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# International Year of the Salmon Ocean Observation System Phase 1 Interim Report

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Brett Johnson and the IYS-OOS Steering Committee

Hakai Institute

1713 Hyacinthe Bay Road, Heriot Bay, BC, Canada

## *Executive Summary*

An agreement was signed between the Hakai Institute and the North Pacific Anadromous Fish Commission on February 3rd, 2020 for Hakai to scope and review the requirements of data management for data collected by the International Year of the Salmon high seas research expeditions in the North Pacific. This report summarizes progress made during the 2019/20 fiscal period towards mobilizing 2019 data, and defining a Data Management & Communications Model for future expeditions.

We recommend that the International Year of the Salmon collaborative project adopt, implement, and extend the Global Ocean Observation System for measuring Essential Ocean Variables. The Global Ocean Observation System is a project of the United Nation's Intergovernmental Oceanographic Commission and unifies networks of scientists around the world. Adopting international standards such as the Ocean Biogeographic Information System, and FAIR (Findable, Accessible, Interoperable, Reusable) Data principles that are widely recognized will ensure a multilateral approach to the standardization of salmon ocean ecology data.

Data collected by the 2019 research cruise is currently being processed and reviewed by expedition team members. The goal is to have data centrally accessible in an International Year of the Salmon Ocean Observation System. Our first step was collecting metadata from the expedition Scientists. Next, we aim to publish metadata records in a Catalogue which will make the datasets 'Findable'. After our process, datasets will be made 'Accessible' from a metadata catalogue record by providing a link to download data. We conducted a thorough review of the 2019 data we had access to, which is roughly half, and noted issues and missing metadata. We also developed a Dataset Submission Form for expedition data holders (see link below) to upload datasets with a complete suite of metadata that describes collection protocols so critical for data integration.

The core components of the Data Management and Communications model include: 1) a Data Catalogue that centralizes data access through a web portal; 2) Catalogue records compliant with ISO 19115 that make the datasets broadly discoverable; 3) Open-access licensing; 4) Open Data Access Protocols, specifically ERDDAP data servers, where necessary and; 4) Controlled Vocabularies that define the variables, methods, units, and measurement types used in salmon ocean ecology adhering to 'Ocean Best Practices' maintained by the Global Ocean Observation System.

## *Introduction*

The North Pacific Anadromous Fish Commission (NPAFC) is implementing a five-year International Year of the Salmon (IYS) collaborative project through 2022 to set the conditions for the resilience of salmon and people in a rapidly changing world. Partners are collaborating for a Pan-Pacific Expedition in March 2021 with up to five vessels simultaneously surveying the North Pacific. Multi-disciplinary programs across at least a dozen institutions and agencies will generate a complex set of data in the 2021 surveys. Success will ultimately demand that standardized and integrated data are available to researchers involved in the work at sea and those who will work with it into the future. It is also important that these data are open, readily accessible to all, and comply with the principles of FAIR data. The NPAFC and the Hakai Institute with support from the BC Salmon Restoration and Innovation Fund and the Tula Foundation are conducting a review of approaches to data standardization and acquisition to support the standards, collection methods, storage, and analysis of data collected during the five-vessel survey. Brett Johnson will serve as the Technical Lead under direction from a Steering Committee and lead a small development team based at the Hakai Institute Quadra Island Ecological Observatory. The objective of this report is to summarize progress made in defining a Data Management and Communications model and consolidating 2019 Expedition data.

## *Data Management and Communications Model*

The proposed model will be founded on protocols and standards for archiving and providing open access to data put forward by the Global Ocean Observation System (GOOS). GOOS is a program that is coordinated by the Intergovernmental Oceanographic Commission of UNESCO (United Nations Educational, Scientific and Cultural Organization). GOOS is governed by a multinational Steering Committee, three scientific domain Expert Panels, and Observation Coordination Groups of people and organizations worldwide. GOOS is partnered with expert agencies in biological data—namely the Ocean Biogeographic Information System (OBIS), Biodiversity of Life Online Database (BOLD) and the Marine Biodiversity Observation Network (MBON), among others. These organizations promote and/or develop the use of Controlled Vocabularies. Standards like this encourage interoperability and reuse of data. We recommend using established international standards connected to GOOS where available, and extending or developing standards where needed. The product of this strategic alignment and development we can call the International Year of the Salmon Ocean Observation System (IYS-OOS) for now.

For every data element, method, platform, and variable produced by the IYS High Seas Expeditions the following tasks need to be completed:

- **Prioritize.** Determine whether the data element naturally belongs in IYS-OOS (with possible GOOS BioEco extensions). Such elements will be processed first because the requirements are well-defined. For data elements that do not naturally belong in IYS-OOS, determine whether there is a recognized and compatible repository where they belong and can be federated or linked to the IYS-OOS.

- **Publish.** For all data elements, generate appropriate and valid metadata records and insert them into the metadata catalogue on the IYS Data Portal, so that they are discoverable by IYS users.
- **Process.** Work closely with the data provider to bring fully validated and standardized copies of data elements into the appropriate repositories.
- **Communicate.** Representatives from each scientific discipline involved with the IYS should connect through a working group that disseminates and advocates for best-practices.

For the 2021 cruise to be successful, the establishment of a data standards science-team made up of a relevant representation of stakeholders needs to be established as soon as possible to begin to prioritize and establish common data standards.

## *Progress*

### **Data Processing**

A number of datasets were delivered to Hakai from holdings that Drs. Evgeny Pakhomov and Brian Hunt had access to. A Google Drive folder was set up to hold data for the short-term. To receive data more efficiently, a Dataset Submission Google Form and a static Word doc. form were created to capture metadata. A number of these need to be filled out still (Table 1.). We've looked through all of the 2019 data we have access to at this time, which is less than half of the expected datasets. We noted issues and missing metadata for the 2019 data and are now soliciting feedback and collaboration with expedition scientists.

Table 1. Gulf of Alaska Expedition 2019 dataset status, and contacts as of March 31, 2020. Feedback from Chief Scientists is needed to adjust the accuracy of this table.

Dataset	Status	Contact
Chlorophyll-a	Received	Brian Hunt, Evgeny Pakhomov
Chum stock ID	Not received	Shigehiko Urawa, Terry Beacham
Coho stock ID	Not received	Christoph Deeg, Chrys Neville
CTD	Received	?
eDNA	Not received	Christoph Deeg, Kristi Miller
Fish energy density	Not received	Brian Hunt, Chrys Neville, Charlie Waters
Fish Trawl Abundance	Not received	Chrys Neville, Sventlana Esenkulova, Vladimir Radchenko
HPLC	Not received	Vishnu Perumthuruthil Suseelan, Maycira Costa
Hydroacoustic	Received	Evgeny Pakhomov
Nutrients	Received	Anna Vazhova
Oxygen	Received	Anna Vazhova
Pathogens	Not received	Kristi Miller, Christoph Deeg
Pink stock ID	Not received	Charlie Waters
Plastics	Received	Gennady Kantakov
POM	Received	Brian Hunt
Real-time Coho stock ID	Not received	Christoph Deeg

Dataset	Status	Contact
Salmon diet data	Received	Brian Hunt, Evgeny Pakhomov
Sockeye stock ID	Not received	Christoph Deeg, Chrys Neville
Zooplankton [Bongo Net]	Not received	Brian Hunt, Evgeny Pakhomov
Zooplankton [Juday net]	Received	?

## Conferences and Meetings

### North Pacific Steering Committee

We presented the idea of applying the GOOS framework to the IYS first at the North Pacific Steering Committee meeting in Vancouver, BC. on February 26 and 27. We received good feedback including consensus from everyone that the data should generally be considered ‘Open’. Next was whether or not there would need to be further discussion on more specific data licenses. Timelines and deadlines for data publication need to be established for post docs and students utilizing these data 1-2 year embargo period. Modelling data access after a PICES/ICES standard was suggested and seems appropriate. Further to that, the point was brought up that we should be thinking about the legacy of these types of systems for which there was general consensus that no one wanted another database to maintain. This was an opportunity to highlight the ‘federated’ approach we plan to take with data storage. Federating in this sense means having a record in the IYS metadata catalogue that sometimes points to the data in an externally established and certified repository that we don’t maintain. The question of when data should be made public came up, and it was noted that some datasets will have embargo periods but that metadata could be published immediately in most cases. Lastly, the question of who will maintain the data long term was asked. A Data Synthesis centre was proposed which is one option. The development of a community of organizations networked in partnership.

### North Pacific Working Group

We discussed the need for user stories from scientists related to sharing data. A survey for the expedition participants and others was suggested. Vladimir highlighted that the timing of the wrap-up symposium was perhaps too close to the final survey. I agree with Vladimir’s concern and I think it would be wise to view the success of this project as the establishment of best-practice. The demonstration of data collection, consolidation, quality control, analysis, and knowledge generation in near real-time for the symposium may only be for a subset of data, depending on the stage of standardization each research domain is able to achieve. The major highlight was the decision to propose a 1-year ‘Data Standards Study Group’ under the umbrella of the NPAFC with participation either directly or indirectly from scientists from each country and each Research Domain identified for the 2021 Expedition. Those Research Domains include: Physical/biogeochemical Oceanography, Biological Oceanography, Modelling, Feeding Ecology and Energetics, Salmon distribution, Abundance and Migration, Genomics and Stock ID, and Micro plastics.

## Development of a Data Strategy

Beyond the recommendation of technical infrastructure and standards, there needs to be a long-term strategy that effectively engages important stakeholders and deepens the impact of data mobilization. This should be a primary focus of, but not limited to, the first phase of the IYS-OOS. Strategic objectives could be modelled after the GOOS 2030 strategy and include 1) Deepening Engagement and Impact; 2) System Integration and Delivery; and 3) Building for the Future.

## *Network of Partners and Key Affiliates*

### Steering Committee

An executive-level steering committee will provide technical and strategic advice on the project while Hakai and NPAFC will retain administrative oversight. Steering Committee participants will include:

- Eric Peterson/Brett Johnson – Hakai Institute
- Mark Saunders/Stephanie Taylor– NPAFC
- Dick Beamish and Brian Riddell – 2019 and 2020 Expeditions/Pacific Salmon Foundation
- Bruce Patten – DFO Pacific Biological Station and OBIS Canada Node Manager
- Erin Satterthwaite – GOOS BioEco Expert Panel Member
- Brian Hunt – University of British Columbia Institute of Oceans and Fisheries, Expedition Scientist
- Expedition Chief Scientists

### Development Groups

The development of the data model will rely heavily on input from expedition scientists, project affiliated Scientists, Professors, and others. Within each scientific domain planned for the 2021 cruise, there should be representation in working group tasked with determining international data standards that apply to their domain of expertise.

Hakai Staff and affiliates to consult as needed:

- Eric Peterson. Strategic direction.
- Ray Brunsting. Hakai Chief Technology Officer.
- Matt Foster. Hakai Chief Data Architect.
- Jennifer Jackson. Physical oceanographer for Hakai.
- Brian Hunt. A faculty member at UBC and the head of Hakai salmon program

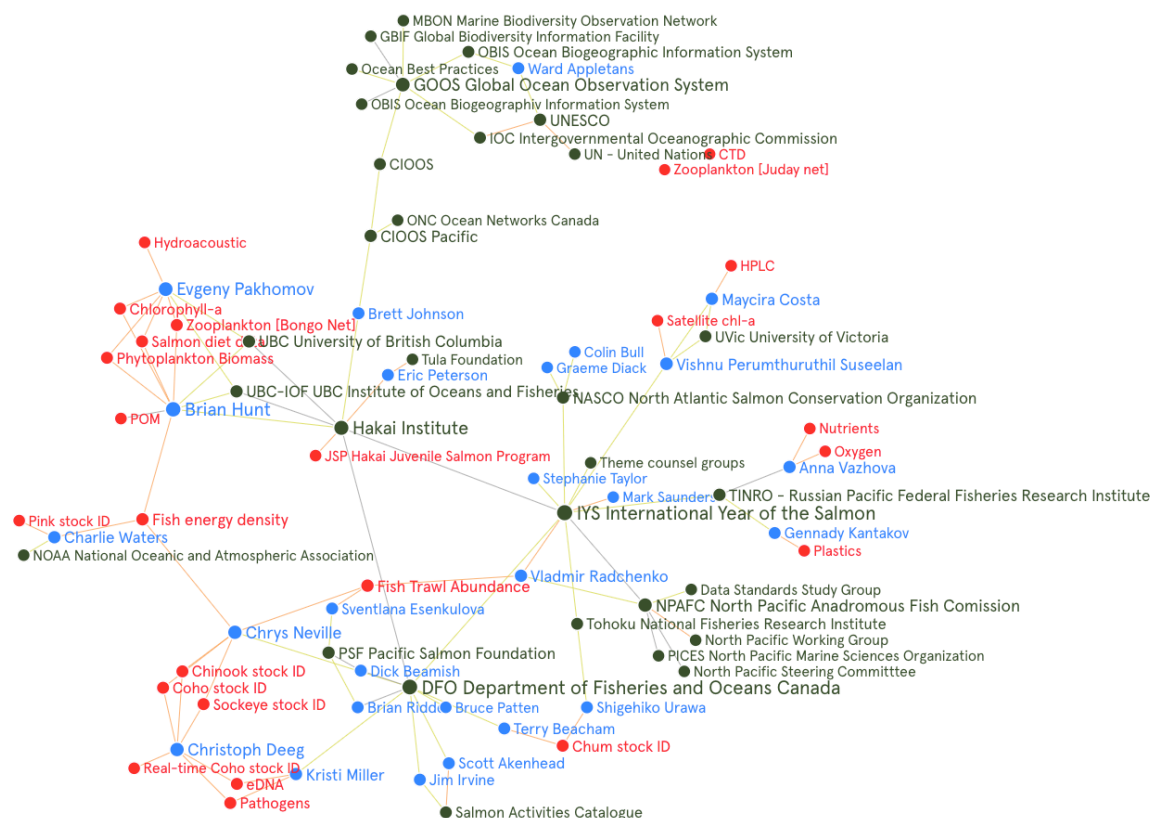


Figure 1: Graph network of the people, organizations, and data related to the International Year of the Salmon 2019 Expedition

## *Road map for IYS Data Mobilization*

Here is the proposed road map and timeline which will be refined before finalization for May 30, 2020.

- Produce a comprehensive Data Strategy May 30, 2020
- Begin Building Data Management and Communication Model June 1, 2020
- Establish 2021 cruise Data Standards Group ASAP
- Bring 2019 Cruise Data into the Correct Repository(s) TBD 2020
- Bring 2020 Cruise Data into the Correct Repository(s) TBD 2020
- Plan 2021 Cruise Data Management TBD 2020
- Integrate 2019, 2020, and 2021 cruise data TBD 2021
- Extend GOOS framework into Salmon Ocean Ecology and Integrate with Salmon Activities Catalogue TBD 2021

## *Time Sensitive Challenges*

Methods used in the field need better documentation in the metadata associated with each dataset produced on the expedition. Many metadata records are still missing. Metadata includes information such as equipment and platform descriptions, calibration files, instructions for how data were summarized or aggregated, and any caveats for data interpretation etc... This will help in ensuring the scientific integrity of the consolidated data sets. Dataset ‘Quality’ levels will eventually be assigned based on completeness of metadata collection and integrity of data provenance. Development of these guidelines among research domains is pressing.

Trawl catch data has not yet been received. My current understanding indicates that the dataset structure is under development, and that expedition Scientists are working on this. Please understand that access to raw outputs and the detailed processing steps that occur to transform data are needed for complete data provenance. Keeping track of changes to raw data will help us ensure reproducibility, which is becoming commonly required in life sciences journals despite it being a high bar to aim for. Using a change log to manually document changes ensures that reproducibility can be achieved when data cleaning is performed ad hoc such as removing outliers during quality control procedures, etc. Otherwise, we recommend moving to using automated version control, scripted data transformations and a metadata standard that canonically defines variables. This will help scientists collaborate on common data and analyses using modern cyber infrastructure that is already in place.

Translation of data is still needed for some datasets, including Juday Net zooplankton hauls. Translators with domain specific knowledge of the data need to be identified. There are also a number of questions we have related to specific data sets that we keep track of here for expedition scientists/data providers to view and respond to. We recommend the ad hoc development of data standards group, in advance of formal designation from overseeing bodies ASAP. We advocate for a core group comprised of representatives of each research domain (physical oceanography, salmon feeding ecology etc.) and representation from as many member nations and stakeholders as feasible.

## *Next Steps*

### **Produce a Data Strategy Document that will:**

- Identify project milestones for 2020, 2021, and 2022 and requisite steps to success
- Describe the foundation for a new best-practice approach to provide open and FAIR access to salmon, oceanographic, and climatic data integrated from numerous sources.
- Propose a survey of key data providers to deepen engagement.

### **Begin Building Data Management & Communication Framework**

Start building a data management and communication framework that initially comprises:

- A web-based IYS Data Portal. We propose to follow the lead of DFO/CIOOS and



implement a cloud-based solution with Amazon Web Services, utilizing the Montreal data centre to host a data catalogue/portal.

- A metadata catalogue (we propose to follow DFO/CIOOS and employ CKAN), which allows for data discovery across the federated system.
- A GOOS-compatible repository for physical and biogeochemical data acquired on the expeditions.
- Solutions for other data types: either as natural extensions of the GOOS model, as contemplated under the GOOS Bio Eco, or in other repositories, as mandated by our modelling decisions.
- Concentrate first on the data types acquired during the 2019 cruise.

## *Links and Resources*

- IYS-OOS GitHub Repository
- Please comment on this document issues in github
- Temporary ‘AirTable’ IYS-OOS Database
- Template CKAN Catalogue
- Global Ocean Observation System
- OBIS ENV-DATA Darwin Core Archive Data Structure
- Good enough practices in scientific computing