2019 Annual Report

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Acknowledgements

The Pacific Northwest Aquatic Monitoring Partnership is a collaborative effort among many individuals throughout the region. We would like to thank Bonneville Power Administration, the US Bureau of Reclamation, Washington Governor's Salmon Recovery Office, and Northwest Power and Conservation Council 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

In 2019, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) celebrated fifteen years of successful collaboration to promote the integration of monitoring resources and development of tools to support monitoring. 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 working teams to advance and achieve objectives for a variety of projects that simultaneously support partner needs and PNAMP goals. For each project, the PNAMP Coordination Team identifies interested Steering Committee (SC) members and subject matter experts to form the working teams who provide project guidance and leadership. The working teams also act as an intermediary between the larger group of project participants and the SC.

In 2019, PNAMP focused on projects related to new technologies to advance natural resource monitoring efforts and research, best practices for data management and visualizations, and watershed monitoring. PNAMP advanced its coordination goals and objectives for these topics by hosting workshops, work sessions, and meetings. Steering Committee members, subject matter experts, and other interested stakeholders participated in these events to exchange information about their own programs, coordinate existing efforts, and initiate new tasks. The PNAMP Coordination Team tracked in-kind contributions of time from participants at meetings, workshops, and other PNAMP hosted events; in 2019 this estimate amounted to 3,404 hours by participants from 84 organizations.

The following list highlights some of PNAMP's accomplishments in 2019:

- Conducted a comprehensive review of MonitoringResources.org with various user groups that lead to a simplified home page, updated pop-up help text, revised landing pages with easier access to information and better search functionality.
- Increased documentation of monitoring by promoting and managing the MonitoringResources.org protocol and method library. Total numbers at the end of 2019:
    - 1,758 methods, 1,104 are published, with 39 of those methods published in 2019
    - 1,196 protocols, 232 are published, with 15 of those published in 2019
- Supported development, training, and outreach for MonitoringResources.org to serve as the system of record for Bonneville Power Administration (BPA) research, monitoring, and evaluation (RM&E) activity location data.
- Provided one-to-one email and telephone support for MonitoringResources.org users, as well as in-person training as requested, videos, webinars, revisions for context-sensitive help text, and reference guides.
- PNAMP and the Pacific States Marine Fisheries Commission StreamNet Program co-hosted the Smolt Estimation and Analytics Workshop, held November 6-7, 2019 in Walla Walla, WA, to

explore analytical uses and approaches to estimating smolt abundance and other ways to use smolt data. There were 118 participants from 33 organizations.

- Continued support for the Coordinated Assessments effort by facilitating the CA Core Team meetings and engaging and assisting as needed with the Data Exchange Standard Development Team (DDT) chaired by PSFMC-StreamNet staff to improve the timeliness, reliability, flow, and transparency of data necessary for regional assessments and management decisions for improved environmental effectiveness.
- Facilitated five workshops to solicit input on the draft Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy developed by staff from BPA, NOAA Fisheries, and the Northwest Power and Conservation Council (NPCC).
- Finalized the *Key Findings and Lessons Learned from Pacific Northwest Intensively Monitored Watersheds* report, an important product funded by NOAA for their decision-making.
- Organized five Data Visualization Work Group meetings, featuring eight presentations ranging from an introduction to Tableau to an overview of the Spatial Hydro-Ecological Decision System. Meetings included speakers from Pacific Northwest tribes and tribal confederations, federal and state agencies from Montana to Missouri, and private consulting companies and universities from Portland, OR to Amherst, MA.
- Finalized the *Citing Aquatic Monitoring Data Sets: Best Practice Recommendations for Authoritative Data Citation* report produced by authors from PNAMP, NOAA, and StreamNet.
- Initiated a new case study for MonitoringResources.org called "All Lands Reporting: making stream habitat metrics FAIR". This project is developing innovative techniques to support publishing in-stream habitat data to the USGS Biogeographic Information System (BIS) by making wadable stream habitat metrics from four federal long-term, large-scale monitoring programs, findable, accessible, interoperable and reusable (FAIR).

PNAMP's work on these tasks supports our partners' 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, 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.

In addition to projects, 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.

There was a great deal of progress made in 2019 on addressing PNAMP partner needs. Continued success of PNAMP and supported projects will always benefit from increased participation from the PNAMP steering committee members, subject matter experts, and community stakeholders. Specifically, we foresee further improvements to the MonitoringResources.org web applications and the Monitoring Metadata Exchange (MMX) standard from additional practitioner engagement and this in turn will lead to improved RM&E coordination.

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. PNAMP has a representative mix of participants to address these goals and we continue to seek increased and diverse participation. 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 the References section), 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 working team participants share the responsibility to collaboratively accomplish our goals efficiently and consistently. Support and open communication are essential for PNAMP to be able to respond to needs of the region. It is equally important to highlight that PNAMP is largely a voluntary organization, whose progress is directly related to participation, the complexity of topics, and the time and hard work required to coordinate many partners. To be successful, we need to hear from subject matter and policy experts on what is needed to improve coordination of aquatic resource monitoring.

Steering Committee Activities

The PNAMP Steering Committee (SC) comprises representatives from the signatory partners (Appendix A). The SC provides the science-policy interface between the signatory partner's executives 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 SC 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.

In addition to the signatory partners, several "courtesy members" 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 2019 included: Idaho Governor's Office of Species Conservation, Natural Resources Conservation Service, Nez Perce Tribe, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, Puget Sound Partnership, Yakama Nation Fisheries Program, Shoshone-Bannock Tribes, and Upper Snake River Tribes Foundation.

In 2019, the SC met in April, May, and September. These meetings tracked the progress of activities, discussed how new tasks or projects align with PNAMP's goals, and offered guidance when necessary. The meetings also provided an opportunity for SC members to connect and communicate with their regional colleagues about monitoring activities in their respective agencies and tribes. The PNAMP Coordinator and the Coordination Team prepared materials before the meetings, facilitated the SC 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 2019, 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 partners/participants and among all relevant Pacific Northwest 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 2019, funding was provided by Bonneville Power Administration ($429,933), US Bureau of Reclamation ($60,000), Washington Governor's Salmon Recovery Office ($1,000) and the Northwest Power and Conservation Council ($1,000) to the 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 2019. 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. 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 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 2019 we calculated 3,404 hours of in-kind contributions of time from 84 participating organizations (Appendix B). In-kind contributions by topical category are shown in Table 1. In-kind contributions by organization type for 2011 through 2019 are shown in Figure 1. The spikes in in-kind contributions in 2013, 2016, 2018, and 2019 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, 2019. 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	2157
Columbia Basin Habitat RM&E Strategy	588
Steering Committee Meeting Series	376
Data Management and Sharing Best Practices	167
MonitoringResources.org - Support and Development	87
Outreach and Communication	29

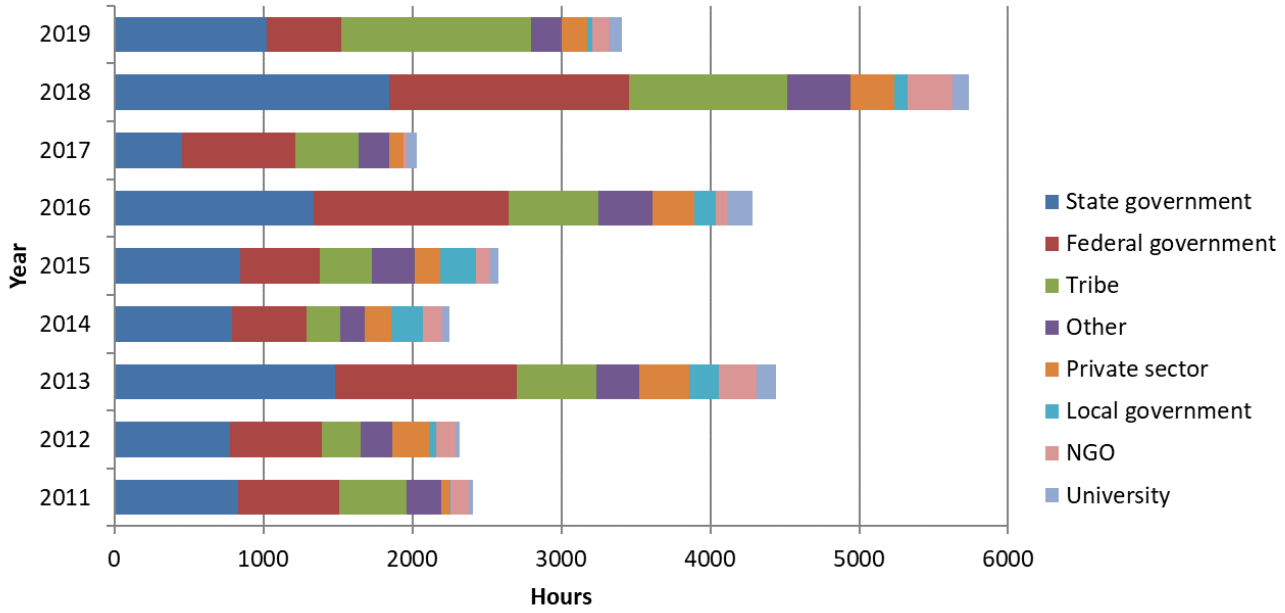

Figure 1. Estimated hours contributed to PNAMP meetings for 2011 to 2019. Hours were estimated for each meeting attendee for every PNAMP meeting from January 1, 2011 to December 31, 2019. For teleconferences the meeting duration was used to estimate the contribution of time from each participant. For 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

Using a project-focused structure, PNAMP gathers 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 work group and the SC. We found that this structure allows better SC/work group 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 2019 focused on tasks related to these main projects:

- MonitoringResources.org
- Methods Review

- Coordinated Assessments
- Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy Outreach
- 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, these were not a focus in 2018.

MonitoringResources.org

Focused on coordination and collaboration, MonitoringResources.org promotes transparency and greater understanding of monitoring activities and approaches 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 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. 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 complementary PNAMP applications, including the Protocol and Method tools, Sample Designer, Master Sample Library, and the 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 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 and on the MonitoringResources.org Project page in the Related Documents.

MonitoringResources.org supports Bonneville Power Administration (BPA) Project Sponsors with RM&E Work Elements (WE): WE156-research and development, WE 157-data collection, and WE162-data analysis and interpretation. Since 2017 we've seen a growing need for helping BPA Project Sponsors due to the changes in the BPA contractual requirement for project sponsors with RM&E Work Elements 156, 157 and 162 to document protocols, study designs, and sample designs 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 2019, we continued development, outreach, and content support for MonitoringResources.org tools and continued to expand the user base. The number of users of the MonitoringResources.org toolset grew from 570 at the end of 2018 to 650 at the end of 2019. To help with general outreach in 2019, PNAMP staff updated the MonitoringResources.org fact sheet published with USGS support, created training presentations, and reference guides for distribution at workshops, briefings, and meetings.

MonitoringResources.org Outreach

In 2019, PNAMP's key outreach task was to conduct a comprehensive review of MonitoringResouces.org and produce a report compiling feedback from various user groups and outlining a set of recommendations to improve MonitoringResources.org. As part of the review we:

- Reviewed MonitoringResources.org elements with key BPA Staff
- Conducted five focus group interview sessions with MonitoringResources.org users
- Conducted interviews with five Steering Committee members
- Held a one-hour feedback session with the NPCC FWP Independent Scientific Review Panel
- Sent an online survey to 276 registered users, received 36 responses (13%)
- Had numerous conversations with users outside the basin

We compiled the results of these sessions in the MonitoringResources.org 2019 Feedback and Recommendations Report that can be found on PNAMP.org. We used this feedback to drive our development priorities, see details in the Development section.

In addition to the comprehensive review, we continued outreach for MonitoringResouces.org via:

- MonitoringResources.org tips, updates, and Method Highlights in PNAMP monthly newsletter
- A poster and presentation at the Organization of Fish and Wildlife Information Managers Conference in Shepherdstown, WV
- Presentation the USGS Community for Data Integration (CDI) Metadata Reviewer's Working Group and at the CDI conference in Boulder, CO
- Presentation during the Thinking Big: Monitoring Overs Space and Time session at Oregon American Fisheries (OR AFS) in Bend, OR
- Discussions of progress and planned work with PNAMP's Steering Committee

We feel that it is imperative for 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. In 2020, PNAMP will continue to reach out to monitoring practitioners, look for opportunities to promote the MonitoringResources.org tool set, complete annual surveys, and conduct user testing.

MonitoringResources.org Development

PNAMP contracted with Sitka Technology Group (Sitka) through USGS and BPA to complete the 2019 development work. Using the 2019 Feedback and Recommendations Report we prioritized redesigning the tools to provide a "call to action" for our users. Our users identified two use cases for the tools, 1) discover metadata, and 2) document metadata. To accommodate these use cases, we simplified the home page to direct the user to discover metadata or to document metadata.

To support users who are documenting metadata we:

- Updated pop-up help text across the tool
- Added a document landing page to guide the users
- Revised the protocol, methods, study plans landing pages improving the search functionality, providing users with easy access to information
- Added an interactive data flow diagram to all pages (Figure 2)
- Revised the Sample Designer to allow users to enter more than one data repository and make data repository mandatory
- Updated privacy policy

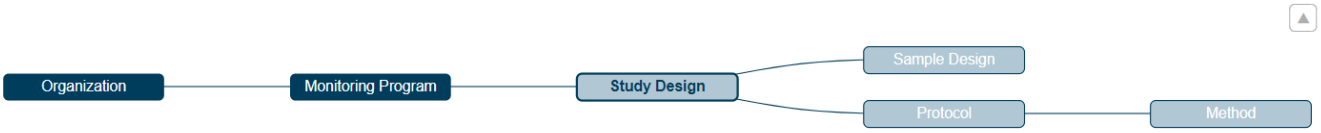

Figure 2. Workflow diagram to facilitate user navigation added to MonitoringResources.org pages

To improve the data discovery tools we:

- Updated the Monitoring Explorer user interface improving the search (Figure 3)
- Added a bounding box search
- Added the ability to download shapefiles and .csv of Monitoring Explorer search results
- Updated the technology stack used in the backend of Monitoring Explorer map viewer

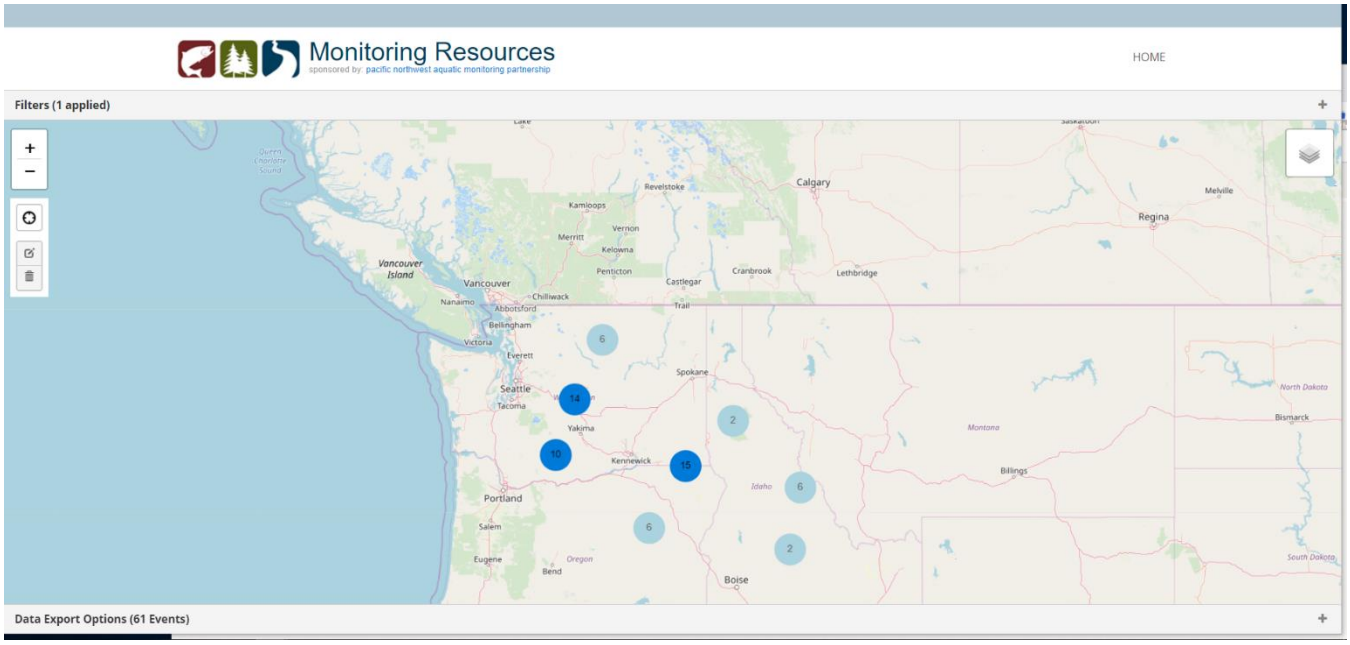

Figure 3. Updated Monitoring Explorer

To support entering data collection locations into the Monitoring Explorer map viewer, PNAMP developed the Monitoring Metadata Exchange (MMX). MMX is a PNAMP standard data exchange 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 2019, PNAMP coordinated with the Columbia River Inter-Tribal Fish Commission (CRITFC) to scope a project linking their Centralized Data Management System (CDMS) to MonitoringResources.org using the MMX standard to format data collection locations to be displayed in the Monitoring Explorer. In 2020, PNAMP and CRITFC will coordinate to write an EPA exchange network grant in order to secure funding to complete the scoped work. PNAMP staff will also focus on outreach of the Monitoring Explorer and MMX standard to those groups with the goal of adding content to the Monitoring Explorer.

In 2016, BPA transferred Pisces' functionality from the desktop application to cbfish.org a web application. BPA management decided to use MonitoringResources.org to track RM&E work element location data (i.e. sampling sites and areas of inference) to limit duplication between Pisces' and MonitoringResources.org functionality, make location data more findable and accessible, and create documentation of sampling into future years. This change was implemented at the end of December 2017. At this time, BPA directed Sitka to transfer location data from Pisces to the MonitoringResources.org Sample Designer tool. The location data migration has caused performance issues, user confusion, and quality issues. In 2019, PNAMP, with the support of BPA RM&E and Sitka staff, devoted time to resolving issues, supporting users, and fixing data. In 2020, we continue cleaning

up migrated data. We could speed up this data cleanup process by dedicating a BPA staff member to supporting Project Sponsors in a onetime cleanup effort, instead of doing this ad-hoc as project sponsors request support.

We have not completed all the work outlined in the 2019 Feedback and Recommendations Report, in 2020 with BPA support we will continue to improve the tool using the feedback summarized in the report.

In 2020, our goal is to continue to improve the tools based on partner's needs. We plan on:

- Updating the rich text editor in the tool
- Improving functionality within tools, e.g. the Metric Method Mapping in the protocols
- Adding and revising approximately 75% of the context-sensitive help text
- Adding functionality to create outputs that save time and effort for project sponsors
- Revisiting the Metadata Builder tool
- Building a design viewer that allows a user to see all planned sampling locations for a given year based on a set of search criteria

We will continue to do user testing and work closely with BPA's RM&E team to implement improvements.

MonitoringResources.org Content

PNAMP staff curates the content in MonitoringResources.org. To support finalizing content, PNAMP staff spent approximately 10 to 40 hours per week in 2019 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 help requests from the support desk, reviewing methods and protocols, and responding to requests to add new organizations or monitoring programs. More complex support involves assisting sponsors to choose and develop appropriate metadata in MonitoringResources.org to support their contract work elements in Pisces Web.

As of mid-December 2019, MonitoringResources.org contains:

- 1,758 methods, 1,104 are published, with 39 of those methods published in 2019
- 1,196 protocols, 232 are published, with 15 of those published in 2019
- 12 master GRTS samples
- 6 projects are displayed in Monitoring Explorer

It is important for users to finalize (publish) their content instead of leaving it in a draft state for their own organizations' continuity. The mechanisms to track version changes in procedures or of location data add valuable provenance. 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 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.

Throughout 2018 and 2019, PNAMP staff has been contacting owners and archiving content. In 2018 with the support of the USGS, we added the state “archive” to MonitoringResources.org. We archive unused content, content associated with long-expired contracts, been abandoned for years, and/or does not meet standards for publication; in 2019, one protocol and 136 methods were archived. 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. Owners of archived content can still see the content from their “My Stuff” page and can continue to update the information and request publishing when they are finished.

Adding content to MonitoringResources.org is important for its sustainability, it creates findable, accessible documentation of how data is collected and analyzed. Additionally, adding content promotes standardization and reuse of methods/protocol. In addition to BPA project sponsors, we are working with national partners to improve content.

MonitoringResources.org Training

In addition to one-to-one email and telephone support, PNAMP staff provides training on demand, videos, webinars, revisions for context-sensitive help text, and reference guides. During 2019, PNAMP

- Revised help text throughout the site in concert with software updates
- Updated the reference guide for MonitoringResources.org and Pisces Web RM&E Integration as an interim document while software upgrades occurred.
- Presented a one-hour training webinar available at MonitoringResources.org/Learn/Videos

Going forward we recommend the following to support PNAMP staff and BPA project sponsors:

- Add and maintain help text to improve user interface and to eventually eliminate the need for training seminars.
- PNAMP conduct ongoing user testing to assess priorities for improving the user interface, user experience, and navigation.
- 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 BPA, BLM, and USGS partners who are financially supporting MonitoringResources.org; in 2020, we will continue to engage stakeholders.

In 2020, we will work with BPA to identify priority project sponsors with enterprise data systems to link their database to the Monitoring Explorer using the MMX API. We are scoping a project with CRITFC to integrate their Centralized Data Management System (CDMS) with MonitoringResources.org, thus saving project sponsors time by reusing existing documentation, and allowing us to know who is collecting what data, where, when, and how, which will improve our ability to facilitate data exchange between multiple entities.

Managing content in MonitoringResources.org is a time-consuming process. Most of protocols and methods in the system have been entered by BPA project sponsors. PNAMP staff work directly with RM&E staff and project sponsors to review these protocols to build metadata consistent with project sponsors' RM&E work elements. PNAMP will 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. 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 RM&E 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 RM&E protocol data since 2013. The platform has now become the system of record for RM&E location data. In the past four years MonitoringResources.org has grown and all the functionality originally proposed is now available.

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.

Smolt Estimation and Analytics Workshop

PNAMP and the Pacific States Marine Fisheries Commission (PSMFC) StreamNet program co-hosted the Smolt Estimation and Analytics Workshop, held November 6-7, 2019 in Walla Walla, WA, to explore analytical uses and approaches to estimating smolt abundance and other ways to use smolt data. There were 118 participants from 33 entities that enjoyed three plenary talks, three guest speakers,

and sessions to address estimation and analytics as well as data stewardship and management. Topics included:

Nuts and Bolts of Smolt Trapping
Data collection, protocols, and methods as they relate to use of the data for analysis. A synthesis of the results of a region-wide survey.

Estimation and Analytics
Presentations by peers and statistical experts to address best practices for conducting analyses of smolt abundance, with consideration of statistical assumptions, population representation, gaps in data, environmental covariates, impacts of life history variations, and estimating abundance at points downstream.

Data Management for Juvenile Out-migrants and Connections to Coordinated Assessments
Ensuring comparability for smolt abundance estimates across the Columbia Basin and understanding terminology and scale of various estimates being presented and used in the region.

A highlight of the workshop was a series of presentations by monitoring practitioners and scientists who used the same dataset of fall Chinook Salmon migrants to estimate abundance.

To improve methods workshops and adapt formats and content to our audiences, we conducted and summarized an evaluation of the workshop, held a post-workshop planning group meeting, and assessed interest in continuing the conversation about uses for smolt outmigration data. Many expressed interest in forming a work group, drafting a guidance document for smolt analytical approaches, and revising and adding information to the Coordinated Assessments Data Exchange Standard for smolt out-migration data.

Coordinated Assessments Effort

Since 2011, PNAMP and the PSMFC StreamNet program have collaborated to manage the Coordinated Assessments (CA) effort, 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 effort 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 effort accomplishes this goal by improving access to fish information through the creation of data exchange standards for key fish population metrics and indicators for ESA listed and non-listed salmonids and by helping partners publish data via the Coordinated Assessments Exchange (CAX), which is managed by the PSMFC StreamNet Project. This information is accessible through the online CAX query where the information can be viewed and downloaded. Submittal from partner agency data systems to CAX and downloading from the CAX data system is also supported via

web services through an application programming interfaces (APIs) that make data available in XML and other standard machine-readable formats.

Participants in the CA Effort 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 informing decision-making and reporting for fish populations in the Pacific Northwest. 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.

In 2019, adjustments were made to the data exchange standard (DES) behind the Coordinated Assessments exchange but overall, the DES is largely sufficient for the specific data elements needed to support the exchange of the four initial viable salmonid populations (VSP) indicators and supporting metrics that were initiated in 2009. As in past years, there was discussion about developing data exchange standards for additional indicators, specifically hatchery effectiveness indicators, resident fish and sturgeon. During 2019 the CA Core Team began work on a proposal that was submitted to the FY20 EPA EN grant opportunity which focused on sharing of hatchery indicators. This work will begin in late 2020 if the grant is awarded.

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 and Bonneville Power Administration to support the CA effort. PNAMP facilitates the Coordinated Assessments Core Team bi-monthly meetings and related workshops as requested. PNAMP also supports StreamNet staff's leadership of the DES Development Team (DDT), which maintains and provides updates to the DES.

Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy Outreach

Fish and wildlife managers across the Columbia River basin have identified the need for a comprehensive research, monitoring, and evaluation (RM&E) strategy for the region. In 2019, staff from BPA, NOAA Fisheries, and NPCC formed a steering committee, outlined a framework, and began drafting a strategy for tributary habitat RM&E as a first step toward the comprehensive RM&E strategy. The intention was that the draft habitat strategy would be advanced through extensive discussion with, and input from, regional fish and wildlife managers and other interested parties. PNAMP was asked to help facilitate outreach and solicit input through a series of workshops. The draft Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy was shared in September, and five workshops were held between October 1st and November 18th in locations across the basin.

Summaries of feedback received during these workshops can be found on the Northwest Power and Conservation Council Columbia Basin Habitat RM&E Workgroup website.

In late October 2019, CRITFC and its member tribes submitted written comments of policy and legal concerns to the Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy Steering Committee. Staff from BPA, CRITFC, NOAA Fisheries, and NPCC are carefully considering how to resolve the concerns and were still in discussions at the end of December as to how to proceed with the development of the Habitat RM&E Strategy. In 2020, PNAMP will be standing by and ready to support the process that is agreed to.

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. **(**Effectiveness Monitoring project page).

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). These meetings and workshops have resulted in number of products including: 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 PNAMP IMW Action Plan that highlights the need for additional venues for stakeholders to discuss findings and practitioners to learn from one another, as well as calling for a number of additional communication products to help disseminate results and lessons learned from the network of IMWs; and improvements to MonitoringResources.org and the PNAMP IMW website to better support the IMW community of practice.

In 2019 PNAMP finalized the Key Findings and Lessons Learned from Pacific Northwest Intensively Monitored Watersheds report, a collaborative effort funded by NOAA (through Pacific States Marine Fisheries Commission). PNAMP gathered information for the report through a questionnaire emailed to IMW scientists that allowed them to point to existing reports that contained the desired information, as well as the opportunity to provide new information not reported elsewhere. The report summarizes the key findings and lessons learned from 16 IMWs in British Columbia, California, Idaho, Oregon, and Washington, and addresses the underlying assumption that habitat restoration improves juvenile salmonid survival and eventually leads to increased adult returns. Even though most IMWs are

still in early phases of habitat restoration and monitoring, the majority of the IMWs demonstrated some level of positive fish response over this timeframe. Across the 16 IMWs included, 12 reported increases in juvenile salmonid metrics and 4 IMWs reported significant increases in adult salmonid metrics. See the report for all the findings.

In 2019, PNAMP staff also worked with IMW practitioners from the Middle Fork John Day IMW (MFIMW) to conduct a small pilot effort to understand how MonitoringResources.org could help support the sharing of IMW monitoring site information and data collection protocols and methods. The pilot resulted in a recommendation for a feature to make it easier to upload monitoring sites into the system using a simplified CSV file template so they can be displayed on the Monitoring Explorer map. This feature is planned to be added to MonitoringResources.org in early 2020. This work also brought to light the need for the ability to identify data collection events in the Monitoring Explorer map that are utilized by more than one monitoring effort. PNAMP always encourages data sharing and reuse of existing data, but there is not currently a way to identify what data collection events in the Monitoring Explorer are used by multiple programs; in 2020 we will continue to explore how to make this possible.

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 work groups.

Data Visualization Work Group

Because the Pacific Northwest aquatic monitoring community now has decades of data, there is considerable 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 that chart new pathways for research and monitoring. In March 2018, 16 people met to explore Data Visualization. As of December 2019, the distribution list had over 80 people from 35 different tribes, agencies and partnerships. The group contributes to a Resources Document and can view previous presentations from the meetings on our YouTube channel/Data Visualization playlist. In 2018, the group met 8 times during which work group participants presented 12 of their data visualization projects. During the five meetings held in 2019, eight presentations ranged from an introduction to Tableau to an overview of the Spatial Hydro-Ecological Decision System (ecoSHEDS.org). Speakers have been featured from Pacific Northwest tribes and tribal confederations, federal and state agencies from Montana to Missouri, and private consulting companies and universities from Portland, OR to Amherst, MA.

An evaluation survey of the work group is in progress during December 2019 to determine whether there is enough interest to continue the work group and to assess participant satisfaction with the format, content and management of the group. In the survey questions, and in every communication, we solicit feedback and invitations to contribute ideas, speakers, examples of data visualizations, techniques to produce data visualizations, and topics.

Data Attribution and Citation Work Group

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, Olson et al. 2019: *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 work group 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. 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 published in 2019.

Integrated Science Using Monitoring Design Principles

Following our 2018 workshop held in Portland Oregon (Integrated Spatial Design & Analysis: Using Complex Survey Designs to Enable Integrated Science Workshop), we hoped to lead a Community of Practice specifically for experts responsible for designing and analyzing data resulting from large-scale long-term natural resource monitoring programs; however, this work was scaled back due to a funding shortfall from our USGS partners. We were able to establish a collaboration work space (https://my.usgs.gov/confluence/display/STATMON/MonitoringStats_CoP) and initiated some discussion threads with the community, but due to future funding uncertainty, we essentially shelved this work for 2019. We hope to reconvene experts with experience and interest specific to this topic in

2020, if funding is available from the USGS Landscapes Program. We anticipate that this emerging community of practice would include PNAMP partners from the Pacific Northwest, as well as representatives from long-term large-scale natural resource monitoring programs from around the country.

Outreach and Communication

Part of PNAMP's work includes reaching out to potential participants as well as 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.

At the end of 2018, PNAMP Coordination Staff totally revamped PNAMP.org giving it a more modern look and more intuitive functionality and navigation. Throughout 2019, PNAMP.org was updated regularly to make the most use out of the greater functionality of the renewed website. Additionally, we continually track PNAMP events and other meeting details (dates, locations, and online conference and phone information) and post documents related to events (meetings, conferences, workshops, etc.) and other PNAMP projects. Regularly, we also post announcements from around the region, jobs openings of interest to the aquatic monitoring community, and a link to the latest PNAMP Newsletter.

For the past ten years, PNAMP has distributed a monthly newsletter to all who are interested. In 2019, the monthly communication continued to include a summary of upcoming meetings, one or two short summaries highlighting the latest PNAMP news, and a feature on the latest update or method of interest in PNAMP's MonitoringResources.org tool. New to 2019, the newsletter put more attention on what's going on around the region by putting more emphasis on getting stories from PNAMP partners and putting those in the foreground. As of December 2019, 821 people are registered to receive the monthly newsletter, and that number continues to grow. In 2020, we have plans to refresh the newsletter when needed and continue to highlight stories from our partners.

PNAMP Coordination staff established a Twitter presence in August of 2014, which steadily gained followers in 2019. We are currently at 125 followers. Staff highlighted events, publications, and other items that are of interest to the regional participants. Additionally, our twitter helps announce the release of PNAMP news like the monthly 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 around the country. These conferences and workshops included: the American Fisheries Society (AFS) Oregon Chapter Annual Meeting in Bend, Oregon; the Salmon Recovery Conference in Tacoma, Washington; the CDI Workshop: From Big Data to Smart Data in Boulder, Colorado; the Columbia River Invasives Workshop in Hood River, Oregon; the Organization of Fish and

Wildlife Information Managers (OFWIM) conference in Shepherdstown, West Virginia; and the Smolt Estimation and Analysis Workshop in Walla Walla, Washington. The PNAMP Coordinator also gave overview presentations to the following audiences BPA executives and senior staff, Northwest Power and Conservation Council and senior staff, US Bureau of Reclamation senior staff, and US Geological Survey executives and senior staff.

USGS Sponsored Work

The USGS Ecosystems Mission Area Status & Trends Monitoring Program has been 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. Although limited by funding in 2019, we continued to conduct limited 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.

In 2019, we initiated a new case study for MonitoringResources.org called "All Lands Reporting: making stream habitat metrics FAIR". This project is developing innovative techniques to support publishing in-stream habitat data to the USGS Biogeographic Information System (BIS) by making wadable stream habitat metrics from four federal long-term, large-scale monitoring programs, findable, accessible, interoperable and reusable (FAIR). These programs: EPA National Aquatic Resources Survey (NARS), BLM Assessment, Inventory, and Monitoring (AIM), and the USFS Pacfish/Infish Biological Opinion Effectiveness Monitoring Program (PIBO-EM) and Aquatic and Riparian Effectiveness Monitoring Program (AREMP) are working together to identify questions, indicators, metrics and design components so that we can develop methods to access, integrate, and publish some common metrics from these programs.

We also support communities of practice with USGS funding. Of particular interest and overlap with PNAMP partners is the Large Rivers Monitoring Forum (LRMF; link in Science Base), which 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. In 2019, the LRMF developed a regionally based, ranking classification that characterized large rivers. Like Jacobson and others (2019) and Kammerer (1987) we used river path length, mean annual discharge, and drainage area to conduct our ranking. Values for these characteristics were derived from NHD Plus Version 2 (McKay and Others 2014). We propose to build on these efforts and classify reaches of the large rivers identified based on their hydrogeomorphic characteristics. The hydrogeomorphic classification of large

river reaches will help to inform comparison of river segments (e.g., with respect to management questions or efficacy of mitigation actions) within and across river basins and connect results to the USGS BIS. The completion of the classification will also allow us to enhance linkages of large river monitoring data to existing large river habitat characterizations such as NHD+ and NFHP and to emerging efforts such as National Stream Summarization, 3DEP, CoNED, and the USGS Environmental Hydrology Initiative.

Lastly, we hosted a workshop for USGS colleagues to develop a robust framework of new predictive tools to guide the development of Dreissenid mussel early detection programs in the Columbia River Basin (CRB), with consideration to how these tools could be applied beyond the CRB and to other taxa. This effort is part of Department of Interior efforts to reduce risk of invasion of Dreissenid mussel in the Columbia Basin, however, the intent is to develop tools that are extensible to other taxa and regions of the US.

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 individual 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.

In 2019, PNAMP strived to be more consistent and thorough in asking for feedback and responding to input. Significant effort was devoted this year to the review of, and application of, input to update MonitoringResources.org. We sought feedback from a variety of funders, users and experience levels in order to improve the user interface and streamline the experience. We feel this was time well spent and that the toolset is greatly enhanced.

We also sought feedback on our newsletter, core website www.pnamp.org, the Data Visualization Work Group, and from the participants in the Smolt Estimation and Analytics Workshop. We consistently receive good response rates to these feedback requests and appreciate the information provided, which helps us improve our performance over time.

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.

We have seen renewed commitment from signatory partners and additional interest from courtesy members to become signatory partners in PNAMP, which will enhance 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, benefits from steady participation from PNAMP Steering Committee members.

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 but we are appreciative of the growing participation we have seen in the past year.

References

Executive Summary

- 15th Anniversary Edition Newsletter: https://www.pnamp.org/newsletter/special-15th-anniversary-edition-newsletter

Introduction

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

Coordination Team Activities

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

MonitoringResources.org

- MonitoringResources.org website: https://www.monitoringresources.org
- MonitoringResources.org Project page: https://www.pnamp.org/project/monitoring-resources
- USGS created MonitoringResources.org Fact Sheet: https://www.pnamp.org/document/monitoringresources-org-fact-sheet
- MonitoringResources.org Training Presentation: https://www.youtube.com/watch?v=E1A4sqcnpC4
- MonitoringResources.org website: https://www.monitoringresources.org
- MonitoringResources.org Feedback and Recommendations: https://www.pnamp.org/document/11080
- MonitoringResources.org Home page: https://www.monitoringresources.org
- MonitoringResources.org Document Landing page: https://www.monitoringresources.org/Document/Home/LandingPage
- MonitoringResources.org Protocol page: https://www.monitoringresources.org/Document/Protocol/Index
- MonitoringResources.org Methods page: https://www.monitoringresources.org/Document/Method/Index
- MonitoringResources.org Study Plans page: https://www.monitoringresources.org/Resources/StudyPlan/Index
- MonitoringExplorer.org website: https://www.monitoringexplorer.org/main
- MonitoringResources.org Training: https://www.monitoringresources.org/Resources/Video/Player/22

Methods Review

- MonitoringResources.org website: https://www.monitoringresources.org
- MonitoringResources.org Discussions page: https://www.monitoringresources.org/Document/Discussion/Index
- Smolt Estimation and Analytics Workshop page: https://www.pnamp.org/event/smolt-estimation-and-analytics-workshop

Coordinated Assessments

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

Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy Outreach

- Draft Columbia Basin Habitat Research, Monitoring, and Evaluation Strategy: https://nwcouncil.app.box.com/s/l1r5bfwoah81mfml504eeoak59l5ur2m
- Columbia Basin Habitat RM&E Workgroup website: https://www.nwcouncil.org/fish-and-wildlife/forums-and-workgroups/rme

Effectiveness Monitoring

- Effectiveness Monitoring project page: https://www.pnamp.org/project/effectiveness-monitoring-coordination-assessment
- 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
- PNAMP 2017-2018 IMW Action Plan: https://www.pnamp.org/document/pnamp-2017-2018-imw-action-plan
- PNAMP IMW website: https://www.pnamp.org/imw/overview
- IMW Key Findings and Lessons Learned report: https://www.pnamp.org/document/15052

Data Management and Sharing Best Practices

- Data Visualization Project page: https://www.pnamp.org/project/data-visualization
- Data Visualization Resources document: https://my.usgs.gov/confluence/display/cdi/Data+Visualization+Resources
- Data Visualization Presentations: https://www.youtube.com/channel/UC6i-mCyumwk7x9hNy9WdvdQ/
- Data Citation and Attribution project page: https://www.pnamp.org/project/data-citation-and-attribution
- Citing Aquatic Monitoring Datasets: Best Practice Recommendations for Authoritative Data Citation: https://www.pnamp.org/document/15001

Integrated Science

- 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
- Monitoring Statistics Community of Practice page: https://my.usgs.gov/confluence/login.action?os_destination=%2Fpages%2Fviewpage.action%3FspaceKey%3DSTATMON%26title%3DMonitoringStats_CoP&permissionViolation=true

USGS

- Large River Monitoring Forum: https://www.sciencebase.gov/catalog/item/56f0319ce4b0f59b85dd1238

Adaptive Management and Lessons Learned

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

Appendix A. Entities signatory to the PNAMP Charter in 2019

PNAMP Signatory Partners	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	Chris Hirsch
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 2019

Hours were estimated for each meeting attendee for every PNAMP meeting from January 1 to December 31, 2019. 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	Hours
Washington Department of Fish & Wildlife	402.50
Oregon Department of Fish and Wildlife	236.00
Confederated Tribes of the Umatilla Indian Reservation	221.75
Idaho Department of Fish and Game	202.25
Bonneville Power Administration	185.00
Nez Perce Tribe	153.50
Shoshone-Bannock Tribes of Fort Hall	137.50
National Oceanic and Atmospheric Administration	131.00
Columbia River Inter-Tribal Fish Commission	125.25
Colville Confederated Tribes	115.25
Confederated Tribes and Bands of the Yakama Nation	112.00
Northwest Power and Conservation Council	98.00
Yakama Nation	96.00
Pacific States Marine Fisheries Commission	81.50
US Geological Survey	76.25
Confederated Tribes of the Warm Springs Reservation	55.50
Oregon State University	54.25
Snake River Salmon Recovery Board	40.50
Oregon Watershed Enhancement Board	39.50
Muckleshoot Indian Tribe	36.00
Confederated Tribes of the Chehalis Reservation	36.00
US Fish and Wildlife Service	32.50
Washington Governor's Salmon Recovery Office	31.25
The Nature Conservancy	31.25
Lumni Tribe	30.00
US Forest Service	27.50
Unknown	23.50
US Bureau of Reclamation	22.75
Quantitative Consultants Inc.	22.50
Columbia River Estuary Study Taskforce	22.50
Washington State Department of Ecology	21.25
Environmental Protection Agency	19.00
Idaho Governor's Office of Species Conservation	19.00

Entity	Hours
Western EcoSystems Technology Inc.	18.50
Northwest Indian Fisheries Commission	18.00
Quinnault Indian Nation	18.00
University of Washington	18.00
Cramer Fish Sciences	18.00
BioAnalysts	18.00
Lower Elwha Klallam Tribe	18.00
Okanagan Nation Alliance	18.00
Biomark	18.00
Fish Sciences	18.00
Puyallup Tribe	18.00
Water Resource Inventory Area 1 Salmon Recovery	18.00
Coos Bay Watershed.org	18.00
Avista Corp	18.00
Makah Tribe	18.00
Stillaguamish Tribe	18.00
Deschutes River Conservancy	18.00
Lower Columbia Estuary Partnership	13.50
Spokane Tribe of Indians	12.00
Oregon Department of Environmental Quality	11.00
Natural Resources Conservation Service	9.00
Puget Sound Partnership	6.00
Jamestown Tribe	6.00
Kootenai Tribe of Idaho	5.50
Burns Paiute Tribe	4.50
Oregon Water Resources Department	4.50
Terraqua Inc.	4.50
Coeur d'Alene Tribe	4.50
Yakima Basin Fish & Wildlife Recovery Board	4.50
Bonneville Environmental Foundation	4.50
Kalispel Tribe	4.50
City of Portland	4.50
Grande Ronde Tribes	4.50
GEUM Environmental Consultants	4.50
Upper Columbia United Tribes	4.50
Grande Ronde Model Watershed	4.50
Chelan County Natural Resources Department	4.50
Cascadia Conservation District	4.50
ICF International	4.00
Washington Department of Health	4.00

Entity	Hours
Washington State University	3.50
South Sound Spatial	3.50
International Year of the Salmon	3.00
Columbia Basin Fish & Wildlife Authority	2.50
University of Massachusetts, Amherst	2.50
Sitka Technology Group	2.00
QW Consulting	2.00
Walla Walla Community College	2.00
Ronin Institute	1.50
North Pacific Anadromous Fish Commission	1.50
Lower Columbia Fish Recovery Board	1.00
Total Hours	3404