

## The International Year of the Salmon makes Progress towards a Pan-Pacific Expedition in 2022

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A team of 12 scientists from Canada, the Russian Federation and the United States at the launch of the 2020 Gulf of Alaska Expedition in Victoria, BC, March 11, 2020.

### Introduction

Despite the unprecedented challenges presented by the COVID-19 pandemic, the International Year of the Salmon (IYS) initiative continues to make progress towards its mission to set the conditions for the resilience of salmon and people in a changing world. As we work to better connect institutions and people, and to generate the knowledge we need to manage salmon in a context of highly uncertain socio-ecological conditions, we are focused on three priorities:

1. Implementing a Pan-Pacific Expedition to test a partnership-driven approach to monitoring and understanding the mechanisms affecting salmon and related species in the high seas;
2. Mobilizing salmon and associated ecosystem data to expedite rapid synthesis and analyses from local to international scales; and
3. Developing analytical methods and decision support-tools to synthesize and communicate the cumulative impacts of socio-ecological changes which are affecting salmon from feeding areas on the high seas to freshwater spawning grounds.

### 2019 and 2020 International Gulf of Alaska Winter Expeditions

For the last 100 years, researchers have been trying to find the missing pieces which could help explain the mechanisms behind trends in salmon abundance and production throughout the Northern Hemisphere. In 2019, through a concerted international effort on the part of the North Pacific Anadromous Fish Commission (NPAFC) and chief organizers Dr. Richard Beamish (DFO emeritus scientist at the Pacific Biological Station in Nanaimo) and Dr. Brian Riddell (science advisor for the Pacific Salmon Foundation), the first salmon winter ecology survey in decades was completed in the Gulf of Alaska aboard the Russian R/V *Professor Kaganovskiy*. This expedition featured 21 scientists from Canada, Japan, the Republic of Korea, the Russian Federation, and the United States working together to study salmon in winter on the high seas. The 2019 Expedition was a first step in addressing knowledge gaps in salmon winter ecology survey work in the central Gulf of Alaska region. This year, on March 11, 2020, just one week before most of the world went into lockdown due to the novel COVID-19 pandemic, a team of 12 scientists from Canada, Russia and the United States embarked on a second month-long salmon winter ecology survey into the Gulf of Alaska.

The scientific team and crew set out to build on the research that was conducted on the 2019 International Gulf of Alaska Expedition. This year, the survey was conducted aboard the *Pacific Legacy No. 1*, a Canadian commercial fishing vessel which was transformed into a research vessel for the purpose of the expedition by Captains Brian Mose and John Roach. The research area was approximately 648,000 km<sup>2</sup> and was covered between March 11 and April 7, 2020. Altogether, a total of 566 salmon (234 chum salmon, 118 coho salmon, 51 sockeye salmon, 136 pink, 26 Chinook salmon, and 1 steelhead) were caught during the trawl survey. The 2019 and 2020 Gulf of Alaska Expeditions were the first major studies of the winter ecology of Pacific salmon in the NE Pacific Ocean in decades, and what is learned will inform plans for a pan-Pacific expedition that is being planned for 2022. Altogether, these three expeditions will form a baseline of observation and experience that will be used to develop a long-term, international approach to monitoring and understanding the changes taking place in the North Pacific Ocean (NPO) and their impacts on salmon and people.

The IYS has played an ongoing role in bringing together scientists from around the Northern Hemisphere to share their results from these expeditions and communicate them to interested audiences. Due to the pandemic, traditional press and media events were not possible. However, the IYS held virtual press conferences as well as a scientific briefing and information session for funders and friends of the Expedition in June, when preliminary results were discussed by Dr. Beamish and Dr. Riddell.



Scientists on the 2020 Gulf of Alaska Expedition collecting their trawl net catches.

Both the 2019 and 2020 Expeditions showed differences in the distribution among the five salmon species. Some species also appear to have associations with certain environmental conditions such as temperature and prey abundance. In 2020, the distribution of trawl net catches was patchier than the previous year. This, in combination with video observations of groups of salmon entering the trawl and some very large differences in hauls that were repeated several weeks apart, suggest that salmon may school more than previously believed. This has implications for survey design and future research.

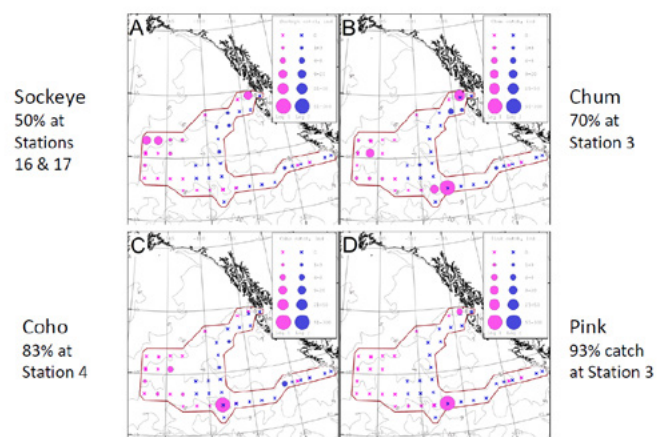
#### Comparison of Salmon Catches between years ...

Salmon catches during the 2019 versus 2020 studies were similar but different in important ways.



Year	2019	2020
<b>Trawl sets:</b>	58	52
<b>Salmon catches:</b>		
Chum	222	234
Pink	30	136
Sockeye	68	51
Coho	94	118
Chinook	3	26
Steelhead	0	1
<b>Total</b>	<b>417</b>	<b>566</b>
<b>Estimated total abundance in Millions</b>	<b>55.00</b>	<b>51.30</b>

increase in odd years in this area. However, they were the least abundant in the catches, apart from Chinook. In 2020,



once again, the scientific team and crew did not find many pink salmon, which should have been three times more abundant than chum salmon in the survey area, despite the overall catches being larger than in 2020 (Fig. 1). In both years, the more abundant species in the catches were coho salmon, which scientists expected to stay closer to coastal waters. We look forward to 2022, when we plan to provide broad spatial coverage to encompass the full range of each species.

The application of new genomic technologies was front and centre during these expeditions. The results from studies on board utilizing eDNA to determine species presence, near real-time genetic sequencing of salmon populations at sea, and assessments of pathogen load and physiological condition of salmon will be available shortly. Laboratory processing has been delayed by COVID-19.

In October 2020, during the PICES Annual Meeting, a topic session entitled "Implementing a collaborative, integrated ecosystem high seas survey program to determine climate/ocean mechanisms affecting the productivity and distribution of salmon and associated pelagic fishes across the North Pacific Ocean" was held, which included talks from key scientists associated with both the 2019 and 2020 Gulf of Alaska Expeditions. We encourage everyone to view the recorded talks to learn more about the results we have to date.

The 2019 and 2020 International Gulf of Alaska (GOA) Expeditions have already advanced our understanding of the winter ecology of Pacific salmon in the NPO and scientists are anxiously waiting to analyze the remaining data from the 2020 Expedition as labs are reopening from the pandemic lockdown. Overall, Dr. Beamish and Dr. Riddell believe that forecasting salmon returns can be improved using data from these surveys and suggest that after two years of single vessel surveys, sampling millions of square kilometres of ocean, it's apparent that a large integrated survey with multiple vessels is required to cover vast regions of the North Pacific Ocean simultaneously in order to learn about the lives of salmon across the North Pacific.

### 2022 Pan-Pacific Winter High Seas Expedition

Changing climate and associated anomalous events in the NPO are progressively exposing Pacific salmon to conditions outside the normal climate cycles. Pacific salmon are a uniquely important cultural, commercial, and biological resource for countries of the North Pacific rim, but there remain significant gaps in our understanding of the mechanisms that regulate salmon distribution, productivity, and survival in coastal and high seas environments. In a major effort to begin to fill in these gaps, as many as four vessels will go to sea in late winter 2022 to conduct the first ever pan-Pacific, epi-pelagic ecosystem survey sampling the biological, chemical and physical oceanography and biota, including salmon and related fishes. While originally scheduled to take place in the winter of 2021, the unprecedented circumstances of the COVID-19 pandemic has led to rescheduling the Pan-Pacific Winter High Seas Expedition to winter 2022.

The major objective of the Expedition is to demonstrate the utility of an international pan-Pacific winter ecosystem survey to understand how increasingly extreme climate variability in the NPO and the associated changes in the physical environment influence the abundance, distribution, migration, growth, fitness and survival of Pacific salmon and surrounding species.

The Expedition in 2022 has a number of sub-objectives including:

- Documenting the spatial and temporal variation in physical and biological oceanographic conditions;
- Documenting the distribution, condition, and standing stocks of zooplankton, and nekton that serve as the prey base for Pacific salmon and associated marine fishes;
- Demonstrating the ability to effectively collaborate across the five NPAFC parties and our partners to conduct integrated ecosystem research that will support the sustainable management of salmon in a rapidly changing North Pacific Ocean.

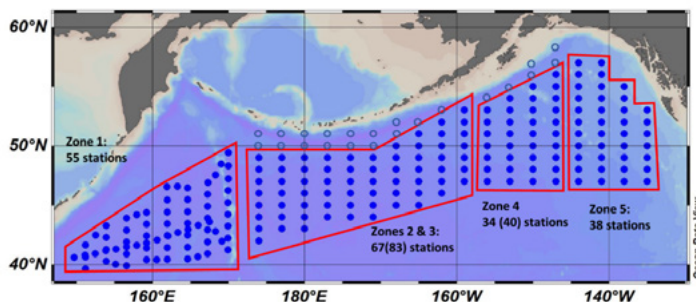


Figure 3. Sampling zones, demarcated by red boxes. Stations, demarcated by solid blue circles are spaced 60 nm north-south along longitudinal transects, up to 120 nm spacing between transects. Empty blue circles demark stations within the USA Exclusive Economic Zone which may only be possible with USA scientists aboard. Fisheries and Oceans Canada will be responsible for completing 38 stations in Zone 5.



Canadian vessel the CCGS *Sir John Franklin*. Photo: Fisheries and Oceans Canada.

The NPAFC member countries (Canada, Japan, the Republic of Korea, the Russian Federation and the United States) are working collaboratively with academic and NGO partners to complete plans for the Expedition. At the present time, we have indications from Canada, the Russian Federation and the United States that they will each make one research vessel available to cover approximately one month of ship time required to survey

one of the five survey zones, subject to the scheduling approval procedures in each country. The Canadian vessel will be Canada's newly commissioned 63m fisheries research vessel the CCGS *Sir John Franklin*. The Russian Federation will make a second research vessel available to cover the remaining two of the five survey zones under a charter arrangement. Approximately CAD\$1.5M will be required to cover each of the two zones. At the present time we have CAD\$300K committed by Fisheries and Oceans Canada and the Province of British Columbia through the BC Salmon Restoration and Innovation Fund (BCSRIF) and a recent commitment of USD\$350K from the North Pacific Research Board. We continue to seek funding from multiple sources and welcome interest from partners in the PICES community who may contribute or know of relevant funding programs. Additionally, we are in the process of developing a UN Decade of Ocean Science for Sustainable Development (UNDOS) proposal that will include the 2022 Expedition as the beginning of a multi-year program to establish an ocean intelligence system linking NPO events to socio-ecological impacts. If endorsed, the proposal will open doors to funding from countries and foundations seeking to support UNDOS proposals.

We often receive questions about how our management systems will benefit from this deeper understanding of the impact of an increasingly changing climate and changing ocean conditions. Particularly with regard to salmon, there is some hesitation towards investment in ocean research due to the assumption that resources are better allocated to freshwater activities where we can actively manage change, versus an ocean system that is assumed to be beyond our control. Our response to this is that management systems need to adopt a holistic approach, where management decisions are informed by knowledge of mechanisms affecting salmon during all life history stages, from high seas to coastal to freshwater. Since we know that increasingly poor and variable marine survival has been driving the decline in many salmon populations in the North Pacific and North Atlantic oceans since the mid 1990s, it makes sense that we deepen our understanding of these mechanisms to better inform our management decisions.



A team of early career scientists on the 2020 Gulf of Alaska Expedition. L-R: Russians Albina Kazneparova and Alexei Somov, and Canadians Rebecca LaForge, Natalie Mahara and Christoph Deeg.

Knowledge gained from understanding the mechanisms affecting salmon and associated fish in the high seas will support the following by:

- Improving the ability to forecast the state of salmon and marine fishes that in the absence of climate/ocean knowledge is increasingly unreliable.
- Informing recovery plans for species at risk and climate change vulnerability assessments — the efficacy of management actions in freshwater, such as habitat restoration, can consider the impact of changing ocean conditions.
- Informing Illegal, Unreported and Unregulated (IUU) Fishing enforcement actions — accurate and timely intelligence of the distribution of fish to effectively target enforcement surveillance aircraft and ships at the burgeoning multi-billion-dollar IUU fishing operations that threaten salmon and associated fish across the high seas of the NPO.
- Informing hatchery management — with 40% of the salmon in the NPO of hatchery origin, understanding interactions with coastal and high seas ecosystems is essential to assess the efficacy of long-term investments and in-season strategies for releases, as well as the impact of these fish on other species.
- Informing assessments and forecasts of marine fishes with leading indicators connecting the high seas to the basin/shelf processes affecting productivity of juvenile salmon and the recruitment/growth of marine fish on the shelf/slope.
- Providing baseline data for the emerging United Nations instruments on marine Biodiversity in areas Beyond National Jurisdiction (BBNJ) to inform management of ocean resource extraction.
- Raising the confidence of industry and communities that decision-makers can act proactively with knowledge of mechanisms at work rather than reacting after the fact.

One of the most important priorities for the Expedition and the IYS in general is the advancement of early career scientists. The generation of scientists that conducted high seas research in the past is largely retired and a new generation of scientists needs to build international connections and, with mentoring from outgoing scientists, take on the challenge of this high seas work. Through funding from BCSRIF, the IYS will be supporting nine early career scientists from a variety of different fields, ranging from biological to oceanographic sciences, to join the pan-Pacific Expedition team.



Collecting samples on the 2020 Gulf of Alaska Expedition. Pictured here: Natalie Mahara (Canada), Jacob Lerner (Canada).

### Data Mobilization

Arguably, one of the largest barriers to research on salmon ecology is rapid access to standardized data. Data Mobilization is a concerted effort on the part of the IYS and various other organizations that have a keen interest in the protection and sustainability of salmon to build a framework of data, models, and knowledge networks that are standardized, accessible, and easy to navigate for dynamic groups of researchers, conservationists, and resource managers. Graph database technology is potentially the ultimate tool to synthesize data generated from the High Seas Expeditions with related socio-ecological data from coastal and freshwater systems. Underpinning the application of this new technology is developing the data standards including metadata and vocabularies for essential ocean and biological variables that will allow data to be federated in a manner that is consistent with the [FAIR data principles](#).

Specifically, FAIR data are findable, accessible, interoperable and reusable. We are working with a number of IYS partners on the broader approach to data mobilization and more specifically on a standardized approach to managing high seas data from the three Expeditions utilizing the Global Ocean Observing System protocols with the Hakai Institute in British Columbia, Canada and an NPAFC Study Group with representatives from all five member countries.



Visualization of a salmon-related graph database

### Outreach

As 2020 wraps up, the IYS is working to intensify its final two years of research and outreach. Due to the increasingly virtual nature of our work, we are looking towards expanding our communications capacity. We are building our networks in order to reach a wider audience through our work, particularly as we approach the launch of the 2022 Pan-Pacific Winter High Seas Expedition, which brings with it opportunities to take advantage of various social media tools and communication technologies, and to potentially partner with some organizations in the nature documentary film-making industry. A wrap-up symposium is being planned for the fall of 2022 to engage partners across the Northern Hemisphere that have contributed to the success of the IYS.

Over the next two years we look forward to working with PICES and partners to use the 2022 High Seas Expedition and the UN Decade of Ocean Science for Sustainable Development as opportunities to re-imagine our approach to providing an ocean science-management interface that meets the challenges of this rapidly changing world.



*Mr. Mark Saunders currently works for the North Pacific Anadromous Fish Commission as the Director for the North Pacific Region of the International Year of the Salmon initiative. He retired several years ago from the Canadian Department of Fisheries and Oceans where he headed up a Salmon, Aquaculture and Freshwater Ecology Division at the Pacific Biological Station in Nanaimo, B.C. with staff working on salmon stock assessment, freshwater habitat, molecular genetics, fish health, and marine ecology. The early part of Mark's career focused on stock assessment of marine fish as well as research related to hydroacoustic surveys and fisheries oceanography of the California Current system.*



*Ms. Stephanie Taylor is the International Year of the Salmon (IYS) High Seas Expedition Coordinator for the North Pacific Anadromous Fish Commission (NPAFC). She is the NPAFC lead on the 2022 IYS Pan Pacific Winter Expedition and has been with the NPAFC since July 2018. She began working as the North Pacific Coordinator for the International Year of the Salmon (IYS) initiative after completing an internship as the NPAFC Secretariat in December 2018, and has been working on the 2022 Expedition since August 2019. She graduated from McMaster University in 2015 with a BSc in Integrated Science and Earth and Environmental Science. She has also received a Masters of Resource and Environmental Management from Dalhousie University in Halifax, Nova Scotia.*



*Ms. Camille Jasinski is the Public Relations and Communications Coordinator for the International Year of the Salmon (IYS)—North Pacific Region. She is currently completing her master's degree in communications at Simon Fraser University, after which she hopes to pursue her PhD. Camille's graduate research interests include classical communication theory, ideology, philosophy, surveillance culture, environmental communication, decolonization theory, and Indigenous rights. Camille currently sits as the co-chair to the IYS Theme Council Group 4—Outreach and Communication.*

