

## The 2019 International Gulf of Alaska Expedition: A pioneering exploration of the overwintering conditions of Pacific salmon

by Moronke K. Harris



Fig. 1 W16 organizers and some attendees, including members of the successful 2019 International GoA Expedition scientific research team, at PICES-2019, Victoria, BC, Canada (Photo Credit: Stuart McNish, Oh Boy Productions).

In the autumn of 2019, the North Pacific Anadromous Fish Commission (NPAFC; [npafc.org](http://npafc.org)) successfully completed two days of meetings (October 19–20) as part of the 2019 PICES Annual Meeting in Victoria, BC, Canada. As an integral part of the International Year of the Salmon (IYS; [yearofthesalmon.org](http://yearofthesalmon.org)) initiative led by NPAFC in the North Pacific and the North Atlantic Salmon Conservation Organization (NASCO; [nasco.int](http://nasco.int)) in the North Atlantic, the workshop (W16: *Developing a collaborative, integrated ecosystem survey program to determine climate/ocean mechanisms affecting the productivity and distribution of salmon and associated pelagic fishes across the North Pacific Ocean*) was co-sponsored by PICES, NPAFC and the North Pacific Fisheries Commission (NPFC; [npfc.int](http://npfc.int)). Significant funding was provided by the BC Salmon and Restoration Innovation Fund. It convened oceanographers, ichthyologists, climatologists and resource managers from around the Pacific Rim and abroad to explore findings from the ground-breaking 2019 winter expedition to the Gulf of Alaska (GoA). The voyage was the first comprehensive winter expedition examining Pacific salmon in the GoA and successfully established a baseline of environmental and ecosystem-level measurements for future comparisons.

Presentations were given by representatives from a wide variety of 2019 International GoA Expedition partner organizations including Fisheries and Oceans Canada, National Oceanic and Atmospheric Administration (NOAA) Fisheries, NPAFC, the Pacific Branch of the Russian Federal

Research Institute of Fisheries and Oceanography (TINRO), the Pacific Salmon Foundation, the University of British Columbia, the University of Victoria and Hokkaido National Fisheries Research Institute. They included members of the 2019 GoA scientific team. In total, W16 brought 24 researchers and multiple participants together from six countries to network, discuss and share their respective research (Fig. 1).

### 2019 International GoA Expedition

The high seas pelagic ecosystems of the North Pacific support six species of Pacific salmon and steelhead trout; chum (*Oncorhynchus keta*), coho (*Oncorhynchus kisutch*), sockeye (*Oncorhynchus nerka*), pink (*Oncorhynchus gorbuscha*), Chinook (*Oncorhynchus tshawytscha*) and masu (*Oncorhynchus masou*) salmon. During winter, approximately one third of all Pacific salmon, spanning all species but the Asian endemic masu, inhabit the GoA. Despite the importance of this region, the vast majority of previous salmon research has focused solely on freshwater and coastal habitats. The current lack of baseline data on salmonids in the GoA adds uncertainty to the already challenging task of forecasting returns and predicting salmon behavior and responses to the changing North Pacific ecosystem.

To bridge the knowledge gap concerning salmon overwintering conditions, the NPAFC as part the IYS, and

along with nongovernmental organizations (NGOs), government, academic and private partners, conducted a high seas expedition with scientists from around the Pacific Rim in winter 2019. The International GoA Expedition was completed with 21 scientific personnel from Canada, Japan, Korea, Russia and the United States aboard the chartered 62 m Russian R/V *Professor Kaganovskiy* (Fig. 2). Organized by Dr. Richard J. Beamish, the Pacific Salmon Foundation and NPAFC with funding from private individuals, government agencies and NGOs, it was the first in decades to study salmon in the winter high seas, and it set a precedent for addressing gaps in our knowledge through survey work concerning salmon, plankton, hydrochemical and physical conditions in the central GoA. The expedition covered an area of approximately 700,000 km<sup>2</sup> between February 16 and March 18, 2019 (Fig. 2). In total, 423 salmon (223 chum, 93 coho, 73 sockeye, 31 pink and 3 Chinook) were caught during the trawl surveys.

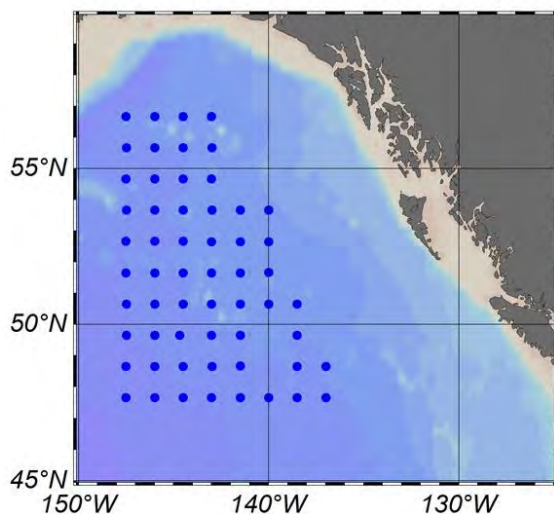


Fig. 2 Top: R/V *Professor Kaganovskiy* (Photo Credit: Pacific Salmon Foundation). Bottom: 58 expedition survey stations sampled between February and March 2019 in the GoA (Pakhomov et al., 2019).

The overarching objective was to demonstrate the effectiveness of using international science collaboration to test key hypotheses on factors regulating salmon survival in

the open ocean during the critical overwintering period of their life history. With these findings, scientists hope to create a strong research baseline for future expeditions leading to a program of coordinated integrated surveys across the entire North Pacific that will investigate the mechanisms affecting salmon distribution and productivity. The results of the 2019 survey will directly inform planning for tentative surveys in the GoA in March 2020 and across the full breadth of the North Pacific in 2021. In time, these efforts will provide communities and resource managers with the timely scientific advice needed to manage salmon and ecosystems in a rapidly changing world.

**GoA survey results: PICES-2019 W16**

The scientific results of the winter 2019 survey revealed that salmon distributions varied by species in the GoA and appeared to correlate with the environmental characteristics of water masses such as changes in ambient temperature, productivity and prey distributional patterns (Table 1, Fig. 3). Most surprising was the relatively high abundance of coho in the GoA catches, given they were previously thought to be mainly coastal in distribution, and the appearance of North American sockeye further west than expected in the small set of central North Pacific samples taken as the R/V *Professor Kaganovskiy* made the return journey from Canada to Russia upon completion of the 2019 expedition.

Novel genomic tools allowed researchers for the first time to conduct at-sea DNA analyses for stock identification, assess physiological conditions and test for the presence of pathogens. Interestingly, stock composition was largely independent of capture site, suggesting that distant stocks do not segregate according to origin but instead readily mix within the open ocean. For example, chum salmon of both Asian and North American origin co-mingled in the survey area.



Fig. 3 Ms. Chrys Neville (Canada) gave a presentation titled “Changes in our thinking of ocean life of sockeye salmon”. Overall, an unexpectedly low proportion of ocean age 2+ Fraser River sockeye and age 1 sockeye was observed in the 2019 International GoA catches. This could be a signal of poor returns to the Fraser River in 2020 (Photo Credit: Stephanie Taylor, IYS).



Table 1 Survey area dominance, frequency of occurrence in trawl catches, estimated numbers and biomass of Pacific salmon species in the upper epipelagic layer (0–30 m) throughout the investigated area in the GoA during winter 2019 at a catchability coefficient ( $q$ ) of 0.3 (Pakhomov et al., 2019).

Salmon Species	Survey Area Dominance	Frequency of Occurrence (%)	Numbers (million fish)	Biomass (thousand tons)
<b>Chum (<i>Oncorhynchus keta</i>)</b>	widely distributed	55.2	24.17	26.96
<b>Coho (<i>Oncorhynchus kisutch</i>)</b>	southern and westerly stations	37.9	13.59	10.37
<b>Sockeye (<i>Oncorhynchus nerka</i>)</b>	northern stations	31.0	8.94	10.28
<b>Pink (<i>Oncorhynchus gorbuscha</i>)</b>	southern and westerly stations	17.2	4.21	1.63
<b>Chinook (<i>Oncorhynchus tshawytscha</i>)</b>	rarely and sporadically occurred	5.17	0.37	1.32

Several discussions on new perspectives and ideas generated by the presentations were held between sessions. Participants suggested additional considerations and improvements for future expeditions, including sampling eDNA at greater depths to better understand vertical distribution of species, installing cameras in the trawl nets to determine if predators enter and exit the net during sets, having dedicated marine mammal and bird observers on board and determining the vertical migration of salmon during the day and night. However, the defining feature of both W16 and the 2019 survey was the enthusiasm that the international team of ocean and salmon scientific experts from around the Pacific Rim displayed:

*“This has been a really wonderful experience [because of] how well everyone is working together...the level of enthusiasm [displayed by] everybody has been fantastic” – Dr. Laurie Weitkamp, NOAA, USA*

*“We have a baseline that has never been available before, we have observations about species distributions that we cannot explain right now.” – Dr. Richard Beamish, Fisheries and Oceans Canada Emeritus*

*“I believe that [aside from] our scientific findings, this will bring our nations closer [diplomatically].” – Dr. Arkadii Ivanov, TINRO, Russia*

*“Being able to work in real time with [international] scientists, looking at similar questions [of interest] from around the North Pacific is fabulous...it’s very, very exciting.” – Ms. Chrys Neville, Fisheries and Oceans Canada*

### **IYS: Salmon and people in a changing world**

The 2019 expedition is a Signature Project of the IYS. The IYS is a five-year initiative (2018–2022) of the NPAFC and its North Atlantic partner, NASCO aiming to establish a new hemispheric-scale partnership of government, Indigenous Peoples, academia, NGOs and industry to effectively address the scientific and social challenges facing salmon and people in an increasingly uncertain environment. More on the preliminary results of the 2019 International GoA Expedition can be found at [yearofthesalmon.org/gulf-of-alaska-expedition](http://yearofthesalmon.org/gulf-of-alaska-expedition).

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### **Reference**

Pakhomov, E.A., C. Deeg, S. Esenkulova, G. Foley, B.P.V. Hunt, A. Ivanov, H.K. Jung, G. Kantakov, A. Kanzevarova, A. Khleborodov, C. Neville, V. Radchenko, I. Shurpa, A. Slabinsky, A. Somov, S. Urawa, A. Vazhova, P.S. Vishnu, C. Waters, L. Weitkamp, M. Zuev, and R. Beamish. 2019. Summary of preliminary findings of the International Gulf of Alaska expedition onboard the R/V *Professor Kaganovskiy* during February 16–March 18, 2019. NPAFC Doc. 1858. 25 pp. Canada, Japan, South Korea, Russia, and USA (Available at <https://npafc.org>).

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