FIS Poster Session
31 October 2024 18:00-20:30

Modeling the impacts of ocean conditions to Japanese chum salmon abundance

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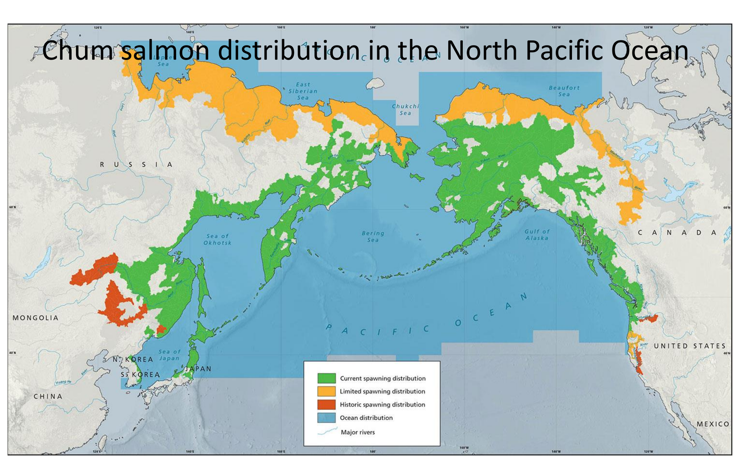
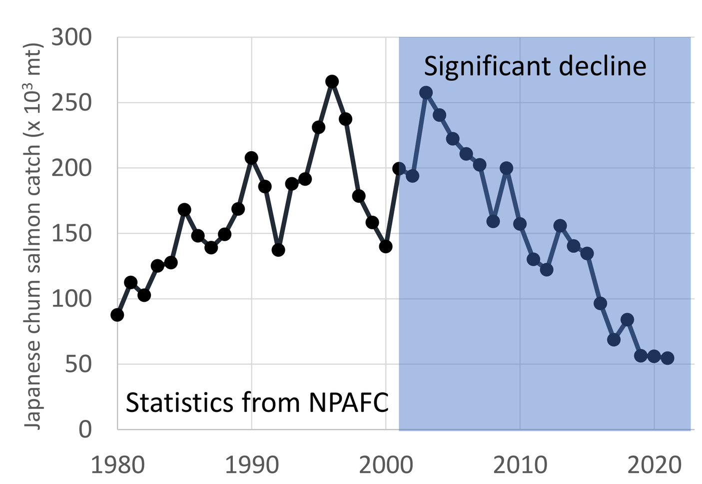
Key points

- Modeled the response of Japanese chum salmon abundance to environmental and climatic changes across its oceanic habitats
- Captured the importance of the area with optimal temperatures in its coastal residence and wintering grounds on chum salmon abundance
- Optimal feeding conditions in the Okhotsk and Bering seas showed positive impact on Japanese chum salmon abundance
- Warming ocean temperatures and poor feeding conditions were detrimental to the survival of chum salmon, potentially leading to recent declines in catches

Overview



https://wildsalmoncenter.org/salmon-species/chum-salmon/



https://www.npafc.org/statistics/

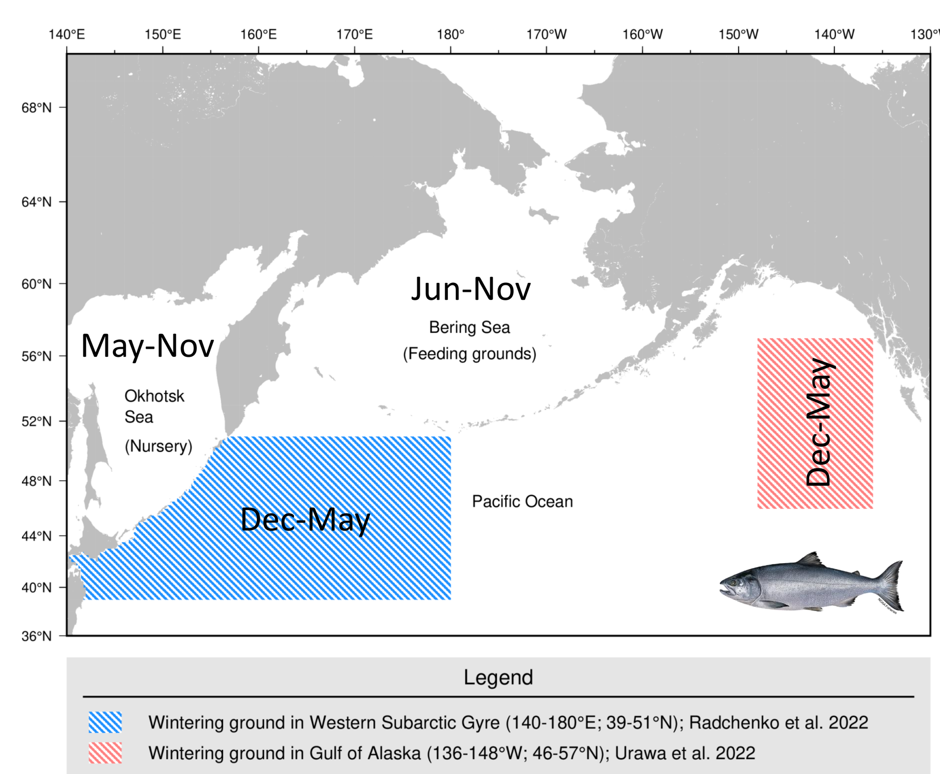
Overall objective

- Examine the impacts of marine environmental conditions to the abundance of the Japanese Chum salmon (*Oncorhynchus keta*) during the recent decades (2001-2022)

Specific questions

1. Are there substantial changes in feeding and wintering conditions of Japanese chum salmon in recent decades?
2. How do these environmental changes at each wintering and feeding migration phases relate to fluctuations in the annual total catch?

Data and Methods



Map of the North Pacific Ocean, noting the potential wintering and feeding grounds of the Japanese chum salmon during ocean migration

List of marine environmental datasets used for the construction of generalized additive model to predict annual catches of the Japanese chum salmon from 2000-2022.

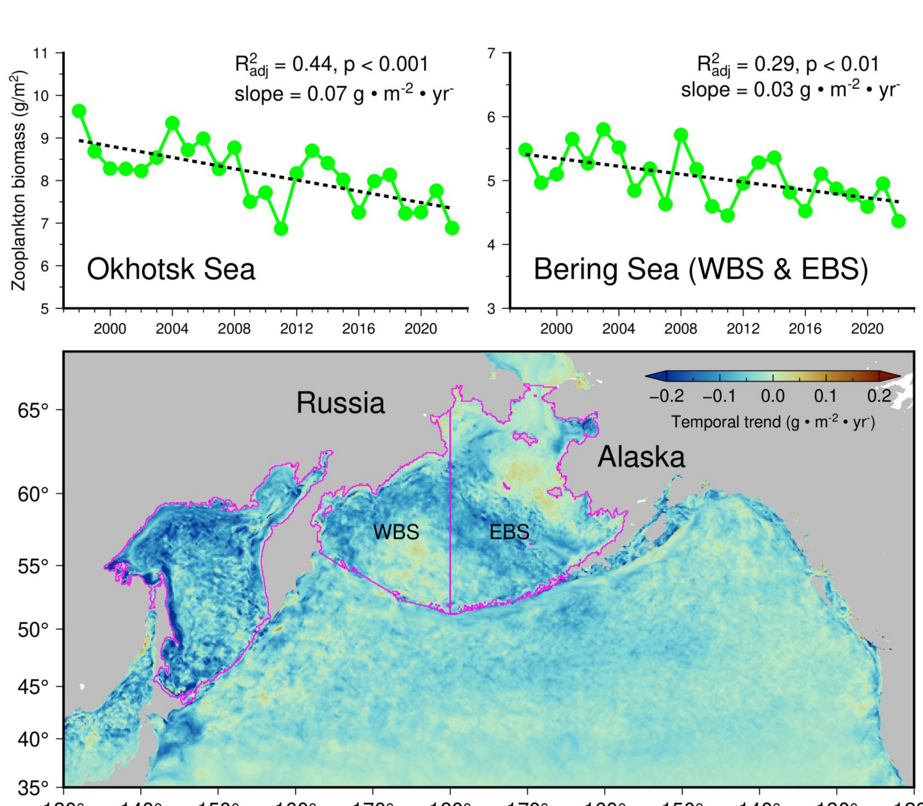
Ocean migration	Variables
Coastal residence	Total area with optimal SST (Okhotsk; 8-13°C)[1,2]
Okhotsk feeding	Averaged zooplankton biomass[3] in Okhotsk Sea
Wintering area 1	Total area with SST (WSAG[4]; 5-7.5°C)
Feeding 1-3	Averaged zooplankton biomass in Bering Sea
Wintering area 2-3	Total area with SST (GOA; 5-7.5°C)[5]
Response/modeled variable	Total Chum salmon catch for Japan (2001-2022)

Construction of Generalized additive model (GAM, mgcv R package)[6]

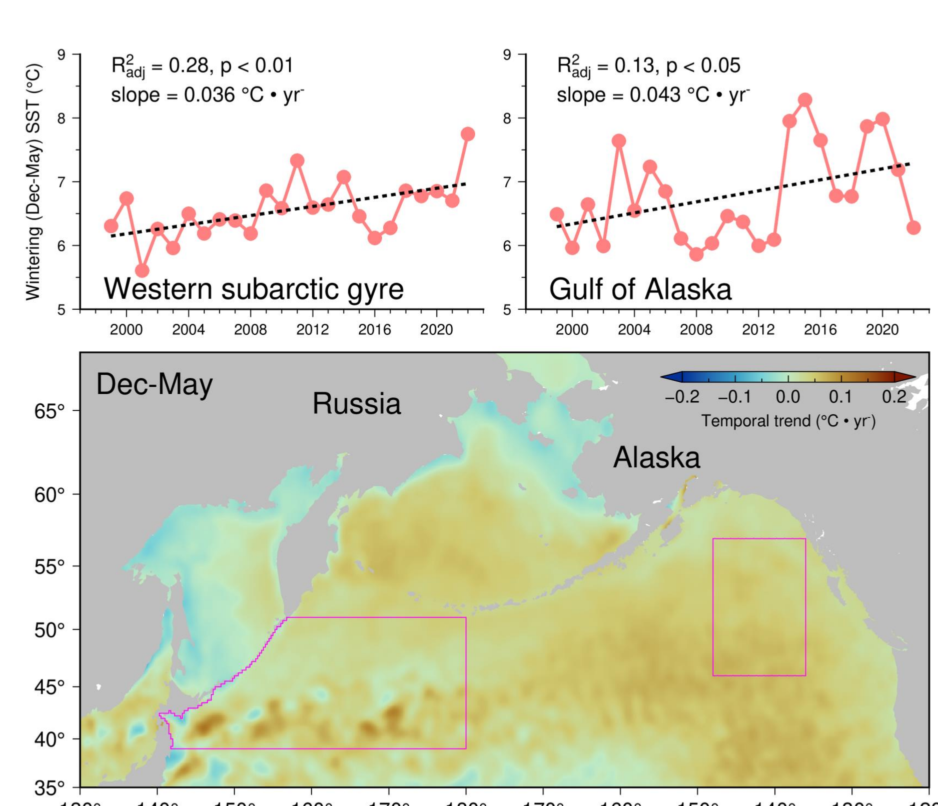
Catch ~ s(OS.Area) + s(OS.Zoop.1) + s(WSAG.AWT) + s(GOA.AWT1) + s(BS.Zoop.3) + s(BS.Zoop.4)

Results

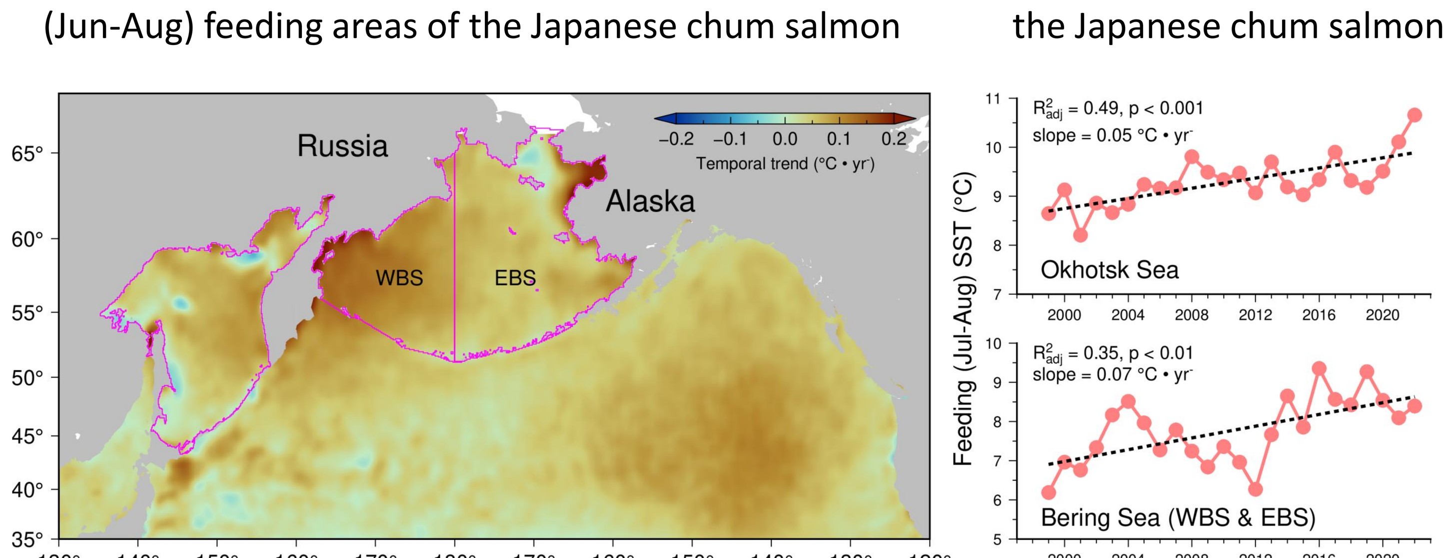
Temporal trends[7] of zooplankton biomass and SST (1998-2022) across the migration routes of the Japanese chum salmon in the North Pacific Ocean



Significant declines of zooplankton biomass in summer (Jun-Aug) feeding areas of the Japanese chum salmon

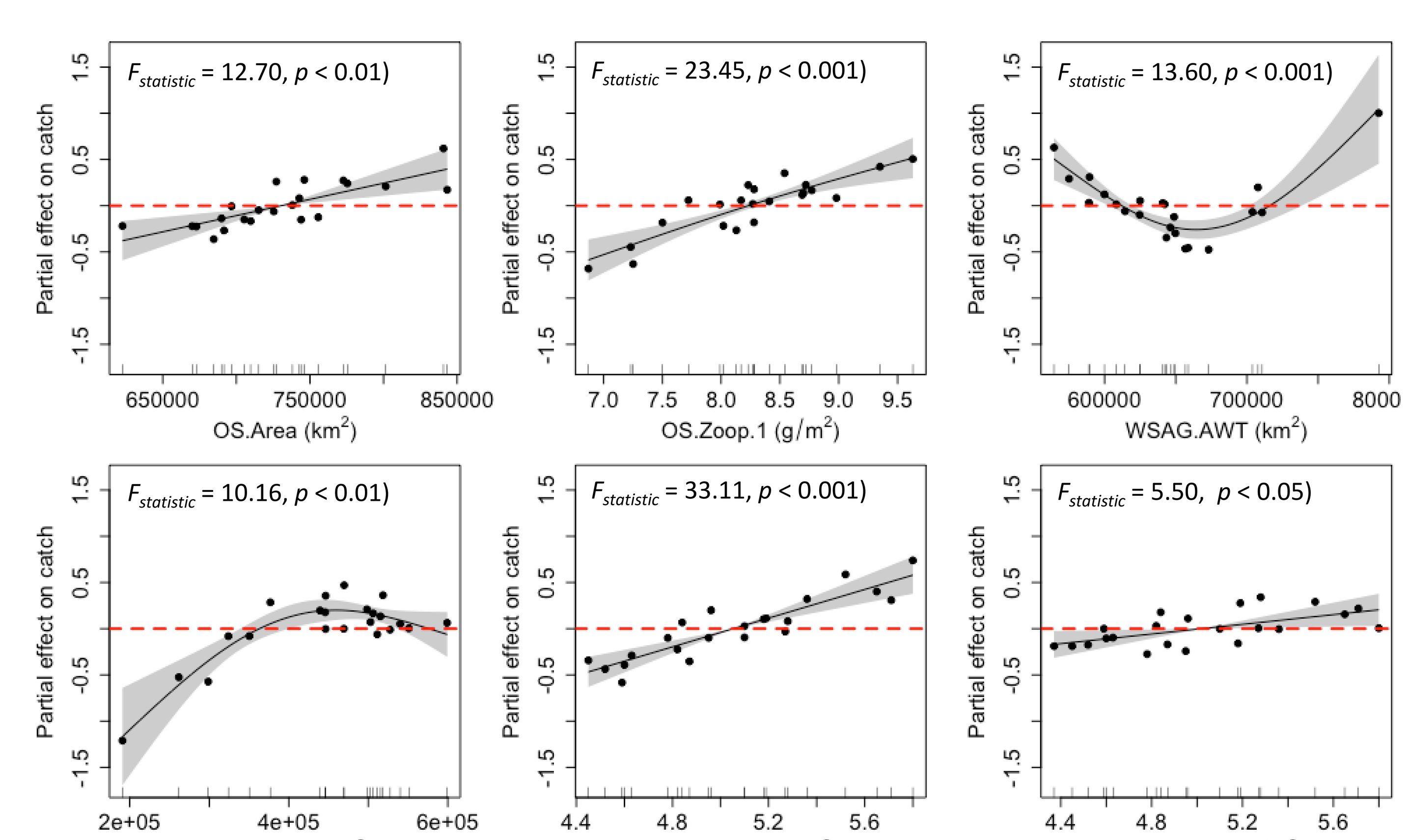


Significant warming in potential wintering grounds of the Japanese chum salmon over time



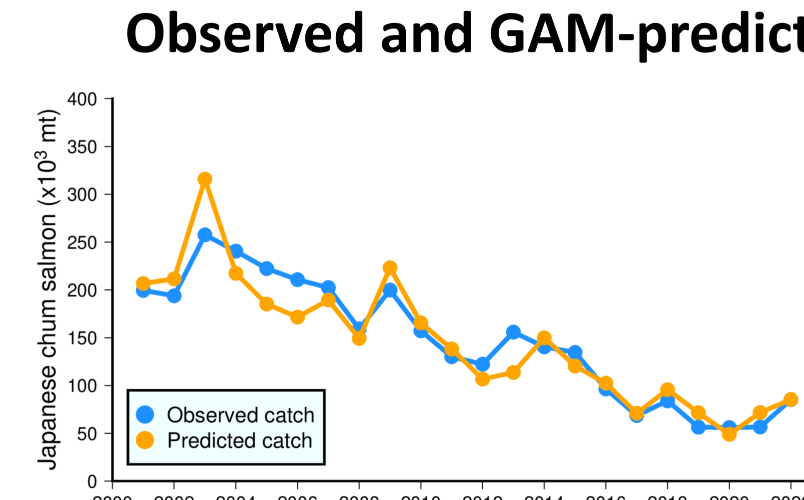
Significant warming in the summer feeding grounds of chum salmon in the Okhotsk and Bering seas

Model-derived responses of Japanese chum salmon catch to environmental covariates



Significant effects of zooplankton biomass in the Bering Sea in year 3 and Okhotsk Sea in year 1 as well as area with optimal wintering temperature in the WSAG.

Observed and GAM-predicted chum salmon catches



- GAM-based catch model captured 91.3% of the total variance
- Satisfactorily predicted the Japanese chum salmon annual catches using the set of covariates

References

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[2]Kaeriyama, M. (2023). Warming climate impacts on production dynamics of southern populations of Pacific salmon in the North Pacific Ocean. Fisheries Oceanography, 32(1), 121–132.
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[4]Radchenko, V. (2022). Winter ecology of Pacific salmon. North Pacific Anadromous Fish Commission Technical Report, 18, 11–19.
[5]Urawa, S., Beacham, T., Sutherland, B., & Sato, S. (2022). Winter distribution of chum salmon in the Gulf of Alaska: a review. North Pacific Anadromous Fish Commission Technical Report, 18, 83–87.
[6]Wood SN (2011). "Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models." Journal of the Royal Statistical Society (B), 73(1), 3-36.
[7]García Molinos J, Schoeman DS, Brown CJ, Burrows MT. VoCC: An r package for calculating the velocity of climate change and related climatic metrics. Methods Ecol Evol. 2019; 10: 2195–2202.

Acknowledgments

This work is supported by EO-RA3 projects 2022-2024, Japan Aerospace Exploration Agency (JAXA), No. RA3MAF006.