2018 Annual Report

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Acknowledgements

The Pacific Northwest Aquatic Monitoring Partnership is the result of a collaborative effort by many individuals throughout the region. We would like to thank Bonneville Power Administration, National Oceanic and Atmospheric Administration, and the Bureau of Reclamation for their funding contributions. Thank you to all our partners, participants, and collaborators for their continued time and effort in this important endeavor.

Executive Summary

The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) continued to promote the integration of monitoring resources and development of tools to support monitoring in 2018. 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 advance and achieve objectives for a variety of projects that support partner needs and PNAMP goals. For each project, the PNAMP Coordination Team identified interested Steering Committee (SC) members and subject matter experts to form the working teams who provide guidance and leadership. The teams act as an intermediary between the larger group of interested participants and the SC, to maintain the concept of better SC/participant exchange. The PNAMP Coordination Team continued to facilitate dialogue among experts to develop ongoing and new projects. The PNAMP Coordination Team tracked in-kind contributions of time from participants at meetings, workshops, and other PNAMP hosted events; in 2018 this estimate amounted to 5,738 hours by 98 organizations.

In 2018, PNAMP focused on projects related to technologies to advance natural resource monitoring efforts and research, best practices for data management, and watershed 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 2018:

- Supported development, training, and outreach to make MonitoringResources.org the system of record for Bonneville Power Administration (BPA) research, monitoring, and evaluation (RME) location data
- Increased documentation of monitoring by promoting and managing the MonitoringResources.org protocol and method library, total number at the end of 2018:
    - 1,798 methods, 1,090 are published
    - 1,166 protocols, 219 are published
    - 12 master samples
    - 6 projects are displayed in Monitoring Explorer
- Simplified the non-GRTS design workflow in the MonitoringResources.org Sample Designer
- Presented six half-day face-to-face Pisces Web 101 and MonitoringResources.org trainings for project managers across the region and produced a reference guide to support project sponsors' use of MonitoringResources.org tools and four instructional videos targeting the use and navigation of MonitoringResources.org
- Refreshed the PNAMP.org and MonitoringResources.org websites for better information discovery and delivery

- Hosted a Natural Origin Spawner Abundance (NOSA) Methods Review Workshop to promote communication and sharing of new techniques. The workshop was held February 22 and was attended by 51 participants from 18 organizations
- Held a Tributary PIT Tag Arrays in the Columbia Basin Workshop on October 16-17, which convened 102 participants to discuss in-stream tributary PIT tag arrays operations and maintenance, and data management, and communication
- Continued efforts to improve regional coordination for data sharing and reporting of habitat indicators by facilitating correspondence and then holding a workshop to discuss these findings and inform the development of recommendations for how to improve data accessibility and interoperability for the selected indicators
- Hosted the fourth IMW workshop on November 1-2. The workshop was attended by 72 people from 38 organizations and featured presentations of recent results and lessons learned from eleven Pacific Northwest IMWs
- Created the Data Visualization Workgroup in March 2018 to discuss ways to visualize data for greater understanding, accessibility, and re-use. Hosted 8 meetings attended by 55 people from 30 agencies.
- Co-hosted the Organization of Fish and Wildlife Information Managers Conference in Hood River on November 4-8, which brought 45 people from all over the country to discuss data sharing, partnerships, and database management
- Hosted along with USGS Status and Trends Monitoring Program, the Integrated Spatial Design & Analysis: Using Complex Survey Designs to Enable Integrated Science Workshop to explore current practices, tools, and needs for integrating existing and new monitoring using complex survey designs. The 2-day workshop was attended by 46 people from 20 organizations
- In 2018, we emphasized case studies with the North American Bat Monitoring Program (NA Bat), BLM Assessment, Inventory, and Monitoring Program, and the Monarch Joint Venture partnership. Continued to expand the use of the MonitoringResources.org web tools through outreach to national and international scale monitoring efforts

PNAMP's work on these tasks supports our partners' research, monitoring, and evaluation (RME) 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, PNAMP manages online tools to support consistent and detailed documentation for projects, supports metadata documentation for datasets, conducts reviews of methodologies to develop and promote best practices, coordinates data management and exchange to support improved assessments and reporting in the Columbia River Basin, and supports projects to demonstrate benefits of an integrated status and trend monitoring process. These activities will continue to support FWP strategies as well as

PNAMP 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.

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 opportunities provided by the PNAMP forum 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.

Although there was a great deal of progress made in 2018, PNAMP projects will always benefit from increased participation from the PNAMP steering committee members, subject matter experts, and community stakeholders. 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 RME coordination.

MonitoringResources.org has been the system of record for BPA's RME protocol data since 2013, and now the platform is the system of record for RME location data. In the past five years, MonitoringResources.org has grown and all the functionality originally outlined is now available. We recommend having a work session to demonstrate the tool to BPA RME staff and management, gather feedback, and document requirements to chart the future of the tool with respect to supporting BPA's metadata documentation.

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 partnership 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 provides the forum where this collaboration can occur and facilitates exchanges among subject matter and policy experts that is necessary to accomplish these goals. Although we are always supportive of more participation, PNAMP has a representative mix of participants to address these goals. Different mandates that drive monitoring and management, policy, and reporting, require collaboration with regional and national organizations and with many individual participating organizations. Regardless of the complexity involved, PNAMP believes that supporting 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 the organizations that are signatory to the Charter (link to PNAMP Charter page, URLs for all links in this report can be found in Appendix C), 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 with aquatic resource monitoring issues to contribute to PNAMP. Coordination of complex topics with many partners takes time and hard work. PNAMP is largely a voluntary organization, and our progress is directly related 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 experts on both subject matter and policy on what is needed to improve coordination of aquatic resource monitoring.

Steering Committee Activities

The PNAMP Steering Committee provides the science-policy interface between the executive partners and project work teams and is responsible for communicating their respective organizations' work and needs to PNAMP, as well as communicating PNAMP progress and challenges to their organizations. The Steering Committee directs the activities of the Coordination Team and helps obtain resources to accomplish projects. The SC assists 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 Steering Committee comprises representatives from the signatory partners (Appendix A). Additionally, several "courtesy members" are invited to participate in Steering Committee 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 2018 included: Great Northern LCC, Idaho Governor's Office of Species

Conservation, Kootenai Tribe of Idaho, Natural Resources Conservation Service, Nez Perce 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 Upper Snake River Tribes Foundation. 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. In 2018, we held a two-day strategic planning meeting with the PNAMP Steering Committee which included a discussion of how we can better fill vacancies, expand membership, and increase participation. The Steering Committee plans to revisit this topic in 2019.

In 2018, the Steering Committee met in February, June, and again in September for a two-day strategic planning workshop. These meetings tracked the progress of activities, discussed how new tasks or projects align with PNAMP's goals, and offered guidance when necessary. The strategic planning workshop provided an immersive opportunity for Steering Committee members to connect and communicate with their regional colleagues, learn about PNAMP's progress over the years, and update our business plan and strategic plan to prioritize partner needs for the future. The PNAMP Coordinator and the Coordination Team prepared materials before the meetings, facilitated the Steering Committee meetings, and disseminated notes following the meetings.

PNAMP Coordination Team Activities

The PNAMP Coordination Team is employed by the U.S. Geological Survey (USGS), Northwest Region Executive Office. In 2018, the PNAMP Coordination Team included PNAMP Coordinator (Jennifer Bayer), Deputy Coordinator (Amy Puls), MonitoringResources.org Project Leader (Rebecca Scully), Communications Liaison (Megan Dethloff), and two Staff Biologists (Sheryn Olson and Sam Cimino).

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

The Coordination Team provides administrative support for PNAMP activities (e.g. logistical support for meetings, record keeping, and maintenance of participant information). At least one member of the Coordination Team 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 2018, government and non-government entities provided organizational support to the U.S. Geological Survey (USGS) to administer and staff PNAMP, with USGS staff responsible for developing

and negotiating fiscal support and managing budgets and associated contracts with those entities. PNAMP staff completed required progress reporting of the Coordination Team activities (within PNAMP) and of PNAMP activities to interested external parties. The Coordination Team sought appropriate outlets for communicating PNAMP's work beyond required progress reporting. The Coordination Team represented PNAMP at several external meetings, workshops, and conferences in 2018. 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) remains 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 PNAMP staff maintain the content of the website, the US Geological Survey provides technical support and hosted the website. The website has been a valued PNAMP resource since 2010. Though the site completed a refresh in 2018, PNAMP will need additional funding to maintain the design and usability of the site.

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

In-Kind Contributions

PNAMP is a dynamic 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. Although 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 tried various ways to track in-kind contributions. In the past, the Coordination Team asked task leads and participants to keep track of their hours spent on PNAMP activities during the year, but very few people did. Reporting only these hours would have vastly underrepresented the total amount of time all people were truly contributing. Because it is relatively easy to track meeting participation, since 2011 we have calculated in-kind contributions based on attendance at PNAMP meetings. For teleconferences, 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.

For 2018 we calculated 5,738 hours of in-kind contributions of time from 98 participating organizations (Appendix B). In-kind contributions by topical category are shown in Table 1 and illustrate how using meeting time to represent participation is imperfect. For example, the hours of in-kind time recorded for meetings related to the Regional Habitat Indicator Project don't reflect the many hours participants spent outside of meetings compiling and submitting information about their organization's data collection and reporting efforts, and the Macroinvertebrate Data Sharing Project doesn't include the

time spent by the taxonomist working on the Standard Taxonomic Effort. Figure 1 shows in-kind contributions by organization type for 2011 through 2018. The spikes in in-kind contributions in 2013, 2016, and 2018 were the result of multi-day workshops held in those years that were attended by large numbers of people. While tracking meeting participation is an imperfect measure of in-kind contributions, it remains our best option.

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, 2018. 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
Method and Protocol Review	1959.50
Intensively Monitored Watersheds	1363.75
Spatial Design Outreach	941.50
MonitoringResources.org - Support and Development	573.00
Steering Committee Meeting Series	498.00
Data Management and Sharing Best Practices	198.00
Regional Habitat Indicators	169.25
Outreach and Communication	30.25
Macroinvertebrate Data Sharing	4.50

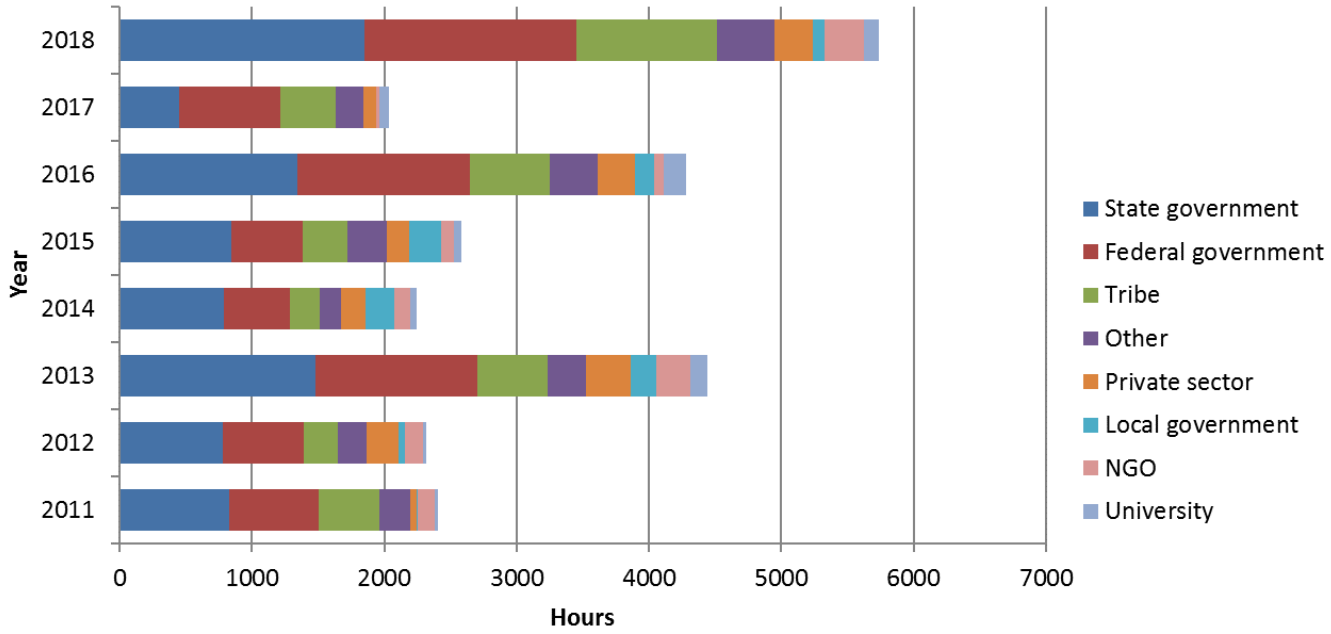

Figure 1. Estimated hours contributed to PNAMP meetings for 2011 to 2018. Hours were estimated for each meeting attendee for every PNAMP meeting from January 1, 2011 to December 31, 2017. For teleconferences the meeting duration was used to estimate the contribution of time from each participant. For 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, associated meetings, and work sessions have been driven by ongoing and new projects. This contrasts 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 gathers interested Steering Committee 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 found that this structure allows better Steering Committee/workgroup exchange without asking every SC member to track every activity. It also allows support from a larger forum of subject matter experts who can 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 found it important to have a dedicated lead for all projects, whether it is someone from the Coordination Team, a Steering Committee member, or subject matter expert who participates in PNAMP. In the absence of a lead who can dedicate time to move things along, PNAMP found that final products can be significantly delayed, much to the frustration of the interested parties.

PNAMP meetings and work sessions in 2018 focused on tasks related to these main projects:

- MonitoringResources.org
- Regional Habitat Indicators
- Effectiveness Monitoring Coordination and Assessment
- Data Management and Sharing Best Practices
- Integrating Science Using Monitoring Design Principles
- USGS sponsored work

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 2018.

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 design and documentation of monitoring projects from beginning to end. The tools assist 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, thus facilitating coordination and collaboration. 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 redundancies in monitoring.

MonitoringResources.org platform houses all other PNAMP applications, including Protocol and Method tools, Sample Designer, User Sample location files, Master Sample Library, Monitoring Explorer map viewer. MonitoringResources.org also supports two tools under development which are not visible to the public: Monitoring Content Advisor to function as a navigation tool and overview for the website, and the Metadata Builder. MonitoringResources.org features, functions, and applications are modular, so that users can take advantage of a single application. At the same time, the individual applications are designed to work together for comprehensive management of the monitoring

workflow. Details about individual tools can be found in fact sheets posted on PNAMP.org, MonitoringResources.org Project page, in the Related Documents.

MonitoringResources.org supports BPA Project Sponsors with RME numbered Work Elements (WE): WE156-research and development, WE157-data collection, and WE162-data analysis and interpretation. We've seen a growing need for support and updates since 2017 when all project sponsors with RME Work Elements 156, 157 and 162 were required to document Protocols, Study Designs, Sample Designs, and User Sampling locations in MonitoringResources.org. Before 2017, project sponsors were only required to document protocols in MonitoringResources.org and document sample locations in BPA's contracting tool 'Pisces'.

In 2018, we continued development, outreach, and content support on all the tools and to expand the user base. The number of users of the MonitoringResources.org toolset grew from 476 at the end of 2017 to 570 at the end of 2018. To help with general outreach, PNAMP staff updated the MonitoringResources.org fact sheet which was published with USGS support, created training presentations, and reference guides for distribution at workshops, briefings, and meetings.

Development

PNAMP contracted with Sitka Technology Group (Sitka) through USGS and Bonneville Power Administration (BPA) to complete the 2018 development work. We focused on supporting RME project sponsors and BPA's documentation of metadata related to RME. We continue to improve tools to support the documentation of methods, protocols, study and sample designs.

In 2016, while transferring Pisces's functionality from a desktop to a web-based system, BPA management decided to use MonitoringResources.org to track RME work element location data (i.e. sampling sites and areas of inference). This change was implemented at the end of December 2017. At this time, BPA supported Sitka to transfer location data from Pisces to MonitoringResources.org Sample Designs tool. New guidance was drafted and BPA and PNAMP staff completed multiple trainings (described below). On the development front, we focused on improving the workflow of the sample designer tool and the quality of the data migrated from Pisces desktop. The data migration clean-up development was completed under the Pisces web contract, but PNAMP staff served as technical advisors throughout the process. The location data migration has cause performance issues, user confusion, and quality issues. PNAMP with the support of BPA RME and Sitka staff devoted substantial time to resolving the issues, supporting users, and fixing data. In 2019, we continue cleaning up migrated data.

In 2018, with BPA's support, we continued to improve MonitoringResources.org based on project sponsors' needs and accommodated documentation of planned sample locations. To better understand those needs, PNAMP conducted one-on-one user testing sessions. The key feedback was that MonitoringResources.org is too complicated. In response, this round of development has focused on reducing the complexities in the Sample Designer tool. In 2018 we:

- Simplified the non-GRTS design workflow in the Sample Designer to a process that;
    - Accommodates documentation of multiple different types of designs
    - Results in users no longer needing to leave the workflow to upload sites
    - Created tools to allow users to filter and select map sites that are already stored in MonitoringResources.org
    - Now within the workflow, a user can upload a .csv file, drop a point on a map, and add a point by with the latitude and longitude
    - Simplified temporal design documentation for users that plan on returning to the same locations every year

In 2019, our goal is to continue to improve the tools based on partner's needs. We plan on:

- Adding and revising approximately 75% of the context-sensitive help text
    - Improve user interface, continue to update the Sample Design tool, improve Protocols, Methods, and update the navigation
- Compile a review of the elements in MonitoringResources.org and design a development plan to streamline the documentation process
- Add functionality to create outputs that save time and effort for project sponsors
- Revisit the metadata builder tool
- Research how MonitoringResources.org can support the creation of a metadata and DOI for data sets
- Build a design viewer that allows a user to see all planned sampling locations for a given year based on a set of search criteria

In 2019, PNAMP will complete review sessions with the BPA RME implementation team to understand how MonitoringResources.org can deliver the core requirements for the metadata that BPA needs. We will also continue to conduct user testing and implement improvements based on user feedback.

Finally, increased interest in MonitoringResources.org from other federal agencies including the US Geological Survey (USGS) and Bureau of Land Management (BLM) has provided alternate sources of funding to assist us in developing a more robust product. Over the past few years, USGS, the BLM Assessment, Inventory and Monitoring Program, and the North American Bat Monitoring Program (NABat) provided funding to improve the MonitoringResources.org tools to better address their needs and support PNAMP staff. In 2019, we will continue to work with these partners. PNAMP staff has been careful to coordinate development so that updates will support the full MonitoringResources.org community and BPA's needs. In 2018 we completed the following:

- Added an archive state to all components to better track early documentation and clarify current metadata documentation
- Updated all tools to follow the same state workflow, draft to published
- Updated the home page to better reflect MonitoringResources.org's functions for usability

- Built a beta tool to upload spreadsheets of data collection locations to the Monitoring Explorer tool
- Added the IMW polygons to the Monitoring Explorer search tool
- Continued to build and document APIs for all the tools in MonitoringResources.org
- Documentation of R code associated with the Sample Designer GRTS work flow
- Built a tool to document NABat cell selections from a master sample stored in MonitoringResources.org

PNAMP staff will continue to pursue national interests. As we gain more partners, we see the need to put tighter controls on how we implement development. In 2019, we will draft governance documents and processes for implementing development in MonitoringResources.org. We will continue to work with BPA to ensure we address their needs.

Outreach

In 2018, PNAMP staff continued to perform outreach for the MonitoringResources.org tools, including:

- Shared MonitoringResources.org tips, updates, and Method Highlights in PNAMP monthly newsletter
- Presented MonitoringResources.org to IMW leadership
- Presented MonitoringResources.org to regional partners at NOAA
- Shared updates and plan with PNAMP Steering Committee
- Facilitated a series of meetings with BPA RME team to review MonitoringResources.org
- Presented the tool set at the Mid and North Coast Water Monitoring Summit
- Two Posters at the Organization of Fish and Wildlife Information Managers Conference in Hood River, OR
- Presented MonitoringResources.org at PNAMP's Integrated Spatial Design & Analysis: Using Complex Survey Designs to Enable Integrated Science Workshop
- Multiple one-on-one phone calls with users to gather feedback on the planned development

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 Watershed Enhancement Board, Idaho Department of Fish and Game, and quarterly reports to the PNAMP Steering Committee. Additionally, we completed an official USGS fact sheet focused on MonitoringResources.org.

In 2019, 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 who can provide support by encouraging or requiring use of the tools within their own organizations. PNAMP will continue to reach out to monitoring practitioners and look for opportunities to promote the MonitoringResources.org tool set.

Content

PNAMP staff curates the content in MonitoringResources.org. To support finalizing content, PNAMP staff spent approximately 10 to 40 hours per week in 2018 supporting help requests received via email, phone, or the support page on the website. Requests included help with login, content entry, sample design and sampling location assistance, how to structure protocols and methods for specific projects, responding to comments on the discussion board and to help requests from the support desk, reviewing methods and protocols, and responding to requests to add new organizations or monitoring programs.

Because of PNAMP staff's work at the end of 2018, we have:

- 1,798 methods, 1,090 are published, with 39 of those methods published in 2018
- 1,166 protocols, 219 are published, with 34 of those published in 2018
- 12 master GRTS samples, 1 was added in 2018
- 6 projects are displayed in Monitoring Explorer, none were added in 2018

PNAMP believes it is important to urge users to finalize (publish) their content instead of leaving it in a draft state for months or years, especially because there are several mechanisms in the tools to track version changes in procedure or of location data. In addition, it is important to the success of MonitoringResources.org to have content in the system that can be shared and will attract new users.

MonitoringResources.org content objects, such as methods, protocols, sample designs, and study designs have states. The state, or status, determines its visibility and whether a user can edit the content. The working version state is "draft", and the default allows only the owner and colleagues to view and edit the content. State "published" allows everyone to view the content and it is then locked for editing, though new versions can be created, and users can clone the object for modification.

In 2018 with the support of the USGS, we introduced the archive state into MonitoringResources.org. We can now archive content in MonitoringResouces.org that is not being used, has not been worked on in years, and/or does not meet standards for publication. Archiving removes the content – e.g. protocols or methods – from the search tables but maintains a persistent URL so that if the protocol, method, study design, or sample design is linked outside of MonitoringResources.org that link is maintained. Additionally, the owner of archived content can see the content in their "My Stuff Page" and can continue to work on update the information and request publishing when they are finished. In fall 2018, PNAMP staff started contacting owners and archiving content. We will continue this clean-up process in 2019.

During the transition from Pisces Desktop to Pisces Web, BPA loaded historical location data that resided in Pisces Desktop from Work Elements 156, 157, and 162 into MonitoringResources.org. This resulted in one Sample Design and one User Sample File for each year a project operated in MonitoringResources.org. PNAMP identified that the data were not quality assurance (QA) checked before they were migrated to MonitoringResources.org. This created excess content in MonitoringResources.org. PNAMP staff and BPA project sponsors have been working hard to correct,

check for accuracy, and finalize the system of record. In 2018, PNAMP worked with BPA staff and Sitka to QA the historic data collection locations.

Adding content to MonitoringResources.org is important to the sustainability of the tool. In addition to BPA project sponsors, we are working with national partners to improve content. We have added North American Bat Monitoring protocols and sample designs and worked with USGS scientists to add environmental DNA (eDNA) project protocols and methods. More information on these efforts is outlined in the USGS Sponsored Work section below.

One important piece of content that PNAMP had not yet captured is monitoring site level metadata (i.e. final, actual data collection locations and descriptions of sampling). We have now built a tool, Monitoring Explorer, to display the who, what, how, when, and where of sampling. This tool supports collaboration by displaying multiple projects' data collection locations, protocols, sample designs, data repositories, and sampling dates on the same map. Additionally, the Sample Design tool has a section for users to update their planned data collection events post-field season with actual sampled site location and metadata information. Once completed, updated user data collection locations will be displayed the Monitoring Explorer. To support project data entry, we facilitated drafting a standard, the Monitoring Metadata Exchange (MMX). MMX is a PNAMP standard data exchange mechanism for data collection event level metadata (the who, what, how, when, and where). Monitoring Metadata Exchange was created for both producers and consumers of monitoring data to foster greater visibility and understanding of the diverse range of data collection happening throughout the region. We have also built and documented web services to help exchange MMX data, but to date use of those services has been minimal, in part because we have not actively marketed the service. We will work with BPA on their priority projects and in 2019 PNAMP staff will focus on outreach of the Monitoring Explorer and MMX standard to those groups with the goal of adding content to the Monitoring Explorer. (MonitoringResources.org project page; MonitoringResources.org website, MMX project page; MMX Draft Standard)

Training

In addition to one-on-one support, PNAMP staff is focusing on training, videos, improved help text and reference guides. During 2018, PNAMP staff paired up with Bonneville Power Administration to conduct six regional training seminars regarding the operation and navigation of MonitoringResources.org and Pisces Web:

- Six half-day face-to-face Pisces Web 101 and MonitoringResources.org trainings for project managers
    - Portland, OR - January 23, 2018
    - Boise, ID - February 1, 2018
    - Spokane, WA - February 13, 2018
    - Wenatchee, WA - February 22, 2018
    - Pendleton, OR - February 27, 2018

    - Yakima, WA - March 8, 2018
- Produced a reference guide to support project sponsors' use of MonitoringResources.org tools
- Produced four short how-to videos concerning the use and navigation of MonitoringResources.org:
    - Create and Search for Methods, Protocols, and Study Designs
    - Cloning a Protocol in MonitoringResources.org
    - Metric Method Mapping
    - Method Customization

We recommend the following to support PNAMP staff and BPA project sponsors:

- BPA provides staff to QA the RME location data
- Add help text to the tools and improve user interface
- PNAMP continues to conduct user interface testing to learn how to improve the workflow of the tool
- PNAMP continues to conduct training seminars, produce how-to videos, and update the guidance document

MonitoringResources.org Conclusion

MonitoringResources.org has experienced 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 meeting between all partners supporting MonitoringResources.org; in 2019, we will host technical workshops and continue to engage stakeholders.

In 2019, 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 allows us to know who is collecting what data, where, when, and how, and to identify how PNAMP could help facilitate exchanging data between multiple entities.

Managing content in MonitoringResources.org is a time-consuming process. Most of protocols and methods have been entered by BPA project sponsors. Staff works directly with RME staff and project sponsors to review these protocols to build metadata consistent with project sponsors' RME work elements. PNAMP will continue to work with RME 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. In the future we would like to support usability updates to MonitoringResources.org and adding help text to the tools.

PNAMP anticipates an increased workload in relation to supporting project sponsors documenting study designs in MonitoringResources.org. We recommend RME staff work with PNAMP staff to design a process for QA/QC in the location data.

MonitoringResources.org has been the system of record for BPA's RME protocol data since 2013. The platform has now also become the system of record for RME location data. In the past four years MonitoringResources.org has grown and all the functionality originally proposed is now available. We recommend a work session to demonstrate the tool to BPA RME staff and management, gather feedback, then document requirements and chart the future of the tool supporting BPA's metadata documentation.

Methods Review

PNAMP partners have interest in learning from each other about monitoring methodologies and how to best share data resulting from monitoring. To support this interest, PNAMP facilitates collaboration, coordination, discussion, and evaluation of implementation methods used for monitoring. We do this in two ways: first, through our online toolset MonitoringResources.org, where the user can discover others' methods, document their methods, and participate in dialogue in the Discussion area; and second, through technical workshops and working groups to address specific topics. These activities focus on discussing the status of a protocol or method, inconsistencies and disagreements, and ways to improve techniques in the future.

Natural Origin Spawner Abundance (NOSA) Methods Review Workshop

As methodologies improve because of changing technologies, or because of new approaches to analysis, PNAMP has been asked to convene workshops to promote communication and sharing of new techniques. Estimations of Natural Origin Spawner Abundance (NOSA) of steelhead is an example of an indicator that many entities throughout the Columbia Basin use and one that practitioners estimate or derive using different procedures or statistical approaches. This workshop was held February 22, 2018, Portland, OR, with the goal of providing a venue for steelhead monitoring practitioners and managers to share their current approaches for estimating NOSA for steelhead populations. The workshop drew 51 participants from 18 organizations. Subject matter experts from Idaho Fish and Game, Oregon Fish and Wildlife, Nez Perce Tribe, and Washington Fish and Wildlife presented their latest work and subsequent discussion led to a consensus of a common techniques to estimate NOSA across the community of practice.

Tributary PIT Tag Arrays in the Columbia Basin

This workshop, held October 16-17, 2018 in Portland, OR, was an opportunity for those who conduct monitoring using PIT tag arrays in tributaries and those who use the data generated to share information, lessons learned, and to assess common issues and differences. The workshop was an initial outline of in-stream tributary PIT tag arrays operations and maintenance, and data management and communication. The workshop's ultimate goal was to form a more cohesive community of practice that could address a wide array of concepts: identification of needs for future coordination among practitioners; advantages and disadvantages of an optimized network of in-stream PIT tag arrays; best techniques and methodologies; how best to inform future operations and maintenance plans for

equipment management and contracting; and how to implement best practice processes to ensure continued access to this information. With 102 participants, concepts at the workshop and the opportunity for interaction provoked enough interest to inspire the planning committee to continue their work into 2019.

Coordinated Assessments Project

Since 2011, PNAMP and the Pacific States Marine Fisheries Commission (PSMFC) StreamNet project have collaborated to manage 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.

The Coordinated Assessments project accomplishes this goal by improving 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 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 are shared across programs within the data collecting organizations, between agencies and tribes, and are 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 supported and facilitated through this approach to data management.

Participants represent four states, six 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, which is comprised of over 50 additional biologists and data managers across the Columbia River Basin representing 26 different tribal, state, federal, and academic organizations. This work benefits from the existing facilitation framework provided by StreamNet, PNAMP, and the substantial cost share contributions from the Bonneville Power Administration. In addition, the project has benefited from a 3-year grant from EPA to support 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 a data exchange standard (DES) for specific data elements needed to support the exchange of four viable salmonid populations (VSP) indicators and supporting metrics. These include: natural origin spawner abundance, smolt to adult return rate (SAR), and recruit per spawner (adult and juvenile). This DES and the partnership behind it demonstrate the feasibility of successful implementation of data flows.

Access to data published via the Coordinated Assessments Exchange (CAX), the DES and supporting materials can be found on the StreamNet website (link to materials). Documentation of project plans and activities may be found on the PNAMP website. (Coordinated Assessments project page). Documentation of the Data Exchange Standard can be accessed here.

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 and related workshops as requested. 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), who developed the EPA Exchange Network virtual node for the CAX.

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 and 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 chose to focus on indicators related to stream temperature, stream flow, macroinvertebrates, and water quality index as these are of interest to many reporting efforts. 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. After agreeing on the management questions of greatest common interest at the November 2016 workshop (RHIP Workshop Summary), stakeholders went through a multistep process in 2017 to select the indicators to best answer the management questions (Survey Results, Meeting Notes), and identified the data that is needed to calculate the indicators (Meeting Notes). In late 2017 and early 2018 through a series of teleconferences and email exchanges, stakeholders provided information about indicator data their organizations collect, the methods used to collect the data, and how the data can be accessed by people outside their organization. In March 2018, a second workshop was held to discuss these findings (Workshop Materials, Data Collection Methods Compilation) and inform the development of recommendations for how to improve data accessibility and interoperability for the selected indicators (Short List of Questions and Indicators). At the workshop, project participants agreed that the next step should be a pilot effort to explore how to improve reporting for two indicators: the 7-day Average of the Daily Maximum Temperature (7-DADMAX) and Median Average Daily Discharge. This effort would include expanding outreach for data sources and participants; compiling data; assessing accessibility, interoperability, and gaps; discussing data visualizations and reporting options; creating mock-ups; and making recommendations for improvements to data sharing and reporting. The reporting pilot is currently on hold due to other competing priorities, but we plan to return to this task when time/resources allow. (Regional Habitat Indicators project page)

Effectiveness Monitoring Coordination and Assessment

The purpose of effectiveness monitoring is to determine the extent to which on-the-ground restoration actions meet their biological and ecological objectives. PNAMP brings together stakeholders to find ways to 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. We want to improve reporting and access to information by working toward more coordinated approaches, monitoring designs, and data management systems. We encourage programmatic-level planning consistency across the region for watershed-scale as well as project-scale effectiveness monitoring. Efforts focus on moving away from "one-at-a-time", project-by-project decision making and moving toward coordinated efforts. Intensively Monitored Watersheds (IMW) are one form of watershed-scale effectiveness monitoring.

To facilitate coordination and communication among IMWs and between IMWs and regulatory agencies, PNAMP has hosted many conference calls and four workshops (2008, 2013, 2016, and 2018). The 2013 workshop shared 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 (Workshop Summary).

In 2017, PNAMP held several meetings with stakeholders to take the feedback from the 2016 workshop and turn it into a practical action plan to improve communication among IMWs stakeholders and help ensure IMWs outcomes (tools, results, and guidance) are valuable to policy-makers and managers. The PNAMP 2017/2018 IMW Action Plan identifies four communication products to help disseminate results and lessons learned from the network of IMWs, and highlights the need for additional venues for stakeholders to discuss findings and practitioners to learn from one another. PNAMP received funding from NOAA (through Pacific States Marine Fisheries Commission) in October 2017 to implement the 2017/2018 Action Plan.

In 2018, PNAMP worked with practitioners to compile information to inform the communication products called for in the action plan. To do this, PNAMP distributed a questionnaire to IMW researchers that allowed them to point to existing reports that contained the desired information as well as provide new information. We received responses from 16 IMWs in British Columbia, California, Idaho, Oregon, and Washington. PNAMP used this information to write a summary report of key findings and lessons learned from the 16 IMWs. The information in the questionnaires was also shared with Tracy Hillman from BioAnalysts Inc. He conducted an independent evaluation of how well the IMWs are working to answer key management questions and made recommendations for improving the IMW network. At the end of 2018 both reports were being reviewed by stakeholders. After reconciling feedback, the reports will be finalized and available in 2019.

On November 1-2, 2018, PNAMP in collaboration with NOAA hosted its fourth IMW workshop. The focus of the 2018 workshop was to support learning and information exchange among IMW stakeholders and discuss priorities for implementing the IMW network going forward (link to agenda). The two-day workshop was attended by 72 people from 38 organizations and featured presentations of recent results and lessons learned from eleven Pacific Northwest IMWs, a presentation by Tracy Hillman followed by a discussion on how well the IMW network is answering key management questions, and breakout sessions to strategize for future success.

In 2018, PNAMP staff also held two meetings with IMW stakeholders to understand how MonitoringResources.org could better support the IMW community of practice. Because of those meetings, a GIS layer was added to the Monitoring Explorer, so users can see IMW watershed boundaries relative to monitoring locations, and a feature was added to enable IMWs to more easily upload monitoring locations into the system, so they can be displayed on the Monitoring Explorer map. Progress was also made on improving the PNAMP IMW website as part of the pnamp.org website renovation. In 2019, PNAMP will continue to work with stakeholders to implement the action plan.

(Effectiveness Monitoring project page)

Data Management and Sharing Best Practices

There has been increasing attention on improving data management in the region, focusing on improving practices within individual entities and interest in the ability to share data across entities. Representatives of PNAMP partners have expressed interest in regional coordination of data management, accessibility and re-use. PNAMP assists groups to further these goals with several approaches, such as participation in professional societies and other partnerships, and in facilitating workgroups.

Data Visualization Workgroup

Beginning March 2018, a new workgroup met to explore Data Visualization. Because the Pacific Northwest Aquatic Monitoring community now has between 10 and 20 years of data, there is much interest and enthusiasm for learning useful ways to visualize the data for greater understanding, accessibility, and re-use. Data Visualization can educate and inform multiple audiences at multiple scales but can also uncover trends or encourage unique insights to produce new avenues of research and monitoring. The group's first meeting to scope interest in the topic had 16 participants and the entire PNAMP staff of 6. The last meeting of 2018 in November had 31 participants. As of December 2018, the mailing list had over 80 people from 34 different tribes, agencies and partnerships. The group can access resources contributed by all and can view previous presentations from the meetings. Throughout 2018, the group met 8 times during which workgroup participants presented 12 of their data visualization projects.

Organization of Fish and Wildlife Information Managers Conference

In 2017, the PNAMP Steering Committee agreed that PNAMP should partner with the Organization of Fish and Wildlife Information Managers (OFWIM) and co-sponsor their annual conference. OFWIM, an international non-profit organization, has a mission to promote the management and conservation of natural resources by facilitating technology and information exchange among managers of fish and wildlife information. OFWIM emphasizes coordination, outreach, technical assistance, and continuing education. Throughout 2018, PNAMP staff assisted planning the conference, developing themes, scoping locations, planning field trips, and scheduling speakers and sponsors. Co-sponsoring was a good opportunity for PNAMP partners to coordinate, learn, and share with national leaders in information management. The conference addressed a variety of topics including, but not limited to data sharing, data visualizations, application development, and database management. The conference took place from November 4-8, 2018 in Hood River, Oregon and was attended by 45 people; Conference Proceedings and abstracts can be downloaded here. A half day workshop was held on "Using ArcGIS Survey and 123 Collector".

Data Attribution and Citation Workgroup

During 2017 and continuing through the first half of 2018, a working group of 18 members met to discuss Data Attribution and Citation, led a discussion at the annual Coordinated Assessments (CA) workshop, May 11, and prepared a white paper, *Citing Aquatic Monitoring Datasets: Best Practice Recommendations for Authoritative Data Citation*. The working group and six authors with nine additional editors of the white paper addressed three items:

- Development of best practices for the Pacific Northwest's natural resources monitoring community for data citation and attribution using recommendations and examples from the global community
- Then, to recommend minimal and optimal metadata documentation to enable best practices data citation and acknowledgement for two case studies (SPS and CA data repositories sponsored by NOAA and StreamNet, respectively) in a white paper
- A further task was planned, given continued interest, to recommend best practices for metadata enabling citation to all PNAMP partners, and the larger aquatic monitoring community of practice via a peer reviewed publication

This workgroup highlighted a need to encourage the aquatic monitoring community to consider larger and long-term goals of best practices to ensure data integrity, such as how to best implement data management and data governance within and across agencies. At the CA workshop in May 2017, PNAMP presented the working group's efforts with an overview of best practices for data attribution and citation. During the discussion, the participants approved adding fields to the CA data repositories to acknowledge contributors of data sets, which were implemented by July 2017. The white paper was reviewed during 2018 and is now in the final stages of the review process and it will be finalized in 2019.

Integrated Science Using Monitoring Design Principles

The monitoring of ecological resources over broad spatial and temporal scales often requires an abundance of financial and logistical resources unavailable to any single entity. Therefore, communities of governments, organizations, and individuals are often needed to provide the information required for sound natural resource management. However, because monitoring projects are developed to meet an individual organization's needs, the ability to integrate data from multiple organizations across large landscapes is often difficult due to differences in data collection methods and spatial designs.

October 23-24, 2018 in Portland Oregon, we hosted (along with the USGS Status and Trends Monitoring Program) the Integrated Spatial Design & Analysis: Using Complex Survey Designs to Enable Integrated Science Workshop to explore current practices, tools, and needs for integrating existing and new monitoring using complex survey designs. Intended as a kick-off to a Community of Practice to support experts responsible for designing and analyzing data resulting from large-scale long-term natural resource monitoring programs, we convened experts with experience and interest specific to this topic.

This workshop is part of a long-term goal to provide a forum for large-scale natural resource monitoring programs to collaborate towards development and enhancement of enterprise resources, coordination across programs, and support of technical experts via a facilitated Community of Practice. These experts helped us plan this workshop by identifying key questions of interest, including: how to piece together multiple designs and combine data to increase precision of estimates and/or expand geographic extent; how to spatially balance around existing points - how to put more points on the landscape and how to optimize that process; Master Samples - Can/should there be fewer? implications for changing to new master sample. How to document and track versioning. We also presented MonitoringResources.org to get their feedback on how to improve the tool to better meet their needs.

We are excited to support this emerging community of practice that includes PNAMP partners from the Pacific Northwest, as well as representatives from long-term large-scale natural resource monitoring programs from around the country.

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 a STE for the Pacific Northwest in October of 2012.

Work on the STE began in 2013 and continued in 2018. 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 three 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 2018, PNAMP developed plans for a dedicated website to host the STE and related documents. Implementation of the new website will be contingent on funding availability in 2019. (Northwest Standard Taxonomic Effort page)

Outreach and Communication

Part of PNAMP's work includes 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 summaries, producing fact sheets which describe PNAMP and individual projects, and presentations to interested groups and organizations.

In 2018, PNAMP Coordination Staff totally revamped PNAMP.org giving it a more modern look and more intuitive functionality and navigation. Additionally, PNAMP.org was updated regularly to include 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 are also posted on a regular basis.

For the past nine years, PNAMP has distributed a monthly email to all participants that included a summary of upcoming meetings. In 2018, the monthly communication continued to include one or two short summaries highlighting the latest PNAMP news. The 2018 list of participants who receive the news and event summary contains approximately 840 recipients and continues to grow. In 2019, we have plans to refresh and add additional partner content to the newsletter.

PNAMP Coordination staff established a Twitter presence in August of 2014, which steadily gained followers in 2018. Participation increased from 75 followers in 2017 to 120. Staff highlighted events, publications, and other items that might have been of interest to the regional participants, as well as releases of PNAMP newsletters.

Beyond communicating PNAMP's work via online resources, the Coordination Team promoted our activities and the MonitoringResources.org toolset with oral and poster presentations at workshops and conferences including the Natural Origin Spawner Abundance (NOSA) Steelhead Methods Review Workshop in Portland, Oregon; the Tributary PIT Tag Arrays in the Columbia Basin Workshop in Portland; the Integrated Spatial Design & Analysis: Using Complex Survey Designs to Enable Integrated Science Workshop in Portland; the Intensively Monitored Watersheds (IMW) Workshop in Portland; and the Organization of Fish and Wildlife Information Managers (OFWIM) conference in Hood River, OR. The PNAMP Coordinator also gave overview presentations to the following audiences: Western Association of Fish and Wildlife Agencies staff; USFWS National Wildlife Refuge Inventory & Monitoring senior staff; Columbia Basin Partner Forum; Monarch Joint Venture staff; BPA executives and senior staff, Northwest Power and Conservation Council senior staff, US Bureau of Reclamation senior staff, and US Geological Survey executives and senior staff.

USGS Sponsored Work

Due to our success in supporting collaboration with partners in the Pacific Northwest, the PNAMP Coordination Team, who are all USGS employees, have been asked to support similar work sponsored by USGS including the Large Rivers Monitoring Forum (link) and exploration of development of enterprise tools for national scale monitoring programs such as the North American Bat Monitoring Program (link to 2016 workshop).

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.

Current objectives focus on forming a hybrid, hierarchical hydrogeomorphic classification of reaches based on statistical analyses that combines geomorphic and hydrologic characteristics at the reach scale for the continental United States. Our goal has been to facilitate comparisons of floodplain, or lateral, connectivity in large US rivers so we can identify river segments that are similar, discriminate among segments that are different, and to help organize our activities going forward. In 2018, the forum focused on completing the conceptual modeling work initiated in 2017 and starting the project's next phase, which is determine how stressors are affecting fisheries communities and aid managers in making decisions formulating a strategy for collating long-term fisheries monitoring data with data describing landscape-level stressors that affect fish populations and other biota.

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 2018, we continued to conduct outreach to potential partner programs and agencies to solicit input from monitoring practitioners, program managers, and information scientists to inform the development of a national scale collaboration forum for monitoring programs and to inform enhancements to MonitoringResources.org. We identified and prioritized ideas for development of this toolset, as well as how we might integrate it with other enterprise resources. We used the support from the USGS to clean up the tool set and improve usability. The specific development tasks are described above in the MonitoringResources.org development section.

Throughout the year, we also conducted outreach on MonitoringResources.org to promote its use at a national scale. This included a range of activities including developing a new poster and presenting it at conferences, presenting an overview of the tools to various audiences, and developing a new fact sheet published by USGS. We worked with specific programs to explore more fully their interest in the toolset, including the Integrate Monarch Monitoring Program and the Monarch Joint Venture (MJV) staff to explore use of design documentation features to support their national scale collaborative monitoring efforts. The MJV outreach resulted in a successful funding from NFWF for this work in 2018 to conduct scoping exercises for their potential use of MonitoringResources.org.

We continue to support case studies of uses for MonitoringResources.org. In 2018, we emphasized the North American Bat Monitoring Program (NA Bat) and the BLM Assessment, Inventory, and Monitoring Program.

Case Study 1) North American Bat Monitoring Program Collaboration (NA Bat)

In 2018, we facilitated and supported a working group of NABat monitoring program staff and leaders to share MonitoringResources.org capacities and gather requirements for NABat's use of the toolset. This work informed detailed plans for the development of a NABat site selection tool using the existing MonitoringResources.org tools. In August 2017, we initiated development and compiled a beta version of the NABat cell section tool to be complete by February of 2018. We conducted user testing and edited the tool to better support the NABat's users. We also supported the drafting of guidance

documents. At the end of 2018, the NABat community decided to use a different tool to select sample locations. In 2019, we will continue to use the two ways APIs we built to load NABat sample design into MonitoringResources.org. We are scoping a sample design map to show planned sample locations based on a set of filters including protocols, methods and year, the NABat planned sample locations will be part of this map.

Case Study 2) Monarch Butterfly Joint Venture Project

With the support of the continental North American Monarch Joint Venture, we are scoping how to integrate the tools built for the NABat Program into the MonitoringResources.org platform. This would allow any user to select their protocol and planned sample locations from a master sample list and use MonitoringResources.org to document the sample design decisions.

Case Study 3) BLM Assessment, Inventory, and Monitoring (AIM) Program Collaboration

We continued to facilitate development work to support BLM AIM's use of the MonitoringResoures.org sample designer tool. Specifically, we documented BLM AIM aquatic monitoring protocols in MonitoringResources.org and explored publication of AIM sites in the toolset. We contracted with an expert to review the R code associated with the GRTS sample design workflow in MonitoringResources.org. In 2019, we will work with the BLM to understand the best way to share and document this code. Additionally, we will work with BLM AIM to understand how MonitoringResources.org can support the BLM site selection and how the BLM can use other programs' (i.e. PIBO, AREMP) data collection locations to guide their sample site selection.

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 a lower level of stakeholder participation. 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. PNAMP has made progress, but expectations about scope and pace of work need to be realistic given these operational constraints. 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 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. 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 continued 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.

Appendix A. Entities signatory to the PNAMP Charter in 2018

PNAMP Partners	PNAMP Steering Committee Representative
Bonneville Power Administration	Jody Lando
California Department of Fish and Game	Kevin Shaffer
Columbia River Intertribal Fish Commission	Denise Kelsey
Confederated Tribes of the Colville Reservation	John Arterburn
Environmental Protection Agency	Christopher Zell
Idaho Department of Fish and Game	Tim Copeland
NOAA Fisheries	Greg Sieglitz
Northwest Indian Fisheries Commission	Bruce Jones
Northwest Power and Conservation Council	Nancy Leonard
Oregon Watershed Enhancement Board	Renee Davis
Pacific States Marine Fisheries Commission	Chris Wheaton
U.S. Army Corps of Engineers	Vacant
U.S. Bureau of Land Management	Vacant
U.S. Bureau of Reclamation	Jude Trapani
U.S. Forest Service	Vacant
U.S. Geological Survey	Steve Waste
Washington Department of Ecology	Stacy Polkowske
Washington Department of Fish and Wildlife	Dan Rawding
Washington Governor's Salmon Recovery Office & Recreation and Conservation Office	Keith Dublanica

Appendix B. Estimated hours contributed by entities to PNAMP meetings in 2018

Hours were estimated for each meeting attendee for every PNAMP meeting from January 1 to December 31, 2018. 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
Washington Department of Fish and Wildlife	465.25
Idaho Department of Fish and Game	418.00
Oregon Department of Fish and Wildlife	384.25
Bonneville Power Administration	358.50
National Oceanic and Atmospheric Administration	353.25
US Geological Survey	320.50
Pacific States Marine Fisheries Commission	219.75
Northwest Power and Conservation Council	185.75
Confederated Tribes and Bands of the Yakama Nation	171.50
Nez Perce Tribe	163.75
Washington State Department of Ecology	135.25
US National Park Service	134.00
Yakama Nation	122.00
Oregon Watershed Enhancement Board	118.75
Colville Confederated Tribes	112.75
Washington Governor's Salmon Recovery Office	112.25
Columbia River Inter-Tribal Fish Commission	107.00
Confederated Tribes of the Umatilla Indian Reservation	101.00
US Fish and Wildlife Service	98.50
US Forest Service	96.50
Confederated Tribes of the Warm Springs Reservation	95.00
US Environmental Protection Agency	94.75
Shoshone-Bannock Tribes of Fort Hall	94.25
US Bureau of Land Management	60.00
Oregon Water Resources Department	52.75
US Bureau of Reclamation	51.00
Crooked River Watershed Council	49.50
Stillwater Science	48.00
Oregon State University	45.25
Quantitative Consultants Inc.	44.00
The Nature Conservancy	38.25
Utah State University	35.75
Columbia River Estuary Study Taskforce	31.50
Statistical Design	29.75

Entity	Total Hours
Chelan County PUD	28.50
Biomark	28.50
Hood Canal Coordinating Council	24.75
Lower Columbia Fish Recovery Board	24.75
Snake River Salmon Recovery Board	24.75
Washington State Department of Natural Resources	24.75
BioAnalysts	24.75
The Cowlitz Indian Tribe	24.75
University of Oregon	24.75
Wild Fish Conservancy Northwest	24.75
Ecosystem Restoration Services	24.75
Upper Deschutes Watershed Council	24.75
Natural Resources Conservation Service	24.25
Oregon Department of Forestry	23.50
Upper Snake River Tribes Foundation	23.25
Lower Columbia Estuary Partnership	22.50
Sitka Technology Group	22.50
Curry Watershed Partnership	22.50
Oregon Department of Environmental Quality	21.50
Calapooia Watershed Council	21.00
Fish Passage Center	14.25
Okanagan Nation Alliance	14.25
Grant County PUD	14.25
King County Department of Natural Resources and Parks	13.50
Terraqua Inc.	13.50
Lower Elwha Klallam Tribe	13.50
Minnesota Department of Natural Resources	12.00
Western EcoSystems Technology Inc.	12.00
Parks Canada	12.00
Maryland Department of Environment	12.00
Cramer Fish Sciences	11.50
Northwest Indian Fisheries Commission	11.25
Battelle Ecology	11.25
Coeur d'Alene Tribe	10.50
Kootenai Tribe of Idaho	10.50
Spokane Tribe of Indians	10.50
National Council for Air and Stream Improvement	9.50
Columbia River Gorge Commission	9.00
Retired or unknown affiliation	8.25
South Sound Spatial	7.50

Entity	Total Hours
Washington State Conservation Commission	6.25
Tetra Tech EC, Inc.	5.25
Shoshone-Paiute Tribes of Duck Valley Reservation	5.25
Kalispel Tribe	5.25
Custer Soil and Water Conservation District	5.25
Eastern Washington University	5.25
Pacific Northwest National Laboratory	4.50
Underwood Conservation District	4.50
Washington Department of Health	4.00
Missouri Department of Conservation	3.25
Bonneville Environmental Foundation	3.00
Burns Paiute Tribe	2.50
EcoAnalysts, Inc	2.50
ICF International	2.00
Montana Fish, Wildlife and Parks	1.75
Aquatic Biology Associates Inc	1.50
Columbia Basin Fish and Wildlife Authority	1.50
Rhithron Associates, Inc	1.50
Washington State Recreation and Conservation Office	1.50
National Phenology Network	1.50
South Fork Research	1.00
Washington State University	1.00
University of Montana	1.00
Western Association of Fish and Wildlife Agencies	1.00
Nevada Department of Wildlife	1.00
Total	5737.75

Appendix C. List of documents referenced in this report

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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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- MonitoringResources.org website: https://www.monitoringresources.org
- MonitoringResources.org project page: https://www.pnamp.org/project/monitoring-resources

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- USGS created MonitoringResources.org fact sheet: https://www.pnamp.org/document/monitoringresources-org-fact-sheet

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- MonitoringResources.org project page: https://www.pnamp.org/project/monitoring-resources
- MonitoringResources.org website: https://www.monitoringresources.org
- Monitoring Metadata Exchange (MMX): https://www.pnamp.org/project/monitoring-metadata-exchange-mmx
- Monitoring Metadata Exchange Draft Standard: https://www.pnamp.org/document/monitoring-metadata-exchange-draft

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- MonitoringResources.org website: https://www.monitoringresources.org
- MonitoringResources.org Discussion page: https://www.monitoringresources.org/Document/Discussion/Index
- Natural Origin Spawner Abundance (NOSA) Methods Review Workshop page: https://www.pnamp.org/event/nosa-steelhead-methods-review-workshop
- Tributary PIT Tag Arrays in the Columbia Basin page: https://www.pnamp.org/event/tributary-pit-tag-arrays-in-the-columbia-basin-workshop

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- Coordinated Assessments materials at the StreamNet website: https://www.streamnet.org/data/coordinated-assessments/

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- Coordinated Assessments PNAMP project page: https://www.pnamp.org/project/coordinated-assessments-for-salmon-and-steelhead
- Documentation of the Data Exchange Standard: https://www.streamnet.org/coordinated-assessments-des/
- 2007 HLI Report: https://www.pnamp.org/document/high-level-indicators-for-salmon-and-ecosystem-health-report-on-current-indicators
- 2009 HLI Report: https://www.pnamp.org/document/high-level-indicators-for-watershed-health-and-salmon-2009-final-report

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- RHIP Workshop 1 Summary: https://www.pnamp.org/document/rhip-workshop-1-summary
- RHIP Indicator Survey Results: https://www.pnamp.org/document/rhip-indicator-survey-results

- RHIP Meeting Notes: https://www.pnamp.org/document/rhip-teleconference-notes-2
- RHIP Meeting Notes: https://www.pnamp.org/document/rhip-teleconference-notes
- RHIP Workshop 2 Materials: https://www.pnamp.org/document/rhip-workshop-2-agenda-and-materials
- Data Collection Method Compilation: https://www.pnamp.org/document/rhip-workshop-2-methods-compilation
- Short List of Questions and Indicators: https://www.pnamp.org/document/rhip-short-list-of-management-questions-and-indicators-march-18-2018
- RHIP Project Page: https://www.pnamp.org/project/regional-habitat-indicators
- Bennett S., G. Pess, N. Bouwes, P. Roni, R. E. Bilby, S. Gallagher, J. Ruzycki, T. Buehrens, K. Krueger, W. Ehinger, J. Anderson, C. Jordan, B. Bowersox, and C. Greene. 2016. Progress and Challenges of Testing the Effectiveness of Stream Restoration in the Pacific Northwest Using Intensively Monitored Watersheds, Fisheries, 41:2, 92-103, DOI: 10.1080/03632415.2015.1127805
- Bouwes N., S. Bennett, and J. Wheaton. 2016. Adapting Adaptive Management for Testing the Effectiveness of Stream Restoration: An Intensively Monitored Watershed Example, Fisheries, 41:2, 84-91, DOI: 10.1080/03632415.2015.1127806

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- PNAMP 2016 IMW Workshop Summary: https://www.pnamp.org/document/pnamp-2016-imw-workshop-summary
- PNAMP 2017-2018 IMW Action Plan: https://www.pnamp.org/document/pnamp-2017-2018-imw-action-plan
- 2018 PNAMP IMW Workshop Agenda: https://www.pnamp.org/document/intensively-monitored-watersheds-imw-workshop-november-1-2-2018-final-agenda
- Intensively Monitored Watersheds project page: https://www.pnamp.org/imw/overview
- Effectiveness Monitoring project page: https://www.pnamp.org/project/effectiveness-monitoring-coordination-assessment

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- Data Visualization Project page: https://www.pnamp.org/project/data-visualization
- Organization of Fish and Wildlife Information Managers (OFWIM): http://www.ofwim.org/
- OFWIM 2018 Conference Proceedings and Abstracts: http://www.ofwim.org/wp-content/uploads/2018/10/2018-OFWIM-Proceedings.pdf
- Data Citation and Attribution project page: https://www.pnamp.org/project/data-citation-and-attribution

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- Integrated Spatial Design & Analysis: Using Complex Survey Designs to Enable Integrated Science Workshop page: https://www.pnamp.org/event/integrated-spatial-design-analysis-using-complex-survey-designs-to-enable-integrated-science-workshop

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- Northwest Standard Taxonomic Effort page: https://www.pnamp.org/project/northwest-standard-taxonomic-effort

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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/visioning-workshop-developing-enterprise-tools-and-capacities-for-large-scale-natural-resource-monitoring

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- MonitoringResources.org website: https://www.monitoringresources.org