StreamNet 2021
Annual Report

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II. Executive Summary

StreamNet serves as a regional coordination body to support data management and facilitate cooperation across organizational boundaries. The Pacific States Marine Fisheries Commission (PSMFC) hosts the StreamNet project and its databases, which provide access to regional fish and fish-related data by maintaining a coordinated, standardized, web-based distributed information network. The need for regionally coordinated and readily accessible data has been identified by the Bonneville Power Administration (BPA), the National Oceanic and Atmospheric Administration Fisheries Program (NOAA), and the Northwest Power and Conservation Council (NPCC). To ensure access to these data, StreamNet supports technical staff within the agencies (data stewards) who compile and submit these data in standardized, publicly accessible, regional data repositories. StreamNet also collaboratively leads and coordinates a number of initiatives to assure a regional approach to data management among federal, state, and tribal fish and wildlife agencies.

This annual report summarizes the work performed during calendar year 2021, which spans federal fiscal years 2020 and 2021. During calendar year 2021 StreamNet continued to implement the Coordinated Assessments Partnership (CAP) with the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) and engaged in collaborative efforts with all partners to advance the quality of shared data. Below is a brief highlight of these 2021 accomplishments:

- StreamNet continued to acquire fish data from our partners resulting in a total of 15,004 records submitted to the CAP Fish High Level Indicator (HLI) Coordinated Assessments Data Exchange (CAX) system, and a total of 190,746 records in the Fish Monitoring Data (trends system). Shoshone Bannock Tribes began submitting their data directly to StreamNet during 2021, while the Nez Perce Tribe (NPT) and the Yakama Nation (YN) continued to submit data.
- Some specific accomplishments achieved by the individual StreamNet subprojects related to development or improvement of their organizations' data storage systems include:
    - The Colville Tribes' updates to the Okanogan Basin Monitoring and Evaluation Program (OBMEP) database, further refinement of the pipeline calculating juvenile population estimates, and automation of QA/QC processes and calculations increasing efficiency and improving data quality by decreasing the opportunity for human error.
    - Idaho Department of Fish and Game's improvements to the Idaho Fish and Wildlife Information System (IFWIS) successfully supported upload of data directly from the system in two-step in order to simplify standardization of the data and speed submission to the StreamNet database, saving significant time from the previous approach.
    - Montana Fish Wildlife & Park's converted data files residing with individual biologists to file types that can be uploaded into the centralized database, thereby eliminating the need for biologists or technicians to spend time hand entering historic data into the system.
    - Oregon Department of Fish and Wildlife's finalized the new web application for Coordinated Assessments data that are entered directly into the ODFW SQL server database and include automated processes for validation and submission to the StreamNet API. The Coordinated Assessments Validation, Evaluation and Submission (CAVES) web application was completed and became fully operational for all-natural origin high-level indicator tables in late 2020 and was utilized to enter all data reported in 2021. Additional updates and efficiencies were incorporated into the system in 2021. In addition, ODFW designed and implemented a new web application for Fish Monitoring Data (FMD) (trends) to be entered directly into the ODFW Fish Monitoring – Data Distribution SQL server database and to automate the processes for validation and submission to the StreamNet API. In 2021, the Trend Evaluation, Validation, and Submission (TEVaS) web application became fully operational for all Location, Reference, Trend, and Escapement Data tables. In 2022, staff anticipate completing the remaining tables for Age and Hatchery Returns.
    - Washington Department of Fish and Wildlife's ongoing development of the EPA funded Juvenile Migrant Exchange and the Adult Fish Exchange data delivery system and services will serve data to StreamNet in the future. WDFW also secured a new EPA Exchange Network grant to facilitate sharing of hatchery and harvest data between tribes and WDFW.

- StreamNet continued to improve its online queries to better support data consumer needs, such as improving data access by developing tabular versions of the Fish Monitoring Data and CAP Fish HLI queries (e.g., age data time series (trends)), providing additional filters, and supporting unique URLs to facilitate sharing. StreamNet provided funding to contribute to advancing tribal data management and sharing capacity to The Colville Tribes and Shoshone Bannock Tribes.
- PNAMP and StreamNet co-organized the Emerging Technology Information Session (ETIS) Webinar Series. Participation in the ETIS webinar series ranged from 30 to over 100 attendees.

Recommendations to the Executive Committee:

- Support **expanding data flow for resident and anadromous fish** (hatchery and natural-origin) from agency/tribal data systems to StreamNet data systems that contribute to informing the NPCC 2020 Addendum (goals, objectives and indicators for natural-origin and hatchery fish); and BPA and U.S. Fish and Wildlife Service (USFWS) information needs.
- Support **implementation of the Five-Year Plan for the Coordinated Assessments Partnership** by strongly encouraging BPA, NPCC, and USFWS to build on StreamNet/CAP standardized data sharing successes for improving access to fish and related habitat data.
- Encourage NPCC, in addition to BPA, to officially recognize PSMFC StreamNet GIS and the StreamNet database systems (Fish HLI and Fish Monitoring Data) as the **system of record for the Columbia River Basin Fish and Wildlife Program**.
- Assist in **securing funding** to support StreamNet and CAP task maintenance, data quality, automation of the entire data flow process including calculations, and new tasks to better support the reporting needs of BPA, NOAA, NPCC and USFWS.
- Support **participation by all data providers and regional data consumers** in StreamNet and CAP related committees and teams, as well as engagement in PNAMP Fish Monitoring Work Group (FMWG) to advance StreamNet/CAP tasks
- Facilitate access to, and advance **metadata documentation** within agencies' and tribes' data systems, especially for data of regional importance.
- Continue to support the collection, update and exchange of foundational datasets by contributing agencies and tribes. These datasets such as hydrography and fish distribution are critical to understanding fisheries holistically.
- Strengthen **engagement and coordination among data stewards** (e.g., database administrators, programmers, GIS experts) by re-implementing annual technical team meetings (or more frequent as needed) to assist StreamNet technical staff in staying engaged and informed of the work others.

Lessons Learned:

- Ensuring **efficient data flow** requires ongoing maintenance and updates, including adopting advances in data management and reporting technology (open source and proprietary programs and tools) to improve efficiencies across the entire data life cycle. Several of the data providers are adopting a more automated data flow from field data collection to StreamNet's data systems, which would be beneficial for all data providers to pursue.
- Communicating the **quality of submitted data** provides data consumers with confidence in their use of these data.
- Improving **access of data** maintained by StreamNet to audiences with different technical knowledge will increase the value and use of these data by the public and for informing decisions.
- Leveraging **target work groups** with the required expertise (e.g., data stewards, biologist) to inform addition of data categories is efficient and effective, including coordinating with PNAMP staff for meeting facilitation expertise.
- Proper **documentation** for data integrity is critical to ensure that these valuable data, funded by the public and ratepayers, remain accessible to inform critical uncertainties and decisions into the future.
- **Succession planning and recruitment** of new partners/members requires documenting and publicly communicating information about StreamNet Program groups and processes. Succession planning also requires

partners agencies and tribes to document new and existing processes used in data management to ensure smooth staff transition.

III. Introduction

The need for effective and timely access of information to inform regional decision-making continues to be prominent in the Columbia River basin (CRB) and the Pacific Northwest as a whole. Specifically, the Bonneville Power Administration (BPA), the National Oceanic and Atmospheric Administration Fisheries Program (NOAA), and the Northwest Power and Conservation Council (NPCC) have all identified an ongoing need for regionally coordinated, securely stored, and readily accessible data to inform their reporting and decision-making processes. Furthermore, the Northwest Power Act, which established the NPCC, calls for decisions to be made using the best available science, which requires the best available information. StreamNet provides regional standardization and access to data throughout the Columbia River basin through development and maintenance of regional data repositories for fish and habitat data. This work improves data discovery, increases efficiency of data access, and facilitates data reuse – ultimately, adding value to data collection efforts

A. Project Background

StreamNet is a collaborative data sharing project that works among the federal, state and tribal agencies, and other partners such as PNAMP to locate, assemble, and share, in a standardized manner, specific data and indicators from the local scale to inform regional needs. StreamNet also has an important role in archiving data sets and providing access to historical information, especially those that support policy decisions such as the NPCC's Protected Areas, system and subbasin planning data, wildlife Habitat Evaluation Procedure (HEP), and US Congress funded Hatchery Reform Group and Hatchery Scientific Reform Group (HSRG) reports and data sets. Data submitted to StreamNet have been recently focused on the Columbia Basin but began as region-wide coverage and may soon find themselves evolving back to the region-wide coverage through the CAP. To properly address regional reporting and decision-making processes there is an ongoing need to include information from other areas of the Pacific States, such as for the NPCC's Protected Areas and NOAA 5-year status reviews for listed salmonids. Information from outside the basin is also submitted to StreamNet when it is more efficient during the data submittal process because the geographic coverage for many of StreamNet's partners overlaps the CRB but extends well beyond its boundaries. The overarching goal of StreamNet is to make river-related information collected in the Pacific States, with an emphasis on the Columbia River basin, standardized and accessible, in order to inform management questions and strategies (Figure 1). The data disseminated represent primary fish-related data, regardless of the funding sources responsible for supporting the work of field collection. Thus, all data of a given type are included, both those paid for under the BPA-funded Fish and Wildlife Program and similar data that are obtained based on other funding. This is important because in order to conduct assessments or monitor population status and trends, all data relevant to each population must be used, regardless of funding source or agency and tribe collecting the data.

Figure 1: StreamNet focuses its data sharing efforts on data within the Columbia River basin. However, data from other Pacific States are included as well to better support partners' information needs such as the NPCC Protected Areas and NOAA's 5-year salmon and steelhead status assessments.

The genesis of StreamNet was the call for standardized information to support the NPCC's 1984 Columbia River Basin Fish and Wildlife Program (Program) and 1983 Northwest Conservation and Electric Power Plan (Plan) Hydro Assessment Study (HAS) to document the environmental health and energy potential of the basin's rivers. When StreamNet began in 1983, albeit under a different name, it was intended to be the region's Rivers Information System. The HAS was a cooperative regional effort by the BPA, the NPCC, the four Northwest states, the region's Indian tribes, and Federal land management agencies. The goal of this effort was to assess the significance of the region's rivers in a standardized fashion with the public's input, and to document those results. The HAS consisted of three distinct, coordinated efforts. For one, BPA, the NPCC, and the U.S. Army Corps of Engineers cooperated to develop the Pacific Northwest Hydropower Data Base and Analysis System (NWHS). For another, the NPCC led the effort to design the region's first anadromous fish data system called the Coordinated Information System (CIS; 1987 Program states needed database content and 1992 Program section 7.6 describes CIS). For the third, BPA began coordinating the inventory and analysis work on the remaining environmental categories, called the Pacific Northwest Rivers Study (PNWRS). Data generated by these efforts covered all four states (comprehensive) and contained the same data elements for each state (consistent structure and content). The HAS efforts resulted in detailed natural resource data sets for the region and the technical and administrative infrastructure to ensure the maintenance and use of the information housed in the Northwest Environmental Database (NED) and in the Coordinated Information System (CIS). These cooperative data collection efforts spanned across agency and state lines with information updates transmitted from the states to the regional system biannually. Source data were maintained at the state level to ensure accuracy and ties to other state data collection efforts.

StreamNet originated following the integration of the Coordinated Information System (CIS) and the Northwest Environmental Database (NED). The NED had previously integrated data from the Hydro Assessment Study (HAS), specifically data from the Northwest Hydropower Database and Analysis System (NWHS) and Pacific Northwest Rivers Study (PNWRS). Over time the original StreamNet project evolved to adopt technology that facilitated data sharing and to respond to information needs from regional decision-making efforts (Figure 2).

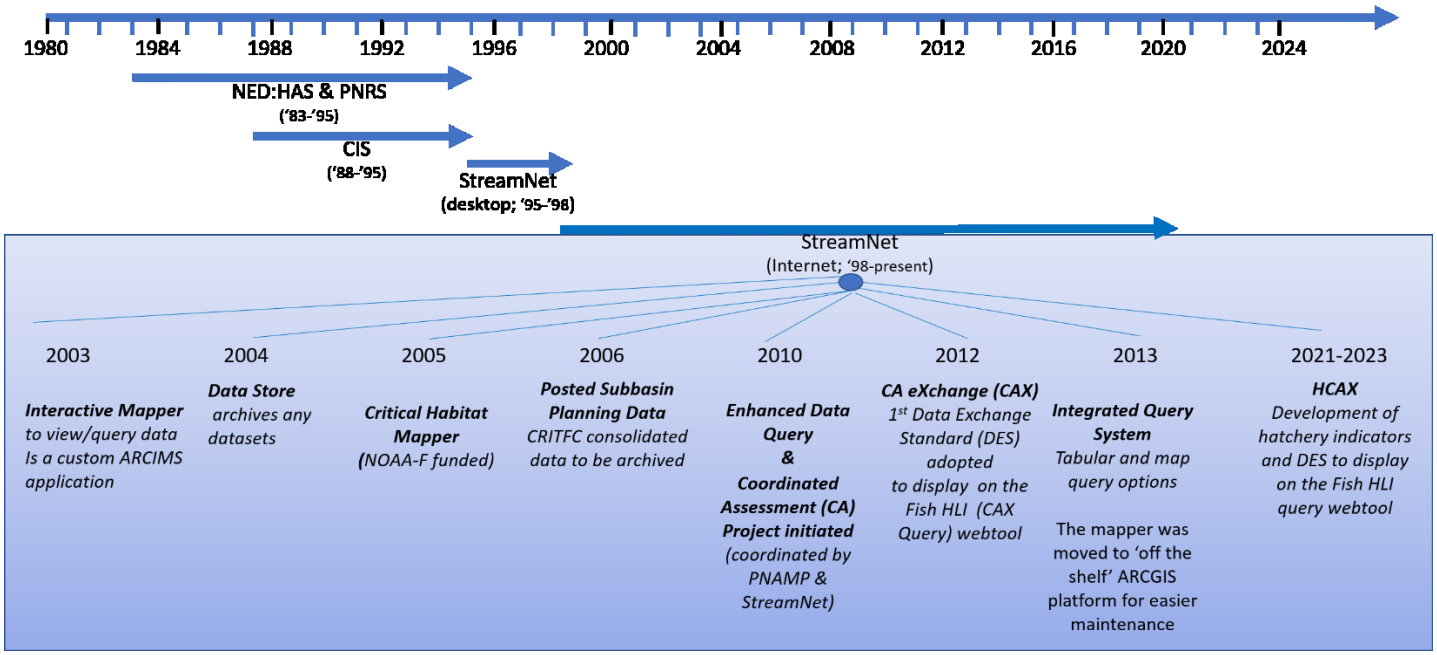


Figure 2: Timeline showing the merging of CIS and NED in 1995 to form the StreamNet project and its subsequent evolution to the current day StreamNet data sharing project.

During its most recent significant evolution, following the 2012/2013 NPCC programmatic recommendations for Regional Data Management Projects[i] and those specific to the StreamNet project, as well as the NPCC recommendations generated from the follow-on Program Evaluation & Reporting Committee (PERC) process[ii], the StreamNet project:

- Established an Executive Committee with representatives of NPCC, BPA and fish and wildlife managers to direct data management direction and priority (Figure 3),
- Prioritized efforts on making synthesized information, such as population estimates, accessible through StreamNet with emphasis on the high-level indicators (HLIs) identified through the Coordinated Assessments (co-led by Pacific Northwest Aquatic Partnership (PNAMP) and StreamNet),
- Continued to evolve towards a more accessible platform for various users and optimize webservices to facilitate coordinated data-sharing and data depiction, including updating its main website and developing an application programming interface (API) that allows different systems to talk to one another and exchange data,
- Expanded its participants to include additional managers and data collecting entities that are not directly funded through the StreamNet project,
- Focused its BPA funds on providing data needed for BPA and NPCC reporting needs such as NPCC HLI reports and BPA Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) reports for priority populations.

The most recent NPCC recommendation, the August 2019 programmatic and project recommendations[iii], continues to support the StreamNet project and further recommended that StreamNet continue its effort to expand its steering committee membership to agencies managing fish data and to initiate work on other priority NPCC program indicators including hatchery indicators. To this end StreamNet continues to seek opportunities for expanding the CAP HLIs to other categories and fish species. StreamNet's prioritization of work continues to be informed by the Five-Year Work Plan for the Coordinated Assessments Partnership (CAP).

Figure 3: StreamNet is hosted by PSMFC and largely funded by BPA to promote efficient data sharing from member agencies and tribes in support of the NPCC Columbia River Basin Fish and Wildlife Program. StreamNet committees' members currently include the four states, Colville Tribes, CRITFC and CBF&W Library. StreamNet teams include representatives from additional data providers.

B. Coordinated Assessments Partnership

The Coordinated Assessments Partnership's (CAP) goal is to develop efficient, consistent, and transparent data sharing among the co-managers (fish and wildlife agencies and Tribes) and regulatory/funding agencies (BPA, NOAA, and US Fish and Wildlife Service) of the CRB for fish-related data. The CAP was designed (in part) to assist and streamline state and tribal data contributions to regional decision-making processes (e.g., NOAA 5-yr status assessments) and reports (e.g., NPCC Program Tracker; BPA FCRPS BiOp reports). The project has been coordinated by PNAMP and the PSMFC StreamNet project since its inception in 2010 (see: https://www.pnamp.org/project/coordinated-assessments-for-salmon-and-steelhead). The development of the CAX was partially funded by a 2015 EPA Exchange Network grant (Salmon Coordinated Assessments Data Exchange project #83546401, closed). Close contact with HLI users (BPA, NPCC, NOAA, others) and with regional fish and wildlife managers is maintained and is crucial to the success of the project.

The project is focused on sharing standardized regional high-level indicators (HLIs) for the health of fish populations. CAP is a collaborative effort amongst many partners and its scope, both jurisdictionally and species topics, remains flexible to address emerging regional data and reporting needs. The intent is for the CAP to be a collaborative, consensus-based effort. Parties involved in the CAP remain flexible so that participants with the required expertise (e.g., resident fish managers, habitat managers, etc.) will be recruited as needed, as CAP moves to additional indicators. Since 2010, the agencies and tribes within the CRB participating in the CAP have successfully developed the Coordinated Assessments Data Exchange (CAX). The CAX's CAP Fish HLIs query has effectively communicated and made accessible natural-origin salmon and steelhead population HLIs to decision-makers and other interested parties. The CAP Fish HLIs query is valuable in providing timely access to CRB HLIs used in federal reports and research, as well as reporting needs of the Washington State Governor's Salmon Recovery Office, NPCC, and BPA (see Appendix C for crosswalk between NPCC populations and CAX populations). Funding has been the limiting factor for expanding the CAP Fish HLIs query (CAX data system) beyond natural origin HLIs.

The second five-year plan for the CAP was discussed in June 2019 by the StreamNet Executive Committee and adopted in August 2019[iv]. The plan is revisited annually to ensure alignment with regional priorities, and changes as needed if regional priorities change; a revised version was adopted September 9, 2021 by the StreamNet Executive Committee. The five-year plan for the Coordinated Assessments Partnership guides the implementation of this project by prioritizing data for contribution from partners. The CAP plan currently focuses on natural origin salmon and steelhead populations in the CRB with emphases on BPA priority populations. The primary data types contained in and disseminated through the CAP that relate to abundance and Viable Salmon Population (VSP) parameters are five VSP indicators including population scale estimates of natural spawner abundance, smolt to adult ratio, adult recruits per spawner (spawner to spawner ratio), smolt outmigrants, and presmolt abundance. In addition to high level indicator data, related data (aka time series trends data sets) are also curated by StreamNet, including spawner counts, juvenile counts, redd counts, and dam and weir counts. These time series trends data relate to the population scale estimates of VSP parameters, summarized to annual totals. The CAP Plan also indicates other fish species, e.g., sturgeon, and category of data, e.g., hatchery indicators, as priorities, and these will be explored as additional funding and resources become available. Implementation of the plan will require resources from a diversity of sources to provide access to the data approved by the Executive Committee. To this end the CAP members secured a USEPA Exchange Network grant in 2015 that was focused on sharing natural origin salmon and steelhead HLIs, and in 2020 the CAP Core Team was awarded an EPA Exchange Network Grant that will fund developing and flow of a small subset of hatchery fish HLI with work occurring during 2021-2023.

C. Policy Guidance

The StreamNet project is implemented following the guidance provided in the 2021-2026 StreamNet Vision and Strategic Plan [v] (adopted September 2, 2020) and through the collaboratively developed Five-Year Plan for the Coordinated Assessments Partnership, which is adopted by the StreamNet Executive Committee. The CAP Plan is updated annually, while considering a 5-year implementation period. The direction provided by the CAP Plan considers guidance from NPCC Program and Project Recommendations, which in turn stipulate a need for StreamNet to address the reporting needs of NPCC and BPA. Below are excerpts of the current NPCC Program and related NPCC and BPA data priorities that inform the CAP Plan, and work implemented by StreamNet.

1. Data Management Principles and Measures

StreamNet follows the 2014 NPCC Fish and Wildlife Program's guidance for data management (Program Part Four and its draft 2020 Addendum Part 1B) by making information accessible to the public and for decision-making at a regional-scale. The Program guidance implemented by StreamNet includes:

- Manage data in a manner that is searchable and usable by interested parties.
- Properly document metadata associated with data and ensure these are accessible through web links or attached documentation when data are accessed.
- Provide access to categories of data, such as fish abundance, through a single centralized website.
- Produce derived estimates and indicators (e.g., population estimates) from preliminary data collection (e.g., redd counts) and make publicly accessible along with supporting data.
- Work collaboratively to refine indicators that can be used consistently to inform decisions and reporting needs, providing these data in regionally consistent formats to all interested parties in a timely manner, and preserving these data beyond the longevity of a project.
- Facilitate collaboration among agencies, tribes, and tribal consortia, as well as with other monitoring entities in the Basin, which contribute and consume data to inform decisions. To effectively support the Program indicators and objectives, which include hatchery, anadromous and resident fish, it is essential to prioritize which information needs to be addressed first, based on the Program's guidance.
- Refine content of the data management system to align with partners' reporting needs including the NPCC.
- Maintain data and products supporting the NPCC FW Program, both historical and current, in a structured manner that facilitates public access such as information related to Protected Areas information, habitat evaluation procedures, and GIS layers.

2. Priority Populations

BPA's Environment & Fish and Wildlife Division staff interact on a regular basis with StreamNet staff to communicate their data needs. The data priorities have expanded since the more restrictive 2016 Tier 1 and Tier 2 priority populations that were associated with data needs for the previous FCRPS BiOp.

3. High Level Indicator Priority Categories

The priority high level indicators (HLIs), which have guided the work of the CAP since its inception, were focused on providing derived indicators to address the Viable Salmon Population (VSP) data needs for NOAA's 5-year status reviews. These also aligned with the specific indicators and metrics for reporting progress on implementation of the reasonable and prudent alternatives (RPAs) identified in the 2008 FCRPS BiOp[vi] and related documents. With the adoption of the 2020 Northwest Power and Conservation Council Columbia River Basin Fish and Wildlife Program, the StreamNet Executive Committee approved StreamNet to work collaboratively with others, leveraging the PNAMP FMWG, to develop recommendations for Executive Committee's review that would better address the NPCC strategic performance indicators for natural origin salmon and steelhead stocks. These HLIs, as well as others identified in the CAP Plan, continue to be a priority.

4. Fish Monitoring Data (Trends) Data Set Priorities

The 2014 NPCC Fish and Wildlife Program provides guidance on the information needed to track the status of the CRB's fish and wildlife resources (Part Two, section V), report on the Program's approved high-level indicators (see 2014 Program Appendix E), and assess progress towards Program goals, objectives and indicators (see 2014 Program Appendix D and its draft 2020 Addendum Part 1A). During 2018, the Executive Committee directed the StreamNet project to resume updating selected, high priority traditional data sets, such as long-term sets that support CAP indicators and those that are used to maintain the NPCC program reporting needs. This continues to be a priority for StreamNet as available resources allow. With the 2020 addendum to the Northwest Power and Conservation Council Columbia River Basin Fish and Wildlife Program it is anticipated that the data needs for the NPCC Program Tracker will more specifically identify the fish species and data categories priorities.

5. GIS Data Layers Priorities

PSMFC's GIS Center supports the management and publication of StreamNet's spatial data layers related to fish populations, monitoring sites, fish facilities, and stream survey reaches associated with time-series data stored in the StreamNet database. This centralized GIS provides a comprehensive location referencing system for finding and accessing Columbia River basin fisheries information compiled by the StreamNet, CAP and other PSMFC programs. It enables discovery and display of the CAP Fish HLIs at the population scale and drives the web-based mapping components of the CAX Query system and StreamNet Query systems. StreamNet's core GIS data layers are recognized as BPA's system of record for mapping fish facilities (e.g., hatchery, weirs) and fish distribution within the basin. PSMFC's centralized GIS also supports the Columbia Basin PIT Tag Information System (PTAGIS) and the Regional Mark Processing Center (RMPC), providing consistency and synergy across projects. As BPA and NPCC continue to clarify what GIS layers PSMFC can provide to better support their reporting tools, such as NPCC's Program Tracker, BPA PISCES (CBFish.org), and PNAMP's MonitoringResources.org, additional GIS layers are being developed by the GIS Center, such as focal species range maps.

D. Budget Considerations

Calendar year 2021 spans two fiscal years (FY), FY21 from January to September 2021 and FY22 from October to December 2021. For FY21, BPA provided an increase to StreamNet that had matched the FY2017 amount recommended by the NPCC in their 2019 project recommendation[vii] (Figure 4). In FY22 BPA provided a smaller increase to the StreamNet Program than the one provided in FY21, but this FY22 amount is higher than the FY20 budget and allowed to continue to support the PSMFC GIS Center lab and the StreamNet PSMFC database administrator/biologist and programmer and contributed to funding a technical subcontract. The StreamNet Program Manager, in FY22 took on additional data management programs at PSMFC, specifically RMPC/RMIS and FINS, and reallocated funds to advance additional tasks, including those requested by BPA, by supporting a few months' time of another PSMFC employee and

to increase funding to the technical support subcontract. The partner agencies did not receive any increase duringCY2021 (FY21 and FY22) with the exception of ODFW which shifted funds from other BPA projects in its BPA project portfolio to its StreamNet subcontract.

To alleviate the financial constraints experienced by StreamNet partners, PSMFC StreamNet staff are continuously seeking alternative funding sources to maintain and address new tasks to support priorities. During calendar year 2020, PSMFC StreamNet secured Interjurisdictional Fisheries Act (IJFA) funding to address the budget shortfall needed to keep the partners' budget at the same level and cover StreamNet PSMFC staff. With the BPA budget increase received for CY2021, the IJFA funds secured by PSMFC StreamNet for FY21 (September 2020 to August 2021) and FY22 (September 2021 to August 2022) were allocated to further advance StreamNet by supporting tribal data management and exchange capacity (Colville Tribes and Shoshone Bannock Tribes), USGS-PNAMP staff time to assist with CAP related tasks, and subcontracting for additional technical support. This added funding directed at specific StreamNet tasks complement the limited PSMFC StreamNet FTE and assist in making progress on several BPA priority tasks during CY2021 and 2022 (FY21 and FY22).

Similarly, the CAP Core Team seeks funding from alternative sources as feasible. For instance, in 2015 the CAP benefited from a multi-year grant received by WDFW from the EPA. StreamNet was a sub-contractor under that grant. The purpose of the grant was to automate data flow on the key VSP indicators across the region and foster collaboration. The CAP Core Team and StreamNet Steering Committee also submitted a proposal to advance hatchery indicators in 2020. This proposal was selected for funding by EPA and the Hatchery Coordinated Assessments Data Exchange (HCAX) work was initiated late in 2020 and will continue to late 2023. This proposal was by Washington State Recreation and Conservation Office / Governor's Salmon Recovery Office with WDFW, The Colville Tribes, PNAMP and StreamNet as sub-awardees, and with Idaho Department of Fish and Game (IDFG) and Oregon Department of Fish and Wildlife (ODFW) being funded through subcontracts from this funding. StreamNet partners also seek and secure additional funding which complement and contribute to advancing StreamNet and CAP tasks, such as the individual EPA Exchange Grants secured by WDFW, YN, and CRITFC.

The StreamNet budget does constrain the ability of PSMFC staff and partners to address the information and tasks requested by BPA in the time frame desired. The lack of cost of living increase in the BPA budget over time compounds this constraint over time as shown in Figure 4, which depicts the decrease in the budget's nominal and real value since 2004. As rates and fees increase over time, the resources available, the ability of PSMFC StreamNet and partners to maintain and recruit staff with the required data management expertise and to support data management needs of Tribes not funded through the StreamNet Program will be further reduced.

E. StreamNet Data Sharing Partners – Providers and Consumers

Current partner agencies funded through this project are: The Confederated Tribes of the Colville Reservation (Colville Tribes); Idaho Department of Fish and Game (IDFG); Montana Fish, Wildlife& Parks (MFWP); Oregon Department of Fish and Wildlife (ODFW); and Washington Department of Fish and Wildlife (WDFW). The Colville Tribes joined in CY2013 (FY2014) when they began receiving funding through StreamNet.

Other partner agencies that are not funded directly through StreamNet include: US Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), Columbia River Inter-Tribal Fish Commission (CRITFC) and its member tribes, Columbia Basin Fish & Wildlife Library (CBF&W Library or Library), and Pacific Northwest Aquatic Monitoring Partnership (PNAMP). During CY2020, Yakama Nation (YN) and CRITFC completed their subcontracted tasks for improving data management and sharing capacity, and the Shoshone Bannock Tribes subcontract was extended in CY21 and increased to further assist them with data sharing that informs the CAX database. Up until 2017, the USFWS was funded through StreamNet, but no longer receives funding through StreamNet. In calendar year 2018 BPA and the USFWS reached agreement on funding these activities through a direct contract focused on integrating USFWS hatchery databases.

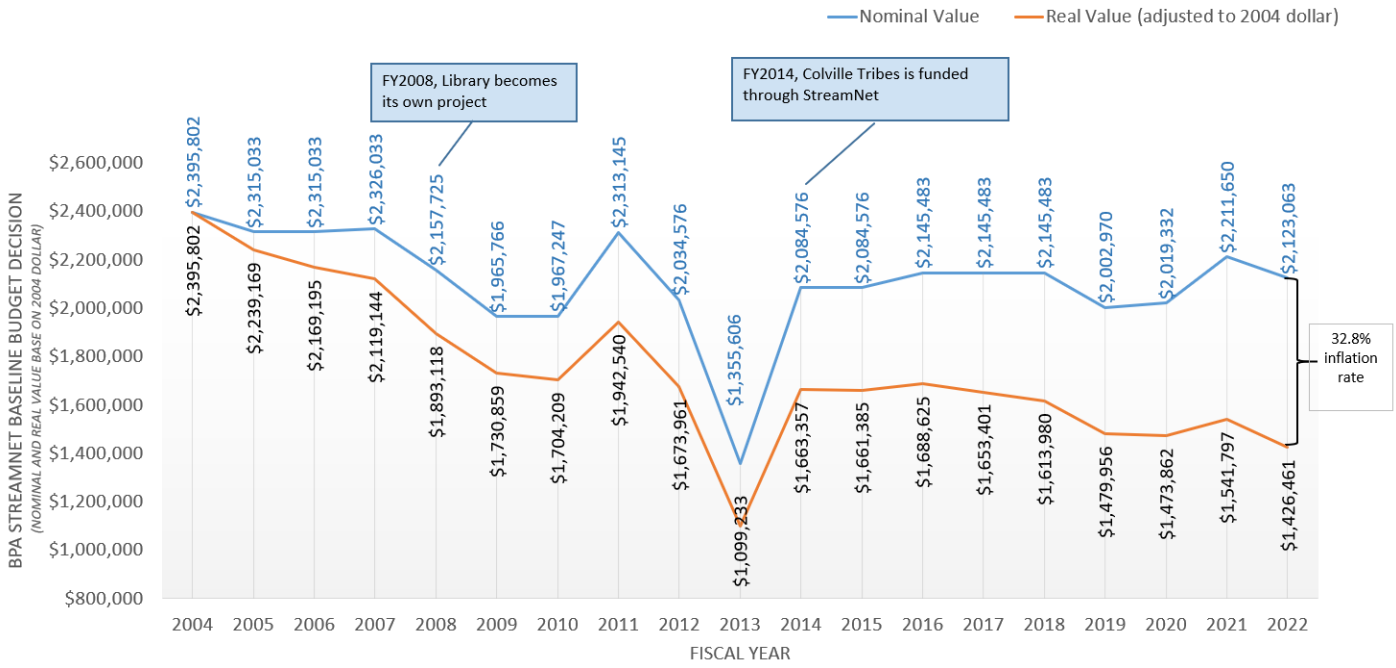


Figure 4: BPA annual budget decision for the StreamNet project between FY2004 and FY2021. In 2008 the Library was split from the StreamNet project and assigned its own project number and budget (BPA project # 2008-505-00). The sharp decrease in FY2013 arose from the percent cut made by BPA across all projects to address a BPA financial crisis. The cut in FY2013 resulted in substantial PSMFC staff time being reallocated to other PSMFC projects until the budget was readjusted to a higher amount in FY2014. Additionally, the FY2013 cut resulted in all PSMFC GIS support no longer being funded through the StreamNet budget from FY2013 to FY2020. The 2019-2020 decrease in the budget reflects the reduction agreed to by the Executive Committee in 2018 to assist BPA with another budget issue. In FY2021 BPA reinstated the StreamNet baseline (excluding ODFW portfolio funds) budget to $2,145,483 as recommended by the NPCC in 2019. When comparing the nominal budget value to the real budget value this further highlights the StreamNet budgetary constraints. The real budget value is adjusted to the 2004-dollar value considering inflation and calculated using https://www.usinflationcalculator.com/

IV. Approach and Methodology

StreamNet[viii] supports a regional approach to data management, coordination, and standardization by increasing partner capacity and by improving access to fish data (Figure 5). The majority of fish-related data originate with the region's state, tribal and federal fisheries agency's fish monitoring programs. StreamNet participates in or leads a variety of teams of data management professionals from states, tribes, and agencies that coordinate regional data sharing. Data flow has been streamlined through the implementation of application programming interfaces (APIs) for various data types.

StreamNet facilitates submittal of time-series data and high-level indicators to its regional databases at PSMFC by supporting technical staff inside these agencies to help increase the capacity of these partners with managing, standardizing, and providing related GIS layers. PSMFC and StreamNet funded agency employees and subcontractors locate data, standardize data reporting through the cooperative development of data exchange standards, complete Quality Assurance/Quality Control (QA/QC), and then assure the flow of data from state, tribal, or agency repositories to StreamNet. StreamNet supports individual agencies and tribes to work collaboratively in the exchange of data contributing to regional decision making.

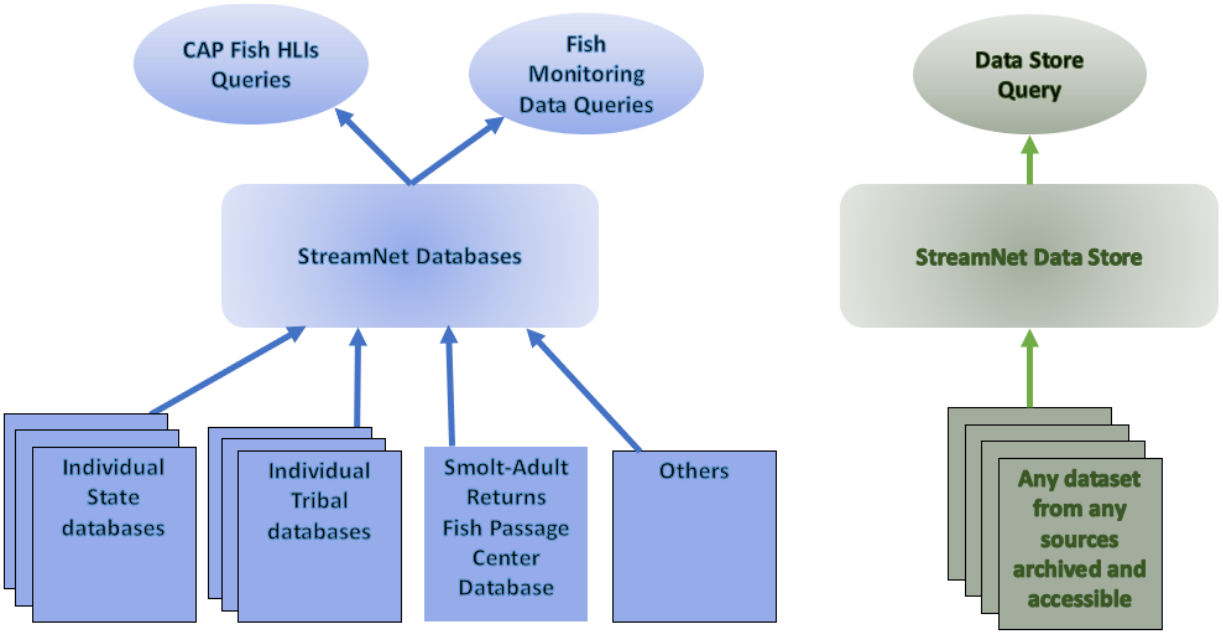


Figure 5: Flow of data from StreamNet members' agency/tribal databases, sub-regional databases, and other sources, to the StreamNet and StreamNet online data access queries.

A. Standing Committees for StreamNet and Coordinated Assessments Partnership

Work Elements:	C. 189 CAP Data Coordination I. 189: Coordination

There are several committees and teams that contribute to the implementation of StreamNet, including an Executive Committee and a Steering Committee, and supporting teams (Figure 6). The Coordinated Assessments Partnership (CAP) co-implemented by StreamNet and PNAMP involves a broader set of partners than the StreamNet project alone, and provides a broader jurisdictional engagement to address partners' Pacific Northwest information needs.

There are specific teams and workgroups associated with StreamNet to provide guidance and coordination for the CAP. The CAP and StreamNet are both discussed and considered by the StreamNet Executive Committee when developing the annual work plan and the Five-Year Plan for Coordinated Assessments to inform data priorities.

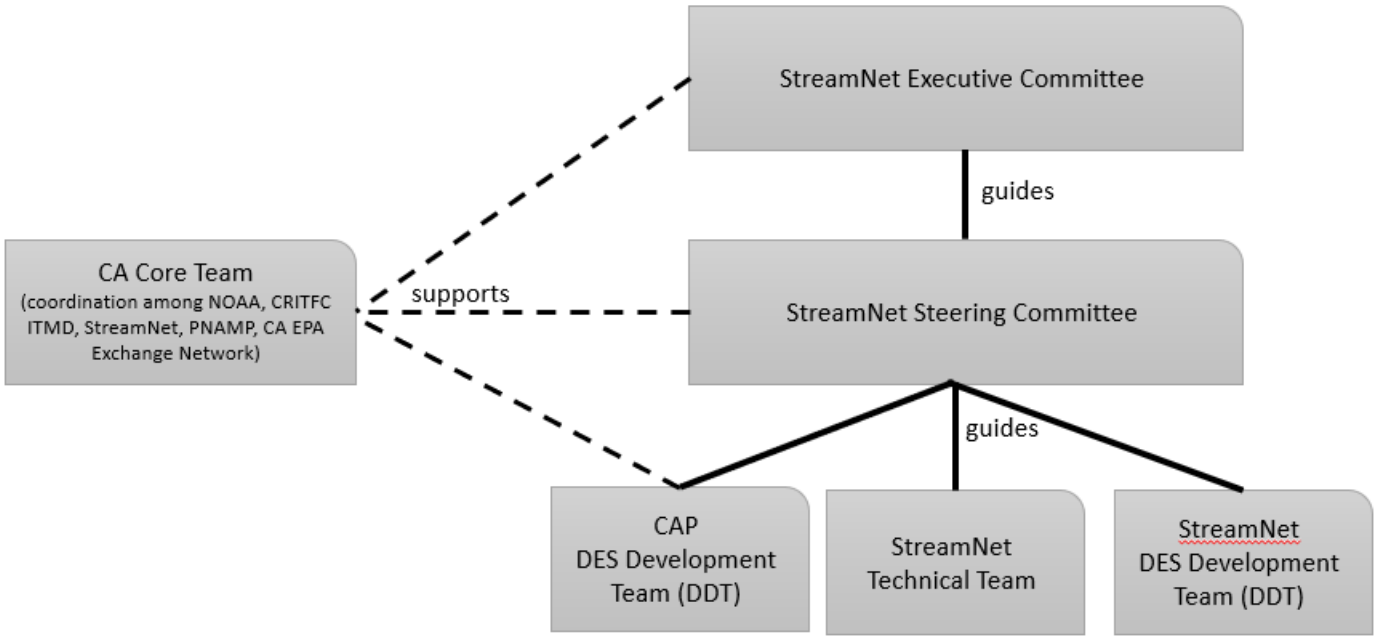


Figure 6: Relationship among the StreamNet Committees and Teams and their connection to the Coordinated Assessments work.

1. StreamNet Executive Committee

As part of the effort to improve coordination, in 2014 StreamNet instituted an Executive Committee. This committee is made up of policy staff and project leaders from the StreamNet partner agencies as well as other related organizations involved in managing and using fisheries data, primarily in the Columbia Basin (Table 1, more details on the StreamNet Executive Committee webpage). The chair is the PSMFC Executive Director who is represented by the StreamNet Program Manager. This group provides the high-level guidance and decision-making for StreamNet and the Coordinated Assessments Partnership. This guidance includes review of the high-level goals and products of the Coordinated Assessments Partnership, Fish HLI query (CAX data system), time series (trends) data set trends for the StreamNet Fish Monitoring Data Query, and making decisions on species, populations, indicators, and priorities on a long-term and an annual basis. The Executive Committee reviews and annually approves the Five-Year Plan for the CAP to ensure that the regional data priorities are being addressed through the CAP CAX and StreamNet databases.

Table 1: Calendar Year 2021 members of the StreamNet Executive Committee

Current Members	**Affiliation**
Randy Fisher (Chair) and Stan Allen	PSMFC
Zachery (Zach) Penney and Sheryn Olson	CRITFC
Patty O'Toole	NPCC
Jody Lando and Rodrigo George	BPA
Greg Sieglitz	NOAA-Fisheries
Tom Stahl and Art Martin	ODFW
Dan Rawding	WDFW
John Cassinelli (Lance Hebdon stepped down during 2021)	IDFG
Don Skaar	MFWP
John Arterburn	Colville Tribes
John Netto	USFWS

2. StreamNet Steering Committee

The Steering Committee helps to implement the decisions of the StreamNet Executive Committee, particularly as it relates to the content of the StreamNet databases and the queries it supports: StreamNet Fish Monitoring Data (trends) Query and Fish HLI Query (CAX). This committee includes active participation by StreamNet and non-StreamNet members at the data manager level (Table 2, more details on the StreamNet Steering Committee webpage). This includes NOAA, BPA, NPCC, state agencies, and some tribal representatives. The committee is made up of technical project leaders from the StreamNet partner agencies as well as other related organizations involved in managing fisheries data, primarily in the Columbia Basin. The chair is the PSMFC StreamNet Program Manager.

Table 2: Calendar Year 2021 members of the StreamNet Steering Committee

Current Members	Affiliation
Nancy Leonard (Chair)	PSMFC
Sheryn Olson and Tami Wilkerson	CRITFC
Kris Holmes	NPCC
Tom Pansky, Russell Scranton, and Matt Schwartz	BPA
Mari Williams	NOAA-Fisheries
Cedric Cooney	ODFW
Brodie Cox	WDFW
Angie Schmidt and Evan Brown	IDFG
Dawn Anderson	MFWP
George Batten	Sitka Tech representing Colville Tribes
Todd Gilmore (Doug Threloff retired in 2021)	USFWS
Jen Bayer	USGS-PNAMP

3. StreamNet Technical Team

The Technical Committee is composed primarily of PSMFC and state and tribal agency staff from StreamNet partners that implement data management actions (Table 3; more details on the StreamNet Technical Team webpage). The chair is one of the PSMFC StreamNet staff, with the staff assigned depending on the team's current task. This team has the responsibilities dealing with the programming details necessary to adequately flow data from partner data systems to the StreamNet database and associated Fish HLI (CAX) and StreamNet Fish Monitoring Data queries.

Table 3: Calendar Year 2021 members of the StreamNet Technical Team

Current Members	Affiliation
Greg Wilke and Mike Banach	PSMFC-StreamNet
Van Hare	PSMFC-GIS Center
Denise Kelsey, Tami Wilkerson	CRITFC
Jon Bowers, Peter Robinson, Jake Chambers, Nadine Craft, and Kasey Bliesner	ODFW
Michelle Groesbeck, Greg Lippert, and Leslie Sikora	WDFW
Chris Harrington, Randy Walsh, Evan Brown, and Rebecca (Bekki) Waskovich	IDFG
Ace Riverman	MFWP
Todd Gilmore and David Hines	USFWS
John Arterburn, George Batten (Sitka Tech consultant)	Colville Tribes
Michelle Steg-Geltner	Yakama Nation

Currently there are no StreamNet Technical Team members identified for CTUIR, CTWSRO, NPT and SBT.

4. StreamNet Data Exchange Standard Development Team (SN DDT)

The StreamNet DES Development Team (SN DDT) meets as necessary to maintain the data-sharing rules for Fish Monitoring Data and documents the rules in the StreamNet Data Exchange Standard (DES). A DES is a set of formal rules for the meaning and structure of shared data. The SN DDT collaborates with the StreamNet Executive Committee (SN ExCom) and StreamNet Technical Team (SN TT) to determine how these data should be presented and made available via online query systems. The SN DDT consists of biologists, data management, and IT technical staff from the federal, tribal, state, and regional organizations submitting and consuming data (table 4, see SN DDT webpage for details). Most member organizations have more than one individual participating on the SN DDT who contribute to discussions, product development, and decisions. The SN DDT is organized and facilitated by Pacific States Marine Fisheries Commission (PSMFC) StreamNet staff, with the PSMFC StreamNet Regional Fishery Biologist / Database Administrator serving as chair.

Table 4: Calendar Year 2021 members of the SN DDT

Current Members	Affiliation
Greg Wilke and Mike Banach (Chair)	PSMFC-StreamNet
Van Hare	PSMFC-GIS Center
Denise Kelsey, Tami Wilkerson	CRITFC
Jon Bowers, Peter Robinson, Jake Chambers, Nadine Craft, and Kasey Bliesner	ODFW
Michelle Groesbeck, Greg Lippert, and Leslie Sikora	WDFW
Chris Harrington, Randy Walsh, Evan Brown, and Rebecca (Bekki) Waskovich	IDFG
Ace Riverman	MFWP
Todd Gilmore and David Hines	USFWS
John Arterburn, George Batten (Sitka Tech consultant)	Colville Tribes
Michelle Steg-Geltner	Yakama Nation

Currently there are no StreamNet Technical Team members identified for CTUIR, CTWSRO, NPT and SBT.

5. Coordinated Assessments Partnership Data Exchange Standard Development Team (CAP DDT)

The CAP Data Exchange Standard (DES) Development Team (DDT) meets as necessary to maintain existing data tables and develop new indicator tables. This team consists of both data technicians and biologists that are responsible for calculating indicators. The DDT determines DES content and import/export guidelines. Actual team membership is fluid and depends on the species/indicators/geography of the data (Table 5, see the CAP DDT webpage for details). The chair of the DDT is the PSMFC StreamNet biologist.

Table 5: Calendar Year 2021 members of the CAP DDT

Current Members	Affiliation
Mike Banach (Chair) and Nancy Leonard	PSMFC
Denise Kelsey	CRITFC
Russell Scranton and Jeffery Stier	BPA
Mari Williams, Monica Diaz and Craig Busack	NOAA-Fisheries
Ace Riverman	MFWP
Jake Chambers, Nadine Craft, Jim Ruzycki, and Kasey Bliesner	ODFW
Brodie Cox, Andrew Murdoch, Dan Rawding, and Michelle Groesbeck	WDFW
Evan Brown, Rebecca Waskovich, and Lance Hebdon	IDFG
George Batten (Sitka Tech consultant)	Colville Tribes
Jay Hesse and Ryan Kinzer	Nez Perce Tribe
Bill Bosch	Yakama Nation

Jen Bayer	PNAMP
Brandon Chockley	Fish Passage Center

6. Coordinated Assessments Partnership (CAP) Core Team

The CAP Core Team meets regularly to coordinate amongst several BPA-funded projects. The Core Team is made up of representatives from BPA, PNAMP, StreamNet, a StreamNet partner agency/ EPA Exchange Network representative, and the CRITFC Inter-Tribal Monitoring Data project representative. A NOAA representative was added in 2019 to this team. The CAP Team are important leaders in ensuring that CAP produces results (Table 6). The Core team facilitates discussion amongst projects, directs requests for work to the appropriate CAP level (as needed), and generally serves to maintain forward momentum. The team manages and implements periodic CAP Workshops.

Table 6: Calendar Year 2021 members of the CAP Core Team

Current Members	**Affiliation**
Nancy Leonard	PSMFC
Denise Kelsey, Sheryn Olson	CRITFC
Russell Scranton and Matt Schwartz	BPA
Mari Williams	NOAA-Fisheries
Brodie Cox	StreamNet partner representative (WDFW)
Jen Bayer	PNAMP
Tom Iverson *(position eliminated at end of 2021 and replaced by Sheryn Olson, CRITFC ITMD lead)*	StreamNet Tribal Outreach
John Arterburn *(added in 2020 for HCAX coordination)*	Colville Tribes
Michelle Steg-Geltner *(added in 2020 for HCAX coordination)*	Yakama Nation
Keith Dublanica *(added in 2020 for HCAX coordination)*	WA GSRO

B. StreamNet Data Specialists within Agencies

Work Elements:	B 159: Support transfer of data into secure and accessible repositories D. 160 CAP Data – DES and database E. 159: CAP Data – compile data F.160: CAP Data -automated data exchange H. 159 Compile high priority traditional StreamNet data J. 160 Enhance data efficiency – system development

The StreamNet project uses subcontracts to support data stewards inside StreamNet member agencies. These data stewards operate within the agency or tribe for which they work, and coordinate with biologists across that organization to identify and collect data of interest to StreamNet.

These data stewards locate and acquire data and metadata, convert these to the DES adopted by StreamNet, perform Quality Assurance/Quality Control (QA/QC), provide related GIS information, and assist with development and utilization of database systems within agencies to streamline the data flow process. Once these data are properly formatted and validated, these data are then submitted to the StreamNet database at PSMFC, where they are quality checked and managed so they become available to the StreamNet online data query systems. These data are then made publicly

available for viewing and downloading in standardized format through the project website, www.streamnet.org. The data submitted by these data stewards may also include data from other agencies and tribes, because state agencies often collect data from partners to calculate estimates, metrics, or indicators that are reporting on CAP Fish HLIs query (CAX data system).

C. Data Store - Archiving Data Sets and Information

Work Elements:	B 159: Support transfer of data into secure and accessible repositories G. 161: Data - dissemination

StreamNet staff continues to maintain public access to structured information for the NPCC FW Program including the Data Store, Subbasin Plans, Protected Areas, HEP, and the HSRG. StreamNet's Data Store, the online searchable data archive, continues to provide access to historical and recent data collected by BPA-funded projects as well as other data sets from partners and the CRB.

Data Store – StreamNet maintains the Data Store archive service[ix]. The Data Store is a secure location for data storage for projects throughout the region and provides access to non-standardized data. The StreamNet Data Store is a searchable archive of data sets related to fish and other aquatic resources. These data sets come from many different sources and are provided for download in their original formats. StreamNet facilitates data submittal to the Data Store by providing a data publishing service that guides the data submitter in how to describe their data set and submit it. The Data Publishing Service is for submittal of data sets. Those who want to archive a report with summary graphs and tables are directed to the Columbia Basin Fish & Wildlife Library[x] hosted by CRITFC. Because the Data Store is a data set archive, data sets housed there are generally not updated after the first version is submitted.

Subbasin Plans – StreamNet maintains documents and data sets[xi] used in the NPCC subbasin planning process. The NPCC (formerly the Northwest Power Planning Council) led the 2001-2004 effort to develop comprehensive subbasin plans throughout the Columbia River basin. StreamNet both provided data to support subbasin planning and also received and distributed compilations of the data used in the plans. After the plans were completed, StreamNet, the Technical Outreach and Assistance to Subbasins Team (TOAST), the CRITFC, and the Northwest Habitat Institute captured new data that were developed for use in the aquatic portion of each subbasin plan. Resources archived by StreamNet include the spreadsheets, maps, GIS layers, subbasin planning modeling input and results, tools, and databases developed for subbasin planning. Included is a large majority of the Ecosystem Diagnosis and Treatment (EDT) and Qualitative Habitat Assessment (QHA) modeling information used in subbasin planning, as well as GIS layers that define the EDT/QHA reach codes.

Protected Areas – StreamNet maintains access to the NPCC Fish and Wildlife Program's documentation of the river reaches designated as areas protected from hydroelectricity development[xii]. This protection was assigned by the NPCC FW Program based on the determination from extensive Pacific Northwest river studies conducted during the 1980s that these areas are to be protected to avoid the unacceptable risks of loss to fish and wildlife species of concern, their productive capacity, or their habitat. To this end the NPPC FW Program states that the Federal Energy Regulatory Commission (FERC) cannot license a new hydroelectric development in a Protected Area, and 2) calls on BPA not to acquire the power from such a project should one be licensed by FERC, nor to allow access to the Pacific Northwest-Pacific Southwest Intertie (the "power grid") in a way that would undermine the Protected Areas policy. The last update to the Protected Areas list was promulgated in 1992, and it remains in effect through the current NPPC FW Program.

HEP – StreamNet also maintains the NPCC's Columbia River Basin Fish and Wildlife Program's (Program) Wildlife Habitat Evaluation Procedures (HEP) documents and data[xiii]. The NPCC FW Program policy guiding wildlife mitigation to

compensate for hydrosystem development relies on the HEP data to support the mitigated habitat unit, where this tool was applied. HEP was used to quantify the impacts of development, protection, and restoration on terrestrial and aquatic habitats by assessing changes, both negative and positive, in habitat quality and quantity. The HEP informed the NPCC FW Program's progress in BPA's mitigation for lost habitat units related to the construction and operations of the hydrosystem dams. StreamNet maintains access to this critical information for the NPCC FW Program and BPA. The NPCC FW Program also relies on settlement agreements between BPA and partners for mitigating for lost habitat and these are tracked by the NPCC.

HSRG – StreamNet staff have begun integrating the content of the Hatchery Reform Project website[xiv] to ensure that its content, including the Hatchery Scientific Reform Group's (HSRG) documents remain accessible to the public through the refreshed StreamNet website that was released during 2021. The NPCC FW Program policy guidance for its *Fish Propagation including hatchery programs*[xv] strategy includes in its rationale the HSRG outcomes, and the Program guidance encourages the application of these HSRG recommendations for FW Program-funded hatcheries, thus maintenance of the HSRG website and documents[xvi] is needed to inform implementation of this policy guidance.

D. Fish Monitoring Data (time series trends)

Work Elements:	B 159: Support transfer of data into secure and accessible repositories D. 160 CAP Data – DES and database E. 159: CAP Data – compile data G. 161: Data - dissemination F.160: CAP Data -automated data exchange H. 159 Compile high priority traditional StreamNet data

StreamNet Fish Monitoring Data query system[xvii] provides access to all time series (trends) data sets submitted to the StreamNet database (excluding content from the Data Store). These data are also georeferenced. The StreamNet Fish Monitoring Data query was refreshed in CY2020 to better integrate with the StreamNet website and supports a simpler filter-based query in a tabular format. During CY2021 a visual map depicting the location of the data set was added by connecting to the PSFMC StreamNet mapper, and work was initiated to improve access to the age data time series. This tabular query allows the user to filter data in different ways to suit their needs and download the resulting data or share a URL to the filtered content. The content of StreamNet's Fish Monitoring Data query system includes fish abundance estimates and indexes at the local scales for native and non-native species, many of which are focal species for the 2014 FW Program, as well as information on hatchery returns, redd counts, and harvest. Data sets relating to monitoring activities such as redd counts and dam counts are generally updated annually.

For current data types that are included in the StreamNet Data Exchange Standard (DES) for Fish Monitoring Data (time series data sets), content is updated annually or less frequently as needed. The StreamNet Program expects needing to refine and/or expand the StreamNet DES in future years to accommodate the data needs for the NPCC 2020 Addendum, such as improving the quality of bull trout data.

The StreamNet Application Programming Interface (API) requires that users request access and get issued a unique programming key to interact with Fish Monitoring Data via this method. This is a case of programming best practice rather than limiting data access.

E. Maintenance and Access to GIS Layers

Work Elements:	B 159: Support transfer of data into secure and accessible repositories D. 160 CAP Data – DES and database E. 159: CAP Data – compile data G. 161: Data - dissemination F.160: CAP Data -automated data exchange

There are three mappers associated with StreamNet[xviii]. The first, the StreamNet mapper, allows exploration of regional fish distribution and stream referenced survey data. The second, the Protected Areas mapper, displays streams protected from hydroelectric development by the NPCC. The third, the Fish Facilities mapper, shows the location and some descriptive information about fish facilities located in the Columbia Basin that submit fish data to PSMFC's data projects, including StreamNet. Facilities that are not linked to data housed at PSMFC currently are not included on this map although the need to support these other facilities is being discussed given the information needs of NPCC and BPA.

StreamNet's interactive mapping applications are useful resources for Fish and Wildlife Program-sponsored projects and related watershed and stream-specific projects. The applications enable users to: 1) explore baseline information on fish abundance and distribution, 2) identify the location of surveyed stream reaches and important fish facilities (e.g., dams, hatcheries, weirs, traps, etc.), 3) create custom data and map products, and 4) summarize data by subbasins and areas of interest.

PSMFC's GIS Center staff maintain and update StreamNet's core GIS layers as new data become available from partners. In general, the GIS Center staff checks about twice a year for available updates from partner agencies.

F. CAP Fish HLIs

Work Elements:	B 159: Support transfer of data into secure and accessible repositories G. 161: Data - dissemination

CAP Fish HLIs and associated Fish Monitoring Data time series data sets (trends) for population level estimates are available through CAP Fish HLIs map query (CAX data system[xix]). Development of CAP Fish HLIs map query (renamed in 2021, formerly named Coordinated Assessments Indicators of Fish Population Health or CAX Query) was initiated in 2016 with the intent of providing access to HLIs and associated trends. CAP Fish HLIs query provides access to these data by having the user select a species and run, and complements the tabular data with a dynamic map that displays the geographic population distribution and summary information in a pop-up box.

StreamNet coordinates closely with PNAMP in providing technical guidance to the CAP which follows the Five-year Plan for CAP. This technical guidance includes development and modifications to the Data Exchange Standard (DES) document which is needed for submitting standardized data that will be displayed on the CAP Query. The DES document specifically identifies the data elements that are to be shared for each indicator, along with definitions, formats, and business rules for each element. The DES document is used to guide the organization of data to be shared via any specific medium, whether by spreadsheet, CSV file, database file, or web service. The data elements are hosted by the originating agency, and exchanged following the DESs using the StreamNet Application Programming Interface (API).

As part of the CAP, staff at PSMFC and subcontracting agencies coordinated with state, federal and tribal agencies in support of increasing data flow in the region and to encourage increased use of information technology to improve the efficiency of data sharing. The StreamNet API facilitates submittal and access of CAP Fish HLIs through the CAX data system. CAP Fish HLIs and supporting time series data sets in the Fish Monitoring Data query are updated at a minimum of once a year, but as automation advances, more partners are submitting more frequently such as on a daily basis by the source agency.

To access the information on CAP Fish HLIs query (CAX data system), users are asked to agree to an End User License Agreement which reflects the data sharing agreement conditions agreed to by parties providing data to StreamNet for the CAX data system. The data sharing agreement is presented for agreement as data are uploaded and shared. The purpose of these data sharing agreements are to articulate how data that are shared are to be interpreted, analyzed, and attributed correctly. Furthermore, if users use the StreamNet Application Programming Interface (API) to access the CAX data, the API requires that users request access to be issued a unique programming key to interact with data via this method. Additionally, if a user accesses CAP Fish HLIs query content from the EPA Exchange Network (EN), the EN requires that users register before accessing any data sets. This is a requirement imposed by the EPA and not StreamNet. The EPA Exchange Network for the CAX Node is accessible at http://www.exchangenetwork.net/data-exchange/columbia-river-basin-coordinated-assessment/

G. Validation Process for Data and HLIs Submitted to the StreamNet Database

Work Elements:	B 159: Support transfer of data into secure and accessible repositories E. 159: CAP Data – compile data F.160: CAP Data -automated data exchange H. 159 Compile high priority traditional StreamNet data K. 160 Infrastructure and base operations

Data exchange standards, a data sharing agreement, and rigorous QA/QC protocols are all part of the data compilation and reporting process. Data, including reference documents, in the StreamNet database must conform to StreamNet DES document, which precisely defines the data elements, their organization in tables, and required formats. This document serves as the common denominator for the specific data types contained in the database. Adherence to the DES document assures that data can be loaded into the database, can be queried accurately, and are equivalent for further analysis by users. Conversion of agency data to the DES document and assuring that they conform before submission is the responsibility of the project's data stewards/compilers in the data source agencies. Additions or changes to the DES are made following a formal documented procedure adopted by the Steering Committee (see the latest version of the available from the CAP DDT document table Data Exchange Standard Development and Revision Procedures for details).

QA procedures are applied at the agency data steward level. An automated data validation and loading system has been implemented at StreamNet. This system provides real-time feedback on the success (or not) of data validation. Data are submitted to the StreamNet database one record at a time, and real-time data validation is run on them at two levels (with a third level planned). First, each field has its own set of rules. Examples include ensuring numeric fields do not contain text, ensuring codes fall within the group of allowable values, and ensuring text strings are within acceptable length ranges. The second level of validation ensures that values in the different fields within a table are compatible. For example, if a record appears that says it is for "spring run coho salmon," the record is rejected because there is no such run. The third level of validation, once implemented, will look for data problems between rows of data within a table. This will primarily be to find and flag duplicate data. A useful feature of the automated validation routines is that

the data may be run against the validation rules and an error report obtained without actually submitting the data for inclusion in the database. This feature allows data submitters to check entire sets of data, fix all errors, and then submit an entire data set after it is known it will pass validation. The interface used for data submittals allows for new records, for changing existing records, and for deleting existing records. The QA/QC procedures implemented pre, during and post submittal were updated and agreed to in the final 2022 version: StreamNet Quality Assurance and Quality Control Plan version February 7, 2022.

H. Enhanced Metadata Documentation by Connecting to Complementary Data Systems

Work Elements:	B 159: Support transfer of data into secure and accessible repositories K. 160 Infrastructure and base operations

Documentation of metadata for information submitted to the GIS Database, Data Store, and StreamNet database has always been a priority to StreamNet as this ensures the appropriate use of these data outside of the original project that created these data.

GIS – Metadata for the GIS data comply with the Federal Geographic Data Committee (FGDC) International Organization for Standardization (ISO) standard and are packaged in ArcGIS file geodatabase format for use with desktop GIS software.

Data Store – Metadata for data sets in the Data Store are provided by the entity that uploads the data set. The BPA Data Management Strategy directs StreamNet to store links to associated protocols and designs to ensure data downloaded and used by third parties can be understood and properly used. The Data Store process requests the user to provide a BPA Project number if relevant. When a BPA project number is provided, the Data Store provides the user with options from the BPA www.cbfish.org and the PNAMP www.monitoringresources.org to facilitate connecting the data set to contact information and documented protocols and methods.

StreamNet Database for Fish Monitoring Data – Preferably metadata for the tabular data should meet the requirements of the FGDC Biological Extension, but we often lack the required level of detail from the source agency, as many agencies have not placed high priority on creating metadata. Depending on the data being submitted, different levels of metadata are captured. Currently, for the data submitted to the StreamNet Fish Monitoring Data (trends) database that are not related to CAP Fish HLIs Query, there is frequently a lack of formal metadata from the data source agencies. To compensate for the lack of formal metadata, StreamNet obtains source documents for all data entered into the database, which are subsequently stored in the CBF&W Library's cloud server. Library created URLs for these source documents are presented with all views of the data and with all data downloads. Many source documents contain methods sections that provide the detail about how the data were collected. When viewed online, there are links to the Library's online catalog record for the document, which include a link to the digitized version of the document. In 2019 the Library began a reconciliation project to ensure the accuracy and accessibility of its links to StreamNet source documents. As of March 2022, over 7,500 documents have been reconciled and the projected completion date is December 2022

CAP Fish HLIs - For CAP Fish HLIs and related Fish Monitoring Data time series (trend) data sets submitted to the StreamNet database to be displayed on CAP Fish HLIs query, some metadata components are required from the data source agencies as part of the DES. Specifically, information on 'calculation method' used is requested in the DES, and this information is presented with all data displays and in data downloads. There is also information captured by the

DES related to general categories or types of methods, rather than detailed descriptions. Additionally, StreamNet now also captures URL information to link to www.monitoringresources.org for the specific method used for a particular component of data related to population-scale HLIs.

StreamNet continued to work on improving the quality of metadata associated with its data records while exploring approaches to reduce the burden on the data provider. Initial work exploring how to leverage documentation of protocols and methods available from other regional data systems (e.g. MonitoringResources.org and CBFish.org) began in 2021 and will inform pilot implementation, which may include modification to the DES, in CY2022. The availability and quality of metadata varies depending on the year the data was collected (older data sets tend to have lower quality metadata) and the documentation requirement associated with the data collection event. At a minimum, StreamNet has gathered the source document or report that detailed the protocols used to collect these data and, working in collaboration with Library staff, have made these accessible through the Library. With the regional recognition that protocols and methods described in reports are not always sufficient for fully understanding the origin and uses of the data, a tool to support full description of methods and protocols was developed through PNAMP (MonitoringResources.org; BPA project #2004-002-00) with support from BPA. StreamNet is collaboratively working with PNAMP on leveraging this existing metadata content to reduce burden of creating metadata on data providers. In the absence of metadata provided by the Library and/or MonitoringResources.org, the StreamNet database will at a minimum point to the originating agency as the source.

StreamNet data and metadata are provided online as web services, allowing users to locate and obtain data through automated means such as national or regional clearinghouses, and in fact, the StreamNet database harvests our own web services as part of the new, more efficient approach to querying our data.

1. PNAMP MonitoringResources.org

In 2008, PNAMP began efforts that lead to the development of MonitoringResources.org. PNAMP leveraged work by National Park Service, US Bureau of Reclamation, and USDA Forest Service that developed a tool for documenting protocols[xx]. The further development of this tool aimed to provide detailed information about protocols, methods, study design, and metric documentation to inform the NPCC's project review process, and BPA's Research, Monitoring and Evaluation (RM&E) needs and for project tracking[xxi]. The current version of MonitoringResources.org promotes transparency and greater understanding of monitoring through a standard process of documentation and information management, which is facilitated through online tools that provide guidance and support design and documentation of monitoring projects from beginning to end[xxii].

The StreamNet database contains a field associated with the CAP Fish HLIs data to allow the submitter to include a URL link to metadata. This can include providing a link to the protocols and methods documented in monitoringresources.org. Work initiated in 2021 is exploring how to improve the use of content in monitoringresources.org by facilitating the connections with the StreamNet data systems.

2. Columbia Basin Fish & Wildlife Library

The Columbia Basin Fish & Wildlife Library (Library) was founded in 1995, to support the StreamNet Project which originated with the consolidation of two projects, NED and CIS. Originally the Library was part of the StreamNet project and was named the StreamNet Library. In 2008 the Library was separated into its own project and is now hosted by the Columbia River Inter-Tribal Fish Commission (CRITFC; project #2008-505-00). To better reflect the scope of the project, the Library was renamed Columbia Basin Fish & Wildlife Library in 2020 and, in 2021, changed the Library's website domain from streamnetlibrary.org to cbfwl.org The StreamNet project continues to rely on the Library to provide access to documents that provide details related to the data submitted to the StreamNet database. In turn, the Library continues to prioritize making StreamNet source reference documents easily accessible through the Library catalog and ensuring their long-term preservation. In 2021, the Library migrated its digital collection, including StreamNet documents, to a cloud-based server with improved security and web-based accessibility for Library staff; these enhancements provide greater stability for the collection.

I. Data Backup Systems

Work Elements:	B 159: Support transfer of data into secure and accessible repositories K. 160 Infrastructure and base operations

The StreamNet databases are backed up on the PSMFC organization-wide system, which entails sending backup copies to the Kennewick PSMFC office.

The StreamNet staff also make backup copies on DVD media monthly and store these offsite. Additionally, StreamNet staff send a differential backup to the cloud on a daily basis.

J. StreamNet Relationship with Mainstem and Sub-regional Data Projects

Work Elements:	B 159: Support transfer of data into secure and accessible repositories C. 189: CAP Data -coordination G. 161: Data -dissemination I. 189: Coordination

StreamNet collaborates with existing mainstem/sub-regional data management projects to further enhance the flow of information needed to inform decision-making and reporting. These types of projects are tasked with compiling information from a subset of the CRB, in some cases to support collaborative analysis. StreamNet works with these data management projects to access relevant information needed to inform HLIs. This coordination reduces the workload placed on individual biologists and data stewards by not requiring them to resubmit these data to the StreamNet database.

1. CRITFC Inter Tribal Monitoring Data Project

StreamNet continues to work with CRITFC tribes and specifically with the CRITFC Inter-Tribal Monitoring Data (ITMD) project (BPA Project #2008-507-00) to integrate these two projects, along with the Columbia Basin Fish & Wildlife Library (BPA Project # 2008-505-00), to maximize data sharing. Much of the data flow during 2020-2021 from the tribes was through a StreamNet member state agency who collaborated with a tribe to collect and process data. Starting in late 2019 and early 2020, Nez Perce Tribe (NPT) and the YNF began to submit data to Coordinated Assessments, such as NOSA/escapement and Juvenile outmigrants. It is expected that other CRITFC tribes will be providing their data directly to StreamNet, as those tribes have developed the capability to share data with regional repositories.

The ITMD Project is the only lower Columbia data project that serves as a forum for CRITFC member tribes to coordinate and collaborate with each other as they develop best practices for data management strategies. ITMD Project members are data and GIS professionals who are partially funded by the ITMD Project and are positioned at each tribe. Similar to coordination work done through the StreamNet project, ITMD Project members coordinate with each other to leverage expertise and resources to develop centralized database systems (CDMSs or Yakama Nation's Information Management System/Status and Trends Annual Report-IMS/STAR), data management strategies, data flow pipelines between regional and tribal data repositories, and innovative data collection, storage, and access techniques. Collaboration occurs via monthly conference calls, educational webinars, and an annual workshop. The Project members participate in frequent smaller group meetings such as for CDMS/GitHub technical meet-up, and in the Indigenous Data Sovereignty work group. Many ITMD and tribal staff attend many regional coordination meetings for data management and sharing within

the Basin, but if tribal staff are not able to attend, the ITMD Project staff serves as liaison between regional agencies, entities, and the tribal data professionals regarding data management and data product requirements. ITMD Project staff participate in meetings in the Columbia Basin including Coordinated Assessments Workshops and Working Groups, StreamNet Executive Committee, StreamNet Steering Committee, CAP Core Team, StreamNet Technical Team, CAP DDT, and PNAMP Fish Monitoring Workgroup meetings that are directly involved in improving Coordinated Assessments. More information about the ITMD Project is available in their Five-Year Strategic Plan: 2022-2026[xxiii]

2. Fish Passage Center's Comparative Survival Study Database

The Fish Passage Center (FPC, 1994-033-00) provides technical analysis, data summaries, and graphic representations for the state, federal and tribal fishery managers' use in developing their recommendations for fish passage management to the federal operators and regulators. One of the FPC's responsibilities includes management, implementation, and assistance in the analysis of the Comparative Survival Study (CSS; Project 1996-202-00) as directed by the Comparative Survival Study Oversight Committee. StreamNet leverages the FPC database to populate the Smolt to Adult Returns (SARs) population high level indicators in the CAX database and provides the URL to the supporting documentation describing the monitoring and analytical methods. StreamNet staff and FPC staff collaborate to ensure that the CSS data are appropriately assigned to the correct CAX populations because this involves deconstructing the annual CSS fish groups and aggregates back to the individual populations.

CRITFC staff worked with StreamNet staff to identify populations so that the CSS SARs for Chinook and steelhead can be submitted to the CAX. To work out an acceptable way to submit these to the StreamNet/CAX system, StreamNet staff has defined 'superpopulations', which are aggregates of populations. These SARs are now updated annually by StreamNet staff who access the FPC database, convert the FPC data into CAP format, and upload these into the CAX.

3. US. Fish and Wildlife Service Database

The USFWS used to receive funds from the StreamNet Project prior to 2018. In calendar year 2018, BPA and the USFWS reached agreement on funding the USFWS's previous StreamNet activities directly. USFWS has active members of the StreamNet Steering Committee and Executive Committee.

USFWS staff with the Fish and Aquatic Conservation Program in Oregon, Washington, and Idaho collect data at 14 National Fish Hatcheries (NFHs). Those data are currently stored in different databases that possess different structures USFWS staff in the Pacific Northwest are in the process of identifying a strategy that will improve the efficiency of managing those data, lead to the standardization of those data, and substantially improve the ability to share USFWS NFH data with StreamNet partners in a timelier fashion. The NFHs in Idaho will continue to use the FINS database.

V. Results – Improved Data Sharing and Access

Work Elements:	159: Support transfer of data into secure and accessible repositories 161: Data – dissemination 189: Coordination

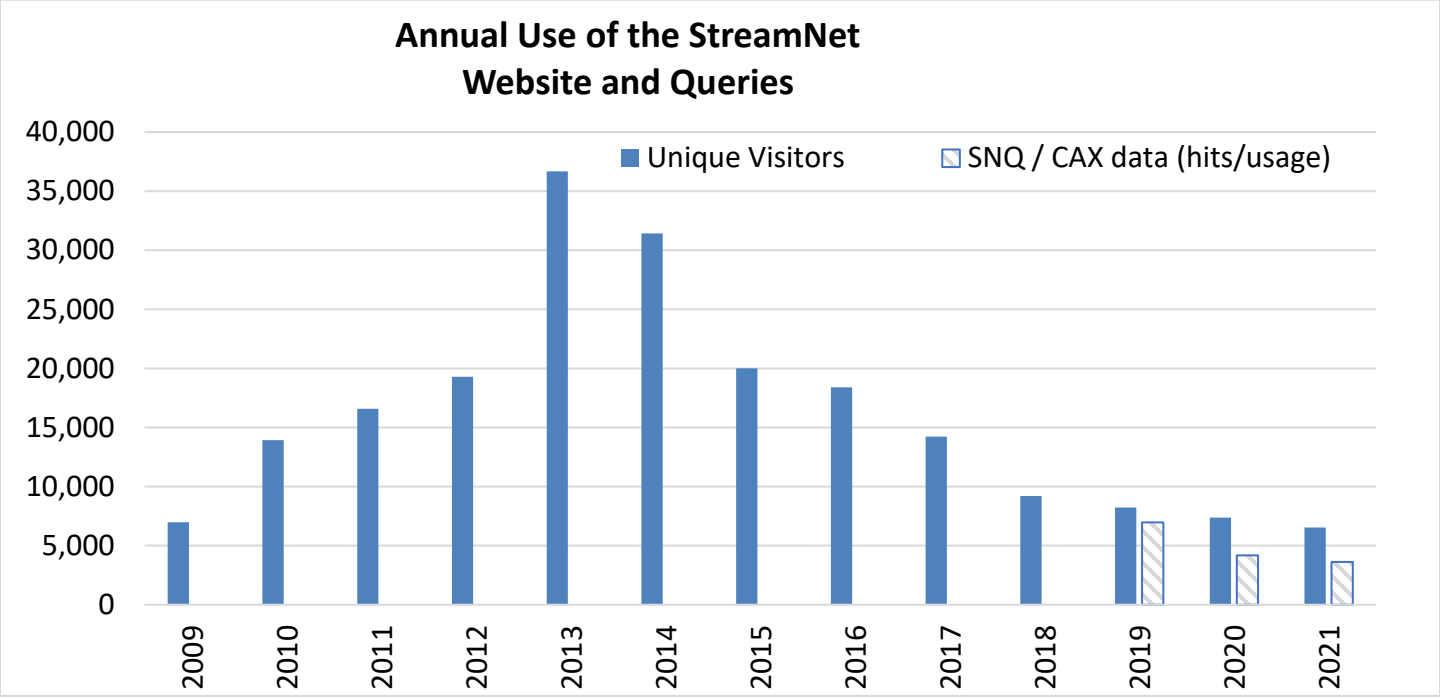
StreamNet continued to acquire fish data from our four partner state fish and wildlife agencies (ODFW, WDFW, IDFG, and MFWP), our tribal partner (Colville Tribes). StreamNet continues to work with other data providers, including 1 federal agency (USFWS for data from the national fish hatcheries), the Shoshone-Bannock Tribes, a tribal consortium (CRITFC[1]), and the Fish passage Center (FPC), to facilitate access to population-level indicator data for the CAP Fish HLIs.

[1] CRITFC member tribes consists of Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Nation.

The Shoshone-Bannock Tribes successfully submitted data to the CAP Fish HLIs for the first time in 2020. These data have been collected and analyzed using a variety of funding processes and sources, only some of which are funded through BPA or other federal programs. As a regional data coordinator, StreamNet strives to provide access to all data of a given type from all sources. The BPA statement of work and work element summary that guide the work performed by StreamNet PSMFC and its partners (The Colville Tribes, IDFG, MFWP, ODFW, and WDFW) are provided in Appendix D.

Data submitted to StreamNet are available through multiple web-based data query tools (tabular and map based) as well as multiple data download formats. All data are available to the public, either directly from the web tools or after requesting access through the StreamNet API as recommended by programming best practices. Some sensitive data, such as specific spawning locations, may be obscured by the submitting agency to protect the resource. In such cases, the agency will typically generalize locations to a larger map section (show a large stream section rather than a point). Users accessing data through the CAP Fish HLIs query system are also required to agree to the End User License Agreement (EULA; renamed in 2022 to Data User Agreement to accurately fit the content) at the request of data submitting agencies.

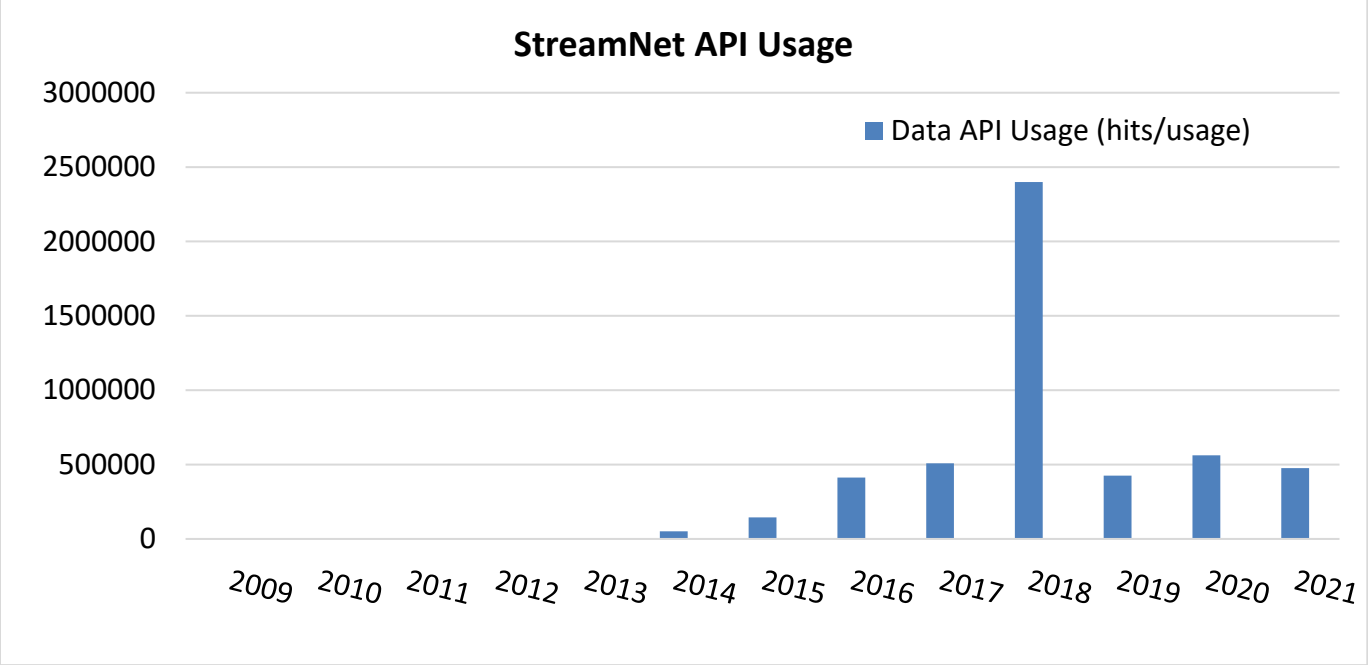
Use of the API to submit and access data on the StreamNet database has continued to increase since the API became available in 2014 (Figure 8a). Recent improvements to the API have led to more partners using the API instead of the StreamNet website. One recent improvement to the API that was completed in 2018 allows data submitters to self-validate their data during the submittal process instead of using the website to download and verify their data. Thus, as the API has increased in use, there has been a decrease in StreamNet website user visits (Figure 8b), because the API is addressing more of the data submitters'/users' needs. (Figure 8a and 8b; see Appendix A for previous years).



(8a)

Note: data for the SNQ and CAX query system usage are only available for 2019 and onwards

Figure 8a: *illustrates the number of times during 2021 that StreamNet's Fish Monitoring Data query (trends) and the CAP Fish HLIs query (CAX) systems (no pre-2019 data available) were used to access data as well as the total number of unique visitors to the StreamNet website. The decrease in website access reflects the shift to using the API for data exchange and verifications.*



(8b)

Note: The increase in API usage shown for 2018 corresponds to new partners beginning to use the API as well as a new version of the API being released that allowed individual agencies/tribes to self-validate their data submission using the API prior to submitting their data to the StreamNet database. The self-validation function of the new version of the API in 2018 improved the quality of data submitted to the database. In 2021 the API use is reflective of a more normal level of use.

Figure 8b: *shows the annual count of times the API was used to submit/use data (2014-2021). Although the y-axis scale differs between 8(a) and (b) one can see that as the use of StreamNet API (8a) increased over time there was a corresponding decrease in the query systems (8b).*

The refreshed StreamNet website reorganized the content by broad categories so that data and tools were more easily located by the user. Per 2021 analytics of the new website in terms of how users came to the website, the majority of users arriving at the website by either using a search engine (organic) or by the user entering the URL of the website (direct, Figure 8c). The webpages most viewed by all users (including repeat users) are the Home page and the Fish Monitoring Data page (Figure 8d).

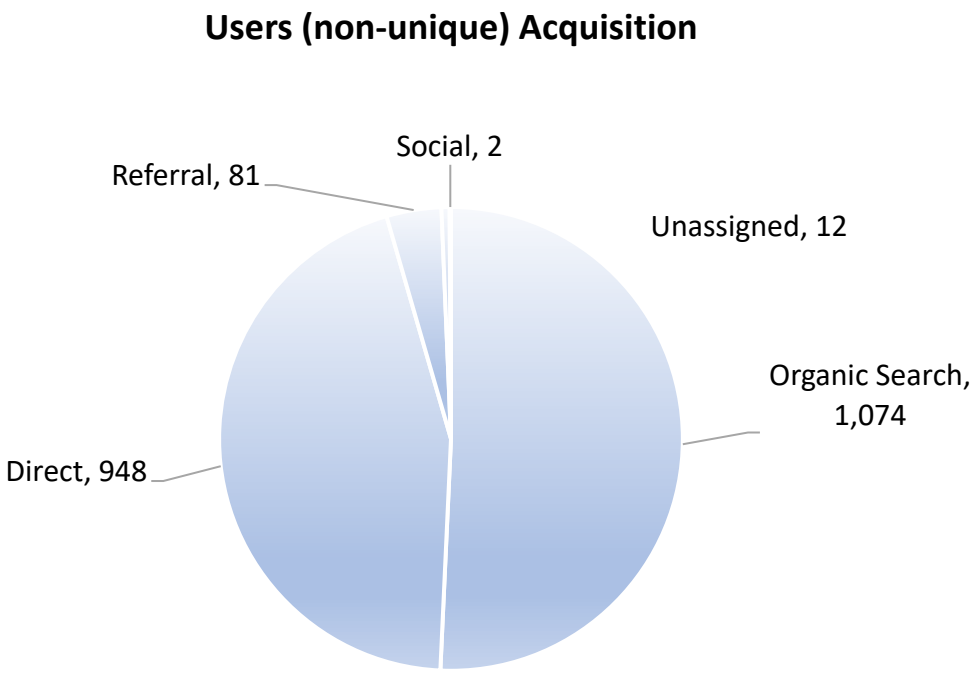


Figure 8c: The StreamNet website was acquired by users mostly by organic search and by direct URL. Direct acquisition channel is a simple acquisition channel that involves the user entering the website's URL. Organic refers to traffic from search engine results that is earned, not paid. Referral involves a user clicking on a link for your website when they are on another website. Social is any kind of traffic that you receive from social media platforms. Other is traffic that doesn't fit the above 4 acquisition channels.

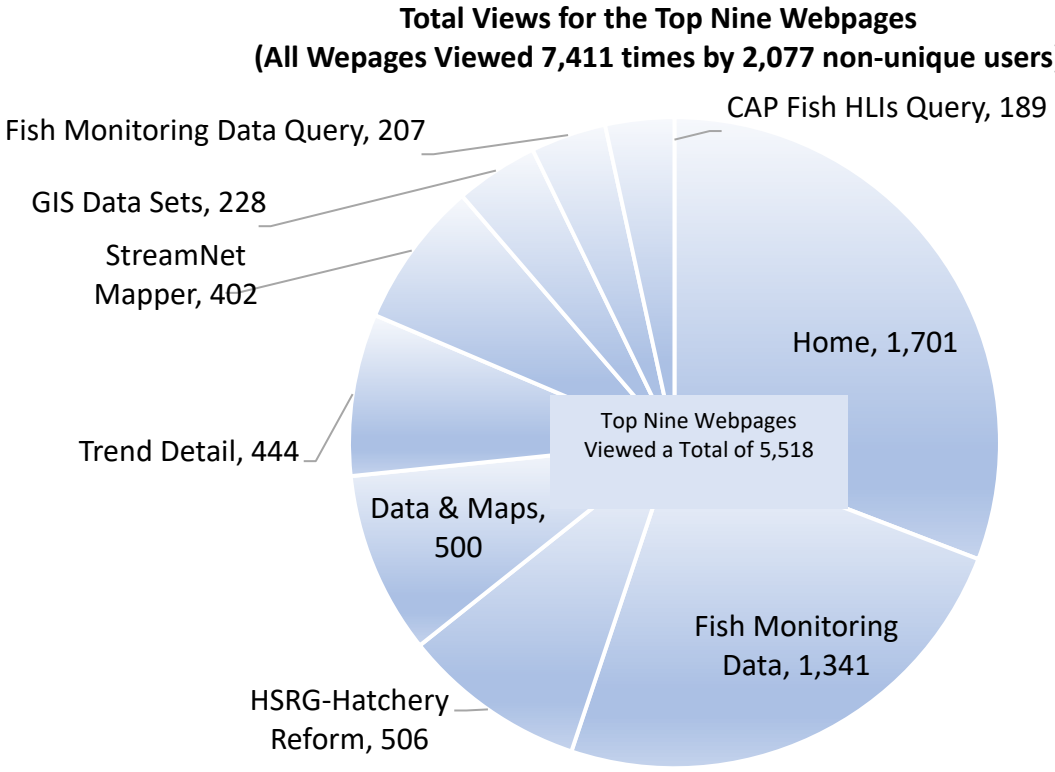


Figure 8d: The new StreamNet website was viewed 7,411 times by 2,077 non-unique users. Of this 7,411 views, 5,518 views were directed to the above top nine webapges.

StreamNet GIS data are published as downloadable spatial data and as publicly accessible web map services. StreamNet GIS data set downloads account for about 30% to 48% of all GIS data sets downloaded from PSMFC (Figure 9). In general, those who download StreamNet's GIS data are associated with IP addresses from academia, agencies, non-profits, private consultants, and the general public (Figure 9). Use of StreamNet's interactive mapping applications has gradually increased over time, with the StreamNet Mapper proving to be the most frequently used (Figure 10).

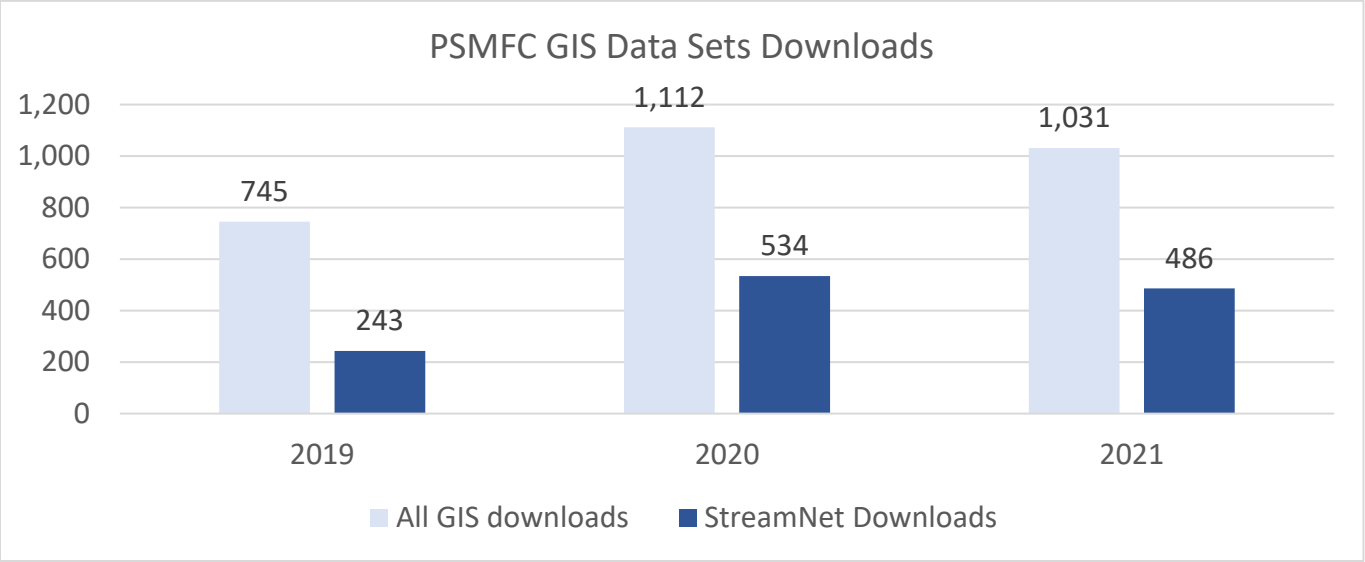


Figure 7 StreamNet's GIS data sets represented about 47% of all GIS data sets downloaded from PSMFC in 2021.

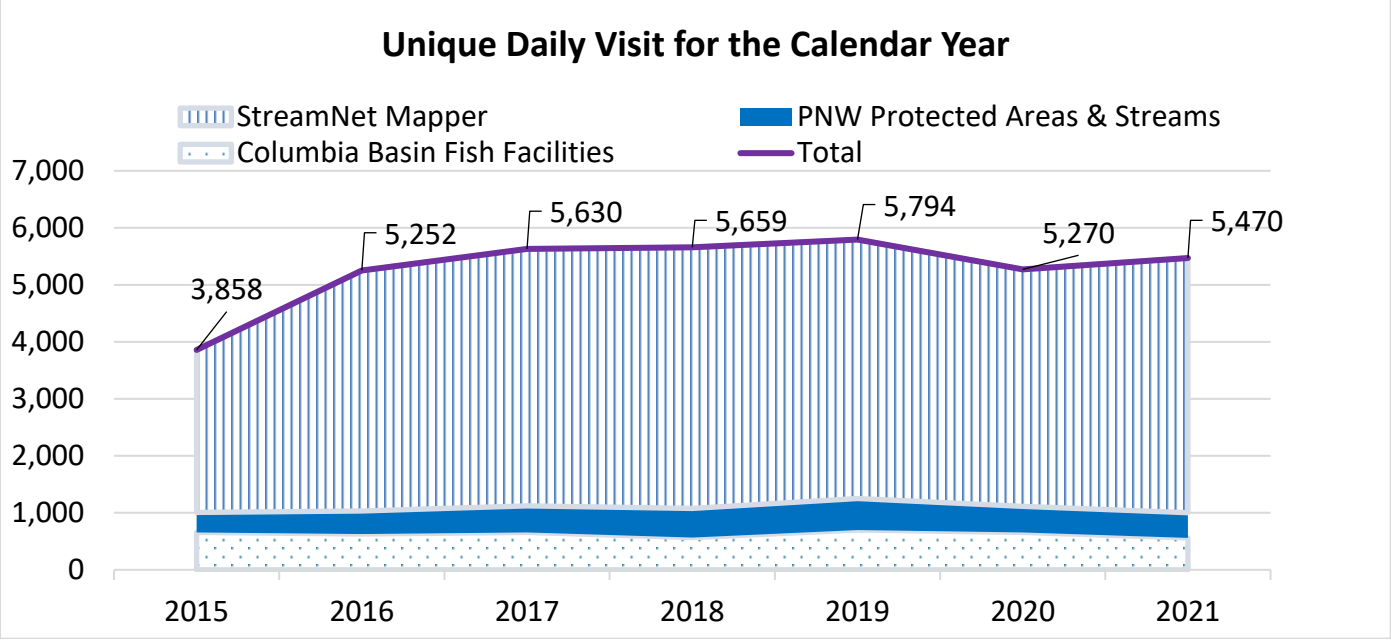


Figure 8: Use of StreamNet's online mapping applications has gradually increased over time, with the total annual unique daily user sessions increasing between 2015 and 2021. A unique daily visit is sometimes referred to as a 'session' in web analytics terms. All StreamNet web mapping applications that are currently in use were published on the ArcGIS platform as of 3/1/2015, and thus the data during the 2015 to 2021 period uses comparable web analytics for reporting unique users. Web analytics for prior applications are different in nature and are not comparable. Note that usage reports generated from ArcGIS Online, 2015 statistics are not for the entire year (3/1/2015 - 12/31/2015).

A. StreamNet Data Stewards within Agencies – Enhancing Data Access

Work Elements:	159: Support transfer of data into secure and accessible repositories 160 CAP Data – DES and database 159: CAP Data – compile data 160: CAP Data -automated data exchange 159 Compile high priority traditional StreamNet data 160 Enhance data efficiency – system development

StreamNet continued to coordinate within partner state agencies and the Colville Tribe as they improve and expand their systems to support broader regional data sharing. The StreamNet subprojects in the state agencies and the Colville Tribe all contributed to development or improvement of their organizations' data storage systems in 2021. StreamNet-funded data stewards provide significant technical database and data transfer support services to state fish and wildlife agencies. This includes database system development, data translation, serving external data requests, and data capture routine development. The focus this calendar year continued to be on increasing the speed and efficiency of data conversion to the regional standard StreamNet DES, and then submission of data and related GIS information to StreamNet. Because each partner uses different approaches to their data management, actions taken by the subprojects differ accordingly.

In addition to the StreamNet funded data stewards, StreamNet supports advancing data management and sharing capacity with other data providing tribes to improve their internal data flow and support regional needs. During CY2021 StreamNet provided funding to contribute to advancing tribal data management and sharing capacity to the Shoshone Bannock Tribes. By the end of CY2021 the Shoshone Bannock Tribes successfully submitted to the CAP Fish HLI. StreamNet secured additional funding towards the end of CY2021 from an internal IJFA grant that is continuing to support the Shoshone Bannock Tribes during CY2022.

Working with the StreamNet funded data stewards, PSMFC StreamNet staff completed several tasks to inform development of a QA/QC plan and implementation of a pilot QC visual check process in CY2022. Early in 2021 an independent party was tasked with reviewing a subset of records in the CAP FISH HLIS to identify QA/QC concerns. The outcome of this work informed a questionnaire that was used to obtain clarification and input from both data providers (current / past) and data consumers. Combined, the information from the independent review, input from the video conference discussions on the standardized questions, and current QA/QC procedures used by data providers and PSMFC StreamNet, were used to draft a QA/QC plan (final 2022 version: StreamNet Quality Assurance and Quality Control Plan version February 7, 2022) and pilot implementation of the visual QC process (final 2022 version: 2022 Implementation Plan for Pilot Focused on Phase 2 QC - Visual Checks, version February 7, 2022). PSMFC StreamNet Steering Committee and data stewards reviewed and provided input which informed the final versions produced in CY22.

As improvements are made within data providers' data flow and in their exchange with StreamNet, more have either achieved or are making substantial progress towards submitting data directly into StreamNet through automated means. PSMFC StreamNet continues to encourage integration of the StreamNet API and data validation system into agency processes and programs. ODFW hosted a presentation of how they have done this and pulled these efficiencies into their systems. As efficiencies are gained through implementation of a streamlined data flow, data stewards should be able to shift to additional regionally important data categories or data sets.

1. The Confederated Tribes of the Colville Reservation

In 2021 the Data Steward maintained and updated the Okanogan Basin Monitoring and Evaluation Program (OBMEP) database, and further refined the pipeline calculating juvenile population estimates. By automating QA/QC processes and calculations, the new system is both more efficient (e.g., reducing the workload on biologists) and improves the quality of data by decreasing the opportunity for human error. Adding automation to the Presmolt Abundance pipeline produced increases in both the quality of the data and efficiencies. Automation also provided the opportunity to explicitly document the assumptions made when collecting the data and performing population estimate calculations. The data steward will continue efforts in automating as many of the 6 HLIs currently reported.

The Colville Tribes also reviewed and provided comments to the proposed procedures included in the 2022 QA/QC plan and will implement them.

2. Idaho Department of Fish and Game

The IDFG StreamNet subproject continued assistance with development of the Idaho Fish and Wildlife Information System (IFWIS), and was able to validate and upload data directly from the system in two-steps in order to simplify standardization of the data and speed submission to the StreamNet database, saving significant time from the previous approach.

IDFG StreamNet staff assisted BPA project biologists to identify and prioritize data available for entry into IFWIS, or an alternative accessible, backed up information system. IDFG StreamNet staff participated in meetings of theCAP planning and development groups. They provided input prioritizing indicators, metrics, and metadata. They coordinated with development between the proposed DES, the prototype database and application, and the web service data exchange. Multiple sources ofCAP data were consolidated into complete, standardized workbooks on a secure and backed up network drive. SQL queries were written to extract and transform those data into the draft DES for natural origin spawner abundance (NOSA), natural origin juvenile abundance (NOJA), and recruits per spawner (RperS). IDFG staff wrote web service routines to enable the transfer ofCAP data to PSMFC and NOAA databases. Those services were successfully tested and the results shared with theCAP exchange Team. After appending into the IFWISCAP database, those data were then transferred to the PSMFCCAP database. IDFG StreamNet staff compiled and submitted hatchery return data for Chinook, steelhead, sockeye, and Chinook salmon index redd counts.

IDFG StreamNet Staff reviewed and approved the manual QAQC protocols in the QA/QC plan and will implement them this CY2022.

3. Montana Department of Fish, Wildlife & Parks

StreamNet staff continued to assist in converting data files residing with individual biologists to file types that can be uploaded into the centralized database. This has eliminated the need for biologists or technicians to spend time hand entering historic data into the system. StreamNet staff are continuing to be a resource to biologists as well as advocates of biologists entering their data into the system. The database currently houses over 5.3 million raw fish records statewide. In 2021, 1290 fish survey locations were added in the Columbia Basin resulting in 154,152 individual fish records. Statewide, 3039 new survey locations were added resulting in 424,314 individual raw fish records being added to the database. In the Columbia Basin 140 redd counts at 140 locations, which identified 1192 redds, were added to the database during 2021. All relevant data were submitted to StreamNet databases or the Data Store.

Staff continue work on resident fish data with an eye toward potential resident fish DES' in the future. MFWP StreamNet staff continued to be involved in the Yellowstone Cutthroat Trout range-wide assessment. During the past calendar year MFWP staff coordinated updates to the database with biologists throughout the sub-species' native range. Discussions were held related to integrating the Yellowstone Cutthroat Trout native trout assessment into the Inland Cutthroat Protocol (ICP) data system. The MFWP native species coordinator position remains vacant, leaving the status of this project in a state of uncertainty. There is potential to revive this project in the future though it is dependent on range-wide priorities and funding.

Large agency projects have been consuming MFWP's Application Development and Projects Bureau staff time. These staff are not funded with StreamNet dollars. This resulted in no opportunity for new development work on the internal database during 2021. Instead time was dedicated to bug and minor fixes to existing systems.

MFWP StreamNet staff reviewed and provided comments to proposed QAQC protocols in the QA/QC plan and will implement them.

4. Oregon Department of Fish and Wildlife

ODFW StreamNet performed routine maintenance and updates on existing core databases. In addition, efforts to improve overall agency data storage and flow from the field continued by ongoing development and maintenance of data management and sharing systems. Once created, ODFW's new resource information system will significantly advance the agency in these areas of data management and increase data flow and sharing efficiency. In the meantime, we continue to encourage the implementation of data management best practices related to standards in field and file names, metadata, folder organization, data sharing and non-disclosure agreements and data management plans, as time and resources allow, particularly as they relate to priorityCAP and Recovery Planning efforts.

StreamNet staff finalized the new web application for Coordinated Assessments data that are entered directly into the ODFW SQL server database and include automated processes for validation and submission to the StreamNet API. The Coordinated Assessments Validation, Evaluation and Submission (CAVES) internal web application was completed and became fully operational for all-natural origin high-level indicator tables in late 2020 and was utilized to enter all data reported in 2021. Additional updates and efficiencies were incorporated into the system in 2021.

StreamNet staff spent considerable time designing and testing the new web application for Fish Monitoring Data (FMD) (trends) to be entered directly into the ODFW Fish Monitoring – Data Distribution SQL server database and to automate the processes for validation and submission to the StreamNet API. In 2021, the Trend Evaluation, Validation, and Submission (TEVaS) internal web application became fully operational for all Location, Reference, Trend, and EscData tables. In 2022, staff anticipate completing the remaining tables for Age and Hatchery Returns and providing additional updates and improved efficiencies to the system.

The ODFW Data Clearinghouse (DC), which makes Oregon's natural resource information more secure and accessible by providing a centralized storage and distribution service, was maintained and updated. During the year, 54 new and existing DC records were created and updated. In 2021, using partial funding from other sources, we continued an effort to improve the accuracy of records from the old ODFW Library electronic bibliography in the DC to preserve this historic record and provide access to digital copies of ODFW documents.

Other internal and external websites were updated and maintained throughout the year including updating URLs and web content and adding new projects to the NRIMP data resources and information pages and the Corvallis Research Lab website.

Oregon StreamNet staff continued a partnership with ODFW Recovery Planning staff throughout the year to coordinate data standardization, DES updates, flow configuration and data sharing documents, metadata and efficient exchange ofCAP and Recovery data to StreamNet and the ODFW Salmon & Steelhead Recovery Tracker. In 2021, with other funding, Oregon updated and submitted coastal coho natural origin spawner abundance and adult recruits per spawner estimates to StreamNet. Recovery populations in the Lower Columbia, Middle Columbia, Snake River and Coast coho (other funding) data were also processed and uploaded to the ODFW Recovery Tracker public website (http://odfwrecoverytracker.org/).

StreamNet supported the proposal to develop the Oregon Salmon Recovery Tracker website from its inception in 2010 and took over hosting the system upon its completion. Oregon StreamNet continues to maintain the system, which

allows users to explore and download information related to salmon conservation and recovery in Oregon. The system was targeted to undergo major technical updates in 2020 but has been postponed until sometime in 2022; therefore, the public website may be unavailable at times throughout the year.

In preparation for the HCAX data exchange standard effort, ODFW staff created an inventory of the location, attributes, and disposition of potentially available indicator and metric data of hatchery salmonid population health. For each salmonid hatchery program within the Columbia River Basin, we addressed the following questions with the inventory:

1. What data has ODFW collected related to high-level indicators of hatchery salmonid population health?
2. Does the data fit the anticipated draft terms, definitions, and look-up lists for a Hatchery Data Exchange Standard (DES)?
3. Is the data published, and if so, where?
4. What available information could contribute to current and future discussions of high-level adult abundance indicators and juvenile production metrics?

Staff summarized the gap between available data and the anticipated DES to assess the extent to which the data for each indicator are complete, accessible, and published for each ODFW hatchery program in the Columbia Basin.

Stakeholders began to utilize the Fish Habitat Distribution (FHD) Data Change Request (DCR) form web application developed by ODFW Natural Resource Information Management Program GIS staff. This form enables FHD stakeholders to submit proposed changes to the FHD data and to improve upon its accuracy and completeness. Keeping this information updated is crucial to the quality of Oregon FHD data submitted to StreamNet.

Oregon StreamNet's server infrastructure was upgraded to support the new TEVaS web application for submitting Fish Monitoring Data (FMD) (trends). In addition, server infrastructure continued to be monitored and upgraded where necessary for long-term support. Software tools used for development were upgraded to their most recent versions. Capacity of the infrastructure is currently adequate at least through 2023.

Conducted thorough reviews of and provided edits to the draft StreamNet QA/QC Quality Assurance and Quality Control Plan document. Also contributed information regarding ODFW procedures, visualization, and metadata.

5. Washington Department of Fish and Wildlife

The WDFW StreamNet subproject coordinated with the Biological Data Systems Program in WDFW on ongoing development of the EPA funded Juvenile Migrant Exchange and the Adult Fish Exchange data delivery system, and developing services which will to serve data to StreamNet in the future. WDFW also secured a new EPA Exchange Network grant to facilitate sharing of hatchery and harvest data between tribes and WDFW.

WDFW continued development of an internal CAP reporting database and participated in all DES development and technical meetings. Particular attention was paid to integrating new NOSA and SAR data where existing and we began integration of Puget Sound NOSA and escapement data at NOAA's request. In addition, to CAP systems development, WDFW StreamNet worked with agency HQ staff to implement mobile data collection platforms, staging databases and automated transfer mechanisms for sport and commercial, adult survey, and juvenile data systems. Ultimately these inform theCAP exchange as well as other consumers like WA Governors Salmon Recovery Office and tribal co-managers. WDFW continued hydrography mapping to NHD framework. Final adoption of WDFW's draft new stream layer has repeatedly been delayed. When it is adopted, the StreamNet funded Location Manager will fully scope the layer and draft a proposal to integrate mixed scale hydro (MSH) with the new line work.

WDFW continues to communicate with project sponsors, review data storage, and offer assistance in submitting data sets to secure accessible repositories. StreamNet's request to submit geometry instead of event data also prompted work to make basic location data more integral and available toCAP and traditional StreamNet data compilers.

WDFW StreamNet Staff reviewed and provided comments to proposed QAQC protocols in the QA/QC Plan and will implement them.

B. Data Store - Archived Data Sets and Information

Work Elements:	159: Support transfer of data into secure and accessible repositories 161: Data - dissemination

The StreamNet Data Store serves as the default database for numerous fish population metrics such as fish habitat, and abundance. As recommended in the 2013 BPA Data Management Strategy[2] the Data Store can function as the interim data storage location during the development of databases for new data sets, such as fish species genetics, blood work, and enzyme analysis. The Data Store also supports the Data Management principles of the 2014 Columbia River Basin Fish and Wildlife Program's Adaptive Management[3]. PSMFC also physically hosts other data storage repositories as a cooperator with state and tribal agencies.

Data Store – StreamNet staff continued to provide support by phone and email for data contributors to the Data Store, including BPA and non-BPA funded contributors. As described in the 2013 BPA Data Management Strategy, the StreamNet Data Store is a repository for any BPA projects where a BPA recognized environmental data repository is not available. BPA relies on the StreamNet Data Store as a core data repository to secure public access to data where not provided in an alternative, publicly accessible system. When a BPA project data set is uploaded to the Data Store, the project number allows pre-populating project attributes housed in the BPA database system (cbfish.org) such as contact information.

Subbasin Plans – Documents and data continued to be archived at StreamNet and remain accessible to the public on StreamNet's website.

Protected Areas – Documents and data continued to be archived at StreamNet and remain accessible to the public on StreamNet's website and on the Protected Areas mapper.

HEP – Data and other resources from the HEP project are archived on StreamNet, at the request of BPA and the NPCC. The data and associated materials from this past program remain accessible for regional use[xxiv].

HSRG – StreamNet staff completed consolidation and integration of the Hatchery Reform Project website content, tools and documents into the new StreamNet website. The Library assisted in the organization and access of documents to ensure copyright rules are followed. During CY2021 the Hatchery Reform website was taken offline and the StreamNet Website will maintain access to the content in a similar fashion as done for HEP, Protected Areas, and Subbasin Plans. The NPCC 2014 Program refers to the HSRG recommendations and thus keeping this content publicly accessible supports the Program's implementation. NOAA's Hatchery Genetic Management Plan (HGMP) development was informed by the HSRG effort, thus maintenance of the HSRG website and documents is needed to provide the details and rationale used in developing the HGMP[xxv].

[2] Bonneville Power Administration. 2013. A Framework for the Fish and Wildlife Program Data Management: Issues and Policy Direction for Development of a Data Management Strategy and Action Plan. Bonneville Power Administration, Fish and Wildlife Policy and Planning Division, June 04, 2013.

[3] Northwest Power and Conservation Council. 2014.2014/2020 Columbia River Basin Fish and Wildlife Program. Council Document 2014-12, revised 2020. Portland, Oregon. https://www.nwcouncil.org/sites/default/files/2014-12_1.pdf

Fifteen new data sets were added to the StreamNet Data Store, and one was updated, during calendar year 2021. The following organizations provided the data sets to the StreamNet Data Store: Montana Fish, Wildlife & Parks (4 data sets); Nez Perce Tribe (1 data set); Shoshone-Bannock Tribes (5 data sets); US Geological Survey (5 data sets); Yakama Nation (1 data set). Some of the BPA funded CHaMP project data sets were added in CY2020 and we anticipate additional data sets to be submitted over time. Currently, the aggregated CHaMP data based on "Channel Units" (Polygon) and "Site" (Point) summary metrics are now available at the DataStore link for 2011-2017. The export of the CHaMP topographic data sets, temperature data, and photos are still pending a BPA decision on how to manage those data files into the future. Given the inclusion of the MAFAC CBPTF salmon and steelhead goals and objectives as a Strategy Performance Indicator in the NPCC 2020 Addendum, it is anticipated that there may be a need to support compilation of MAFAC CBPTF data with managers and to secure it in the Data Store in 2022.

In general, StreamNet partners encourage BPA project sponsors to secure data in repositories, including the Data Store.

1. The Confederated Tribes of the Colville Reservation

The Colville Tribes continues to communicate with Project Sponsors, inventory data storage and aid in securing data in accessible repositories.

2. Idaho Department of Fish and Game

IDFG StreamNet supported state and tribal project sponsors in the transfer of data to secure and accessible repositories.

3. Montana Department of Fish, Wildlife & Parks

MFWP StreamNet continued to communicate with and support sponsors in the transfer of data to secure and accessible repositories. In addition, staff submitted data types without a formal DES such as the Yellowstone Cutthroat Trout Range-Wide assessment, population surveys, and genetic sample information, to the StreamNet Data Store as independent data sets.

4. Oregon Department of Fish and Wildlife

ODFW StreamNet staff continued to assist and encourage BPA funded, ODFW, and local project sponsors to manage or locate their data within secure and accessible data repositories.

5. Washington Department of Fish and Wildlife

WDFW continued to communicate with project sponsors, review data storage and offer assistance to secure accessible repositories.

C. Fish Monitoring Data (time series trends)

Work Elements:	B 159: Support transfer of data into secure and accessible repositories G. 161: Data - dissemination H. 159 Compile high priority traditional StreamNet data

StreamNet's Fish Monitoring Data new tabular query released in 2020 was designed so that users can quickly find and access the data they are looking for by using filters. Once located, the users can view the table of data along with metadata and a map of the monitoring location. The user can also choose to download these data into an Excel spreadsheet file or copy the URL to easy reference and share these data with others. The Fish Monitoring Data tabular query pulls data using the API and was designed to better integrate with the StreamNet website. Improvements to the Fish Monitoring Data query was initiated in 2021 to improve access to age data. We are currently looking at adding several georeferencing filters to the Fish Monitoring Data query.

Updating trend data sets was prioritized by the StreamNet Executive Committee in 2018, with emphasis on trends supporting CAP Fish HLIs and NPCC reporting tools. With the recently adopted 2020 Addendum to the Columbia River Basin Fish and Wildlife Program, it is anticipated that the Fish Monitoring Data query will be supporting specific data needs for the NPCC's Program Tracker, with initial interest from the NPCC during 2021 being focused on accessing Bull Trout redd counts.

The StreamNet DES, which contains data submission standards for fish monitoring data, was updated in 2020. Validation rules were updated to implement those changes. The 2020 version of the DES continued to be used in 2021. Validation rules were not updated, because, due to no DES changes there was no need for validation rule changes. Multiple API programming updates were made to accommodate agency requests for API interaction improvements.

A summary of the Fish Monitoring Data trends data sets updated in CY2021 is provided in the below table (Table 7) along with a highlight of the number of records associated with CAP Fish HLIs (Table 8).

Table 7: Summary of the number of trends data sets and Protected Areas records in the StreamNet database, by data category. This summary represents all data submitted by the end of calendar year 2021 from any geographic areas in Montana, Idaho, Washington, and Oregon (not limited to the Columbia River basin). The number of trends in 2021 equaled 18,152 data sets consisting of 190,746 observations. The number of Protected Areas records has been stable since the NPCC last amended the Protected Areas in 1992. Note: beginning in 2018, fish distribution, barriers, dams, and hatcheries are being managed as GIS layers rather than as tables in a database.

Data Category	2021 Available Data (2020 data count)	2021 Year Range (2020 range)	2021 Observation (2020 observations)
Redd counts	5,049 Trends (4,970 Trends)	1901 - 2021 (1901 - 2020)	55,788 (54,819)
Fish counts	442 Trends (438 Trends)	1956 - 2020 (1956 - 2019)	2,491 (2,331)
Spawner counts	5,112 Trends (5,153 Trends)	1944 - 2021 (1944 - 2019)	39,216 (40,205)
Spawning population estimates	3,116 Trends (3,173 Trends)	1901 - 2021 (1901 - 2020)	20,964 (22,400)
Dam / weir counts	515 Trends (508 Trends)	1926 - 2021 (1926 - 2020)	14,516 (14,201)
Fish abundance estimates	126 Trends (128 Trends)	1976 - 2020 (1976 - 2019)	1,215 (1,218)
Hatchery returns	1,087 Trends (1,082 Trends)	1906 - 2021 (1906 - 2020)	10,534 (10,355)
Freshwater harvest	2,705 Trends (2,708 Trends)	1894 - 2020 (1894 - 2015)	46,022 (45,661)
Protected Areas	32,997 Records	n/a	n/a

Table 8: Summary of Coordinated Assessments Partnership populations with associated time series data sets in the Fish Monitoring Data (trends). First column is population grouping; second column is the type of data; third column is number of extant populations (includes superpopulations) with associated time series data sets in the Fish Monitoring Data (trends) for the population group and data category indicated; fourth column is the year range for the trends; fifth column is the number of records of data in the group. Fish Monitoring Data time series data (Trends) data are generally at a smaller geographic scale than populations and are generally indexes of abundance.

Population Group*	Data Category	Pops (2020 value)	Years (2020 range)	Records (2020 value)
Priority	Redd counts	42 (40)	1949 - 2021 (1949 - 2020)	13,286 (12,611)
	Fish counts	15 (13)	1994 - 2020 (1994 - 2019)	960 (836)
	Spawner counts	14 (14)	1985 - 2020 (1985 – 2019)	4,745 (4,533)
	Spawning population estimates	8 (8)	1954 - 2020 (1954 – 2019)	1,324 (1,220)
	Dam / weir counts	9 (8)	1963 - 2021 (1963 - 2020)	421 (405)
	Fish abundance estimates	10 (10)	1996 - 2020 (1996 - 2019)	351 (284)
	Hatchery returns	13 (13)	1978 - 2021 (1978 - 2020)	355 (266)
	Freshwater harvest	1 (1)	1996 - 2020 (1992 - 2011)	50 (57)
Columbia River Basin	Redd counts	78 (74)	1949 - 2021 (1949 - 2020)	18,876 (17,716)
	Fish counts	22 (20)	1994 - 2020 (1994 - 2019)	1,769 (1,583)
	Spawner counts	49 (48)	1948 - 2021 (1948 - 2019)	11,220 (10,336)
	Spawning population estimates	43 (41)	1944 - 2020 (1944 - 2019)	3,945 (3,197)
	Dam / weir counts	28 (26)	1950 - 2021 (1950 - 2020)	2,251 (2,110)
	Fish abundance estimates	13 (13)	1996 - 2020 (1996 - 2019)	492 (384)
	Hatchery returns	31 (31)	1942 - 2021 (1942 - 2020)	637 (537)
	Freshwater harvest	10 (9)	1961 - 2020 (1961 - 2011)	377 (222)
Oregon Coast	Spawner counts	19 (NA)	1950-2020 (NA)	4,592 (NA)
	Dam / weir counts	2 (1)	1946 - 2021 (1946 - 2018)	137 (118)
Puget Sound	Spawner counts	0 (22)	-- (1965 - 2019)	0 (1,774)
	Spawning population estimates	0 (25)	-- (1952 - 2020)	0 (1,556)
	Dam / weir counts	0 (1)	-- (1978 - 2019)	0 (64)
	Fish abundance estimates	0 (1)	-- (1985 - 2017)	0 (39)

* *Priority = The 68 BPA Tier 1 and Tier 2 priority populations identified during 2015 by BPA to support their reporting requirements under the Federal Columbia River Power System Biological Opinion.*

Columbia River Basin = All population within the Columbia Basin, including the Priority populations.
Oregon Coast = Populations in Oregon coast river systems draining directly into the Pacific Ocean. These are outside the Columbia River Basin and are compiled using alternative funding.
Puget Sound = Populations in Washington draining into Puget Sound / Strait of Juan de Fuca. These are outside the Columbia River Basin. Data sets were removed in 2021 pending further discussion between WDFW and Puget Sound tribes as to which data sets could be exchanged with StreamNet.

1. The Confederated Tribes of the Colville Reservation

The Colville Tribes compiled related trends data for Summer Chinook and uploaded them to StreamNet.

2. Idaho Department of Fish and Game

Idaho compiled and delivered fish data to StreamNet as time and staffing allowed. All metric data used to derive HLIs for CAX were uploaded to the StreamNet database (e.g. redd counts, hatchery returns, weir counts). The Chinook, steelhead, and sockeye salmon redd counts, weir counts, and hatchery returns were all updated.

3. Montana Department of Fish, Wildlife & Parks

MFWP compiled traditional StreamNet data throughout the year and exchanged trend data consisting of 140 redd counts at 140 locations in the Columbia Basin which identified 1192 redds. In addition, 16 references were added and fish population and genetic data were submitted to the StreamNet Data Store as independent data sets. Fish distribution was submitted as a spatial data set and the submission included all fish distribution records in the MFWP dataset to ensure StreamNet had a comprehensive and current dataset.

4. Oregon Department of Fish and Wildlife

Oregon utilized the Trend – Evaluation, Validation, and Submission (TEVaS) internal web application to exchange 47 new and 389 updates to existing traditional trends (including updating and adding 761 records for escapement data only) and 24 new and 174 updates to existing references via the StreamNet API. The submissions originated from BPA-funded projects, NPCC dashboards, opportunistic connections toCAP data, priority populations within the Columbia Basin and QC information from StreamNet staff. Staff submitted new trends for populations of Deschutes River fall Chinook redd counts and spawner abundance; Warm Springs River spring Chinook weir counts; and John Day River basin spring Chinook redd and carcass counts by individual stream and added additional years for long term trends in the Granite Creek system, within the John Day Basin.

5. Washington Department of Fish and Wildlife

WDFW updated Columbia Basin trend data in 2020 and HLIs for existing populations for Upper Columbia populations. Lower Columbia data submissions consisted of HLIs for existing populations, as well as continue to update corresponding trend data.

D. GIS Layers Updated Content and Access

PSMFC's GIS Center continues to support an integrated Columbia Basin fish facilities GIS data set. This effort eliminates multiple data sets with varying degrees of accuracy for location information, and establishes a common layer which is now shared between programs. This integrated GIS data set approach continued to support StreamNet and CAP during 2021. Since BPA reinstated funding to support PSMFC GIS center's StreamNet related task in 2020, the GIS center has engaged in FMWG task groups to advance development of polygons for focal species in a standardized manner that includes manager input, has assisted in improving connections between queries and GIS tools, and is working with StreamNet to improve use of PSMFC GIS layers in NPCC, PNAMP, and BPA tools. Some of the GIS funding provided by BPA is also being applied to scoping new data integration tools, such as a screw trap dashboard that pulls information from multiple regional data systems.

PSMFC StreamNet's Regional StreamNet also provides links to barrier data sets that partner agencies publish publicly. These barriers data are not currently being compiled and standardized regionally. The status of this information reflects that this data category has not been identified as a priority for standardized compilation and distribution at the regional level. However, StreamNet partners are often involved in maintaining these datasets to meet internal state mandates and to inform the fish distribution dataset. It is noteworthy to point out that although PSMFC's GIS Center receives new stream routes from partner agencies, StreamNet no longer maintains a coordinated regional hydrography layer.

StreamNet's regional GIS Datasets including fish distribution and population boundary datasets are packaged for download and made available on the project website. In addition, spatial data are published as web map services that can be queried and leveraged by project partners via PSMFC's ESRI REST Services endpoint (https://maps.psmfc.org/server/rest/services/StreamNet). In the coming year, we plan to improve the visibility of this resource and actively coordinate with BPA, NPCC and PNAMP to facilitate use.

The following regional GIS Datasets were updated based on partner data submissions.

- Fish Facilities (updated ~quarterly, mostly edits & additions from PTAGIS)
- Sampling locations/trends (updated as needed, attribute updates are processed via the StreamNet API)
- Fish Distribution (updated as needed, submission received from MFWP in late 2020 will be included in 2021 dataset.)
- Population Boundaries (updates/additions of non-TRT populations as needed, attribute updates are processed via the StreamNet/CAP API)

1. The Confederated Tribes of the Colville Reservation

GIS related tasks are not included in the StreamNet scope of work for the Colville Tribes, though information on the layout of the research (assessment units, reaches, sites) and location of fish facilities is available in an interactive map on the site okanoganmonitoring.org.

2. Idaho Department of Fish and Game

The generalized fish distribution layer was updated per new stream and lake survey data via direct GIS Exchange with StreamNet.

3. Montana Department of Fish, Wildlife & Parks

MFWP StreamNet staff manage the agency's fisheries spatial data and post GIS layers to the MFWP Open Data site where they are available for viewing and download. Spatial data sets include fish distribution, fish survey locations, genetic sample locations and hatchery locations. StreamNet staff under the guidance of PSMFC have begun to submit some data sets as spatial data sets rather than tabular.

In addition to managing StreamNet data sets as GIS layers, MFWP staff outside of StreamNet also make further fisheries GIS layers and products available to the public and partners such as aquatic invasive species information, fish stocking data, disease information and interactive maps, data dashboards and Story Maps.

4. Oregon Department of Fish and Wildlife

Staff coordinated with the ODFW GIS Coordinator to review and executed QAQC protocols on all Fish Monitoring Data (FMD) locations available for download in the StreamNet online query tool. Linear referencing was conducted on all points, lines, and supercode streams and was submitted via a GIS Feature Class geodatabase to the PSMFC GIS Project along with the location of ports to improve the accuracy of spatial data associated with FMD (trends).

Barrier data were linear referenced to the National Hydrography Dataset, improving the integration with fish habitat distribution data to support refinements to those data.

Updated fish habitat distribution datasets were published to the ODFW Data Clearinghouse and shared with regional StreamNet staff. Federal Geographic Data Committee compliant metadata are developed and embedded within the respective GIS datasets.

5. Washington Department of Fish and Wildlife

WDFW StreamNet GIS staff continued updates of WA NHD hydro databases and continued to support GIS needs to ensure the flow of StreamNet trend, fish distribution and CAP data. In 2021 the GIS work continued to focused on fish distribution, population geometry reviews and supercode, linework and dataflow tools AND the addition of Hatchery location ID and verification for upcoming HCAX work. With this work we synchronized StreamNet with WDFW's master Statewide Washington Integrated Fish Distribution layer and submitted new trends for new supercode locations to coordinate better with CAP data. Work this year also focused on effort to centralize the StreamNet data compiling via an online feature service.

E. CAP Fish HLIs

Work Elements:	159: Support transfer of data into secure and accessible repositories 161: Data - dissemination

The CAP Coordinated Data Partnership aims to build automated HLI sharing capability in all the data source agencies. StreamNet works with the agencies to develop procedures for internal conversion of the data to regional standards defined in the Coordinated Assessments Data Exchange Standards, and continues to contribute to the coordination and standardization of monitoring data throughout the basin.

StreamNet staff and members actively supported improving data sharing capabilities in the region through the CAP, such as by using an exchange network approach and dynamic web services to share data. Contributing to this effort, in 2012 StreamNet staff developed an automated means of feeding indicators and metrics from the CAP to the NOAA Salmon Population Summary (SPS) database, and continued to maintain this tool in 2021. In 2021, StreamNet staff also continued to support NOAA staff accessing data directly from the CAX online query. Access to these data is also facilitated by the CAP Fish HLIs mapping query system, which displays HLIs in the CAX and related Fish Monitoring Data time series stored in the StreamNet database. A tabular version of the CAP Fish HLIs query was initiated in 2021 to support filtering options and unique URL in response to user requests.

This past year has been very active for the Coordinated Assessments Partnership (CAP) co-lead by PNAMP and StreamNet. With funding secured from an EPA Exchange Network grant, along with funding from BPA and NOAA IJFA, the CAP dove into regional sharing of hatchery fish high level indicators (HLIs), starting in March 2021 with the Hatchery Coordinated Assessments Exchange (HCAX) Workshop 1. Over 50 participants representing 20 organizations provided input on the information to be considered for sharing through the CAP data system. Results of this workshop were the basis of the work of the HCAX Biologist Work Group over the summer and fall, ultimately completing the challenging task of agreeing to common terms and definitions in December (see 2022-01-05 HCAX Controlled Vocabulary_v1.0.xls).

The hatchery fish metrics and HLIs in development consist of four groups:

- Program Information — such as program name, facility name, hatchery stock name, run and agency contact (9 total metrics/indicators)
- Adult Return Information — such as brood year, return location, proportions of natural origin and hatchery origin used as broodstock (13 total)
- Juvenile Release Information — such as year, location, date, number released (15 total)
- Hatchery Indicator Information — including hatchery broodstock demographics and age at return (12 included now; 6 additional for future review).

In 2022, we will engage the data stewards participating in the HCAX (i.e., HCAX Data Manager Work Group) to develop data sharing rules and procedures and test implementation. The project is expected to be completed no later than early 2023. To learn more, access HCAX meeting documents at Hatchery Data Sharing (HCAX).

During CY 2021, the Shoshone-Bannock Tribes for the first time submitted their data directly to the Coordinated Assessments Data Exchange (CAX) system towards the end of the CY. The Nez Perce Tribe continued to successfully submit their data after their initial start in 2020, and the Yakama Nation's STAR data system continues to submit data. We continue to hear about improvements in the data sharing capacity of other CRITFC tribes, and we hope that this will translate to additional data being submitted to the CAX. Overall, during the calendar year 2021 the CAP partners continued to maintain and publish new records to the CAX resulting in a total of 15,004 records by the end of calendar year 2021 (Tables 9 and 10).

Table 9: Number of records of data, by high level indicator and StreamNet partner, as of 12/31/2020 and 12/31/2021.

High Level Indicator	Partner*	12/31/ 2020 records	12/31/ 2021 records
Natural Origin Spawner Abundance (NOSA) *Note that NOSA includes both escapement and true NOSA.*	Colville Tribes	14	19
	YN	280	280
	IDFG	1,441	1435
	NPT	389	389
	ODFW	2,499	2,800
	USFWS	23	24
	WDFW	2,305	2,446
Presmolt Abundance	Colville Tribes	49	134
	ODFW	89	97
	PSMFC	1	1
	Terraqua Inc.	23	23
Juvenile Outmigrants	Biomark	31	31
	Colville Tribes	12	81
	IDFG	548	785
	NPT	157	157
	ODFW	321	364
	SBT	0	23
	WDFW	450	462
Smolt to Adult Return Rate (SAR)	Colville Tribes	10	18
	FPC**	955	1,040
	ODFW	273	283
	USFWS	16	16
	WDFW	47	48
Recruits per Spawner (R/S) *(total value may include both adult and juvenile R/S)*	Colville Tribes	10	11
	IDFG	1,200	1,212
	ODFW	2,323	2,343
	USFWS	13	13
	WDFW	310	313
Proportionate Natural Influence (PNI)	Colville Tribes	15	17
	WDFW	149	157
Total number of records	**All combined**	**13,953**	**15,022**

*Biomark = Biomark, Inc.; Colville Tribes = Confederated Tribes of the Colville Reservation;
YN = Confederated Tribes and Bands of the Yakama Indian Nation; FPC = Fish Passage Center
IDFG = Idaho Department of Fish and Game; NPT = Nez Perce Tribe; ODFW = Oregon Department of Fish and Wildlife;
PSMFC = Pacific States Marine Fisheries Commission; SBT = Shoshone-Bannock Tribes; USFWS = U.S. Fish and Wildlife Service; WDFW = Washington Department of Fish and Wildlife.

Table 10: Summary of populations represented in the data as of 12/31/ 2021, by population group and high-level indicator. Groups reported are the combination of the first two columns. First column is population grouping; second column is high level indicator; third column is number of populations represented in the group; fourth column is the number of populations that are represented only as part of one or more superpopulations rather than as data specific to only a single population; fifth column is the number of records of data in the group; sixth column is the year range of the group. The third column minus the fourth column is the number of populations that were represented by data specific to only a single population (i.e., not represented only by superpopulations). The records included in the Priority group are also included in the Columbia River Basin group. Note that the Recruits per Spawner (R/S) total value may include both adult and juvenile R/S).

Population Group*	High Level Indicator	Pops	Superpops Only	Records	Year Range
Priority	Natural Origin Spawner Abundance (NOSA) *NOSA includes both escapement and true NOSA.*	67	1	2,773	1949 - 2021
	Presmolt Abundance	9	0	255	1993 - 2020
	Juvenile Outmigrants	45	0	1,210	1987 - 2020
	Smolt to Adult Return Rate (SAR)	59	41	331	1985 - 2018
	Recruits per Spawner (R/S)	52	12	2,178	1949 - 2018
	Proportionate Natural Influence (PNI)	4	0	143	1985 - 2020
Columbia River Basin	Natural Origin Spawner Abundance (NOSA)	177	1	6,600	1938 - 2021
	Presmolt Abundance	9	0	255	1993 - 2020
	Juvenile Outmigrants	72	4	1,739	1978 - 2020
	Smolt to Adult Return Rate (SAR)	100	75	1,281	1985 - 2018
	Recruits per Spawner (R/S)	84	14	3,177	1949 - 2018
	Proportionate Natural Influence (PNI)	5	0	174	1985 - 2020
Oregon Coast	Natural Origin Spawner Abundance (NOSA)	21	9	775	1994 - 2020
	Juvenile Outmigrants	7	0	132	1997 - 2017
	Smolt to Adult Return Rate (SAR)	7	0	124	1997 - 2016
	Recruits per Spawner (R/S)	21	0	715	1994 - 2016
Puget Sound	Juvenile Outmigrants	2	0	32	1999 - 2019

*Priority = The 69 BPA Tier 1 and Tier 2 are priority populations identified during 2015 by BPA to support their reporting requirements under the Federal Columbia River Power System Biological Opinion.
Columbia River Basin = All population within the Columbia Basin, including the BPA priority populations.
Oregon Coast = Populations in Oregon coast river systems draining directly into the Pacific Ocean. These are outside the Columbia River basin and are compiled using alternative funding.
Puget Sound = Populations in Washington draining into Puget Sound / Strait of Juan de Fuca. These are outside the Columbia River Basin.

1. The Confederated Tribes of the Colville Reservation

The Colville Tribes' HLIs are housed in the OBMEP database, and a Python script syncs these data with the CAX database.

The Colville Tribes improved the data pipeline used to calculate Presmolt Abundance estimates. Specifically, raw mark-recapture field data are collected as P4 files, go through a QA/QC process, and loaded into the OBMEP database where population estimates are automatically calculated. These steps replace the previous protocol which relied solely on spreadsheets and manual calculations.

The Colville Tribes submitted multiple years of data for Summer Chinook 10j fish. Data include NOSA, SAR, Juvenile Outmigrants, and Presmolt Abundance.

2. Idaho Department of Fish and Game

The IDFG StreamNet subproject can currently accomplish nearly automated submittal of data consistent with the DES through their IFWIS database and APIs, which the Idaho StreamNet project helped to initiate and partially supports.

IDFG StreamNet expanded streamlined data flows for CAX HLI data to include new species, populations, and life stages.

3. Montana Department of Fish, Wildlife & Parks

CAP HLIs have not been developed for resident fish species. MFWP staff have been staying aware of work being done for the CAX project and will be prepared as work begins to develop metrics and indicators for resident species.

4. Oregon Department of Fish and Wildlife

In 2021, ODFW StreamNet staff completed development of a new internal web application that allows Fish Monitoring Data (FMD), formerly known as trends, to be entered directly into the ODFW Fish Monitoring – Data Distribution SQL server database and automates the processes for validation and submission to the StreamNet API. A production and test application for Location, Reference, Trend, and EscData tables was developed and is currently in operation. The new application has increased efficiency, reduced potential errors, and eliminated previous DES data transfers to StreamNet. In 2022, staff anticipate completing the remaining tables for Age and Hatchery Returns. Additionally, in 2021, ODFW StreamNet staff enhanced the Coordinated Assessment web application (CAVES, developed in 2020) based upon feedback from user's experiences with the application.

ODFW StreamNet acquired new and maintained existing data sets for population estimates from various contributors in the Columbia Basin. This resulted in the submission in Coordinated Assessments DES format of most BPA priority populations in the Lower Columbia, Middle Columbia, and Snake River that ODFW committed to in 2021. ODFW was not able to submit 2021 NOSA estimates for Lower Columbia fall Chinook due to project staffing shortages and workload, however staff are planning to submit these data in 2022. ODFW submitted new NOSA indicator data for superpopulations of Lower Columbia (Oregon portion) and Oregon Coast coho salmon (alternative funding source), by ESU and Stratum. Updates and edits were conducted to follow validation rules of the DES and to standardize metadata to be more consistent among similar records and populations.

Staff coordinated internally and externally to ensure priority CAP and recovery related efforts were addressed. ODFW regional coordination focused on ESA listed recovery population changes, regional information gathering requests, data exchange standards, traditional data category definitions, and StreamNet's Fish Monitoring Data query system.

In addition, ODFW StreamNet conducted an inventory to discover what data ODFW collects related to potential hatchery HLIs and metrics, and where that data is located. ODFW StreamNet staff hired and coordinated the efforts of a temporary staff member to conduct the inventory. This effort resulted in a preliminary database that documents hatchery related metrics and indicators that may be available, the best potential source of the data, and where that data is located, and included a gap analysis and resources. This endeavor will support timelier compilation and submission of data when the HCAX DES is developed.

5. Washington Department of Fish and Wildlife

WDFW is in the process of modifying their Salmon Population Indicator data base to carry CAP indicator data and deliver them to the Coordinated Assessments Data Exchange (CAX) database using the StreamNet API.

WDFW StreamNet staff loaded the WDFW CAX database with NOSA (2020-2021) and SAR (2010+) data through the API. Although the test was successful, these data were not published as at that time the PopFit and TRTmethod columns in the data tables needed to be documented further to accurately reflect the data. The Upper Columbia Data Steward conducted a regional WDFW review to identify CAP metric data and associated time series for CAX data in the upper Columbia Basin. These data were identified and were integrated into the CAX database. GL-2022

The Lower Columbia Data Steward maintained existing data sets for population estimates, this consisted of submitting CAP HLI data through the CAX database and API process. Currently working on compiling current and historical metric data to compliment the CAP HLI data populations that already exist in the form of new Trends. MG-2022

All StreamNet staff contributed and continue to contribute to the new design of the TWS (Traps, Weirs, Surveys) restructure and to ensure all measurements were being collected to support metrics needed to create focal indicators.

6. CAP Co-Lead Update (PNAMP and StreamNet)

With an increasing number of new organizations submitting data to the Coordinated Assessments Data Exchange (CAX) system, most of whom were not engaged when CAP began in 2011, the need to tighten up CAP processes, improve documentation, and CAP communication became evident. One area of focus was improving how StreamNet and PNAMP can leverage their areas of expertise and membership to benefit CAP. In 2020 we formalized how the PNAMP Fish Monitoring Work Group (FMWG) can assist developing new HLIs identified by the StreamNet Executive Committee by bringing together the relevant fish and habitat experts, and how the FMWG can also assist the CAP DDT by participating in CAP DDT ad hoc workgroups as needed. The other area of focus was to address the need for better documentation and communication. In response to this need, the CAP co-leads Jen Bayer and Nancy Leonard, worked with the CAP Core Group that is facilitated by Jen (PNAMP) to update existing descriptive materials and to develop new materials where needed. These 2021 products include:

- Produced Second and third CAP newsletters in June and December 2021 (view all issues)
- Initiated several FMWG task group to receive input and, in some cases recommendations, for specific CAP/StreamNet data related topics
- Updated Five-Year Plan for Coordinated Assessments Partnership, adopted by the StreamNet Executive Committee in September 2021.

This effort to improve documentation and communication about CAP has also resulted in improved diagrams to describe relationships among groups (see StreamNet CAP webpages). These diagrams are also used in presentations such as presentations to CRITFC ITMD, StreamNet committees, and PNAMP Steering Committee (e.g., see Executive Committee meeting documents) . This work also helped inform the StreamNet Vision and Strategic Plan adopted in September 2020 to ensure alignment in how overlap StreamNet-CAP groups and tasks are described (see StreamNet's CAP Process webpage and committees and teams webpages). Ongoing work includes implementation of issues discussed during the 2021 QA/QC interviews and plan development, such as reinstating a regular, biennial CAP workshop focused on biologists responsible for the data and the data managers. Other CAP related work is described in previous sections of this report.

Since 2011, PNAMP and the PSMFC StreamNet program have collaborated to manage the Coordinated Assessments Partnership (CAP). Over time, much has been refined and improved to continue to make progress towards the CAP's overarching goal of improving the timeliness, reliability, flow, and transparency of data necessary for regional assessments and management decisions for improved environmental effectiveness. PNAMP staff work with StreamNet and Bonneville Power Administration to support the CAP. PNAMP facilitates the Coordinated Assessments Core Team 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. Participants in the CAP 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 multi-year grants from EPA to support HLI development and data sharing.

F. DES and Validation Process for Data and HLIs Submitted to the StreamNet Database

Work Elements:	159: Support transfer of data into secure and accessible repositories 159: CAP Data – compile data 160: CAP Data -automated data exchange 159 Compile high priority traditional StreamNet data 160 Infrastructure and base operations

StreamNet maintains a thorough data validation system as detailed in the approach/methodology section. During CY2021, StreamNet PSMFC staff developed and gathered proposed changes to the DESs for both the CAP HLIs and for the fish monitoring data (StreamNet trends). These proposals were included in the draft/working copies of the DES versions. Because no new DES was adopted this year, neither were there related validation rule changes During CY2021 the CAP DES version adopted in July 2020 (Coordinated Assessments DES documents for current version (20200715) remained active. Validation rules were already in place for the 2020 DES version, and thus not updated in 2021. The 2020.1 version of StreamNet DES that guides the Fish Monitoring Data remain active during CY2021 as no version updates occurred in 2021.

CAP DDT members and StreamNet DDT members (including data stewards) engaged in development of the DESs and validation process.

In CY2021 several new initiatives begun in 2020 to improve the functions of the DDTs were adopted. First, a charter was adopted for each DDT (see team document table for CAP DDT Charter and SN DDT Charter) . These charters specify the roles of DDT members, and outline the general approaches used to develop/update a DES. Second, our formal DES change process that was first created in 2003 was updated in 2021 (see Data Exchange Standard Development and Revision Procedures). The DES change process lists specific steps in the development of new/changed DESs. As part of the new DES process, we solidified how StreamNet can access a broader group of experts across the Northwest as needed to inform specific tasks. To do so, StreamNet worked with PNAMP to re-invigorate the PNAMP Fish Monitoring Work Group (FMWG), and that group was very active in 2021 (see FMWG task groups). This collaborative approach with the FMWG generated recommendations to the StreamNet Executive Committee for improving data display in 2021, and several other StreamNet/CAP tasks were initiated through the FMWG and recommendations/products are expected in 2022 (see task group and products). We expect to continue leveraging this new collaborative approach to inform tasks that benefit from broader input including DES, new data categories, and data display/queries.

1. The Confederated Tribes of the Colville Reservation

The Colville Tribes staff participated in the DES development meetings during 2020.

2. Idaho Department of Fish and Game

IDFG StreamNet staff continued to support the development and maintenance of Coordinated Assessments DES and CAX database. They coordinated with development between the proposed DES, the prototype database and application, and the web service data exchange. IDFG StreamNet staff completed, corrected, and standardized data source workbooks for natural origin HLI data.

IDFG StreamNet staff collaborated with PSMFC staff to update validation rules and used web services to exchange data between IDFG, StreamNet, and the CAX databases. They also helped regional staff test updates to DES and validation.

3. Montana Fish, Wildlife & Parks

MFWP staff are ready to engage when CAP indicators and DES are developed for resident fish.

4. Oregon Department of Fish and Wildlife

ODFW staff contributed input to CA DES discussions, various forums and email correspondences throughout the year, including significant participation in the proposals and discussions for adding Escapement as an estimate type in the NOSA DES. The DES Development Team (DDT) accepted the proposed modifications, and they were implemented at PSMFC and ODFW StreamNet.

5. Washington Department of Fish and Wildlife

WDFW participated in CA DES development discussions and meetings with the CA DES Development Team (DDT). WDFW SN Staff continued to map the CA DES to ETL processes in our own internal corporate systems for the three primaryCAP indicators in 2020.

G. Metadata Documentation

Work Elements:	159: Support transfer of data into secure and accessible repositories 160 Infrastructure and base operations

During 2021, metadata continued to be captured for data submitted to the StreamNet databases. The metadata captured differed depending on whether the data were submitted to the CAP Fish HLIs (CAX data system) or the Fish Monitoring Data (StreamNet trends data system), as described in Section IV.H. The Data Store online upload process requires that the organization uploading the data set provides descriptive information (metadata) before the data set is accepted. For data from projects funded under the Fish and Wildlife Program, the application pre-fills some project-related metadata fields directly from the BPA CBFish.org database. All metadata are included whenever users download data sets. The amount of detail regarding sampling methodology and other key aspects is dependent on the person providing the metadata and uploading the data set. Data Store metadata constitute an extension to the FGDC Biological Profile metadata standard.

The metadata requested by the StreamNet data systems is summarized below for each system:

- Fish Monitoring Data
  Due to the very large volume of individual records of fish monitoring data, each independent of all the others, metadata provided, by necessity, are limited.

  Each time series ("trend") has the following time series-level metadata:
  -- associated hatchery, if any;

-- associated dam, if any;
-- whether all known historical data are included;
-- whether the time series is continuing to be added to the StreamNet database, and if not then why;
-- organization that created the time series and is responsible for updates;
-- comments associated with a time series;
-- date and time the time series record was last updated.

Each record of data for annual counts/estimates contains the following record-level metadata:
-- general approach to field methods and calculation methods;
-- comments associated with each individual annual record;
-- organization that created the record and is responsible for updates;
-- whether a regularly-scheduled annual measurement is unavailable, and why;
-- a citation for a reference document where the data come from;
-- date and time the record was last updated.

In addition, when a fish monitoring data set is obtained from the StreamNet online query system it is given a time stamp to indicate the time at which the data set was created.

- CAP Fish HLIs

  Each record of data for fish HLI estimates contains the following record-level metadata:
  -- comments associated with each individual annual record;
  -- organization and contact person information for questions about the record;
  -- whether the value of that record is considered the providing organization's best available estimate (when multiple reasonable estimates are provided by that organization);
  -- protocols used to produce the HLI estimate (provided as name(s), URL(s), or document citation(s));
  -- whether the protocols cited were adjusted when making this estimate;
  -- complete list of organizations that contributed to the estimate;
  -- whether a regularly-scheduled annual estimate in a time series is unavailable, and why;
  -- status of the data provided (draft, reviewed, or final);
  -- location where the source HLI is available;
  -- location(s) where "metrics" used to calculate the HLI are available;
  -- location(s) where field measurement data used to calculate the metrics are available;
  -- a citation for a reference document where the data come from;
  -- date and time the record was last updated.

  In addition, when a fish HLI data set is obtained from the CAX online query system it is given a time stamp to indicate the time at which the data set was created.

- Data Store

  The StreamNet Data Store uses and enforces the federal FGDC metadata standard, modified for Pacific Northwest fish data sets that are assumed to not have a GIS component.

- GIS Data

  All published GIS Data include FGDC compliant metadata with feature/record level metadata as provided by data compilers and set forth in the DES.

The documentation of metadata associated with data sets submitted to StreamNet could be further improved. During CY2021 StreamNet staff worked with PNAMP staff to explore how metadata documentation could be facilitated by connecting StreamNet data sets to the new MontoringResources.org (MR.org) Study Plan. IJFA funding was secured to support a USGS biologist to manually confirm existing steps and identify additional steps/modifications to support this StreamNet - MR.org connection. This work is now informing CY2022 discussion with the StreamNet data stewards to

initiate the pilot connection. In addition, to advance the overall quality of the data submitted to the CAP Fish HLI, during CY2021 a visual quality control (QC) review by an independent third party was performed. The issues identified during this independent review, informed questions that were posed to data consumers and data providers, to further understand why these issues arose and how the data quality could be improved. A draft QA/QC plan was written and shared with the StreamNet Steering Committee/ Data Stewards at the end of CY2021 that included a CY2022 pilot exercise to inform annual visual QC checks as well as other recommendations that would be implemented by appropriate groups, e.g. PNAMP FMWG, CAP Core Team, CAP DDT, and SNTT. Lastly, progress was made in securing the supporting documents submitted along with data sets in the Library and to add a Library provided URL, and StreamNet staff has put in place a process for the Library to access all new Annual Project Reports from CBFISH.org to secure these in the Library in a more streamlined and automated manner.

1. The Confederated Tribes of the Colville Reservation.

The metadata related to the compilation of field data used for the HLI are housed in MonitoringResources.org.

2. Idaho Department of Fish and Game

IDFG continued to create and update metadata for all data submitted to SN and CAX per the DES. Sampling and analysis protocols, and links to data sources were updated.

3. Montana Department of Fish, Wildlife & Parks

MFWP StreamNet staff created and updated metadata for all spatial data sets submitted to StreamNet or posted to the MFWP Open Data site. Metadata were completed for all data submissions to the StreamNet Data Store.

4. Oregon Department of Fish and Wildlife

ODFW StreamNet staff updated and standardized metadata within existing records in the Coordinated Assessments (CA) DES and updated or created metadata for in-house datasets used to calculate and report high-level indicators. Additionally, (Jake) ODFW StreamNet submits references associated with Fish Monitoring Data (FMD) and Coordinated Assessments to the Library and contributes references, data, GIS files, and metadata to the ODFW Data Clearinghouse.

In late 2021, staff began reviewing Fish Monitoring Data (FMD) andCAP records to identify potential improvements to protocol/method name and URL, method adjustments, trend status, historic status, and general comments associated with internal database records and information stored at StreamNet.

5. Washington Department of Fish and Wildlife

WDFW StreamNet staff continued to work with contributing biologists to document methodologies and update them within our corporate reporting systems. The development of formal metadata for CAP data and beyond will greatly aid efforts to document data origin, protocols used to collect the data, and uses of the data.

H. Data Backup Systems

Work Elements:	159: Support transfer of data into secure and accessible repositories 160 Infrastructure and base operations

In 2021, server infrastructure was stable, backups maintained on all systems and data.

The StreamNet staff continued to maintain and implement the data backup approach described in Section IV-I above. No material changes in data backup systems were made in 2021. Annual testing of database restore function was initiated and tested. Previously, this was done intermittently.

I. Supported Reporting and Decision-Making Processes

Work Elements:	185 Produce PISCES Status Report 161: Data Dissemination 119: Manage project activities 132: Produce annual reports

Regular meetings were held for ExCom and SN SC. Agendas were formulated, issues discussed and resolved where possible, and priorities were set. Reporting and posting of notes and decisions was facilitated via the StreamNet website. Subcontracts were executed and invoices tracked. New SOW and budgets were developed and provided to BPA. Inventory list and cost share report were also developed and provided to BPA. All StreamNet funded partners engaged in meetings and related products, as well as contributed to the contractual reporting requirements, In summary,

- Colville Tribes
  - Participated in StreamNet Technical and Steering committee meetings as well as the DES Development Team. Budgets effectively tracked and managed.
  - Provided input that informed the quarterly status review, the Annual Report and Cost Share report.

- IDFG
  - IDFG StreamNet staff, budgets, and resources were effectively managed to meet all program objectives.
  - Provided input that informed the quarterly status review, the Annual Report and Cost Share report.

- MFWP
  - MFWP StreamNet staff participated in project management, StreamNet Technical and Steering committee meetings. Budgets were effectively tracked and managed. Staff participated in all relevant budget and Statement of Work discussions and provided input to the SOW and budget.
  - MFWP StreamNet staff provided input that informed the quarterly status review, the Annual Report and Cost Share report.
- ODFW
  - ODFW StreamNet staff participated in project management, StreamNet Technical/DES, Steering Committee, and Executive Committee meetings. Staff were effectively supervised, and budgets were

tracked and managed throughout the year. ODFW StreamNet staff provided input to Statement of Work and budget discussions and submitted updated inventory reports to Regional StreamNet

- .
- ODFW StreamNet staff summarized activities in preparation for completing the Annual Progress Report. Staff provided input for the Annual Report and participated in editing efforts. Staff also provided input that informed the quarterly status review and Cost Share report.
- A temporary Data Assistant was hired to inventory ODFW hatchery data to help guide efforts for developing the hatchery DES and assess information and data potentially related to future HLI's.

- WDFW
  - WDFW StreamNet staff participated in project management, StreamNet Technical and Steering Committee meetings. Staff were supervised, budgets were tracked and managed throughout the year. Staff provided input to the SOW and budget.
  - Provided input that informed the quarterly status review, the Annual Report and Cost Share report.

StreamNet continued to support BPA's mandate to have data sets collected using rate payer funding be publicly accessible in a web-based data repository by facilitating submittal of data sets to the StreamNet Data Store. The availability of CAP Fish HLIs estimates through the CAX has facilitated BPA's pilot "One Fish Two Fish" tool to pull information from the CAX database as well as other data sources to display these on an interactive web-tool that communicates the status of ESA-listed salmon and steelhead populations (http://www.onefishtwofish.net/sps/SPS3.html).

BPA also manages a web-based project contracting tool, CBFish.org, which contains annual reports of BPA funded projects, several of which submit their data to the StreamNet Data Store, CAP Fish HLI, and/or as a time-series (trends). To secure access to these supporting project documents that contain information on how data are collected and analyzed, StreamNet PSMFC staff worked with the CBF&W Librarian to provide library URLs to those documents submitted along with a data set. Library URLs for other documents associated with a data set are also being provided.

NOAA staff involved in the data compilation to inform the 5-year status review of CRB salmon and steelhead populations continue to participate in the CAP and StreamNet committees and teams to inform the content of the CAX to support their data needs. NOAA Fisheries uses the natural origin CRB salmon and steelhead indicators currently reported through CAP Fish HLIs map query (e.g., adult spawner abundance and productivity) to inform their status reviews and delisting decisions. The CAP's Fish HLI have greatly reduced the time and effort required by NOAA Fisheries staff to obtain and process data for their CRB ESA status assessments. StreamNet staff continued to assist NOAA staff and respond to their requests during this calendar year. The recent, and increasing use of StreamNet to access broader expertise via the PNAMP FMWG to address needed improvements to data accessed from StreamNet is also serving to inform changes to better support reporting and decision-making needs.

StreamNet Staff continued to provide support to NPCC staff and their Program Tracker contractors. NPCC staff continued throughout to use and rely on the Protected Areas mapper and associated database and documentation to inform their decisions related to whether proposed new hydroelectricity development is consistent with the NPCC FW Program policy. Furthermore, StreamNet databases and maps supports the NPCC FW Program reporting needs related to tracking the status of the basin's fish and wildlife resources (2014 FW Program Part Two, section V), reporting on the program's approved high-level indicators (2014 FW Program Appendix E), and tracking progress towards Program goals, objectives and indicators (2014 FW Program Appendix D and its draft 2020 Addendum Part 1A). NPCC also has several online reporting tools that rely on StreamNet's Fish Monitoring Data query and the CAP Fish HLIs query including their mapping tools and Program Tracker. StreamNet maintains an API that allows NPCC to retrieve, in an automated way, data from the CAP Fish HLIs and specific sets of detailed Fish Monitoring Data "trend" for use in NPCC online reporting tools. During this calendar year, NPCC requested StreamNet assistance in displaying CAP Fish HLIs in groupings aligning with the MAFAC SPI for adult salmon and steelhead associated with the 2020 Addendum. Recommendations on improving the map query for this purpose were discussed and supported by the StreamNet Executive Committee during

its September meeting. Additional work has been initiated leveraging a FMWG Task Group to further inform how the CAP Fish HLIs data can be organized/displayed to support these MAFAC SPIs.

The Emerging Technology Information Session Webinar Series co-organized by StreamNet and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) was held from October 2020 to the end of February 2021 and covered various topics related to emerging technologies for monitoring and data management, with each of the four months focusing on one topic and including three or four virtual sessions with expert speakers from the field. The topics and expert speakers were identified by the ETIS Planning Group members, consisting of StreamNet staff (Mike Banach, Nancy Leonard, Greg Wilke), PNAMP staff (Jen Bayer, Sam Cimino, Amy Puls, Becca Scully), BPA staff (Russell Scranton), CBF&W Library staff (Tami Wilkerson), Oregon State University staff (Erik Suring), OWEB staff (Ken Fetcho), US BOR staff (Mitch Mumma), and USGS staff (David Pilliod). Participation in the ETIS webinar series ranged from 30 to over 100 attendees and including individuals from across the USA and other countries. Each of the sessions was recorded and posted to PNAMP's YouTube Channel to support broader access. The 2021 presentation and speakers consisted of:

- **January 2021: Fish Monitoring and Assessment**

  Thursday, Jan 7, 1:00-2:30pm Pacific (watch recording)
  Chris Harrington (IDFG), Justin L Welty (USGS), Michelle Steg-Geltner (YN), and Samantha Smith (NPT): *Latest applications for handheld devices for field data collection*

  Thursday, Jan 14, 1:00-2:30pm Pacific (watch recording)
  Thomas Delomas (PSMFC/IDFG): *Measuring ploidy with non-lethal tissue samples and amplicon sequencing.*
  John Hargrove (PSMFC/IDFG): *Parentage-based tagging improves escapement estimates for ESA-listed adult Chinook Salmon and Steelhead in the Snake River basin.*

  Thursday, Jan 21, 1:00-2:30pm Pacific (watch recording)
  Gabriel Brooks and Benjamin Sandford (NOAA) : *Advances in PIT tag technology and what this can mean for assessments.*

  Thursday, Jan 28, 1:00-2:30pm Pacific (watch recording)
  Ryan Kinzer (NPT): *A streamlined data flow for improved decision making: data collection to analysis and all the gunk in between.*
  Dan Isaak (USFS): *The Fish Data Analysis Tool: Applying spatial stream network models with standardized databases to provide information for decision making.*

- **February 2021: Data Management**

  Thursday, Feb 11, 1:00-2:30pm Pacific (watch recording)
  Amanda Whitmire (Stanford University): *The basics of data management plans for research*
  Stacy Schumacher (Confederated Tribes of the Umatilla Indian Reservation): *The Centralized Data Management System used by the Confederated Tribes of the Umatilla Indian Reservation for the storage of fisheries data*

  Thursday, Feb 18, 1:00-2:30pm Pacific (watch recording)
  Kevin D. Henry and Jeff Peters (USGS): *Data visualization tools and frameworks for hazards and risk research*
  Brendan Ward (Astute Spruce, LLC): *Using open-source technologies to build spatial web apps*

  Thursday, Feb 25, 1:00-2:30pm Pacific (watch recording)

Tami Wilkerson (Columbia Basin Fish & Wildlife Library/CRITFC): *Tools and best practices for data sharing and reuse to advance research*
Patricia Soranno (Michigan State University): *The ethics of data sharing in the environmental sciences*

StreamNet staff are also serving on the PNAMP Fish Monitoring Work Group (FMWG) Core Team, assisting PNAMP in the organization and identification of topics for the FMWG. StreamNet staff engagement and assistance focuses on the tasks that aim to support the Coordinated Assessments Partnership and StreamNet by providing a venue for discussion of topics to inform tasks with appropriate subject matter experts (e.g. fisheries biologists, program managers, etc.). During this CY recommendations were provided to the StreamNet Executive Committee on improving the CAP Fish HLIs display, and other task groups co-lead by StreamNet PSMFC staff were initiated and are ongoing. See the PNAMP FMWG website for more details and access to task group documents.

1. The Confederated Tribes of the Colville Reservation
    - Tribal data management advancements supported in part by StreamNet data stewards have also contributed data informing The Colville Tribes Okanogan Monitoring and Evaluation Program Report Card which informs decisions related to habitat action implementation.
2. Idaho Department of Fish and Game
    - IFWIS and StreamNet data compilation and access tools were used by IDFG and other organizations for research and management purposes.
    - Researchers and policy makers used the data to answer research questions in journal manuscripts, annual reports, fishery management plans, updates to status assessments, and ESA compliance.
3. Montana Department of Fish, Wildlife & Parks
    - MFWP data and information websites have advanced their capacity for providing access and sharing data for resident fish species important to the NPCC FW Program. These include:
    - The Fisheries Inventory System (FIS). FIS is available through the agency internal website and holds survey data, individual fish information, distribution, tagging data and hatchery data to name a few. FIS also contains sophisticated analysis tools which incorporate the use of R statistical code. This application puts the data entry, analysis and reporting in the hands of biologists. Data are continually updated, and sources include FWP, US Forest Service (USFS), USFWS, Bureau of Land Management (BLM) and tribal fisheries biologists and supplemented with information provided in technical documents and reports.
    - FishMT is a public facing web application that provides users with access to vast amounts of fish and fishing information. Through FishMT the public can get information related to fish stocking records, survey data, species distribution, reports, publications and more. In addition, users can find fishing opportunities, report catching tagged fish and link to the state's fishing regulations.
4. Oregon Department of Fish and Wildlife
    - In 2016, ODFW initiated Phase 1 efforts to pilot a comprehensive information system, which, once fully implemented, will greatly improve ODFW data management and sharing efficiency. Such a system was also called for in the 2018 ODFW Strategic Plan. With the establishment of an Enterprise Governance Committee in 2018, agency data management was deemed to be an enterprise level project under their purview. Discussions are ongoing to determine the best data management and sharing approach for the agency.
    - Select ODFW managers reviewed and commented on the draft ODFW Take, Hold, Release, and Observe (THRO) data standard document. The THRO Team Lead and Product Owner worked to refine the data standard specification as well as the document narrative. The THRO Team was reconvened after a 10 month break with a goal of finalizing the standard in the first half of 2022. This effort is a crucial part of the future ODFW resource information system that will significantly advance the agency in areas of data management and increase data flow and sharing efficiency.
    - In 2017, the Oregon Legislature passed several mandates around state agencies' management, use and sharing of data. The state has launched an Open Data Portal (data.oregon.gov) and published an Open Data Standard, which requires agencies to maintain an inventory of agency information resources,

identify publishable data and publish "publishable" data to the Open Data Portal. ODFW has initiated an Open Data project to meet these requirements. ODFW began compiling a detailed Natural Resources Dataset Inventory (NRDI). The NRDI will provide agency staff with increased visibility of datasets held by ODFW while also allowing the agency to respond more quickly and accurately to data requests, more easily locate data for decision making, understand needs for future data management systems, and move toward treating data consistently with other valuable agency assets and mature data governance structures in the agency.

- In 2021, ODFW began work on the second stage of the Open Data Portal requirement by generating an Inventory of High-Use Information Assets that will allow the agency to better assess data applicability to, and prioritization for publication on the Oregon Open Data Portal.
- Currently, ODFW maintains and provides access to salmon and steelhead information and data through several websites:
    - Data Clearinghousev stores natural resource information, including reports, data files, databases, GIS files, maps and pictures from natural resource projects. This includes agency projects that provideCAP data for recovery populations, and Oregon Watershed Council projects funded by the Oregon Watershed Enhancement Board, and other partners implementing the Oregon Plan for Salmon and Watersheds.
    - Oregon Salmon and Steelhead Recovery Tracker website) allows exploring and downloading information related to salmon conservation and recovery in Oregon.
    - Centralized Oregon Mapping Products and Analysis Support System (Compass). This online fish and wildlife habitat map provides coarse-scale, non-regulatory fish and wildlife information, and crucial habitat layers emphasizing areas documented as containing important natural resources. Compass is intended to support early planning for large-scale land-use, development or conservation projects, helping users make informed decisions related to fish and wildlife habitats as energy, transportation, conservation and other large projects are planned.
    - Fish Habitat Distribution and Barrier Data Viewer facilitates access to ODFW stewarded data sets for fish habitat distribution and fish passage barriers.

5. Washington Department of Fish and Wildlife

- Washington Department of Fish and Wildlife (WDFW) manages multiple data resources which provides up-to-date information on populations and provides context for the efforts WDFW and its partners are taking in the arenas of habitat, hatcheries, and harvest to protect and conserve salmon and steelhead in Washington. These databases have benefited from advances funded through StreamNet and include:
    - SCoRe Interactive Map allows the user to explore salmon and steelhead hatchery and population data and related information by salmon recovery region, county, lead entities, and by water resource inventory area (WRIA).
    - SalmonScape delivers the science that helps recovery planners identify and prioritize the restoration and protection activities that offer the greatest benefit to fish. SalmonScape merges fish and habitat data collected by state, federal, tribal and local biologists and presents them in an integrated system that can be readily accessed by other agencies and citizens. SalmonScape is an interactive mapping application designed to display and report a wide range of data related to salmon distribution, status, and habitats.
    - The Spawning Ground Survey (SGS) database was designed as a repository for unexpanded data collected during spawning ground surveys and from adult traps. It is intended to provide a common framework for the collection, storage, retrieval, and dissemination of data collected by public and private entities. It includes status and trends of Coastal, Puget Sound, and Columbia Basin salmonid stocks.
    - CWT Recovery Database live updates posted to Data.WA.gov website.

J. Coordination with Partners and Responding to Data and Information Requests

Work Elements:	189: Coordination 161. Disseminate Raw/Summary Data and Results

During CY2021 PSMFC StreamNet secured additional IJFA funding for FY22 (September 2021-August 2022). Part of this funding supported the Shoshone-Bannock Tribes as describe in a previous section. Remaining funding went to support StreamNet and CAP activities by subcontracting for technical support and by providing USGS staff with support to assist with specific CAP related tasks. The StreamNet-PNAMP tasks focused on further enhancing the implementation of the CAP 5-year plan, along with current funding received from an EPA Exchange Network Grant and Bonneville Power Administration. StreamNet-PNAMP tasks initiated in CY2021 include:

- Support CAP task management, facilitation, and implementation in a manner consistent with the Five-Year Coordinated Assessments Partnership Work Plan.
- Schedule, lead, and attend regional coordination meetings regarding topics supporting CAP tasks and activities.
- Facilitate work sessions with data providers (biologists and data stewards) to improve data integrity (new fields and existing DES) and data fields.
- Conduct a manual assessment of what is needed for the CAP Fish HLIs, PNAMP MR.org, CBFISH, and CBF&W Library to more effectively leverage each other's content to strengthen the quality of the data and supporting material (metadata)
- Leverage outcome of the manual assessment to discuss what cost-effective solutions can be implemented to improve the connection among CAP Fish HLIs, PNAMP MR.org, CBFISH, and CBF&W Library

In 2020 we learned about the Yakama Nation's data flow into the StreamNet systems. The Yakama Nation's biologists use a standardized electronic template to upload data to the Tribes' centralized data management system. The standardized electronic template, developed by YN data coordinator, was created based on the guidelines defined in the Coordinated Assessment DES documentation and provides quality assurance measures such as data validations and limits prior to data submittal. Once the data is deemed finalized, the YN biologist initiates the submittal process to StreamNet Exchange from the Tribe's centralized data management system. This automated exchange process built within the Tribe's centralized data management system uses the StreamNet REST API to submit data. To alleviate surprise changes in the CAP DES resulting in disrupting the YN data submittal to StreamNet, and other data providers, PSMFC staff met with YN and CRITFC staff in 2020 to discuss the difficulties being experienced, and how these could be relieved. Part of the solution involved providing YN access to data templates in Excel and Access formats with the DESs that are downloaded from the StreamNet web site. In addition, to benefit all data providers, StreamNet initiated new proposed rules for timing adoption of DES and validation rule changes. In 2021 we updated our DES change procedures, which included new DES implementation rules to lengthen to two months the time between DES adoption and implementation. We also codified our communication practices to data providers, to ensure all parties have a chance to respond to and implement these changes in their systems before they are adopted on the main database / API. The PSMFC now provides YN staff with release notes when DES changes occur so that the automated exchange process can be updated and ensure the continued flow of data.

PSMFC StreamNet continue to engage in the CAP Core Team which serves to coordinate among StreamNet, CRITFC-ITMD, NOAA, BPA and states. PSMFC StreamNet continued to organize and chair the StreamNet Steering Committee meetings and update the StreamNet Executive Committee. PSMFC staff continue to collaborate with and assist with partners submitting data to the StreamNet and CAX databases to improve data flow to the CAX and access to CAX HLI and related data. PSMFC staff continue to convene and chair DES team meetings and SN Tech Team meetings to inform DES development/improvements. PSMFC StreamNet staff have also leveraged the PNAMP FMWG to convene a broader

group of experts, including biologists, to inform tasks to enhance StreamNet products and data flow/access. During 2021, the FMWG Task Group co-lead by PSMFC StreamNet staff worked with interested parties to develop recommendations for the StreamNet Executive Committee to improve data organization and display on the CAP Fish HLIs map query tool. Additional FMWG Task Groups are also in place to address other aspects beneficial to StreamNet, including clarification of smolt-equivalent in the CAP DES, developing guidance for producing GIS polygons for focal fish species, exploring options with biologists on how existing StreamNet data can be used to inform NPCC MAFAC SPI for natural abundance of adult salmon and steelhead (See all tasks). PSMFC StreamNet also regularly engages, on an individual basis, with USFWS, NOAA, BPA, CRITFC, PNAMP and NPCC staff to be informed about each entity's needs and how coordination can be enhanced.

Direct requests for information or help have become less frequent over the years, as the StreamNet web site has been more stable, our online services more robust, and our priority shift to population-scale data has meant that our traditional data are not updated as frequently. Six non-trivial direct requests were received by PSMFC StreamNet staff in 2021. All were promptly and satisfactorily addressed.

1. The Confederated Tribes of the Colville Reservation

The Colville Tribes Data Steward participated on the CAP Core Team and the CAP DES Development Team, and provided feedback on the DES.

The Colville Tribes' anadromous division coordinated with other separately funded Colville Tribes' programs such as the Chief Joseph Hatchery and the Resident Fish Department to keep them informed of the efforts and data structure The Colville Tribes is using for the Coordinated Assessments Partnership.

The Colville Tribes responded to 12 data requests this year which were either met by directing users to appropriate data sources, or by running specific queries in the OBMEP database to fulfill the request.

2. Idaho Department of Fish and Game

IDFG StreamNet staff participated in the Steering Committee and Technical Committee, and supported development of DES and streamlined data flows. They provided input prioritizing indicators, metrics, and metadata.

Staff coordinated data management and analyses with tribal collaborators. Staff also updated and improved data source workbooks and databases in cooperation with research and hatchery staff.

IDFG StreamNet staff responded to data requests coming from internal and external partners, and the general public. The number of data requests continues to decrease as the number of IFWIS users increases, and people find data for themselves.

3. Montana Department of Fish, Wildlife & Parks

Staff participated in Western Association of Fish and Wildlife Agencies' efforts which relate directly to the use of StreamNet data.

MFWP StreamNet staff responded to all data and map requests coming from internal staff, partners and the public. Many external data requesters are being referred to the FishMT web query system or the MFWP Open Data site to meet their needs. Internal requests consist of data queries and map requests that internal staff cannot complete themselves. MFWP GIS staff received approximately 45 map or data requests during the calendar year and all requests were fully satisfied.

4. Oregon Department of Fish and Wildlife

During 2021, ODFW staff participated and contributed to the CAP DES Development Team (DDT), Hatchery Coordinated Assessments Exchange (HCAX) Development Team, PNAMP Fish Monitoring Work Group (FMWG), and the StreamNet

Technical and Steering Committee meetings, along with state and other regional discussions, workshops and planning efforts related to trend data development and CAX data flow.

ODFW StreamNet participated in a StreamNet webinar to demonstrate the agencies' new internal web applications (CAVES and TEVaS) for validation and submission of Coordinated Assessments and Fish Monitoring Data using the StreamNet API. Staff presented the software, SQL database structure, web design, query capabilities, and data entry forms to the audience.

Oregon StreamNet staff responded to data requests coming from internal and external partners, with GIS, data and tech support requests being the most frequent. Agency staff are also utilizing StreamNet funded staff as a resource for assistance with developing data standards and responding to data requests that come to them. Staff participated in ODFW annual Region staff meetings and the Conservation and Recovery staff meeting. The East Region StreamNet staff assisted District staff with knowledge and resources for local and historical data. Staff continued contributions to BPA regarding priority population commitments and responding to requests from StreamNet partners.

Staff also reviewed and conducted user testing of the new StreamNet website to assess issues with data visualization and display of CAP Fish HLIs and Fish Monitoring Data. Detailed suggestions were submitted to Regional StreamNet staff which led to improvements of the website. ODFW staff were also involved with workshops to improve general data and super population displays. Recommendations related to carrying capacity data standard development, and juvenile outmigrant refinement of the smolt equivalent definition were also shared.

5. Washington Department of Fish and Wildlife

WDFW StreamNet continued this year to participate in the CAP process. Attention was given to DES development efforts, working with other agencies on overlapping populations, and continued development of data flow. Staff developed the code and processes to update CAP tables with final products.

In 2021, WDFW collaborated with CAP partners to develop and submit a hatchery CAX grant proposal and preliminary scoping.

WDFW StreamNet staff responded to data requests coming from internal and external partners, and the general public, with GIS, data, and tech support requests being the most frequent.

VI. Discussion – Recommendations and Lessons Learned

StreamNet serves as a regional coordination body to support data management and facilitate cooperation across organizational boundaries. StreamNet supports coordination through establishing and implementing regional data exchange standards for a specific suite of fish monitoring data (time series trends) and fish HLIs, including abundance, distribution, and productivity, with a long-term goal of extending coverage to additional metrics of regional importance. These data have traditionally been created and managed internally by the region’s state, tribal, and federal fish management agencies or programs, and the StreamNet data systems provide access to these data in a consistent format as agreed upon by the data providers.

The success of StreamNet relies on its staff, and partner and member organizations’ ability to learn, adapt, and adjust to regional information needs. The dynamic arena of data management and technology provides challenges and opportunities that StreamNet must tackle to be responsive to data providers’ and consumers’ needs. These needs include improving processes and tools to both enhance access to quality data and, strengthen proper use and attribution of data, while lessening the burden on data providers. Below we highlight some lessons learned and recommendations to further strengthen the StreamNet Program and its value to regional reporting and decision-making processes.

A. Recommendation for Supporting a Broader Group of Data Categories to Support Regional Information Needs

The diversity of data maintained by StreamNet addresses the different regional needs ranging from providing access to publicly funded data (such as via BPA ratepayers) to providing a common source of manager-approved data sets to inform regional decisions. In recent years these regional needs have become clearer and the approach used by StreamNet and CAP recognized as highly effective. The time is ripe for the Executive Committee to expand their guidance to StreamNet to improve data access for BPA, NOAA, NPCC and USFWS assessments and reporting needs, and to assist StreamNet, CAP, and its participants in securing funding to advance this work, whether through short-term grants or contracts or longer commitments (e.g. multi-year agreements or project funding).

Recommendations to the Executive Committee members:

- Support expanding data flow for resident and anadromous fish from agency/tribal data systems to StreamNet data systems that contribute to informing the NPCC 2020 Addendum (goals, objectives, and indicators); and BPA and USFWS bull trout and sturgeon needs. For instance, some bull trout and resident fish time-series data are submitted to StreamNet's Fish Monitoring Data (trends) system; this could be expanded to be comprehensive and better support BPA, NPCC and USFWS.
- Support participation, either by providing in-kind or BPA funding, in PNAMP Fish Monitoring Work Group (FMWG)/StreamNet joint task groups to ensure proper representation by state and tribal natural resources experts to work on tasks that contribute to improving expanding data managed by StreamNet.
- Support implementation of the Five-Year Plan for Coordinated Assessments Partnership by strongly encouraging BPA, NPCC and USFWS to build on StreamNet/CAP successes for improving access to fish and related habitat data.
- Assist in securing short-term funding to support CAP co-leads to perform outreach with potential data providers outside of the Columbia River Basin to better support NOAA and USFWS. For example, WDFW began efforts in 2020 to facilitate submittal of NWIFC member tribes' data to the Fish HLI; however, the tribes wanted more information and discussions before supporting the flow of their data to CAP Fish HLIs (CAX system). StreamNet secured NOAA IJFA funding in September 2020 to support some initial outreach by StreamNet and PNAMP (CAP co-leads) with NWIFC in coordination with WDFW and NOAA. WDFW is continuing discussions with the NWIFC member tribes, however the CAP co-leads are restricted in their ability to assist by the one-year IJFA funding.

B. Recommendations to Secure Funding for Quality Data Exchange

BPA funding of the StreamNet project was reinstated in October 2020 (FY 2021) to $2,145,483 as recommended by the NPCC in 2019 (Figure 4 in Section III.D). The reinstated BPA funding allowed StreamNet to continue to fund StreamNet partners (Colville Tribes, IDFG, ODFW, MFWP, and WDFW) to the same level as during FY2020 while also fully funding StreamNet PSMFC staff, and funding some time to PSMFC GIS Center staff. Having the StreamNet PSMFC staff fully funded has allowed significant progress in improving the data queries and process informing data submittal. StreamNet PSMFC staff also secured additional funding from NOAA IJFA (September 2020-August 2021) and EPA Exchange Network Grant (December 2020 – September 2023) which, together with the reinstated BPA funding, has allowed StreamNet to make significant advances during FY2021. The combined funding from BPA, EPA, and HCAX has also allowed StreamNet to further support data management and sharing capacity of the Shoshone-Bannock Tribes; support The Colville Tribes to work on developing and submitting HLI for a new population; coordinate with PNAMP to conduct outreach with Northwest Indian Fisheries Commission about the CAP; and given the small StreamNet PSMFC staff, allowed StreamNet to employ independent contractors to advance several priority tasks including improving the StreamNet website to enhance access and facilitate site maintenance; initiating an effort to inform a sustainable quality control procedure for CAP Fish HLIs data; initiating a stronger collaboration with PNAMP FMWG to engage fish biologists and managers in developing recommendations for improving the Coordinated Assessments DES and display of fish information including fish polygons, fish names, fish without HLIs, and HLIs for super/sub populations. The work initiated at the end of

CY2020, which overlaps with the start of FY2021, shows the ability of StreamNet to nimbly respond to priority tasks when appropriately funded.

Recommendations to the Executive Committee members:

- Assist in **securing funding** to support StreamNet and CAP task maintenance, data quality, automation of the entire data flow process including calculations, and new tasks to better support the reporting needs of BPA, NOAA, NPCC and USFWS.
    - Facilitate discussions among BPA, NPCC, NOAA, and USFWS on funding avenues that could be secured to address new tasks, and to reduce the budget shortfall associated with decline in the purchasing power of the budget (i.e., the budget will effectively decline as costs increase).
    - Encourage BPA to consider providing and/or increasing funding for Columbia River Basin data stewards, especially with Tribal partners.
    - Encourage and support BPA and NPCC decisions to maintain or increase the StreamNet FY2021 base funding ($2,145,483, not including ODFW portfolio funding), to facilitate meeting the needs of BPA and NPCC (while keeping up with inflation).
    - Continue discussions with NOAA about contributing to StreamNet annual budget to maintain current support for their data needs and explore further enhancement to better address their information needs for the PNW.
    - Support efforts by StreamNet and PNAMP to secure alternative sources of funding to complement BPA funding such as EPA grants by providing letters of support and exploring synergies among federal agencies and multi-state compacts that consume StreamNet data.

C. Recommendation to Enhance and Maintain Access to High Quality Data

CAP Fish HLIs (CAX data system) has been flowing data since 2015. The increase in users accessing these data to inform their assessments and reporting, including BPA, NOAA, and NPCC, has raised awareness of needed improvements, including an on-going quality control procedure to ensure data integrity over-time. The time is ripe to take a close look at what needs to be strengthened before we begin flowing hatchery indicators that will be developed through the HCAX during 2021-2023. StreamNet PSMFC staff have initiated an effort, with the support of a consultant, to inform the development of a quality control procedure that will assesses whether CAP Fish HLIs content in the CAX meets expectations to support proper use and attribution of these data.

During CY2021, StreamNet anticipates identifying aspects of the QC procedure that could be addressed by StreamNet-funded data stewards. Depending on the effort needed some additional funding may be needed to support this new task. StreamNet also expects that some issues identified will require more in-depth work to properly address the problems, and may require working closely with biologists through the PNAMP FMWG, PNAMP MonitoringResources.org staff, and the CBF&W Library staff. This work will likely require additional funding, and StreamNet will be attempting to secure funding for this work once it is better defined.

Recommendations to the Executive Committee:

- Support implementation of the CAP Fish HLIs QC procedure once finalized in CY2021 by StreamNet funded partners by providing BPA funding for this task.
- Support participation, either by providing in-kind or BPA funding, by all data providers and data consumers in discussions to refine or develop new data categories and exchange standards in PNAMP FMWG/StreamNet task groups to address issues that require input from a broader group of experts including biologists, fisheries managers, and CBF&W librarian.
- Advance implementation of improved metadata documentation within agencies' and tribes' data systems, especially for data of regional importance. For instance, this could include documenting data set progress and procedures in accessible documents or project management applications like Asana (asana.com). This enhanced access to data increases input that improves overall quality control and assurance, as well as timeliness of data delivery, resulting in improved data accessibility. This documentation not only benefits the data quality but is

critical to maintaining the integrity and stability of projects and workflows during periods of high personnel turnover. Additionally, new data visualizations should be implemented in order to facilitate data discovery and uses by all of our customers.

- Support continued engagement and collaboration with PNAMP MonitoringResources.org team to explore how the monitoringmethods can further be improved to better support StreamNet and its partners' data documentation while considering the value added of options and the workload on project leads submitting content to MonitoringResources.org
- Encourage partners to continue improving overall documentation of their field data collection and data analysis especially for data submitted to StreamNet.

D. Recommendation to Establish StreamNet as System of Record for BPA/NPCC Program

BPA recognizes the PSMFC StreamNet GIS data layers for GIS locations related to fish populations and sites associated with data submitted to the StreamNet database as the System of Record for fish facilities funded by the Program (e.g., hatchery, weirs, screens) and for fish distribution. Establishing StreamNet as the System of Record for these GIS data layers and associated attributes provides a definitive location for Columbia River basin information that is collaboratively informed by partners and facilitates consistency across users.

Recommendation:

- Encourage NPCC, in addition to BPA, to officially recognize PSMFC StreamNet GIS and the StreamNet database systems (Fish HLI and Fish Monitoring Data) as the System of Record for the Program. This would ensure that the underlying information informing BPA and NPCC assessments and reporting tools are based on the same information, thus reducing the potential for inconsistencies and confusion. This would also allow for a common set of information used among StreamNet, BPA, and NPCC GIS-based tools ensuring consistency in data display (e.g. hatchery facilities location and cross-walk of non-standardized names) across BPA, NPCC Program, as well as other partners.

E. Recommendation to Adequately Support State and Tribal Data Stewards and Participation in StreamNet

A critical component of StreamNet is being able to financially support data management staff within data-providing states and tribes. This tight connection between PSMFC-StreamNet and funded partners is instrumental in ensuring that relevant BPA-funded data are submitted on a regular basis to the StreamNet database in the agreed upon format. At the same time, integrating data stewards within agencies and tribes allows for implementation of more efficient data flow to decision makers, as there is a collaborative approach and common vision about how to make the desired information accessible. The existing committee and team structure of StreamNet further facilitates this shared effort as all levels are informed through the same flow of information, from the Executive and Steering Committees to the DES Development Teams and Technical Team. The success of this approach is reflected in the increase in data submitted by The Colville Tribes since becoming a funded partner, and is also observed when StreamNet has the financial ability to fund small subcontracts with CRITFC ITMD project, CRITFC member tribes, and the SBT.

Recommendations:

- Encourage BPA and NPCC to consider providing and/or increasing funding for data stewards, especially with Tribal partners. This funding could be managed through the StreamNet project to facilitate coordination and engagement of all data providers submitting to the StreamNet data systems. This funding should complement, and not reduce, existing funding provided through individual projects and or through data management projects including the CRITFC ITMD (2008-507-00) project that partially supports data stewards, and the Intermountain Province / Pend Oreille Subbasin Data Management Project (2011-020-00).
- The Executive Committee should continue to encourage and invite other data providers, including CRITFC member tribes, NWIFC member tribes, SBT, and others to participate in and/or become members on both the

Executive Committee and Steering Committee. Based on past discussions, funding may be required to secure the participation of tribes in StreamNet and CAP.

- Strengthen engagement and coordination among data stewards (e.g., database administrators, programmers, GIS experts) by re-implementing annual technical team meetings (or more frequent as needed) to assist StreamNet technical staff in staying engaged and informed of the work other states are doing and challenges they face. These meetings also serve as an excellent group to discuss updates to DES' and changes and improvements to data exchange processes.

F. Lessons Learned about the Benefits of Streamlining Internal Data Submission for Direct Staff Data Submittal to CAP and StreamNet

Ensuring the **integrity and efficiency of data flow** requires ongoing maintenance and updates, including adopting advances in data management and reporting technology (open source and proprietary programs and tools) to improve efficiencies across the entire data life cycle. Several of the data providers are adopting a more automated data flow from field data collection to StreamNet's data systems. This is evolving the roles within an organization as to who ultimately submits the data to regional data systems, including delegating the decision to submit data into the CAX to the staff responsible for that data set. Approaches in place and under development differ in their specific approach, however, the development of similarly purposed applications for submitting fish data to Fish HLI (CAX) and to Fish Monitoring Data (SN Trends) would be beneficial to all StreamNet data providers. Some examples of approaches currently in use by StreamNet funded partners are described below.

- In 2020 The Colville Tribes developed software to automatically calculate pre-smolt abundance estimates in Okanogan River tributaries. Estimates are determined using mark-recapture techniques with field data recorded in PTAGIS P4 files. Prior to 2020, population estimates were determined by aggregating and performing all calculations manually (using spreadsheets) – a time-consuming process. Now P4 files are loaded directly into the OBMEP database where the calculations are run. The Colville Tribes are currently exploring similar efficiencies for other HLIs.\
- ODFW's new Trend (TEVaS) web application has enabled ODFW staff responsible for specific data to enter this data directly into ODFW's Fish Monitoring – Data Distribution SQL database for validation and submission to the StreamNet API. The new functionality has made ODFW's internal submission process more efficient and allows the responsible staff member to receive real-time data validation. Similar functionality could be beneficial to all StreamNet partners, and we plan to continue identifying improvements and adding new functionality in 2022

The availability of a **fixed increase in financial support** for a certain number of years, such as the three-years of funding secured for HCAX, has shown to be integral in advancing standardization and sharing of specific priority data categories. For example, during 2021 ODFW StreamNet applied some of the HCAX funding from the EPA Exchange Network grant to hire a temporary staff member to inventory potential hatchery indicators, metrics, and hatchery program-related information to guide ODFW participation in the HCAX project. This allowed ODFW StreamNet to (1) lessen the workload on permanent staff; (2) describe the hatchery data types and formats collected by ODFW's Propagation Program such as location and attributes; (3) support timelier data compilation for testing of the hatchery data exchange web service in 2022 and subsequent final data submission; and (4) inform the Hatchery Biologist Work Groups development of data fields and controlled vocabulary by leveraging the inventory results. Furthermore, it is anticipated the HCAX inventory can be leveraged as a model for future projects, such as, a Coordinated Assessments DES for carrying capacity and white sturgeon. This approach should be endorsed and encourage for similar activities related to priorities discussed in the CAP Five-Year Plan for all StreamNet partner agencies and tribes (as time and resources allow).

G. Lessons Learned about the Importance of Communicating QA/QC and Improving Access to Data Consumers

StreamNet staff have been working on facilitating access to StreamNet data by different audience groups ranging in their technical expertise. To this end, StreamNet staff have developed a filterable API that better meets the custom data requests from the diversity of users accessing the StreamNet data system. This improved API also supports the

improved Fish Monitoring Data query system released in CY2020 and will be supporting a new Fish HLI tabular query system that will complement the existing Fish HLI map query. To ensure ease of access to these queries and information on using the API, the refreshed StreamNet website planned for a summer 2021 release is focusing on facilitating locating these tools on the website. Improving access of data maintained by StreamNet to audiences with different technical knowledge will increase the value and use of these data by the public and for informing decisions.

Furthermore, improving communication of the **quality of submitted data** provides data consumers with confidence in their use of these data. To this end, StreamNet adopted in 2022 a QA/QC Plan that captures current procedures and expands to include a post-submittal visual check process that is documented and shared with the data consumers. This QA/QC plan reflects input received from data providers and well as the data consumers who seek to better understand these data to ensure proper use.

H. Lessons Learned on Efficient Approach to Access Needed Expertise

Leveraging **target work groups** with the required expertise (e.g., data stewards, biologist) to inform addition of data categories is efficient and effective, including coordinating with PNAMP staff for meeting facilitation expertise. The use of smaller workgroups via the StreamNet-PNAMP collaboration has illustrated the success of this approach as final products and recommendations have rapidly been achieved during 2021 to inform hatchery indicators and metrics, general data display, super population display, carrying capacity data standard development, and juvenile outmigrant refinement of smolt equivalent definition. Each of the 2021 topic specific work groups utilized the expertise of biologists who are the subject matter experts in these areas to provide input that can then be further refined by data managers to develop a comprehensive DES for each subject. This methodology streamlined efforts and allowed groups to stay focused on specific tasks.

I. Lessons Learned about the Importance of Documentation for Data Integrity and Succession Planning

Proper documentation for data integrity is critical to ensure that these valuable data, funded by the public and rate-payers, remain accessible to inform critical uncertainties and decisions into the future. This applies both for data managed within an organization and for data submitted to regional data systems. Projects such as StreamNet serve a key role in ensuring that this documentation and the data needed to inform the assessment process are accessible and stable during any upcoming transition, such as retirement of core biologists with significant institutional knowledge about the data methods and analysis conducted. Some of the StreamNet partners have acknowledged that they also need better overall documentation of field collection and analysis to improve the quality of their data submissions to CAP Fish HLIs (CAX system) and are exploring how this can be accomplished, including utilizing PNAMP's MonitoringResources.org. StreamNet and PNAMP, with BPA support, continue to work on improving how to facilitate the connection between data submitted to StreamNet data systems and metadata submitted to MonitoringResources.org to reduce the burden on the data provider. The ongoing priority of proper metadata documentation (data source, definitions, and monitoring and analytical methods) resulted in StreamNet initiating in CY2020 an effort that will continue past CY2021 to inform the development of a quality control procedure. The procedure includes assessing metadata in CAP Fish HLIs and increasing discussions with PNAMP and CBF&W Library to determine what is needed to strengthen metadata while minimizing the burden on project sponsors of submitting the same metadata in multiple data systems (e.g., how to connect StreamNet, PNAMP and the Library's data systems).

Documentation of the StreamNet Program groups and processes is also necessary to ensure successful successor planning and coverage when needed both within PSMFC-StreamNet and among its partners and members. The StreamNet Program has matured in its committees' and teams' organization, including the CAP team, and how they function. To facilitate understanding of the roles of these groups and processes guiding the work implemented by StreamNet PSMFC staff, members and partners, it is important to clearly document this information and make it publicly accessible. During 2020, PSMFC StreamNet staff took the lead in drafting this content and requesting review by

members and partners, including basic organizational hierarchy, description of group roles and responsibilities, and team charters. The refreshed StreamNet website launched in 2021 also includes new webpages aimed at transparently conveying information about the existing committees and teams and the CAP. This improved documentation and transparency of the StreamNet not only contributes to succession planning but also facilitates communication and recruitment of new partners/members.

VII. Appendix A: User Statistics for PSMFC-StreamNet Project Information Tools

Table 11a: Summary of the number of visitors to the StreamNet website including the number of page-views, average page viewed, and average time on the website. Last two columns on the far right summarizes the combined usage (hits) of the StreamNet Query (SNQ) and the Coordinated Assessments Exchange (CAX), as well as the usage of the API (hits).

Calendar Year:	Total Visits	Unique Visitors	Page Views	Ave. Page Views	Ave. Time on Site (min)	SNQ / CAX data (hits/usage)	Data API Usage (hits/usage)	Map applications Unique Visitors
2021	6,658	6,533	13,794	2	1	3,621	475,897	5,470
2020	10,723	7,373	20,338	2	1	4,181	561,707	5,270
2019	11,774	8,232	23,458	2	1	6,968	425,710	5,794
2018	13,371	9,197	34,551	3	2		2,399,444*	5,659
2017	22,630	14,228	54,677	2	1		508,123	5,630
2016	29,708	18,399	83,182	3	3		412,504	5,252
2015	32,590	20,014	63,880	3	3		144,698	n/a
2014	39,171	31,424	75,112	2	1		51,358	n/a
2013	44,798	36,683	89,681	2	1		n/a	n/a
2012	27,163	19,291	66,686	2	1		n/a	n/a
2011	25,169	16,586	63,186	2	1		n/a	n/a
2010	23,029	13,924	49,725	2	2		n/a	n/a
2009	11,578	6,983	26,261	2	2		n/a	n/a

** New API feature allowing internal agency/tribal validation before data submission and new partners starting to use the API resulted in the large increase of usage in 2018 before stabilizing in 2019.*

Table 11b: Platform used to access the StreamNet website remains about the same between 2020 and 2021. Pre-2020 data are not available.

Year	Desktop	Mobile	Tablet
2021	77%	20%	3%
2020	84%	14%	2%

Table 12: The below information is no longer available from the Google website analytics starting in 2021. Below table is keep in thus annual report to provide explanation for its omission in out-years. The below table is a summary of the number of visits per year by entities/groups visiting the StreamNet website based on their IP addresses. The sharp decline in the non-public entities is likely a reflection of the move to remote work from home due to the COVID-19 restrictions.

Calendar Year:	**2020**	**2019**	**2018**	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
General Public/Rate Payers (Comcast, Verizon, Etc.)	**7,119**	7,417	6,170	9,621	10,906	9,241	17,862	17,711	12,515	4,200	8,369	2,530
State of Oregon	**26**	438	203	380	948	776	640	600	961	881	974	594
National Oceanic and Atmospheric Administration	**21**	216	115	251	540	574	349	309	385	144	572	306
Washington State Department of Fish and Wildlife	**14**	154	64	111	220	194	165	89	156	36	584	261
State of Idaho	**11**	142	52	134	270	158	118	120	132	63	166	128
U.S.D.A. Forest Service	**11**	90	172	218	308	347	241	393	443	0	593	339
Bonneville Power Administration	**8**	235	91	173	536	448	213	220	258	141	296	150
U.S. Fish and Wildlife Service, IRM/BFO Hq	**6**	160	86	208	388	256	201	109	182	111	262	185
Headquarters USAISC (Us Army)	**6**	98	72	120	198	394	360	462	342	96	515	277
USDA Office Of Operations	**5**	74	50	78	129	126	122	148	130	58	244	201
U.S. DOI Bureau Of Land Management	**4**	47	38	83	125	176	122	139	186	81	155	95
Nez Perce Tribe	**3**	66	36	37	80	99						
National Wetlands Research Center-USGS	**3**	34										
Oregon State University		79	77	146	175	187	158	186	152	40	148	64
University of Washington		69	65	17	141	167	114	91	109	24	169	70
Portland State University		47	81	40	103	146	70	73	88	0	55	39
State of Washington		35										
Total	7,237	**9,401**	**7,372**	**11,617**	**15,067**	**13,289**	**20,735**	**20,650**	**16,039**	**5,875**	**13,102**	**5,239**

VIII. Appendix B: NPCC FW Program Focal Species and other Fish Species included in StreamNet Query System

NPCC Focal Species	SN Query Trend data
Chinook salmon	Yes
Chum salmon	Yes
Coho salmon	Yes
Green sturgeon	Yes
Pacific lamprey	Yes
Sockeye salmon	Yes
Steelhead	Yes
American shad	Yes
Black crappie	Yes
Bluegill	Yes
Brook trout	Yes
Brown trout	Yes
Bull trout	Yes
Burbot	Yes
Channel catfish	Yes
Coastal cutthroat trout	Yes
Cutthroat trout	Yes
Kokanee	Yes
Lahontan cutthroat trout	Yes
Lake trout	Yes
Largemouth bass	Yes
Mountain whitefish	Yes
Northern pike	Yes
Northern pikeminnow	Yes
Rainbow trout	Yes
Rainbow trout X Cutthroat trout hybrid	Yes
Redband trout	Yes
Sculpins	Yes
Smallmouth bass	Yes
Walleye	Yes
Western brook lamprey	Yes
Westslope cutthroat trout	Yes
White crappie	Yes
White sturgeon	Yes
Yellow perch	Yes
Yellowstone cutthroat trout	Yes
Oregon Chub	No

IX. Appendix C: NPCC FW Program Draft 2020 Addendum Salmon and Steelhead Groupings Cross-walked to StreamNet/CAX Query Systems

Below we provide a preliminary crosswalk between the populations with data within the CAX and the grouping of populations used by NPCC and Marine Fisheries Advisory Committee's (MAFAC) Columbia Basin Partnership Task Force (CBPTF). For populations not linked to data in the CAX we need to verify with managers if there are available data.

Preliminary crosswalk between the NPCC/MAFAC salmon and steelhead groups with content of the CAX query system. Below is summary figure that reflects the more detailed data from the below table.

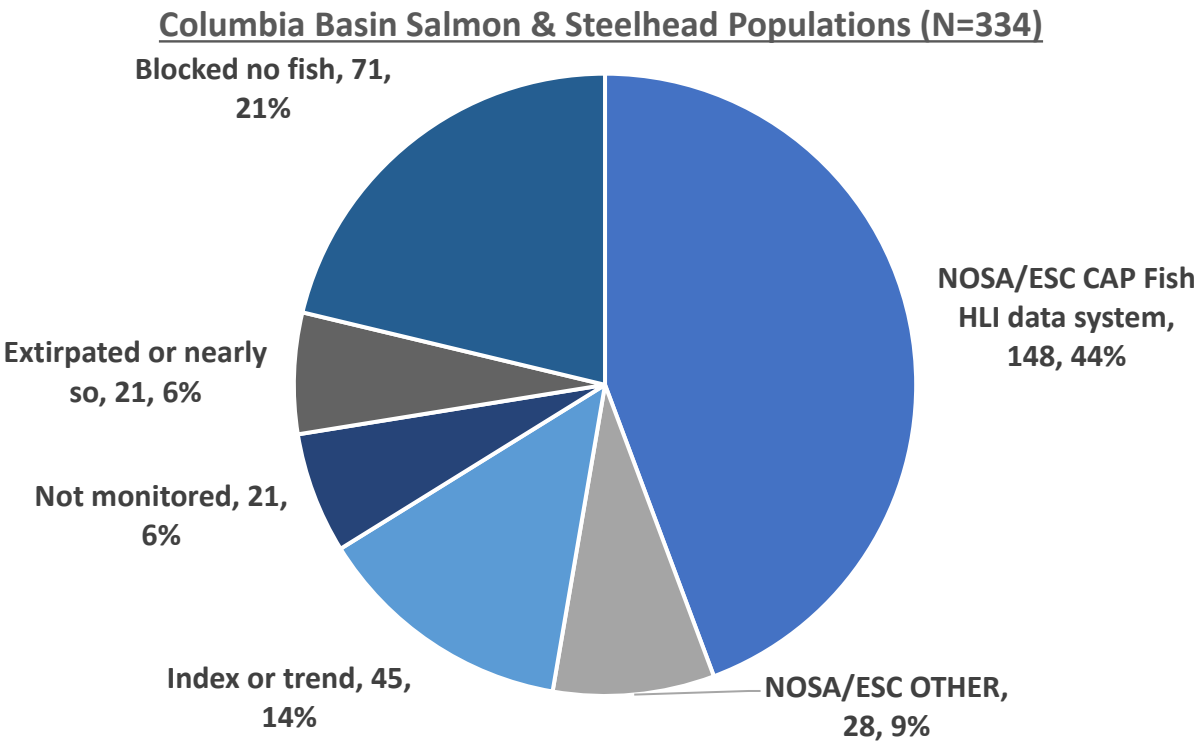


Table 13: Summary of data available form CAP Fish HLI and other sources for the population/stocks included in the 27 Columbia Basin Partnership Task Force groups.

Region	Group	NOSA/Esc HLI		Stream Net and other index or trend	Not monitored	Extirpated or nearly so	Blocked no fish	Total populations
		CAP Fish HLI	Other data source					
Columbia		148	28	45	21	21	71	334
	CBPTF Lower Columbia / SW Washington Winter Steelhead group	4	0	3	0	0	0	7
	CBPTF Lower Columbia Chum group	4	0	4	8	2	0	18
	CBPTF Lower Columbia Coho group	20	2	3	0	0	0	25
	CBPTF Lower Columbia Fall Chinook (bright) group	0	1	0	0	0	0	1
	CBPTF Lower Columbia Fall Chinook (late bright) group	2	0	0	0	0	0	2
	CBPTF Lower Columbia Fall Chinook (tules) group	16	0	4	1	0	0	21
	CBPTF Lower Columbia Spring Chinook group	2	1	4	1	0	1	9
	CBPTF Lower Columbia Summer Steelhead group	4	0	1	1	0	0	6
	CBPTF Lower Columbia Winter Steelhead group	9	2	2	4	0	0	17
	CBPTF Mid-Columbia Coho group	0	2	1	0	2	0	5
	CBPTF Mid-Columbia Sockeye group	0	2	0	0	0	0	2
	CBPTF Mid-Columbia Spring Chinook group	3	11	1	0	0	0	15
	CBPTF Mid-Columbia Summer Steelhead group	17	0	1	0	1	1	20
	CBPTF Mid-Columbia Summer/Fall Chinook group	0	1	0	0	0	0	1
	CBPTF Snake River Coho group	0	0	2	0	3	0	5
	CBPTF Snake River Fall Chinook group	0	1	0	0	0	1	2
	CBPTF Snake River Sockeye group	1	0	0	0	5	3	9

CBPTF Snake River Spring/Summer Chinook group	31	0	6	1	5	25	68
CBPTF Snake River Summer Steelhead group	20	0	3	1	0	16	40
CBPTF Upper Columbia Coho group	0	2	0	0	2	1	5
CBPTF Upper Columbia Fall Chinook group	0	2	1	1	0	1	5
CBPTF Upper Columbia Sockeye group	0	1	1	0	0	3	5
CBPTF Upper Columbia Spring Chinook group	3	0	0	1	0	6	10
CBPTF Upper Columbia Summer Chinook group	3	0	3	1	0	7	14
CBPTF Upper Columbia Summer Steelhead group	4	0	0	1	0	6	11
CBPTF Willamette Spring Chinook group	5	0	1	0	1	0	7
CBPTF Willamette Winter Steelhead group	0	0	4	0	0	0	4

X. Appendix D: Status Summary of Work Elements

Details of the work conducted for each work element is described in the appropriate section of the report.

A summary of the work element milestones for the Contract 78040 Rel 14 is publicly available from CBFISH.org https://www.cbfish.org/Contract.mvc/Milestones/78040%20REL%2017 . The more detailed statement of work with descriptions and status is provided below.

WE ID	Work Element Name	Title	Description	Type	Title2	Start	End	Status
185	Produce Pisces Status Report	Periodic Status Reports for BPA	The Contractor shall report on the status of milestones and deliverables in Pisces. Reports shall be completed either monthly or quarterly as determined by the BPA COTR. Additionally, when indicating a deliverable milestone as COMPLETE, the contractor shall provide metrics and the final location (latitude and longitude) prior to submitting the report to the BPA COTR.	SR	Oct-Dec 2020 (10/1/ 2020 - 12/31/ 2020)	1/1/ 2021	1/15/ 2021	Completed
185	Produce Pisces Status Report	Periodic Status Reports for BPA	The Contractor shall report on the status of milestones and deliverables in Pisces. Reports shall be completed either monthly or quarterly as determined by the BPA COTR. Additionally, when indicating a deliverable milestone as COMPLETE, the contractor shall provide metrics and the final location (latitude and longitude) prior to submitting the report to the BPA COTR.	SR	Jan-Mar 2021 (1/1/ 2021 - 3/31/ 2021)	4/1/ 2021	4/15/ 2021	Completed
185	Produce Pisces Status Report	Periodic Status Reports for BPA	The Contractor shall report on the status of milestones and deliverables in Pisces. Reports shall be completed either monthly or quarterly as determined by the BPA COTR. Additionally, when indicating a deliverable milestone as COMPLETE, the contractor shall provide metrics and the final location (latitude and longitude) prior to submitting the report to the BPA COTR.	SR	Apr-Jun 2021 (4/1/ 2021 - 6/30/ 2021)	7/1/ 2021	7/15/ 2021	Completed

185	Produce Pisces Status Report	Periodic Status Reports for BPA	The Contractor shall report on the status of milestones and deliverables in Pisces. Reports shall be completed either monthly or quarterly as determined by the BPA COTR. Additionally, when indicating a deliverable milestone as COMPLETE, the contractor shall provide metrics and the final location (latitude and longitude) prior to submitting the report to the BPA COTR.	SR	Final Jul-Sep 2021 (7/1/ 2021 - 9/30/ 2021)	9/16/ 2021	9/30/ 2021	Completed
159	Transfer/Consolidate Regionally Standardized Data	Support transfer of data into secure and accessible repositories	Work with BPA project sponsors and others, as needed, to assist in assuring that data are archived and backed up in repositories, as listed at monitoringresources.org, that are secure from catastrophic loss and are web accessible to specified data users.	DELIV	Support transfer of data into secure & accessible repositories		9/30/ 2021	Completed
189	Coordination -Columbia Basinwide	CA Data - coordination	The Coordinated Assessments project seeks to improve basin-wide assessments of salmon and steelhead population abundance and productivity indicators by improving how data are shared among agencies and tribes. StreamNet will provide leadership and coordination for the project, particularly its technical aspects. StreamNet will continue serving on theCAP Core Team and the Planning Group (CAPG). StreamNet will lead the DES Development Team to manage existing contents and to expand to new data types, and will participate in project meetings and workshops. StreamNet will work with partners to establish an exchange node on the EPA network forCAP data.	DELIV	Coordinated Assessment Leadership		9/30/ 2021	Completed
160	Create/Manage/Maintain Database	CA Data - DES and database	Manage the existing Coordinated Assessments Data Exchange Standard (DES) for the initial indicators and metrics. Continue development of regional data exchange standards using the regional coordination and collaboration approach as developed in theCAP project. Expand the DES andCAP databases to include additional metrics as they are adopted by the StreamNet Executive Committee and participating state and tribal agencies. Implement development of DES and databases in priority order as established by the road map of indicators for the next 5 years of the project identified by the StreamNet Executive Committee. Manage and QA theCAP data in a database conforming to the CA DES tables.	DELIV	The CA DES is maintained and updated		9/30/ 2021	Completed

159	Transfer/Consolidate Regionally Standardized Data	CA Data - compile data	Obtain the availableCAP indicator and supporting metrics, convert them into the DES format, and exchange them with theCAP database at PSFMC StreamNet. Work with partners to assist in data exchange between agency databases and the node.	DELIV	CA indicators and metrics are compiled	9/30/2021	Completed
160	Create/Manage/Maintain Database	CA Data - automated data exchange	Maintain automated feeds of theCAP data to theCAP database at PSMFC StreamNet (and to other client databases) via web services or other automated means.	DELIV	Automated feeds ofCAP data to theCAP database are implemented and evaluated	9/30/2021	Completed
161	Disseminate Raw/Summary Data and Results	Data - dissemination	StreamNet will disseminate theCAP indicator data by hosting a database for this data on the StreamNet website and/or by supporting access portals on NPCC or other regional fisheries management sites. Searchability and access to this information will be provided, consistent with Data Sharing Agreements, and made accessible for use by regional fish managers for review and decision-making. Maintain effective web-based tools that allow self-directed access to information on StreamNet. Respond to requests for data, maps and other information; source materials; and custom data products, with priority given to information requests having direct relevance to BPA, the Fish and Wildlife Program and data source agencies/departments. Work with PNAMP and Sitka Technologies to provide metadata for an online project and data locator tool on the MonitoringExplorer.org website. Develop and provide automated, user driven tools that integrate with data users to reduce workload. The Data Sharing Agreements forCAP and the StreamNet Data Store guide release and use of data sets. Provisions of the Agreements are implemented effectively, and the use of these agreements as templates for further sharing are explored for other databases.	DELIV	CA indicators, metrics and metadata are available	9/30/2021	Completed

159	Transfer/Consolidate Regionally Standardized Data	Compile high priority traditional StreamNet data	StreamNet will update selected high priority traditional Trend datasets and integrate them into theCAP query system. As regional priorities are established through collaboration and coordination, additional traditional data types may be included in a CA-type process for regional standardization, necessitating additional partnerships, such as with resident fish data managers. StreamNet will work with these partners collaboratively to develop, select indicators, compile data, and automate data flow as regional fish managers determine priorities for potential standardization of these new data types. The existing StreamNet DES and database for other fish metrics are maintained and data are loaded into the StreamNet database and quality assured as they are received.	DELIV	Specific high priority data sets are updated and maintained	9/30/2021	Completed
189	Coordination-Columbia Basinwide	Coordination	Participants in the StreamNet project will coordinate with a wide range of entities to assure data flow, improve data sharing, promote data standards, and encourage widespread adoption of modern information technology to improve fish and wildlife management and recovery programs. Highest priority for coordination activities will be for entities participating in the Fish and Wildlife Program (BPA, NPCC, PNAMP, Federal Caucus, FWP project sponsors, etc.) and the agencies and tribes in the StreamNet program. Additional coordination may take place to promote the acquisition of priority data, learn about data management developments, and to inform others about StreamNet functions. The project will be promoted through participation in technical and professional groups on an opportunistic basis.	DELIV	StreamNet coordinates to improve data sharing, data standards, and automated data flow	9/30/2021	Completed
160	Create/Manage/Maintain Database	Enhance data efficiency	Assist agencies in development of database systems and data management procedures forCAP data, traditional StreamNet data, and other fish metric information that increase the efficiency of data flow internally and externally, with focus on data collected as part of the regional fish and wildlife program. Work with PNAMP, private sector experts and other interested parties to coordinate ongoing regional review and discussion of the use of handheld electronic data capture devices in fisheries settings. Work will include assessment of certain devices, applications, 'cloud' database systems, and processes, as funds are available for purchase, deployment, and testing.	DELIV	Enhanced agency database procedures and systems	9/30/2021	Completed

160	Create/Manage/Maintain Database	Infrastructure and base operations	Maintain the infrastructure necessary for acquiring, managing and disseminating regionally standardized and georeferenced data, including system administration, databases, website pages, query systems, web services, and various data related applications. Maintain access to existing and historic data sets. Perform necessary operations to georeference, QA, maintain and manage data, and provide reference documents for all data to the StreamNet Library. Provide support and training to staff to maintain up to date operational system skills.	DELIV	Project infrastructure and databases are maintained		9/30/2021	Completed
119	Manage and Administer Projects	Manage project activities	Program direction is provided by a Strategic Plan and an Executive Committee made up of policy level representatives of StreamNet partners and regional management agencies and organizations. The focus of this group is to ensure that StreamNet is aligned with the data management needs and regional priorities established in the NPCC F&W program, recovery plans for listed species, and the participating agencies and tribes. Implementation of this direction and the SOW is completed with the help of a Steering Committee, made up of data management professionals from each partner agency, as well as representatives of other groups and organizations involved in data management. The oversight of personnel, work statement and budget preparation, coordination among participating agencies, and implementation of the program is completed by PSMFC StreamNet staff and funded employees embedded in partner organizations.	Draft New	Begin drafting contract renewal documents and conduct internal review as needed	1/30/2021	4/30/2021	Completed
119	Manage and Administer Projects	Manage project activities	Program direction is provided by a Strategic Plan and an Executive Committee made up of policy level representatives of StreamNet partners and regional management agencies and organizations. The focus of this group is to ensure that StreamNet is aligned with the data management needs and regional priorities established in the NPCC F&W program, recovery plans for listed species, and the participating agencies and tribes. Implementation of this direction and the SOW is completed with the help of a Steering Committee, made up of data management professionals from each partner agency, as well as representatives of other groups and organizations involved in data management. The oversight of personnel, work statement and budget preparation, coordination among participating agencies, and implementation of the program is completed by PSMFC StreamNet staff and funded employees embedded in partner organizations.	Cost Sh01	Facilitate inputting Cost Share information into Pisces at the Project level	9/30/2020	11/15/2020	Completed

119	Manage and Administer Projects	Manage project activities	Program direction is provided by a Strategic Plan and an Executive Committee made up of policy level representatives of StreamNet partners and regional management agencies and organizations. The focus of this group is to ensure that StreamNet is aligned with the data management needs and regional priorities established in the NPCC F&W program, recovery plans for listed species, and the participating agencies and tribes. Implementation of this direction and the SOW is completed with the help of a Steering Committee, made up of data management professionals from each partner agency, as well as representatives of other groups and organizations involved in data management. The oversight of personnel, work statement and budget preparation, coordination among participating agencies, and implementation of the program is completed by PSMFC StreamNet staff and funded employees embedded in partner organizations.	DELIV	Project is successfully administered	9/30/2021	Completed
132	Produce (Annual) Progress Report	Submit Progress Report for Calendar Year 2019	Produce a detailed annual report for Calendar year 2019, using BPA reporting tools in Taurus.	DELIV	Annual report submitted to BPA	9/30/2021	Completed
132	Produce (Annual) Progress Report	Submit Progress Report for Calendar Year 2020	The progress report summarizes the project goal, objectives, hypotheses (for research), completed and uncompleted deliverables, problems encountered, lessons learned, and long-term planning. Examples of long-term planning include future improvements, new directions, or any ramping up or ramping down of contract components or of the project as a whole. Non-technical Progress Reports must conform to BPA guidelines. See the "Non-technical Progress Report" link at: http://www.cbfish.org/Help.mvc/GuidanceDocuments. If producing a manuscript for a peer-reviewed publication, use work element 183: Produce Journal Article.	DELIV	Completed Annual Report	4/2/2021	Completed

XI. Definitions of Terms and Acronyms

API	Application Programming Interface. A published standard format for communicating with applications.
BiOp	Federal Columbia River Power System Biological Opinion (FCRPS BiOp)
BPA	Bonneville Power Administration
CAP	Coordinated Assessments Partnership. A collaborative process to efficiently share and provide access to standardized derived information, such as fish population high level indicators (HLI) and supporting metrics. The geographic scope of the CAP is the Pacific Northwest with a focus on sharing natural and hatchery origin fish information and fish habitat-related information, such as fish population high level indicators (HLIs) and supporting metrics.
CAP DDT	Coordinated Assessments Partnership Data Exchange Standard Development Team. The CAP DDT consists mainly of the data contributing partners' data management professionals and biologists who calculate the HLIs and metrics. The CAP DDT is a team serving under the StreamNet Steering Committee that in turn serves under the StreamNet Executive Committee. The CAP DDT also coordinates, as needed, with the StreamNet Technical Team and the StreamNet DDT.
CAX	Coordinated Assessments Data Exchange. This is the aggregated database of Coordinated Assessments indicators and metrics submitted by data source agencies and housed at StreamNet.
Colville Tribes	Confederated Tribes of the Colville Reservation
CHaMP	Columbia Habitat Monitoring Program
CRB or Basin	Columbia River Basin
CRITFC	Columbia River Intertribal Fish Commission
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CTWSRO	Confederated Tribes of the Warm Springs Reservation of Oregon
DES	Data Exchange Standard. The DESs is the set of formal rules for the structure of data elements for a data category, and documents agreements on the representation, format, definition, structuring, tagging, transmission, manipulation, use, and management of data in which data are shared. The document that holds the various DES for the different data categories in a database is referred to as the DES Document.

EN	Exchange Network: Nationwide data repository and exchange that resides within the EPA for EPA related data
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary significant unit
FCRPS BiOp	Federal Columbia River Power System Biological Opinion
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
HEP	Habitat Evaluation Procedures. HEP are used to evaluate and document habitat losses and habitat gains. HEP is used to quantify the impacts of development, protection, and restoration on terrestrial and aquatic habitats by assessing changes, both negative and positive, in habitat quality and quantity.
HLI	high level indicator representing the estimated value for a group of fish, such as the natural origin spawner abundance estimate for a specific salmon population.
HSRG	Hatchery Scientific Review Group. HSRG is an independent scientific panel under the Pacific Northwest Hatchery Reform Project that reviewed hatcheries and developed comprehensive reform recommendations to improve the hatcheries role in meeting harvest and conservation goals for Pacific Northwest salmon and steelhead.
IDFG	Idaho Fish and Game's mission is to protect, preserve, perpetuate and manage Idaho's wildlife resources. A 1938 voter initiative created the Idaho Fish and Game Commission structure that governs the agency today.
ITMD	Inter-Tribal Monitoring Data. The purpose of CRITFC's ITMD project is to assist CRITFC and its member tribes in the timely and accurate capture, storage, processing, and dissemination of data for management of anadromous fish and their habitats. The CRITFC ITMD, by coordinating and integrating appropriate activities with the CAP, ensures consistent data sharing with the CAX data system for Basin salmon and steelhead high level indicators and related trend data.
MFWP	Montana Fish, Wildlife, and Parks. MFWP provides for the stewardship of the fish, wildlife, parks, and recreational resources of Montana, while contributing to the quality of life for present and future generations,
MR	Monitoring Resources
NED	Northwest Environmental Data Network

NOAA or NOAA-F	National Oceanic and Atmospheric Administration Fisheries, NOAA-F is responsible for the stewardship of the nation's ocean resources and their habitat. NOAA Fisheries provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems—all backed by sound science and an ecosystem-based approach to management.
NOSA	Natural Origin Spawner Abundance. Number of natural origin fish that actually spawn, not necessarily the number of fish returning to a spawning area.
NPCC or Council	Northwest Power and Conservation Council. The 1980 Northwest Power Act authorized Idaho, Montana, Oregon, and Washington to develop a regional power plan and fish and wildlife program to balance the Northwest's environment and energy needs. The heart of the Council's mission is to preserve the benefits of the Columbia River for future generations.
NPT	Nez Perce Tribe
NWIFC	Northwest Indian Fisheries Commission
OBMEP	Okanogan Basin Monitoring and Evaluation Program
ODFW	Oregon Department of Fish & Wildlife. ODFW mission's is to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations.
OWEB	Oregon Watershed Enhancement Board
PNAMP	Pacific Northwest Aquatic Monitoring Partnership. PNAMP is a forum to facilitate collaboration around aquatic monitoring topics of interest, promote best practices for monitoring, and encourage coordination and integration of monitoring activities as appropriate.
PNI	Proportionate natural influence. PNI is an estimate of the relative selection pressure of the natural environment in an integrated natural / hatchery population.
PNW	Pacific Northwest
PSMFC	Pacific States Marine Fisheries Commission. As stated by the governing compact, PSMFC's purpose shall be "to promote the better utilization of fisheries – marine, shell, and anadromous, which are of mutual concern, and to develop a joint program of protection and prevention of physical waste of such fisheries in all of those areas of the Pacific Ocean over which the compacting states jointly or separately now

	have or may hereafter acquire jurisdiction." Member states include California, Oregon, Washington, Idaho, and Alaska.
PTAGIS	Pit TAG Information System
QA	Quality Assurance, the process of ensuring that the development effort will result in the desired product. Quality assurance focuses on defect prevention. Typical quality assurance tools are check lists, project audits, and documented standards. QA activities typically occur up-front in a project.
QC	Qualty Control, the process of verifying that product deliverables are complete, correct, and meet expected outcomes. Quality control focuses on defect identification. Typical quality control tools include products inspections and testing processes, and peer reviews. QC activities occur at the end of a project.
QA/QC	Quality Assurance/ Quality Control
RperS	Recruit per spawner ratios are specific to the locations and seasons described in each record of data. The number of "recruits" can be defined at any life stage.
REST	Representational State Transfer. For our purpose, this is a simple type of web service that is generally implemented via the common HTTP protocol (browser speak).
RMPC	Regional Mark Processing Center
RMIS	Regional Mark Information System
SARs	Smolt to adult returns. For natural origin fish this is the point estimate of the number of returning natural origin adults, divided by the point estimate of the number of smolts that produced those returning adults. This value is multiplied by 100 to obtain a percentage.
SBT	Shoshone-Bannock Tribes of Fort Hall
SOW	Statement of Work, from BPA contracts to describe Work Elements (WE)
SN ExCom	StreamNet Executive Committee provides policy-level guidance and decision-making for StreamNet and the CAP. The primary role of the SN ExCom is to ensure alignment with regional data management and sharing needs, that tasks are focused on achieving strategic goals, and that resources are allocated to regional and agency priorities.

SN SC	StreamNet Steering Committee. The Steering Committee provides support, guidance and oversight of progress for the StreamNet Program.
Status and Trends	"Status" describes the current condition of whatever is measured; "trends" described changes over time
StreamNet	Pacific States Marine Fisheries Commission's StreamNet Program that is a cooperative information management and data dissemination project focused on fisheries and aquatic data and data-related services in the Pacific Northwest, with a focus on the Columbia River Basin. , also name for a BPA funded project
Trend	Long-term temporal pattern (i.e. change over time) in what you are monitoring.
TRT	Technical Recovery Teams
USEPA	United States Environmental Protection Agency
USFWS	United States Fish & Wildlife Service. USFWS is the premier government agency dedicated to the conservation, protection, and enhancement of fish, wildlife and plants, and their habitats. USFWS is the only agency in the federal government whose primary responsibility is the conservation and management of these important natural resources for the American public.
USGS	United States Geological Survey
VSP	viable salmon population
WA GSRO	Washington Governor’s Salmon Recovery Office
Wed Services	is platform-neutral, vendor-independent protocols that enable distributed processing to be performed using XML and Web-based technologies. Sometimes instantiated as remote procedures calls in which the request is an XML document. Or as more simply defined by StreamNet, an “always-on” function available at a specific World Wide Web address.
WDFW	Washington State Department of Fish & Wildlife. WDFW is dedicated to preserving, protecting, and perpetuating the state’s fish, wildlife, and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities.
YN	Confederated Tribes and Bands of the Yakama Nation

XII. References / Endnotes

[i] NPCC 2012/2013 Decision Memorandum: Council recommendations on Resident Fish, Data Management and Regional Coordination Category Reviews – projects and associated programmatic issues https://www.nwcouncil.org/sites/default/files/CouncilDecision_0.pdf

[ii] NPCC 2012 Program Evaluation and Reporting Committee https://www.nwcouncil.org/fw/program/perc and the November 2012 Council recommendations based on the PERC https://www.nwcouncil.org/sites/default/files/2012_1106_1.pdf

[iii] NPCC 2019, Committee Recommendations on mainstem and Program Support Project Review: Project Implementation and Programmatic Issues https://www.nwcouncil.org/sites/default/files/2019_0716_f1.pdf; Council recommendations from August 2019 are similar https://www.nwcouncil.org/fish-and-wildlife/fish-and-wildlife-program/project-reviews-and-recommendations/mainstem-review

[iv] 2019 version of the Five-Year Plan for Coordinated Assessments, revised September 2, 2020 https://www.streamnet.org/wp-content/uploads/2020/10/Five-Year-Plan-for-Coordinated-Assessments-rev20200902-Final.doc

[v] 2021-2026 StreamNet Vision and Strategic Plan, September 2, 2020, https://www.streamnet.org/wp-content/uploads/2020/10/StreamNet-Vision-Strategic-Plan-Final-Adopted20200902.doc

[vi] NOAA Fisheries Biological Opinion for operation and maintenance of the Columbia River System Operations and related documents https://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2008FCRPSBiOp.aspx

[vii] NPCC July 2019 Committee Recommendations on mainstem and Program Support Project Review: Project Implementation and Programmatic Issues https://www.nwcouncil.org/sites/default/files/2019_0716_f1.pdf; Council recommendations from August 2019 are similar https://www.nwcouncil.org/fish-and-wildlife/fish-and-wildlife-program/project-reviews-and-recommendations/mainstem-review

[viii] For more details see the Project Summary: https://www.cbfish.org/Project.mvc/Display/1988-108-04 and past and current Contract Summary: https://www.cbfish.org/Contract.mvc/Summary/66435

[ix] StreamNet Data Store https://app.streamnet.org/datastore_search_classic.cfm

[x] Columbia Basin Fish & Wildlife Library hosted by CRITFC https://cbfwl.org/

[xi] StreamNet subbasin plans and achieved datasets used during the NPCC2001-2004 subbasin planning effort https://www.streamnet.org/services/technical-assistance-to-agencies-and-tribes/subbasin-plans-archived-datasets/

[xii] NPCC FW Program Protected Areas documentation, river reach, and online Protected Areas database and interactive map https://www.streamnet.org/data/protected-areas/

[xiii] Habitat Evaluation Procedures (HEP) https://www.streamnet.org/hep

[xivxiv] Hatchery Reform Project http://hatcheryreform.us/

[xv] NPCC FW Program Strategy for *Fish Propagation including hatchery programs* https://www.nwcouncil.org/reports/2014-columbia-river-basin-fish-and-wildlife-program/b-fish-propagation-including-hatchery-programs

[xvi] Hatchery scientific review group's products resulting from the hatchery reform project http://hatcheryreform.us/

[xvii] StreamNet Fish Monitoring Data (replaces the previous StreamNet Query – Abundance Estimates and Indexes at Local Scales) https://www.streamnet.org/data/trends/

[xviii] GIS Data & Mapping Applications https://www.streamnet.org/data/interactive-maps-and-gis-data/

[xix] StreamNet Fish HLI query https://cax.streamnet.org

[xx] PNAMP 2009 annual report https://www.cbfish.org/Document.mvc/Viewer/P115609
[xxi] PNAMP 2010 annual report https://www.cbfish.org/Document.mvc/Viewer/P120754
[xxii] PNAMP 2018 annual report https://www.cbfish.org/Document.mvc/Viewer/P167990
[xxiii] Inter-Tribal Monitoring Data (ITMD) Project Work Group. 2022. Inter-Tribal Monitoring Data Project Strategic Plan: January, 2022 - December, 2026. Columbia River Inter-Tribal Fish Commission. 25 pages.
[xxiv] HEP archived data and documents http://www.streamnet.org/hep.
[xxv]NOAA and USFWS engagement in the hatchery reform project and the hatchery scientific review group https://www.nwfsc.noaa.gov/research/divisions/efs/hatchery/review.cfm ; products produced by the hatchery scientific review group for the hatchery reform project http://hatcheryreform.us/