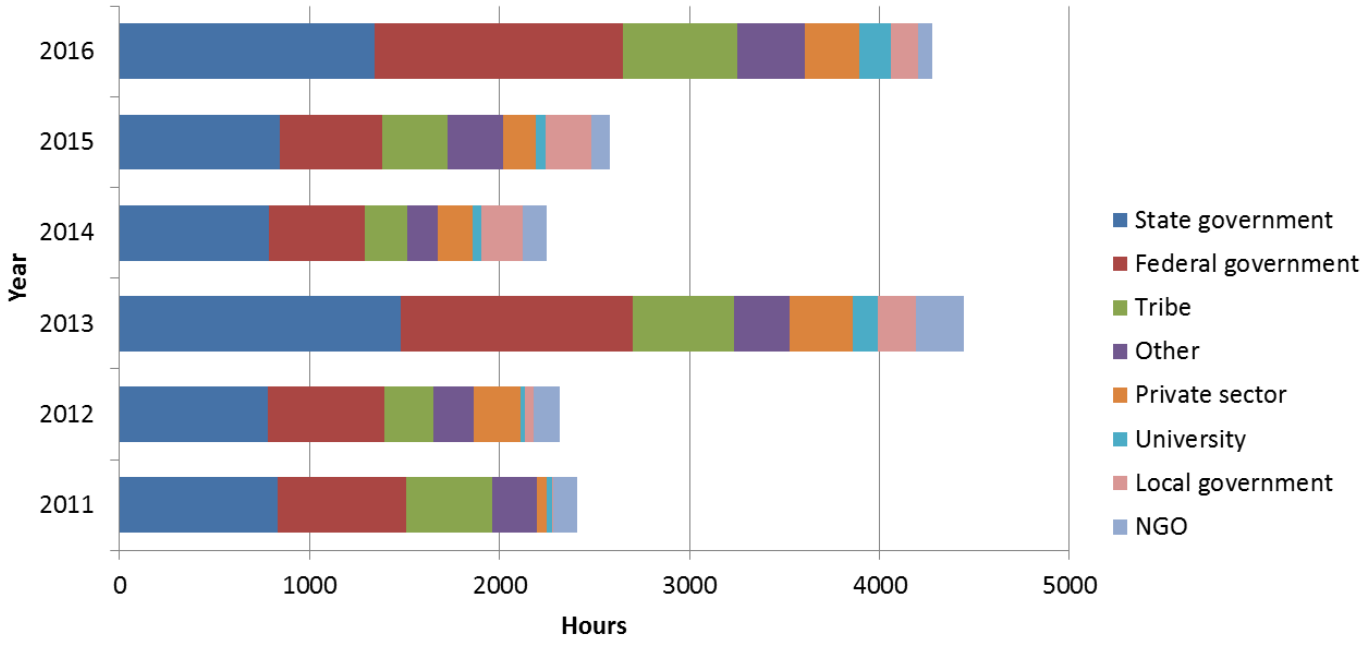

Figure 1. Estimated hours contributed to PNAMP meetings for 2011 to 2016. Hours were estimated for each meeting attendee for every PNAMP meeting from January 1, 2011 to December 31, 2016. For teleconferences the meeting duration was used to estimate the contribution of time from each participant. For in-person meetings contributions were calculated as 1.5 times the meeting duration to help account for travel and prep time. Hours were then grouped by their entity type and year. The entity type of "other" was used in cases when the other seven categories were not appropriate.

Project Activities

For several years, PNAMP's work and associated meetings and work sessions have been driven by ongoing and new projects. This is in contrast to the previous approach of standing work group meetings (organized around topics) throughout the year. The project-focused structure allows for better information distribution among participants in cases where a project cuts across multiple topical areas.

Using a project-focused structure, PNAMP is able to gather interested SC members and subject matter experts to form working teams that focus on completing specific tasks for the project. These teams guide the progress of the project and act as intermediaries between the larger workgroup and the SC. We have found that this structure allows better SC/workgroup exchange without asking every SC member to track every activity. It also allows support from a larger forum of subject matter experts who are able to contribute to an open, inclusive process if they choose. The project-focused structure recognizes the smaller work teams while maintaining the framework of a larger forum of interested participants

In addition, PNAMP has found that it is important to have a dedicated lead for all projects, whether it is someone from the Coordination Team, a SC member, or subject matter expert who participates in PNAMP. In the absence of a lead who can dedicate time to move things along, PNAMP has found that final products can be significantly delayed, much to the frustration of interested parties. In cases where no volunteer lead has been identified via in-kind time contribution, PNAMP has distributed funds to support the time of a lead, as the budget allows.

PNAMP meetings and work sessions in 2016 focused on tasks related to these main projects: MonitoringResources.org (includes all web applications and development), USGS sponsored work, Regional Habitat Indicators, Effectiveness Monitoring Coordination and Assessment, Lower Columbia Habitat Status and Trends Monitoring Project, Coordinated Assessments, and Macroinvertebrate Data Sharing. Several smaller work teams met regularly to focus on specific tasks identified within these projects. Details for each project are described below. Topics or projects not listed above that have been mentioned in previous PNAMP annual reports are still being tracked; however, they were not a focus in 2016.

MonitoringResources.org

Focused on coordination and collaboration, MonitoringResources.org promotes transparency and greater understanding of monitoring through a standard process of documentation and information management. MonitoringResources.org consists of online tools that provide guidance and support for design and documentation of a monitoring project from beginning to end. The tools allow practitioners to document methods, protocols, sample designs, and implementation details associated with data collection and analysis. Once published by the practitioner, monitoring partners and the broader monitoring community can easily search and view this information making coordination and collaboration easier. The tools also support decision making by providing resource managers, funders, and policy makers a comprehensive view of existing and proposed monitoring projects across the region allowing them to better understand how priorities are being met, as well as where there are gaps and overlaps in monitoring.

PNAMP contracted (through USGS and BPA) with Sitka Technology Group (Sitka) to develop these online tools. MonitoringResources.org contains the framework that provides central user and organizational management and houses all other PNAMP applications, including Protocol and Method tools, Sample Designer, Site Manager, Monitoring Explorer, Monitoring Advisor, and the Metadata Builder. The MonitoringResources.org

features, functions, and applications are designed to be modular in nature so that users can take advantage of a single application. At the same time, the individual applications are designed to work together for end-to-end management of the monitoring workflow and to integrate with data collection applications such as Sitka's GeoOptix tool. Details about MonitoringResources.org's individual applications can be found in the sections that follow.

In 2016, we continued support, development, and outreach on all the tools to expand the user base. The number of users of the MonitoringResources.org toolset grew from 322 at the end of 2015 to 382 at the end of 2016. To help with general outreach, PNAMP staff updated the MonitoringResources.org fact sheet to be distributed at workshops, briefings, and meetings. In 2016, a video help page was added to MonitoringResources.org, and two tutorial videos were produced.

In 2016, staff shared a poster on Monitoring Explorer at River Restoration Northwest Symposium in Stevenson, WA, a presentation on Sample Designer at the Oregon Chapter of American Fisheries Society Meeting, a presentation on Sample Designer and a booth at the Northwest Chapter Society for Ecological Restoration Regional Conference, and a presentation on MonitoringResources.org at the International Data Science Conference in Denver, CO.

PNAMP completed the second six-part webinar series focusing on the MonitoringResources.org functionality. Each webinar focused on an individual feature of MonitoringResources.org; Monitoring Explorer, Site Manager, Sample Designer, Documenting Protocols, and Methods and Tool Integration. All presentations can be found on pnamp.org. There were over 60 participants across all the webinars with many individuals attending multiple webinars. Participants ranged from local biologists to national project leaders. Due to the success of the webinar series, PNAMP will continue the webinars in March 2017.

We continued to look for additional opportunities to implement a project tracking process for organizations. This included outreach efforts to increase awareness of the tools, such as briefings with the Oregon Department of Environmental Quality, Upper Columbia Salmon Recovery Board, Puget Sound Partnership, US Environmental Protection Agency Exchange Network Region 10, Oregon Watershed Enhancement Board, US Geological Survey Core Science, Analytics, Synthesis, and Libraries (CSAS&L), North American Bat Monitoring (NABat), US Geological Survey Status and Trends, BLM Assessment, Inventory, and Monitoring (AIM) strategy and Washington Department of Ecology. In 2016, the BLM AIM, USGS Status and Trends, USGS CSAS&L and the North American Bat Monitoring Program (NABat) provided resources to improve the MonitoringResouces.org tools and support PNAMP staff. Details about the improvements made with these resources can be found in the appropriate sections below. In all cases, PNAMP staff has been careful to coordinate development so that updates will support the full MonitoringResources.org community and BPA's needs.

In 2017, we plan to continue to update MonitoringResources.org systems to support multiple funders' needs and enterprise monitoring beyond the Pacific Northwest, while at the same time keeping focus on supporting BPA's needs. We will seek feedback on the tools to improve usability. We will focus on creating resources such as training videos, recorded webinars, information pages, and face to face trainings to improve user experience and proficiency. Additionally, these tools are intended to support information sharing across other online systems, so we will continue to seek input with respect to what systems and organizations would mutually benefit from connecting via web services to MonitoringResources.org. We feel that it is imperative to the success of these tools to find additional partners who share our vision for better documentation and

information sharing and provide support by encouraging or requiring use of the tools within their own organizations. Continued outreach will be essential to get this support. PNAMP will continue to reach out to monitoring practitioners and look for opportunities to promote the MonitoringResources.org tool set. We will also continue to promote use of the MonitoringResources.org tools by PNAMP projects such as the Coordinated Assessments for Steelhead and Salmon. (MonitoringResources.org project page; MonitoringResources.org application)

Tools for Documentation of Methods and Protocols

MonitoringResources.org hosts tools to support the documentation of methods and protocols for data collection and data analysis. By promoting collaboration and standardization through online services like MonitoringResources.org method and protocol documentation tools, the need to perform expensive and error prone crosswalks will be reduced. This will lead to timelier, less expensive, higher quality, and more widely used monitoring data across entities.

PNAMP originally developed the Monitoring Methods Library to promote improved business practices around documentation and to support standards development. Over time, additional applications to support monitoring design and data discovery were developed, culminating in a 2015 refresh and merging of functionality into MonitoringResources.org to improve user experience and streamline documentation. Users can now go to MonitoringResources.org to document methods and protocols or find information about others' methods and protocols, as well as definitions of monitoring terminology. The data collection method descriptions in MonitoringResources.org can also be used to build data dictionaries that drive electronic form displays and data collection on mobile devices.

In 2016, with funding support from USGS CSAS&L, we updated the methods and protocol tools application program interfaces (APIs) from simple object access protocol (SOAP) to representational state transfer (RESTful) web APIs. We also fixed bugs and continued to support users entering content. In 2017, PNAMP recommends additional development as funding allows. Development would be based on needs already identified or additional feedback from users. Feedback received this year included:

- Increase usability, remove unnecessary elements from methods and protocols
- Remove study design information from the protocol allowing for protocols to be used by multiple entities with varied study designs
- Improve links between protocols and the Sample Design tool, allowing for more general documentation of protocols
- Allow upload of figures, forms, documents into customized methods
- Allow ordering of methods in protocol to match how methods are implemented in field
- Support for documentation of analysis only protocols
- Support for documentation of high level indicators methods

In 2016, significant staff effort was put into content management of methods and protocols. There are 1,688 methods in MonitoringResources.org, 938 are published, with 70 methods published in 2016. There are 977 protocols in the system, 132 are published, with 32 published in 2016. PNAMP feels it is important to urge users to finalize (i.e., publish) their content instead of letting it sit for months or years in a draft state. In addition, it is important to the success of MonitoringResources.org to have content in the system that will draw in new users, not turn them away.

To facilitate the publishing of content in 2015, PNAMP and BPA RM&E staff selected projects, such as the BPA Action Effective Monitoring (AEM) Program, Columbia River Habitat Monitoring Program (CHaMP), and Integrated Status and Effectiveness Monitoring Program (ISEMP), and worked directly with protocol owners and project sponsors to publish methods and protocols. This one-on-one interaction helped streamline the publishing process. In 2016, PNAMP focused on Upper Columbia United Tribes (UCUT) and the Nez Perce Tribe (NPT). To support the UCUT, PNAMP staff traveled to Spokane, WA to present a full day training seminar with 20 project sponsors. Since that training, PNAMP staff has worked with UCUT project sponsors to publish their protocols and methods. We repeated the process with the NPT in Lapwai, ID, working with 12 project sponsors. In 2017, PNAMP will continue work with the NPT to document their program-wide protocols and methods. PNAMP recommends that we continue to seek out programs with unpublished protocols and work directly with the protocol owners in one-on-one work sessions. We have scheduled training with Idaho Fish and Game (IDFG) for March 2017, where we will work directly with over 15 project sponsors. We will also focus on documenting standard protocols applied by more than one regional partner such as pit tagging, smolt trapping, and redd surveys.

Regarding reviewing methods and protocols, when a user requests publishing in MonitoringResources.org, PNAMP staff review individual methods for completeness in the step by step instructions, ensure the description mostly follows a generic format, and look for duplication in the system. Staff then provides feedback via the comments section of the method in MonitoringResources.org. PNAMP staff does not have expertise in all methodologies documented in MonitoringResources.org; therefore, we recommend that PNAMP build a network of professionals who are willing to review methods in their area of expertise. With enough people participating, it may only be a time commitment of one to two hours per month per individual. Method reviews by subject matter experts would provide more rigorous scientific review than what is currently being implemented by staff. It would be beneficial for PNAMP partners to encourage technical staff to share their expertise by volunteering to be method reviewers.

In 2016, PNAMP staff worked with RM&E staff to review RM&E work elements in relation to protocols. PNAMP staff drafted a guidance document to help BPA project sponsors understand the relationship between protocols and RM&E work elements in their contracts. We also designed a day long training and presentation to describe these relationships. We reviewed approximately 50 contracts in 2016 based on the guidance template and process established in 2015. In 2017, we will work with RM&E staff to streamline the review process and engage the contracting officer's technical representative (COTRs) in the review process. We will continue to support BPA and project sponsors in documentation of protocols and methods in relationship to work elements.

In 2016, we cleaned up method documentation in MonitoringResources.org. PNAMP staff identified poorly documented and incomplete methods. For methods that were widely referenced, but poorly documented, PNAMP staff contacted users and recommended alternative methods in the system. For methods that were well documented, PNAMP staff asked users to assume ownership or PNAMP took ownership in order to work towards publication. In 2017, PNAMP will continue to identify poorly documented methods or ones that are not being actively maintained, and follow a similar process to move towards a more complete and robust documentation of information. PNAMP recommends continuing to manage content by doing yearly reviews of unpublished methods, searching out common methods, and working with users to improve and publish content.

A common issue identified in MonitoringResources.org method documentation is the creation of duplicate methods creating unnecessary redundancy and confusion. To maintain a more organized library of methods, PNAMP will continue to identify better ways to highlight well documented methods to use as examples for the level of detail that should be documented. We also recommend that program managers be identified in the system and begin "approving" well documented methods for use in their programs. In addition, staff recommend that methods be entered (or poorly documented methods be updated) to fill any gaps in content. We recommend continuing to conduct Method Reviews to improve documentation of universally applied methods. In 2017, we would like to focus Method Review process on PIT tag methods. Currently, MonitoringResources.org has 61 methods with "PIT tagging" in the method title, of those 61, 15 methods are Published. We propose to review those methods, work with subject matter experts to document the PIT tagging methods and delete duplicate and incomplete methods.

Additionally, staff spent approximately 8 to 32 hours per week in 2016 supporting help requests received via email, phone, or the support page on the website. Requests included help with login, content entry issues, how to structure protocols and methods for specific projects, responding to comments on the discussion board, reviewing methods and protocols, and responding to requests to add new organizations or monitoring programs.

Overall in 2016, PNAMP continued to support clear, consistent documentation of methods and protocols for data collection and analysis. We will continue to improve documentation, user support, and tools to improve data management and information sharing in the region. (Document Methods; Document Protocols)

Monitoring Sample Designer, Site Manager, and User Sample Files

PNAMP has pursued development of discrete, but integrated tools to support documentation of monitoring sampling designs and locations of data collection events. These applications, the Monitoring Sample Designer and the Monitoring Site Manager, were released in October 2012. These tools aid users to create permanent, sharable online documentation of their sample designs. In 2015, MonitoringResources.org was redesigned; the functionality of the tools and the users' data was retained, but the organization of the site was updated to improve user experience. PNAMP and Sitka staffs are currently working on updating workflow documentation, information pages, and training videos.

Sample Designer

The Sample Designer helps users build sample designs. It supports probabilistic site selection using an algorithm called Generalized Random-Tessellation Stratified (GRTS) to generate a spatially-balanced set of sites for status and trends monitoring, defining the target frame, stratification, site evaluation, and creating panels. The Sample Designer also supports non-probabilistic designs. At the end of 2016, there were 244 sample designs in the tool (132 were finalized) and over 1.3 million sites located throughout the region.

Probabilistic designs in the Sample Designer leverage the work of Don Stevens and Tony Olsen in the application of the GRTS algorithm to facilitate selections of sites within a sample frame in a manner that is spatially balanced. The GRTS algorithm developed by Stevens and Olsen is also capable of "densifying" existing master samples and integrating sites selected by non-probabilistic means into probabilistic designs and adjusting weights accordingly. For probabilistic designs, the Sample Designer allows users to define their target frame through any number of spatial attributes that are already present in the system, plus any number of custom-defined attributes that users can append to the system for their particular purpose. The Sample

Designer incorporates a sophisticated Boolean logic evaluation engine to narrow the sites desired to match those of the target population. Once sites are selected, the GRTS algorithm assigns sites randomly to panels and strata defined by the design. The system automatically determines the range of values in the categorization variable(s) of interest and creates strata accordingly. Assuming that the user understands the parameters of their particular study, a draft statistically valid design can be produced in as little as 15 minutes.

In 2016, PNAMP received funding for the probabilistic design tool from the BLM Assessment, Inventory, and Monitoring (AIM) program. We used this to develope tools to support dynamic grouping of master sample sites based on covariates associated with sample locations. We also improved the user's ability to upload documents associated with sample designs. Sitka is working to add the ability for users to integrate "legacy" sites into GRTS draws, meaning that a selection of probabilistic balanced sample locations can be drawn which will account for a project's existing sample locations. In 2017, we will continue to receive support from the BLM AIM program to improve the probabilistic sample design functionality in MonitoringResources.org. These improvements will benefit the CHaMP, AEM, and other project sponsors using the sample designer tool to draw spatial balanced probabilistic sample sites using the GRTS algorithm.

MonitoringResources.org Sample Designer also supports non-probabilistic designs. For non-probabilistic design types, users upload shapefiles as a User Sample File, users are then able to create panels and strata and assign sites to them manually. Based on PNAMP analysis of the sample designs documented in the protocol library, over 80% of study designs are non-probabilistic. In 2017, PNAMP recommends we focus on improving the workflow and usability of the non-probabilistic design tools.

Once sites are organized into blocks (an intersection of a strata and a panel) in either type of design, the Sample Designer can incorporate a feature that allows users to perform site evaluations prior to sending crews out to the field. Site evaluations are conducted to ensure that the site is a member of the target population (e.g. it is in a stream that fish spawn or rear in), is safe for crews to survey, and that the landowner has given permission (in cases where the sites are on private land or require crews to traverse private lands). When sites are rejected, the reason for rejection is recorded for post data collection analysis. For both types of designs, users can also "pin" the starting panel to a year, which fixes multi-year designs in time and facilitates the transfer and construction of data collection events in data collection systems. All designs created in the Sample Designer can be transfer to Sitka's data collection system (GeoOptix), to facilitate the creation of data collection events and the collection of field data.

In 2016, PNAMP facilitated the design and building of an additional step into MonitoringResources.org Sample Designer tool to allow users to document data collection events information. The tool requirements are compatible with the requirements established in the Monitoring Metadata Exchange (MMX); once users' data are updated, their sites can be visualized in the Monitoring Explorer Map viewer. This tool increases the number of sites being displayed in Monitoring Explorer, thus improving regional data discovery and creating opportunities for funders and project implementers to identify inefficiencies in sampling. In 2017, PNAMP will continue training, outreach, and user support for the Sample Design tool, including the new MMX editor feature. We will work with BPA staff to identify project sponsors to test the new tool. We will create help documents and videos to support users.

We recommend increasing support in the coming year to load additional designs. In 2016, BPA has expressed interest in linking their internal agency system (Gemini) to MonitoringResources.org with respect to tracking

locations of RME activities. PNAMP staff worked with BPA to define the current Sample Design workflow and propose updates based on new BPA requirements. In 2017, PNAMP staff will use this workflow documentation to run a pilot project with project sponsors to gather feedback and requirements to guide Sample Design development needs. We will work with BPA and Sitka to draft requirements and broadsheets and prioritize development to meet Gemini release deadlines. PNAMP staff will create guidance and trainings to support project sponsor's use of the tools. Supporting BPA project sponsor's use of the Sample Design tools as part of the BPA contracting process will require additional staff time going forward.

Site Manager

The Site Manager works in conjunction with the Sample Designer tool. The Site Manager supports information associated with master samples and sample designs created in the Sample Designer. The goal of the Site Manager tool is to provide an easy to use interface, a simplified list of what master samples are available in a region of interest, a way for users to upload and maintain project-specific sites, and serve as a source for making the locations of these sites transparent to funders and other stakeholders.

The Site Manager stores a variety of master samples from both linear stream networks and area-based water bodies such as estuaries and mainstem rivers in the Pacific Northwest, attribute information for sites in each master sample, and is where users can explore details about sites in master samples and sample designs used in monitoring projects. Site Manager also allows users to upload their own attributes to be associated with master sample locations. Currently, there are eight master samples in the tool. In 2015, two master samples were added to support the BLM; one is a linear master sample to support lotic sampling, and one is area-based to support terrestrial sampling. These master samples are fully documented and available for all MonitoringResources.org users.

In 2016, PNAMP has continued to outreach and support the master sample library. Staff presented the work at multiple conferences, regional meetings, and PNAMP facilitated work sessions to gather feedback. Based on user feedback, Sitka modified the master sample library to improve user's experience in adding attributes to the master sample, downloading attributes, and allowing all users to see and use other users' extended attributes. Additionally, we have received support from the BLM AIM program and NABat for development of the master sample tool. Both are using the master sample tool to serve, document, and display master samples. All development work funded by BLM AIM and NABat will benefit all MonitoringResources.org users. In 2017, PNAMP will continue to support the master sample library, solicit feedback on the tool, and facilitate a workshop discussing the use of Master Samples and GRTS designs. (Site Manager- Master Sample application)

User Sample Files

Because we support both probabilistic and non-probabilistic designs, it makes sense to support users' uploading their sample location in the tool; these are referenced as "User Sample Files". We defined User Sample Files as documentation of sites that are not drawn from one of the supported Master Samples, but instead are selected by a monitoring practitioner in any other manner. The application allows users to import shapefiles of sample locations, document information about those points, add points by dropping the points on a map, and add or modify attributes associated with sites. These sample files can then be used in the Sample Designer tool where the sites can be assigned to panels and blocks, and the user will be guided through the documentation of site selection.

In 2016, there were 61 user sample files in the application, up from 49 in 2015. In 2017, if BPA links Gemini RM&E work elements to MonitoringResources.org Sample Design tool, we anticipate a jump in the number of User Sample Files in MonitoringResources.org. It will be important to devote PNAMP staff resources to managing this content.

In 2016, based on user feedback we updated the application to allow users to batch update their User Sample Files by uploading Excel files, and improved the user interface to support the ability to edit and update attributes and the schema associated with User Sample Files. In 2017, we will focus on making improvements to support users in creating User Sample Files when they have less than 10 sites. This will be critical to support the BPA project sponsor's use of the Sample Designer application, since over half of BPA project sponsors have less than 10 sites in their study design. We recommend continuing to seek user feedback on the User Sample File application and making updates to improve its usability.

In 2017, PNAMP will continue to support the User Sample File application by soliciting feedback from users on the tools, and working to document and fix issues. The two major development issues we will focus on are updating the tool to allow users to create files without first uploading a shapefile and improving guidance and documentation on the MonitoringResources.org tool set. (Site Manager- User Sample Files application)

Monitoring Explorer

Whereas the Site Manager, User Sample Files and Sample Designer are concerned exclusively with pre-data collection processes, the Monitoring Explorer is concerned with post-collection visualizations. In 2013, we began development of the Monitoring Explorer feature. The Monitoring Explorer is a database containing extensive information about the location, method, and timing of data collection events in the field as well as the organization that collected it and specific links to where the measurement or metric data may be downloaded. The Monitoring Explorer database is designed based on the Monitoring Metadata Exchange (MMX) Standard. It currently provides access to a full-featured interactive GIS map that utilizes ArcGIS Server and several common layers for the region. The work to populate sites (locations) in the Monitoring Explorer began in fall of 2013.

The idea for the Monitoring Explorer was based on a variety of past PNAMP discussions and new tool development. Since 2005, PNAMP participants have expressed the need for a web-based data system that provides geographic locations in an interactive map-based format with monitoring activities linked to information about who is carrying out the activities and what is being monitored. PNAMP developed an idea for a tool that would provide information associated with project sites from multiple organizations in one online resource so users wouldn’t have to search through a variety of project tracking databases to gather the information they needed. Proponents envision that this tool would support the ability to summarize current and historic monitoring activities and would assist in coordinating future activities. It should be noted that the intent is not for PNAMP to develop a tool that becomes a system of record for all monitoring location information in the region, but rather to develop a tool that has the ability to display a comprehensive list of monitoring locations and site level metadata information from other systems.

Monitoring Explorer is an interactive web mapping application that displays the location of actual data collection events along with the ancillary information described above. This information is displayed in a “web friendly” way where hyperlinks to other MonitoringResources.org pages or the pages of responsible agencies can be quickly called up in a browser.

Monitoring Explorer uses the power of the ArcGIS Server and the Javascript API to provide advanced mapping and geoprocessing capabilities. This includes a full suite of base map imagery and the ability to quickly add other GIS layers of regional interest (fish population layers, Beechie classification, land ownership, etc.). A sophisticated search tool built to work closely with the map and the database, allows users to find sites that have data that may be of interest to sponsors and stakeholders and quickly allow them to access data collected at that site.

In 2016, we did not focus on Monitoring Explorer development. Instead we worked on adding content and building tools to help users add content. We integrated NOAA's Pacific Northwest Salmon Habitat Project (PNSHP) Database to Monitoring Explorer layers. PNSHP houses site locations and project information from over 51,000 restoration projects across Washington, Oregon, Idaho, and Montana. The data is from multiple federal, state, and tribal entities. Monitoring Explorer is dynamically linked to the PNSHP data layer; meaning that when the layer is updated on NOAA's ArcGIS Server, those updates are automatically displayed in Monitoring Explorer. Now users can see locations of restoration actions in relationship to monitoring locations.

Our 2016 development focused on developing the Sample Designer to allow users to update their data collection events. This added functionality will provide additional location to the Monitoring Explorer Map. Additionally, we worked on updating and sharing the Monitoring Metadata Exchange (MMX) API, to support the sharing of data collection events from enterprise data systems. In 2017, we will work with users to prioritize updates to Monitoring Explorer.

PNAMP gave demonstrations of Monitoring Explorer at regional meetings, trainings, and workshops to help educate potential users about its capabilities and encourage participation in sharing site level data. (Monitoring Explorer application)

MonitoringResources.org Monitoring Metadata Exchange

In 2014 to facilitate integration of monitoring, PNAMP and regional partners drafted a data exchange template for exchanging monitoring site level metadata. Monitoring Metadata Exchange (MMX) is a PNAMP standard data exchange mechanism for data collection event level metadata (the who, what, how, where, and when). Monitoring Metadata Exchange was created to be used by both producers and consumers of monitoring data to foster greater visibility and understanding of the diverse range of data collection happening throughout the region. PNAMP staff presented the first version of the MMX to regional partners and incorporated their comments to further refine the exchange. PNAMP hosted efforts with stakeholders to refine the MMX specification and contributed significantly to its design, and also participated in EPA Region 10 work sessions related to ongoing development of exchanges on the EPA Exchange Network (EN) and advocated for MMX to become an Exchange Node standard.

One of the major drivers behind drafting the MMX standard was to facilitate the sharing of site level information to be used in the Monitoring Explorer, but because the data are freely exchangeable, any organization with the desire and resources to do so could create alternative repositories and tools on top of this shared data. To facilitate sharing in 2014, Sitka developed a RESTful web service implementation of the MMX data exchange standard (complete with a validating xml schema). This implementation is written using Microsoft's .NET technology stack and is the mechanism that Sitka is using to integrate CHaMP and AEM site level data into the Monitoring Explorer. The source code of this implementation serves as an MMX reference

implementation and can be freely shared with any organization that wants to publish their data into this exchange. In 2017, we will publish the MMX API with full documentation.

The PNAMP MMX will convene a working group to refine the MMX standard as necessary. PNAMP has adopted this standard and begun seeking participation by regional partners. Since 2014, PNAMP staff has presented the Monitoring Explorer and MMX to various partners and outside organizations; outreach efforts will continue in 2017. PNAMP will seek additional opportunities to collaborate and establish automated transfer of information using the RESTful web services. PNAMP will target organizations with large publically available databases.

Additionally, PNAMP will investigate ways to integrate the MMX standard into current PNAMP projects including Coordinated Assessments. In an effort to increase use of the MMX standard, PNAMP will structure all other data sharing efforts around the established standard; which is incorporating established date, time, location, and metadata elements from the MMX standard into future data sharing efforts.

In 2017, with the goal of adding information to the Monitoring Explorer map viewer, PNAMP will continue to seek partners to exchange information using the MMX standard and the RESTful web services. PNAMP will also reconvene the working group to assess if updates need to be made to the standard. (MMX project page; MMX Draft Standard)

MonitoringResources.org Conclusion

MonitoringResources.org has seen increased interest from local and national monitoring efforts. PNAMP staff is working to coordinate development to increase efficiencies and support all users. In 2016, PNAMP facilitated our first meetings between all partners supporting MonitoringResources.org; we will continue to do that in 2017. We recommend BPA focus support on improvements to the Sample Designer tool and the User Sample File tool to accommodate their changes to the Gemini RM&E documentation process. We also recommend supporting efforts to understand what BPA project sponsors need and making small functionality changes to meet those needs, allowing us to reward people who complete documentation. In 2017, we would like to work with BPA to identify priority project sponsors with enterprise data systems to link their database to the Monitoring Explorer using the MMX API. This will allow us to know who is collecting what data, where, when, and how, and to start thinking about how PNAMP could help facilitate exchanging data between multiple entities.

Managing content in MonitoringResources.org is a time consuming process. A majority of protocols and methods have been entered by BPA project sponsors. Staff works directly with RM&E staff and project sponsors to review these protocols to build metadata consistent with project sponsors' RM&E work elements. We recommend PNAMP continue to work with RM&E staff to refine this process to eliminate unnecessary steps and streamline the documentation process to alleviate burden on sponsors while still providing BPA with the necessary information. PNAMP anticipates an increased workload in relationship to supporting project sponsors documenting study designs in MonitoringResources.org. We recommend RM&E staff work with PNAMP staff to design trainings for sponsors and contracting officer's technical representatives (COTRs). With continued support from BPA and others, MonitoringResources.org will help fulfill the region's needs for consistent documentation of monitoring and will result in opportunities to share data, complete regional analyses and improve knowledge of regional monitoring to support timely, consistent decision making.

USGS Sponsored Work

Due to our success in supporting collaboration with partners in the Pacific Northwest, PNAMP staff, who are all USGS employees, have been asked to support similar work sponsored by USGS including the Large Rivers Monitoring Forum (link), exploration of development of enterprise tools for national scale monitoring programs (link to 2016 workshop), and support for USGS Fisheries Program's exploration of documentation of protocols and methods as part of a pilot Fisheries Program task.

The Large River Monitoring Forum (LRMF) focuses on fish, fish habitat research, and monitoring approaches, including: scientific objectives for comparisons within and among aquatic ecosystems; scientifically sound monitoring design; methods for data collection and analysis; and best practices for data and information management. The forum consists of 13 scientists from five major river systems in the US. During 2016 the LRMF held monthly meetings that were structured towards formulating a strategy for collating long-term fisheries monitoring data with data describing landscape-level stressors that affect fish populations and other biota. In 2017, the forum will continue to hold regular teleconference calls to refine ways to look at this research to determine how stressors are affecting fisheries communities and assess where more data is needed. We will also hold a two-day workshop in Hood River, OR to work on a conceptual modeling design. The forum will also try to bring additional large river basins into the collaboration.

The USGS Ecosystems Mission Area Status & Trends Monitoring Program is very supportive of exploring potential expansion of the use of PNAMP's enterprise web tools (www.MonitoringResources.org) and the concept of a facilitated monitoring network beyond the Pacific Northwest. In 2016, we were provided funding to: 1) scope interest in expanded use of MonitoringResources.org; 2) identify and scope potential pilot projects to be new use cases of MonitoringResources.org; 3) scope interest in a facilitated national monitoring network; 4) coordinate with related tasks funded by other programs in USGS involved in monitoring and information management. In order to identify and prioritize development and enhancement of enterprise resources for coordination, design, implementation, documentation, and discovery of data from monitoring programs, a workshop was held October 12-13, 2016 in Fort Collins, CO. The 30 participants included federal natural resource researchers and land managers (e.g., US Geological Survey, National Park Service, BPA) and non-governmental organizations responsible for large-scale, long-term natural resource monitoring programs. Results will be used to help increases participation and support for the MonitoringResources.org tools. In 2017 work will continue to explore the interest in a facilitated national monitoring network and how the MonitoringResources.org tools can support interested partners.

Regional Habitat Indicators

Over the past decade there has been increasing interest at the executive level in improving our collective ability to track and communicate changes in environmental conditions and salmon populations in easily understood terms. Doing so fosters accountability, encourages consensus, supports priority-setting and budgeting, and can engender support. High level indicators (HLIs) are typically derived from one or more individual metrics across broad geographic scales and are intended to communicate complex information in easily understood terms for use in reports to Congress, legislatures, governors, and the public.

PNAMP has been working toward improved HLI reporting for many years. In 2007, PNAMP produced a white paper that highlighted the need for collaboration around HLI common reporting. In response to a need identified at the Northwest Environmental Information Sharing (NWEIS) executive summit in 2008, PNAMP produced a report summarizing: 1) high level indicators currently in use in the PNW, 2) who is using the

indicator, and to the extent possible, 3) metrics being used to support the indicator (link to report). In 2009 PNAMP produced another report that built upon the earlier work, substantively advancing and providing recommendations for watershed health and salmon indicators (link to report). In 2010 PNAMP began the Coordinated Assessment for Salmon and Steelhead Project (CA) to develop efficient, consistent, and transparent data-sharing among the co-managers (fish and wildlife agencies and Tribes) and regulatory/funding agencies (BPA & NOAA) of the Columbia River Basin (CRB) for salmon and steelhead high level indicators.

In 2015, after recognizing overlapping interests, PNAMP partners and the Northwest Power and Conservation Council staff agreed to collaborate to advance coordination of habitat indicators at the regional level. In discussions with PNAMP steering committee members, it was also evident that other broad-scale efforts, both within and across jurisdictions, such as the State of the Salmon Report by the Washington Governor's Salmon Recovery Office, as well as reporting needs for the Clean Water Act and the Columbia River Treaty, would likely benefit from this effort.

As a pilot, we have chosen to focus on indicators related to surface water attributes as these are of interest to many reporting efforts; the four indicator topic areas are: flow, macroinvertebrates, temperature, and water quality index. The goal is to come to agreement on a small set of indicators for which data will be efficiently coordinated and communicated to allow comparisons at multiple scales across the region, while respecting the goals and unique mandates of the individual partners. A leadership team was assembled and a work plan was developed outlining the proposed goal, actions, and outcomes for the project. Starting in April of 2016, work group participants compiled over 70 management questions from their organizations' reports and websites. The large list was reduced to 22 questions by removing redundancies. This reduced set of questions was evaluated against 5 criteria in Survey 1, and then voted on in Survey 2 to identify the top three questions of greatest common interest for each of the four topic areas. Work groups subsequently reviewed and discussed survey results and made final recommendations for the top three management questions they wanted to focus on for future discussions of indicators, targets, and data accessibility and sharing. The first workshop was held in November to vet the work group recommendations; the final list of agreed upon questions can be found in the Workshop 1 Summary. In 2017, stakeholders will select indicators to best answer the management questions and discuss ways to improve data availability and shareability.

Effectiveness Monitoring Coordination & Assessment

This project is an effort to integrate and align existing and new regional effectiveness monitoring efforts, provide more scientifically robust data for use in management decisions, and improve cost efficiency in the implementation of monitoring programs. The focus of this effort is on coordinating approaches, monitoring design, and data management systems to allow alignment and reporting of results; informing a regional network of effectiveness monitoring coverage; and encouraging programmatic-level planning consistency across the region for Intensively Monitored Watersheds (IMW) and effectiveness monitoring projects and programs. Efforts are focused on supporting partner efforts to move away from "one-at-a-time", project-by-project decision making and moving toward coordinated efforts.

To facilitate coordination and communication among IMWs and between IMWs and regulatory agencies, PNAMP has hosted three workshops, in 2008, 2013, and 2016. The 2013 workshop focused on sharing monitoring results and led to two papers, published in 2016, that clarified definitions of and the role of IMWs as long term monitoring entities, while illustrating challenges and summarizing results from 17 IMWs (Bennett et al. 2016, Bouwes et al. 2016). The 2016 workshop focused on improving the flow of information about

tools, results, and guidance produced by those working in IMWs to those who can apply this information to improve decision making, policy guidance, and on-the-ground mitigation actions. Details about the workshop panel discussion, presentations, and work session outcomes can be found in the Workshop Summary. In 2017, PNAMP will work with stakeholders to take the feedback from the 2016 workshop and turn it into a realistic plan to improve bilateral communications among IMWs stakeholders that will ensure IMWs outcomes (tools, results, and guidance) are valuable to policy-makers and managers. **(**Effectiveness Monitoring project page)

Lower Columbia Habitat Status and Trends Monitoring Project

Since October of 2012 PNAMP has partnered with the Lower Columbia Fish Recovery Board (LCFRB) and others to build on progress made in the PNAMP Habitat ISTM project (ISTM Habitat project page) and combine efforts with municipal stormwater managers in Southwest Washington to develop an integrated status and trends monitoring strategy for the Lower Columbia tributaries. The project, funded by the Washington Department of Ecology (WA Ecology), is a collaborative effort being led by the Lower Columbia Fish Recovery Board who has subcontracted with Stillwater Sciences and PNAMP for help with technical and facilitation tasks, respectively. The project is focused on integrating stormwater permit monitoring activities with habitat monitoring efforts to enhance regional coordination in the Lower Columbia tributaries and inform local management approaches. The project will also inform future Municipal Stormwater NPDES Permits in Southwest Washington by producing a monitoring design that addresses multi-scale questions about physical, chemical and biological attributes impacted by stormwater.

Phase 1 of the project, completed in 2013, resulted in a preliminary monitoring design and a list of recommendations and next steps (link to report). In 2014, Phase 2 focused on increasing stakeholder engagement and finalizing the monitoring design (link to report). Phase 3 began in early 2015, with another grant from WA Ecology, to resolve decisions about the appropriate/available level of effort and resources that will be needed to implement the recommended plan, as well as to make final determinations of site allocation and metrics that depend on the fiscal decisions. To help accomplish this work two caucuses were formed, one that focused on recommendations for implementation of the stormwater monitoring portion of the design, and the other caucus focused on recommendations for implementation of the habitat monitoring portion of the design. The caucuses meet every other week from August 2015 – January 2016; the outcomes of these meetings were summarized in the Roles and Responsibilities document. The final workshop was held in April of 2016 to discuss and vet the final drafts of the Roles and Responsibilities, Implementation Plan, and Quality Assurance Project Plan (link to reports). Workshop feedback on the documents was incorporated and final documents were submitted to WA Ecology in September 2016.

The Municipal Stormwater NPDES Permits in Southwest Washington expire in 2018. The reports resulting from this project will be used in drafting the new permit requirements. The first year of stormwater monitoring under the new permits is expected to begin October 1, 2019. There is currently no identified funding to implement the Regional Habitat Monitoring portion of the strategy. In 2017, the Lower Columbia Fish Recovery Board will form a steering committee and initiate efforts to secure funding.

Coordinated Assessments Project

Since 2011, PNAMP and the Pacific States Marine Fisheries Commission (PSMFC) StreamNet project have collaborated to coordinate the Coordinated Assessments (CA) project, which has resulted in the development of the Coordinated Assessments data exchange (CAX). The CAX defines the framework by which the fish and wildlife agencies and tribes compile and provide data for salmon and steelhead populations for access through

the EPA data exchange network. The overarching goal of the CA project is to improve the timeliness, reliability, flow, and transparency of data necessary for regional assessments and management decisions for improved environmental effectiveness. This includes support for biological opinions that affect state and federal agencies. Participants represent 4 states, 6 tribes, an inter-tribal consortium, and multiple federal regulatory agencies; all with an interest in collaboratively sharing fish population data for the Columbia River watershed. The federal Columbia River action agencies and fisheries co-managers have also participated through the CA Working Group; comprised of over fifty additional biologists and data managers across the Columbia River Basin representing 26 different tribal, state, federal, and academic organizations. This work benefits from existing facilitation framework provided by StreamNet, PNAMP, and substantial cost share contributions from the Bonneville Power Administration. In addition, the project has relied on a 3-year grant from EPA for coordination and to develop a virtual node on the Exchange Network for sharing data.

A key output of the CA effort to date has been the development of an agreed upon data exchange standard (DES) describing the data exchange templates (DETs) for specific data elements needed to support the exchange of four VSP indicators and supporting metrics. These include: natural origin spawner abundance, smolt to adult ratio, and recruit per spawner (adult and juvenile). The DETs for these indicators were developed with wide participation of the larger working group; first through an extensive pilot program to document data flows and availability of the indicator and supporting metrics conducted with Oregon, Washington, and Idaho state agencies, six Columbia River Basin tribes, and one tribal coalition (Columbia River Inter-Tribal Fisheries Commission). This was followed by intensive focus on refining the draft DES by a development team consisting of data management and resource management expertise. The draft DES was then vetted and approved by the CA Working Group for implementation. This DES and the partnership behind it demonstrated the feasibility of successful implementation of data flows. Documentation for the specific DETs and supporting materials can be found on the StreamNet website (link to materials). Expansion of the CAX to include additional indicators is under way and made possible due to the initial efforts of the CA Project. Documentation of all project plans and activities may be found on the PNAMP website. (Coordinated Assessments project page)

The CA project is designed to improve access to environmental information through the alignment and maintenance of standardized databases for key fish population metrics and indicators for major populations of listed and non-listed salmonids. This information can be shared across multiple agencies and jurisdictions in a common format and with improved efficiencies via the created web services. Information can also be accessed through application programming interfaces (APIs) that make data available in XML and other standard machine-readable formats. Data is shared across programs within the data collecting organizations, between agencies and tribes, and is available to the public, action agencies, and the courts; all of whom are directly involved in expensive and complex management and regulatory arrangements which are made possible and streamlined through this data management approach.

Since 2015, the CA project has been sharing data via the CAX, with significant growth in reporting effort in 2016. The Coordinated Assessments state and tribal partners have all implemented an automated or semi-automated flow of data to the main CAX database using the StreamNet REST API. All agencies have submitted some or all of their available production CAX data sets and all valid data are live and available via the node. Due to limitations on state and tribal partners' staff capacity work on developing standards for sharing additional indicators has slowed; however, the project's five year work plan includes plans to address this need in the future.

PNAMP staff work with StreamNet, Bonneville Power Administration and contractors (TKI Natural Resource Consulting) to support the project. PNAMP facilitates the Coordinated Assessments Core Team (CACT) bi-monthly meetings, the bi-annual meeting of the Coordinated Assessments Planning Group (CAPG), and the annual Coordinated Assessments Workshop. PNAMP also supports StreamNet staff's leadership of two subgroups: the DES Development Team (DDT, which maintains and provides updates to the DET; and the Exchange Configuration Team (XCT), which developed the EPA Exchange Network virtual node for the CAX.

Resilient Salmonid Habitat

In 2015, PNAMP supported the Resilient Salmonid Habitat (RSH) Federal Caucus Focus Area Team as they worked to develop a way to identify salmonid habitat that is resilient to disturbance, particularly climate change. As a pilot, they focused on steelhead in the John Day subbasin in Oregon and identified indicators and thresholds using scientific literature and then applied the thresholds to existing data to identify steelhead RSH within the watershed. Based on the available data and literature, the following six indicators were selected: 1) steelhead presence (adult and juvenile); 2) water temperature; 3) water quantity (flow); 4) habitat complexity; 5) food availability (biotic index); and 6) riparian condition. The pilot was successful in using existing information to display data that was deemed informative in the identifying steelhead RSH; the full assessment can be found here.

In 2016, PNAMP initiated planning for a workshop to further address these topics and to make connections with the Riverscape Analysis Project that is working on a climate change vulnerability DSS for aquatic species and their habitat. We hosted several meetings to explore interest and willingness of partners to engage in a workshop. While everyone approached was interested in the topic of resilient salmonid habitat, it was very difficult to engage a group committed to planning a workshop. We intend to continue to host conversations as the PNAMP Steering Committee directs in 2017. However, this topic seems to be a lower priority than other topics presented for staff support.

Macroinvertebrate Data Sharing

There is agreement among aquatic ecologists in the Pacific Northwest that the sharing of macroinvertebrate data would be aided by a regional standard taxonomic effort (STE) agreement. Data sharing is constrained in part by lack of agreement among organizations that collect and/or process macroinvertebrates samples as to the authoritative taxonomic nomenclature appropriate for collected specimens and the level of taxonomic resolution that is appropriate for different assessment purposes. Following on work done in other regions, PNAMP's Macroinvertebrate Planning Group (MIPG) group decided to pursue development of an STE for the Pacific Northwest in October of 2012.

Work on the STE began in 2013 and continued in 2016. Taxonomists Sean Sullivan (Rhithron), John Pfeiffer (EcoAnalysts), Bob Wisseman (Aquatic Biology Associates), and Sue Salter (Cordillera Consulting) have been developing the taxa lists that provide standardized nomenclature and 3 levels of taxonomic resolution to use when identifying macroinvertebrate samples. They have also drafted supporting documentation including the rules that were used to build the taxa list and how they will be maintained in the future. In 2016 the STE was promoted and progress was shared in November at the Society for Freshwater Science Pacific Northwest Chapter Meeting in Astoria, OR. In 2017, PNAMP plans to develop a dedicated webpage to host the STE and related documents. (Northwest Standard Taxonomic Effort page)

Outreach and Communication

A large part of PNAMP's work focuses on reaching out to potential participants and informing the aquatic monitoring community of upcoming events and announcements, showcasing new tools, and sharing relevant documents. PNAMP's outreach and communications efforts can be categorized into four areas: maintaining the PNAMP website, producing and disseminating the monthly news and meeting summary email, producing fact sheets which describe PNAMP and individual projects, and presentations to interested groups and organizations.

Throughout 2016, PNAMP Coordination Staff frequently updated content on the PNAMP website. Most updates included tracking PNAMP and other meeting details (dates, locations, and online conference and phone information) and posting documents related to meetings and other PNAMP projects. Announcements and jobs openings of interest to the aquatic monitoring community were also posted on a regular basis.

For the past seven years, PNAMP has distributed a monthly email to all participants that included a summary of upcoming meetings. In 2016, the monthly communication was updated and continued to include one or two short summaries highlighting the latest PNAMP news, but also added a photo highlight section to increase participation between PNAMP and subscribers. The 2016 list of participants who receive the news and meeting summary contains approximately 800 recipients and continues to grow.

PNAMP Coordination staff has also maintained a Twitter presence for the past 2 years, which steadily gained followers in 2016. Participation increased from 46 followers to approximately 75. Staff highlighted events, publications, and other items that might have been of particular interest to the regional participants, as well as releases of PNAMP newsletters and photo highlight winners.

Beyond communicating PNAMP's work via online resources, the Coordination Team participated in several outreach activities in addition to regular PNAMP activities. In 2016, the PNAMP Coordinator gave overview presentations to the following audiences: BPA executives and staff, Northwest Power and Conservation Council executives and staff, Oregon Watershed Enhancement Board senior staff, Great Northern Landscape Conservation Cooperative, Columbia Basin Partner Forum, US Bureau of Reclamation senior staff, and US Geological Survey executives.

The PNAMP staff presented a series of trainings on MonitoringResources.org, a six-part webinar series, and also gave several presentations describing PNAMP's online tools suite, MonitoringResources.org (see the above MonitoringResources.org summary for more details).

Adaptive Management and Lessons Learned

Federal, state, tribal, local, and private natural resource monitoring programs in the Pacific Northwest have evolved in response to different organizational mandates, jurisdictional needs, issues and questions. However, while some issues are unique to particular entities, PNAMP has learned there is much common ground. Where common ground exists, improved coordination can avoid duplication of effort and increase cost-effectiveness of expenditures. This cooperation also allows more timely and accessible information and increases the overall quantity and quality of scientific information used to inform public policy and resource management decisions. This common ground and cooperation is central to the PNAMP strategy and mission.

Though considerable progress has been made in some aspects of regional coordination, less progress has been made in others. For example, the Coordinated Assessments Project has made significant progress towards improving the timeliness, reliability, flow, and transparency of salmonid population data necessary for regional assessments. Less progress has been made furthering those same goals for high-level habitat assessments; reasons for this include a lack of clear mandates as well as fewer stakeholders participating. And while PNAMP efforts have helped to support improved regional data management standards and structures, much work remains to be done.

It is important to recognize that PNAMP successes are largely attributed to the in-kind participation from member organizations' staff and other interested parties. However, this volunteer approach, combined with the diverse interests of participants, presents many challenges. Although PNAMP has made progress, expectations about scope and pace of work need to be realistic given this framework. A fundamental ongoing challenge has been to balance PNAMP's resources with the level of shared interest in working on potential subject areas. There will always be many more areas of interest than there is the capacity to address them. Expectations of PNAMP members and others should be tempered with these realities, while recognizing that adjustments in approach would yield different results. Most importantly, consistent with PNAMP's guiding principles, PNAMP's expertise and limited resources must be focused on topics of the highest priority to decision-makers.

Improved coordination across the wide spectrum of monitoring efforts of shared interest (e.g., design and implementation, from local to Pacific Northwest scales) will only occur if commitments exist within and among the hierarchy of affected programs. As reflected in the membership of PNAMP, these include local, state, tribal, federal and other entities and programs. Unfortunately engagement at the Steering Committee level has declined in recent years, especially as PNAMP founding members retire and their organizations are slow to designate replacements. Renewed commitment from signatory partners and additional commitment from courtesy members to become signatory partners would strengthen PNAMP's ability to effect meaningful change. While the mere existence of PNAMP represents a base level of commitment toward improved coordination, the specifics of how much coordination is sufficient for individual entities or how much coordination is attainable or sufficient to meet management expectations needs further clarification through interaction with and among PNAMP Executives.

Appendices

Appendix A. Entities signatory to the PNAMP Charter in 2016.

PNAMP Partners	PNAMP Steering Committee Rep	PNAMP Executive Network Representative
Bonneville Power Administration	Ben Zelinsky	Lorri Bodi VP Environment, Fish and Wildlife
California Department of Fish and Game	Kevin Shaffer	Neil Manji Northern Regional Manager
Columbia River Intertribal Fish Commission	Zachary Penney	Paul Lumley Executive Director
Confederated Tribes of the Colville Reservation	John Arterburn	Joe Peone Director, Fish and Wildlife Dept.
Environmental Protection Agency	Gretchen Hayslip	Dennis McLerran Regional Administrator
Idaho Department of Fish and Game	Tim Copeland	Jim Fredericks Chief of Fisheries
NOAA Fisheries	Greg Sieglitz	William Stelle, Jr. Regional Administrator
Northwest Indian Fisheries Commission	Bruce Jones	Mike Grayum Executive Director
Northwest Power and Conservation Council	Nancy Leonard	Tony Grover Director of Fish and Wildlife Division
Oregon Watershed Enhancement Board	Renee Davis	Tom Byler Executive Director
Pacific States Marine Fisheries Commission	Chris Wheaton	Randy Fisher Executive Director
U.S. Army Corps of Engineers	Vacant	Colonel Steven R. Miles, P.E. U.S. Army Commander and Division Engineer
U.S. Bureau of Land Management	Vacant	Jerome Perez State Director, Oregon/Washington
U.S. Bureau of Reclamation	Jude Trapani	Lorri Gray Regional Director
U.S. Forest Service	Mark Raggon	Kent Connaughton Regional Forester PNW Region
U.S. Geological Survey	Steve Waste	Max Ethridge Northwest Regional Director
Washington Department of Ecology	George Onwumere	Rob Duff Environmental Assessment Program Manager
Washington Department of Fish and Wildlife	Dan Rawding	Jim Unsworth Director
Washington Governor's Salmon Recovery Office & Recreation and Conservation Office	Keith Dublanica	Kaleen Cottingham Director

Appendix B. Estimated hours contributed by entities to PNAMP meetings in 2016.

Hours were estimated for each meeting attendee for every PNAMP meeting from January 1 to December 31, 2016. For teleconferences the meeting duration was used to estimate the contribution of time from each participant. For in-person meetings, contributions were calculated as 1.5 times the meeting duration to help account for travel and prep time.

Entity	Total Hours	Hours for SC Only
US Geological Survey	433.75	42.25
Bonneville Power Administration	265.00	107.75
Washington Department of Fish & Wildlife	244.75	47.00
National Oceanic and Atmospheric Administration	233.50	72.75
Idaho Department of Fish and Game	225.25	60.25
Northwest Power and Conservation Council	181.75	96.25
Washington State Department of Ecology	171.75	24.00
Pacific States Marine Fisheries Commission	160.75	59.50
Oregon Department of Fish and Wildlife	141.75	
Colville Confederated Tribes	115.50	52.50
Oregon Watershed Enhancement Board	103.00	103.00
Confederated Tribes and Bands of the Yakama Nation	91.50	73.00
US Fish and Wildlife Service	87.00	13.50
Spokane Tribe of Indians	84.00	
Nez Perce Tribe	83.25	5.25
Columbia River Inter-Tribal Fish Commission	82.75	58.25
Washington Governor's Salmon Recovery Office	78.75	78.75
US National Park Service	70.00	
US Forest Service	67.50	36.25
US Environmental Protection Agency	62.75	35.25
Stillwater Science	59.25	
Washington State Department of Natural Resources	54.25	
US Bureau of Reclamation	52.00	
Lower Columbia Fish Recovery Board	48.75	
Terraqua Inc.	45.75	
Sitka Technology Group	44.50	
Upper Columbia Salmon Recovery Board	42.25	
Oregon Department of Environmental Quality	41.50	1.50
Oregon State University	40.00	
City of Longview	36.75	
California Department of Fish and Wildlife	34.75	
Oregon Water Resources Department	34.50	
Washington State University	30.25	
City of Vancouver	30.00	
Washington State Department of Transportation	30.00	
Utah State University	29.50	
Private Sector	28.50	
Coeur d'Alene Tribe	24.00	
University of Washington	24.00	
Snake River Salmon Recovery Board	22.50	
Confederated Tribes of the Warm Springs Reservation	21.75	
Freshwater Maps	21.75	

Appendix B. Continued. Estimated hours contributed by entities to PNAMP meetings in 2016.

Entity	Total Hours	Hours for SC Only
Methow Restoration Council	21.75	
University of Oregon	21.75	
Yakama Nation	21.75	
Oregon Department of Agriculture	21.50	
Oregon Department of Environmental Quality	17.00	
National Council for Air and Stream Improvement	16.75	
Unknown	16.50	
Kootenai Tribe of Idaho	15.75	15.75
Clark County	15.00	
Confederated Tribes of the Umatilla Indian Reservation	15.00	
Columbia River Gorge Commission	14.00	
The Nature Conservancy	13.50	
Michigan State University	13.00	
US Bureau of Land Management	13.00	
DOI North Central Climate Science Center	12.00	
Kalispell Tribe	12.00	
NatureServe	12.00	
Shoshone-Bannock Tribes of Fort Hall	12.00	
US Department of Agriculture	12.00	
City of Battle Ground	10.50	
City of Kelso	10.50	
City of Washougal	10.50	
Cowlitz Tribe	10.50	
EnTranRight	10.50	
Idaho Governor's Office of Species Conservation	10.50	
Normandeau	10.50	
Conservation Biology Institute	9.75	
Lower Columbia Estuary Partnership	8.75	
Northwest Indian Fisheries Commission	8.25	8.25
Puget Sound Partnership	8.25	8.25
National Fish and Wildlife Foundation	7.25	
Western Forestry and Conservation Association	6.75	
City of Bellingham	5.25	
City of Camas	5.25	
Fish First	5.25	
Port of Kalama	5.25	
Port of Longview	5.25	
Tetra Tech EC, Inc.	5.25	
Washington State Conservation Commission	5.25	
University of British Columbia	5.00	
GPS World	4.50	
Idaho State University	3.00	
Oncorh Consulting	3.00	
Pierce County	3.00	
Ross Strategic	3.00	
Thurston County Washington	3.00	
Watercourse Engineering, Inc.	3.00	

Appendix B. Continued. Estimated hours contributed by entities to PNAMP meetings in 2016.

Entity	Total Hours	Hours for SC Only
Nebraska Game and Parks Commission	2.50	
Alaska Department of Fish and Game	1.50	
Atlantic Coast Cooperative Statistics Program	1.50	
Habematolel Pomo of Upper Lake	1.50	
ICF International	1.50	
Quinnault Indian Nation	1.50	
Skagit Watershed Council	1.50	
University of Missouri	1.50	
Xerces Society	1.50	
GEUM Environmental Consultants	1.00	
Simon Frasier University	1.00	
Creative Resource Strategies	0.75	
Total	4281.00	999.25

Appendix C. List of documents referenced in this report and associated hyperlinks.

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- PNAMP Charter: http://www.pnamp.org/charter

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- PNAMP website: http://www.pnamp.org/

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- PNAMP website: http://www.pnamp.org/

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- MonitoringResources.org project page: http://www.pnamp.org/project/3875
- MonitoringResources.org application: https://www.monitoringresources.org

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- MonitoringResources.org Document Methods application: https://www.monitoringresources.org/Document/Method/Index
- MonitoringResources.org Document Protocol application: https://www.monitoringresources.org/Document/Protocol/Index

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- Monitoring Metadata Exchange (MMX) project page: https://www.pnamp.org/project/4849

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- Site Manager Master Sample application: https://www.monitoringresources.org/Sites/Master/Index

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- Site Manager User Sample File application: https://www.monitoringresources.org/Sites/User/Index

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- Monitoring Explorer application: https://www.monitoringresources.org/Sites/Explorer/Index

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- MMX project page: http://www.pnamp.org/project/4849
- MMX Draft Standard: http://www.pnamp.org/document/4854

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- Large River Monitoring Forum: https://www.sciencebase.gov/catalog/item/56f0319ce4b0f59b85dd1238
- Visioning Workshop: Developing Enterprise Tools and Capacities for Large-scale Natural Resource Monitoring: https://www.pnamp.org/event/5509
- Fisheries Program Task: https://www2.usgs.gov/ecosystems/fisheries/
- MonitoringResources.org: https://www.monitoringresources.org

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- 2008 PNAMP HLI Report: http://www.pnamp.org/document/2023
- 2009 PNAMP HLI Report: http://www.pnamp.org/document/2060
- RHIP Management Question Survey 1, Results: https://www.pnamp.org/document/5534
- RHIP Management Question Survey 2, Results: https://www.pnamp.org/document/5577
- RHIP Workshop 1 Summary: https://www.pnamp.org/document/5597

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- PNAMP 2016 IMW Workshop Summary: https://www.pnamp.org/document/5628
- Effectiveness Monitoring project page: http://www.pnamp.org/project/3137
- ISTM Habitat project page: http://www.pnamp.org/project/3152
- Phase 1 report for the Lower Columbia Habitat Status and Trends Monitoring project: http://www.pnamp.org/document/4244
- Phase 2 draft final design report for the Lower Columbia Habitat Status and Trends Monitoring project: http://www.pnamp.org/document/4997
- Phase 3 final Implementation Plan and Quality Assurance Project Plan for the Lower Columbia Habitat Status and Trends Monitoring project: https://media.wix.com/ugd/810197_9cfd21f7e1eb44f485d5ea13a91afca1.pdf

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- Coordinated Assessments materials at the StreamNet website: http://www.streamnet.org/data/coordinated-assessments/
- Coordinated Assessments PNAMP project page: http://www.pnamp.org/project/3129
- Five Year Plan for Coordinated Assessments: https://www.pnamp.org/document/5186

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- Federal Caucus Approach to Defining Resilient Salmonid Habitat: John Day Pilot Framework December, 2015: https://pnamp.org/document/5309
- Northwest Standard Taxonomic Effort page: https://www.pnamp.org/project/4210