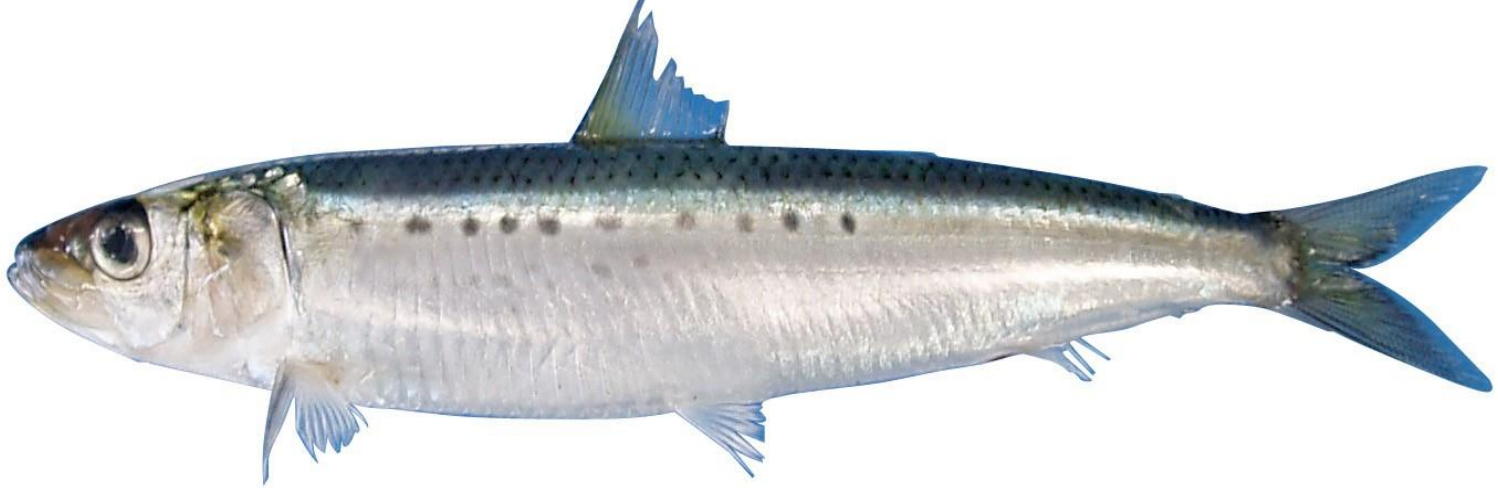
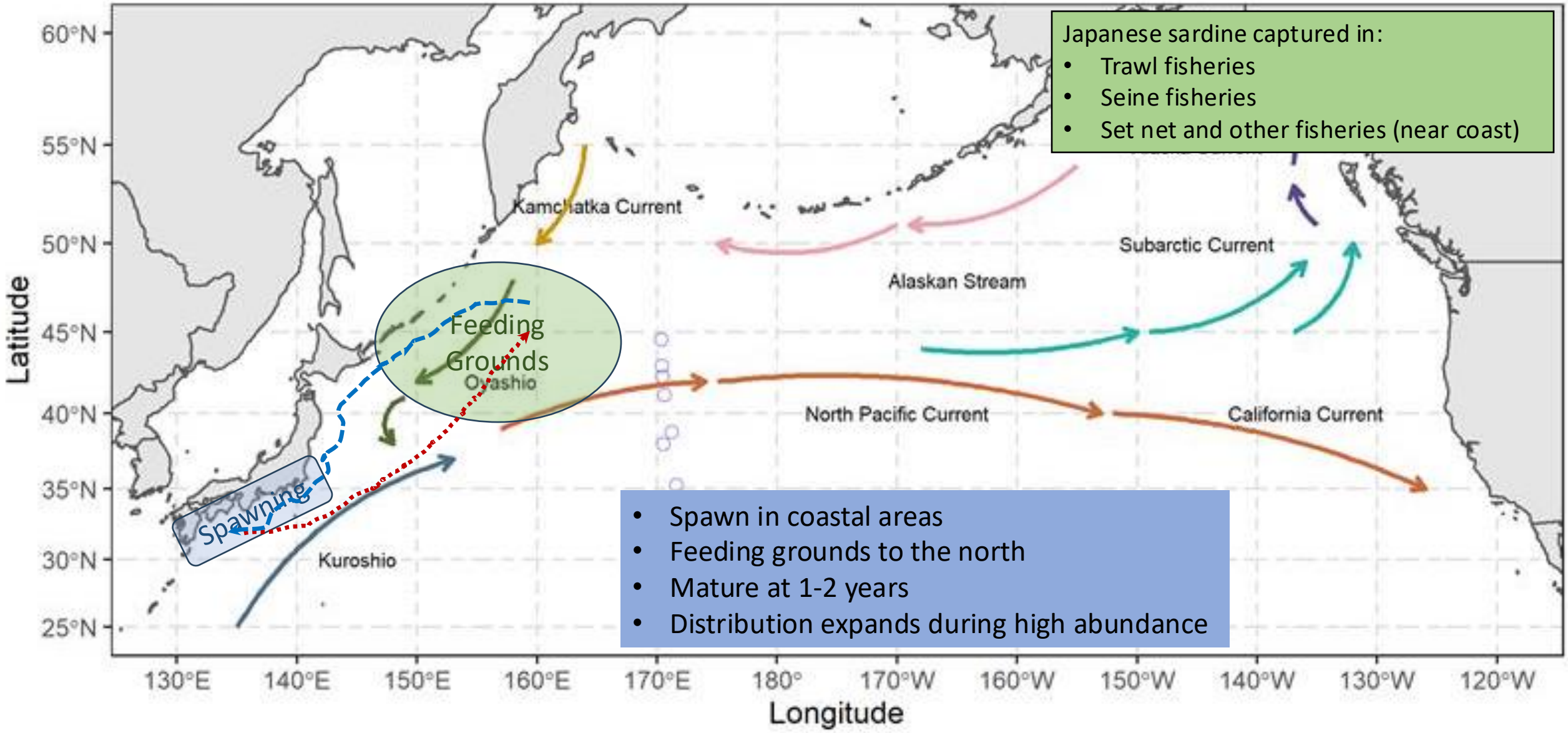


A literature review of studies relating environmental conditions to Japanese Sardine (*Sardinops melanosticta*) in the North Pacific Ocean

Chris Rooper[1], Jennifer Boldt[1], Dmitrii Antonenko[2], Jon Brodziak[3], Janelle Curtis[1], Libin Dai[4], Karolina Molla Gazi[5], Zhengyan Jiang[4], Don Kobayashi[3], Vladimir Kulik[2], Quiyun Ma[4], Shuya Nakatsuka[6], Kazuhiro Oshima[6], Alex Zavolokin[7]

[1]Pacific Biological Station, DFO, Nanaimo, BC, Canada
[2]Pacific Branch, Russian Federal Research Institute of Fisheries and Oceanography, Vladivostok, Russia
[3]Pacific Islands Fisheries Science Center, NOAA, Honolulu, HA, USA
[4]Shanghai Ocean University, Shanghai, China
[5]Wageningen Marine Research, Wageningen University & Research, IJmuiden, The Netherlands
[6]Japan Fisheries Research and Education Agency, Yokohama, Japan
[7]North Pacific Fisheries Commission, Tokyo, Japan

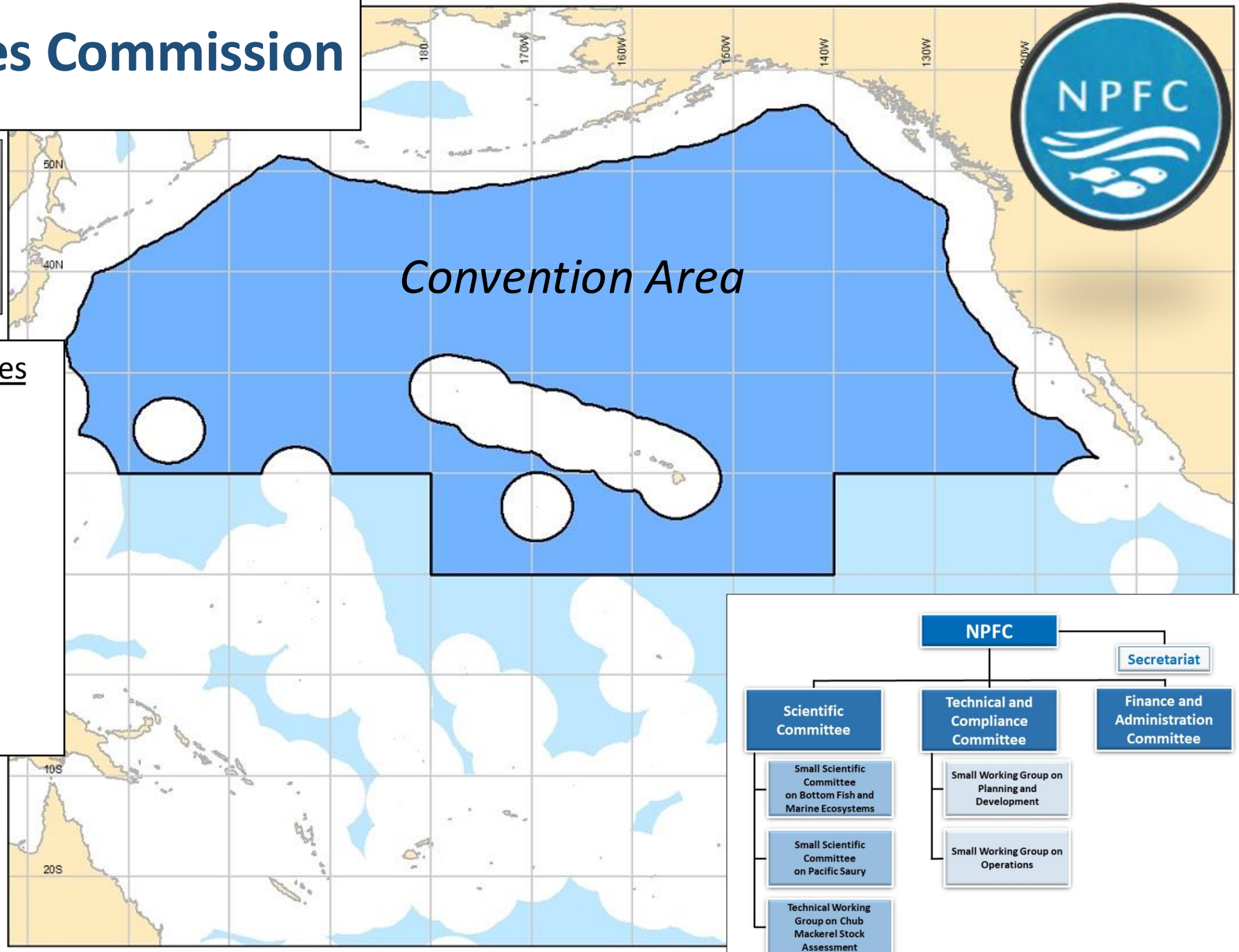
Distribution, migration and life history



North Pacific Fisheries Commission

Members
Canada, **China,** Chinese Taipei, European Union, **Japan, Korea, Russian Federation,** USA, Vanuatu

Major fisheries and management issues
Pacific saury
Chub and blue mackerel
Japanese sardine
Squids (neon flying, Japanese)
North Pacific Armorhead
Splendid alphonsino
Sablefish
Other bycatch species
Vulnerable Marine Ecosystems

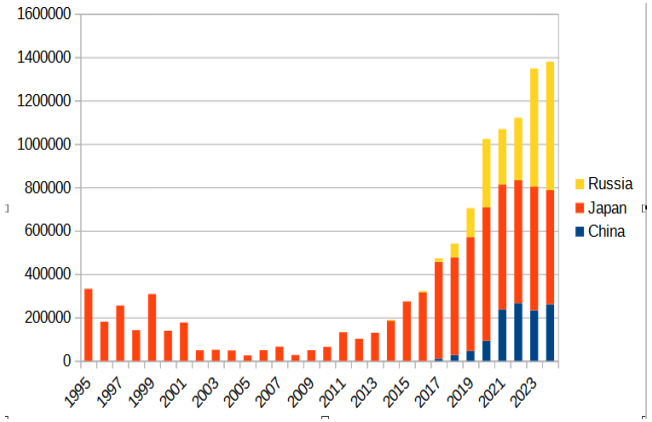


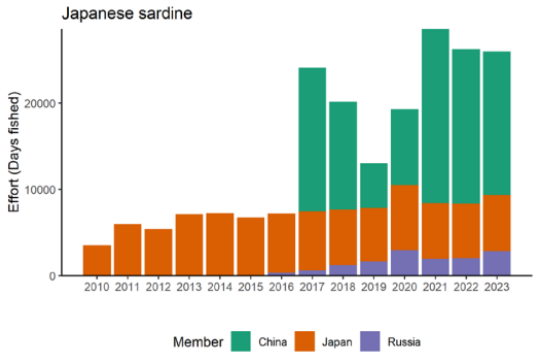
Small Scientific Committee on Japanese sardine (SSC JS)?

Lead: Shuya Nakatsuka (Japan)

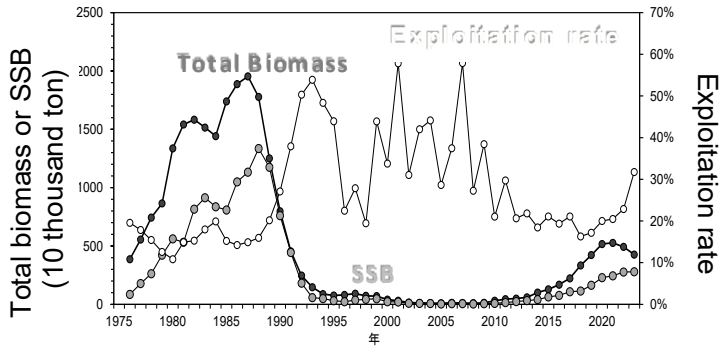
Japanese sardine

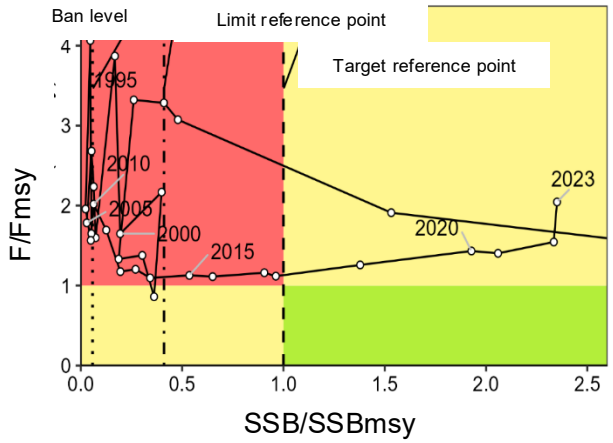
Catch and Effort





Stock Assessment-Japan





Comments

- SSB above SSBmsy (Japan stock assessment)
- Fishing mortality is above Fmsy (Japan stock assessment)
- Japanese catch and majority of Russian catch are from their national waters
- Chinese catch and some portion of Russian catch is from Convention Area
- NPFC is developing its own stock assessment
- Currently no catch limits in place in the Convention Area

https://www.npfc.int/species-summaries

Motivation for this review

2024 COM08

North Pacific Fisheries Commission

Resolution on Climate Change

The North Pacific Fisheries Commission,

Noting that several regional fisheries management organizations have taken recent steps to recognize the importance of preparing for the emerging impacts of climate change on the fisheries under their jurisdiction, including International Commission for the Conservation of Atlantic Tunas, Indian Ocean Tuna Commission, Western and Central Pacific Fisheries Commission, Commission for the Conservation of Antarctic Marine Living Resources, and South Pacific Regional Fisheries Management Organization;

Noting also that the UN General Assembly's Sustainable Fisheries Resolution (A/RES/77/118) calls upon States and regional fisheries management organizations and arrangements, as appropriate, to assess the risks and potential adverse impacts of climate change with respect to fish stocks and consider them when establishing conservation and management measures and identifying options to reduce risks and adverse impacts with respect to fisheries management and the health and resilience of marine ecosystems;

Emphasizing that climate change is leading to potential shifts in the distribution and abundance of global fisheries, altering ecosystems, and affecting livelihoods and food systems worldwide;

Acknowledging that the North Pacific Fisheries Commission (NPFC) does not currently have provisions to analyze and address the potential impacts from climate change on the fisheries

Task the Scientific Committee to:

1) identify relevant data availability and needs
2) integrate analyses of climate change relevant to NPFC fisheries into its work plan
3) consider to the extent possible key **vulnerabilities and management implications of climate change on NPFC fisheries**
4) discuss how best to incorporate existing climate change data and analyses in its work

How will climate changes impact Japanese Sardine and what should we be monitoring to anticipate those changes?

Impacts of climate change and environment on JS

INITIAL SEARCH (310 records):

- (japan* sardine OR Sardinops melanosticta OR Sardinops melanostictus) AND (oceanography OR environment OR temperature)

FILTERS (238 records):

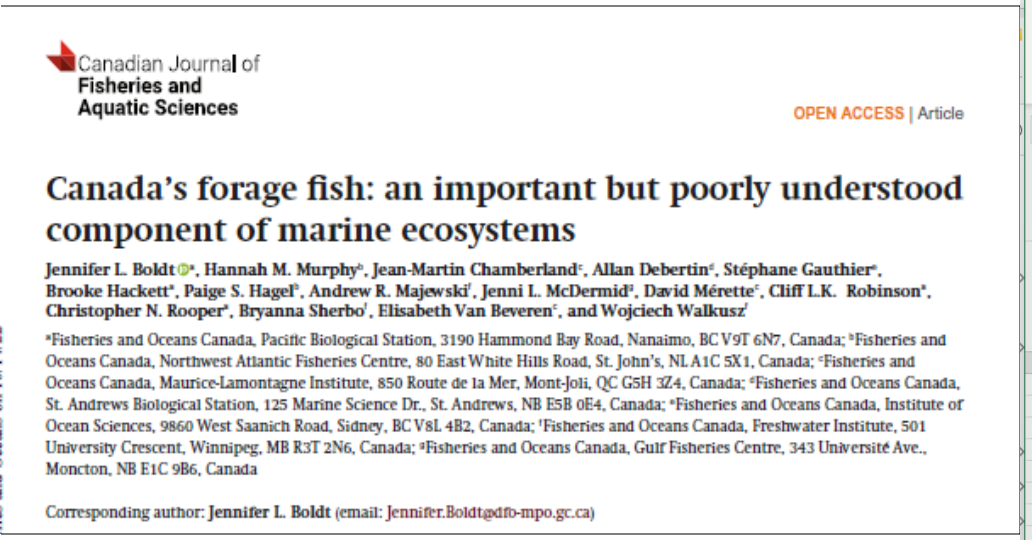
- NOT (processing fishery products AND minced products AND storage effects AND food technology)NOT (PICES 13th Annual Meeting Book of Abstracts AND PICES 14th Annual Meeting Book of Abstracts AND Pittsburgh Post - Gazette AND Sunday Herald - Sun AND The Independent AND The Kingston Heritage EMC AND The Standard AND Times - Colonist AND Weekend Australian)NOT (INE, USA, California AND INE, Pacific, California Current AND ISE, Peru AND Seriola quinqueradiata AND ANW, Canada AND ASE, South Atlantic, Benguela Current AND California AND IN, Bering Sea AND ISE, Chile AND ISE, Pacific, Humboldt Current AND PN, Arctic AND United States--US AND A, Atlantic AND ANW, Canada, Nova Scotia, Halifax AND Arctic region AND ASW, Panama AND Gulf of Sakhalin AND Illex argentinus AND INE, Canada, British Columbia AND INE, USA, Alaska AND INE, USA, Alaska, Alaska Gulf, Alaskan Gyre AND INE, USA, Oregon AND INE, USA, Washington AND ISE, Mexico, Baja California Sur, Magdalena Bay AND ISEW, Southeast Asia)

- Manual examination (112 records):
  - remove records that did not include information on Japanese Sardine,
  - records that did not concern the species in the NW Pacific and
  - confirm records that examined impacts of the environment on Japanese Sardine

- Removal of duplicate records = **106 records**

The method

- Distribute excel worksheet to co-authors
- Each person read a set of papers and fills out standardized worksheet
- Analysis and summary of results/trends
- Written report for Scientific Committee



Canadian Journal of Fisheries and Aquatic Sciences

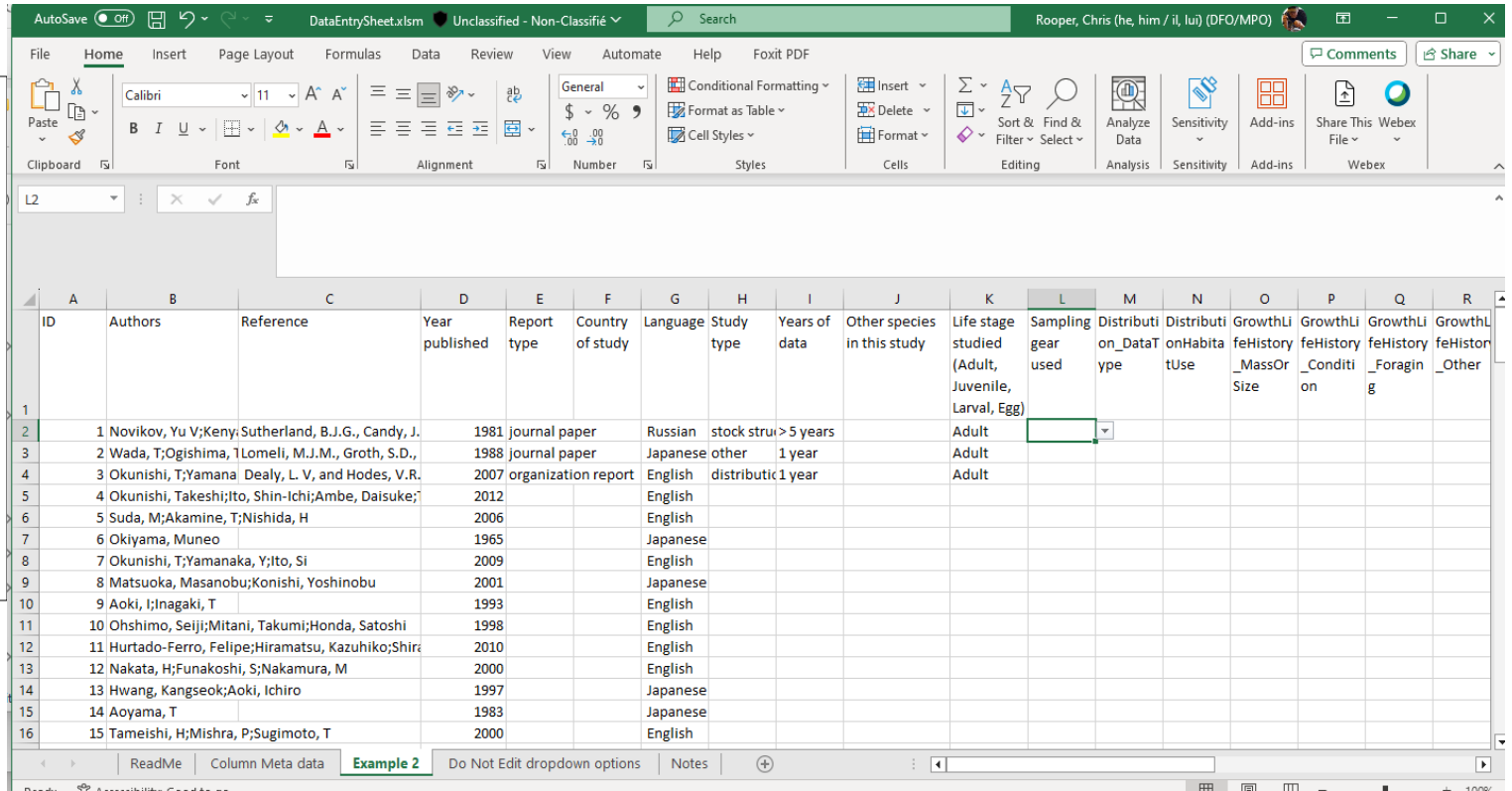
OPEN ACCESS | Article

Canada's forage fish: an important but poorly understood component of marine ecosystems

Jennifer L. Boldt*, Hannah M. Murphy, Jean-Martin Chamberland, Allan Debertin, Stéphane Gauthier, Brooke Hackett, Paige S. Hagel, Andrew R. Majewski, Jenni L. McDermid, David Mérette, Cliff L.K. Robinson, Christopher N. Rooper, Bryanna Sherbo, Elisabeth Van Beveren, and Wojciech Walkusz

Fisheries and Oceans Canada, Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, BC V9T 6N7, Canada; Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, 80 East White Hills Road, St. John's, NL A1C 5X1, Canada; Fisheries and Oceans Canada, Maurice-Lamontagne Institute, 850 Route de la Mer, Mont-Joli, QC G5H 3Z4, Canada; Fisheries and Oceans Canada, St. Andrews Biological Station, 125 Marine Science Dr., St. Andrews, NB E5B 0E4, Canada; Fisheries and Oceans Canada, Institute of Ocean Sciences, 9860 West Saanich Road, Sidney, BC V8L 4B2, Canada; Fisheries and Oceans Canada, Freshwater Institute, 501 University Crescent, Winnipeg, MB R3T 2N6, Canada; Fisheries and Oceans Canada, Gulf Fisheries Centre, 343 Université Ave., Moncton, NB E1C 9B6, Canada

Corresponding author: **Jennifer L. Boldt** (email: Jennifer.Boldt@dfo-mpo.gc.ca)



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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	ID	Authors	Reference	Year published	Report type	Country of study	Language	Study type	Years of data	Other species in this study	Life stage studied (Adult, Juvenile, Larval, Egg)	Sampling gear used	Distribution_DataType	DistributionHabitatUse	GrowthLifeHistory_MassOrSize	GrowthLifeHistory_Condition	GrowthLifeHistory_Foraging	GrowthLifeHistor_Other
2	1	Novikov, Yu V;Keny	Sutherland, B.J.G., Candy, J.	1981	journal paper		Russian	stock stru	> 5 years		Adult							
3	2	Wada, T;Ogishima, T	Lomeli, M.J.M., Groth, S.D.,	1988	journal paper		Japanese	other	1 year		Adult							
4	3	Okunishi, T;Yamana	Dealy, L. V, and Hodes, V.R.	2007	organization report		English	distributio	1 year		Adult							
5	4	Okunishi, Takeshi;Ito, Shin-Ichi;Ambe, Daisuke;		2012			English											
6	5	Suda, M;Akamine, T;Nishida, H		2006			English											
7	6	Okiyama, Muneo		1965			Japanese											
8	7	Okunishi, T;Yamanaka, Y;Ito, Si		2009			English											
9	8	Matsuoka, Masanobu;Konishi, Yoshinobu		2001			Japanese											
10	9	Aoki, I;Inagaki, T		1993			English											
11	10	Ohshimo, Seiji;Mitani, Takumi;Honda, Satoshi		1998			English											
12	11	Hurtado-Ferro, Felipe;Hiramatsu, Kazuhiko;Shira		2010			English											
13	12	Nakata, H;Funakoshi, S;Nakamura, M		2000			English											
14	13	Hwang, Kangseok;Aoki, Ichiro		1997			Japanese											
15	14	Aoyama, T		1983			Japanese											
16	15	Tameishi, H;Mishra, P;Sugimoto, T		2000			English											

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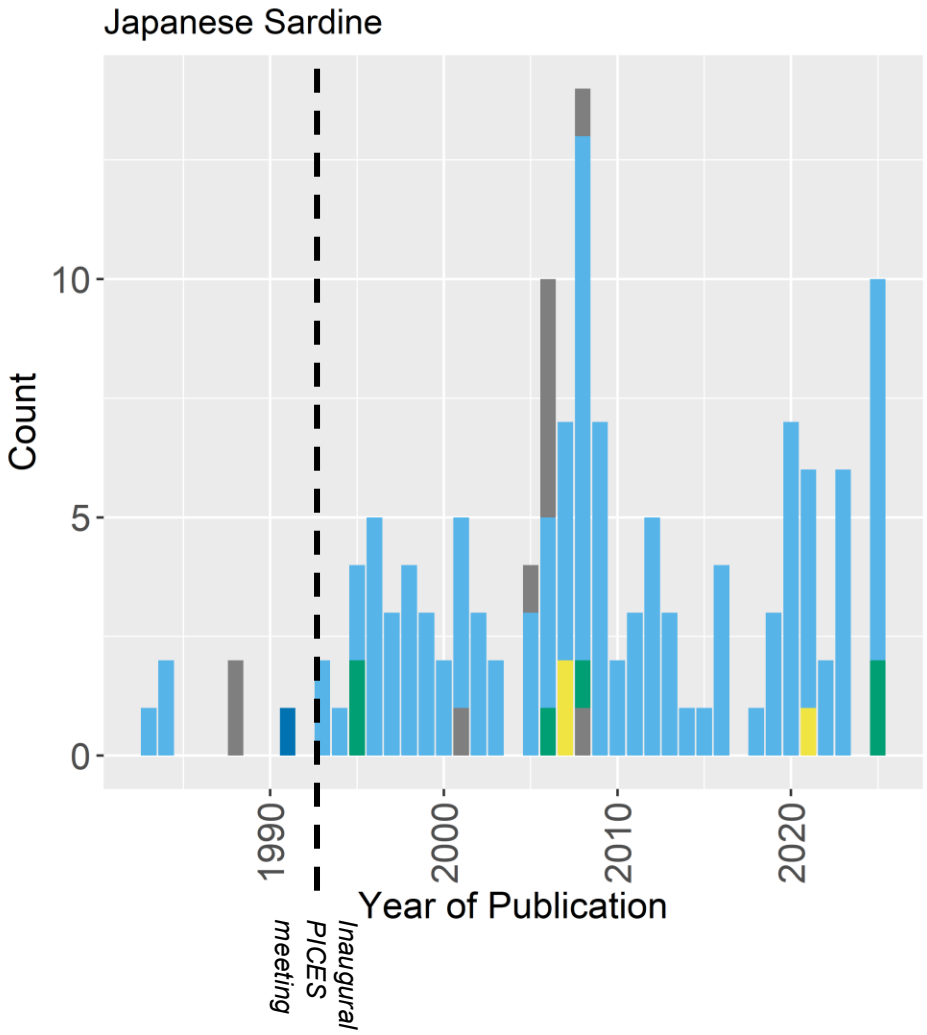
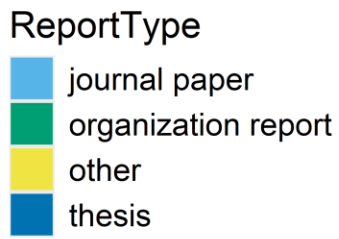
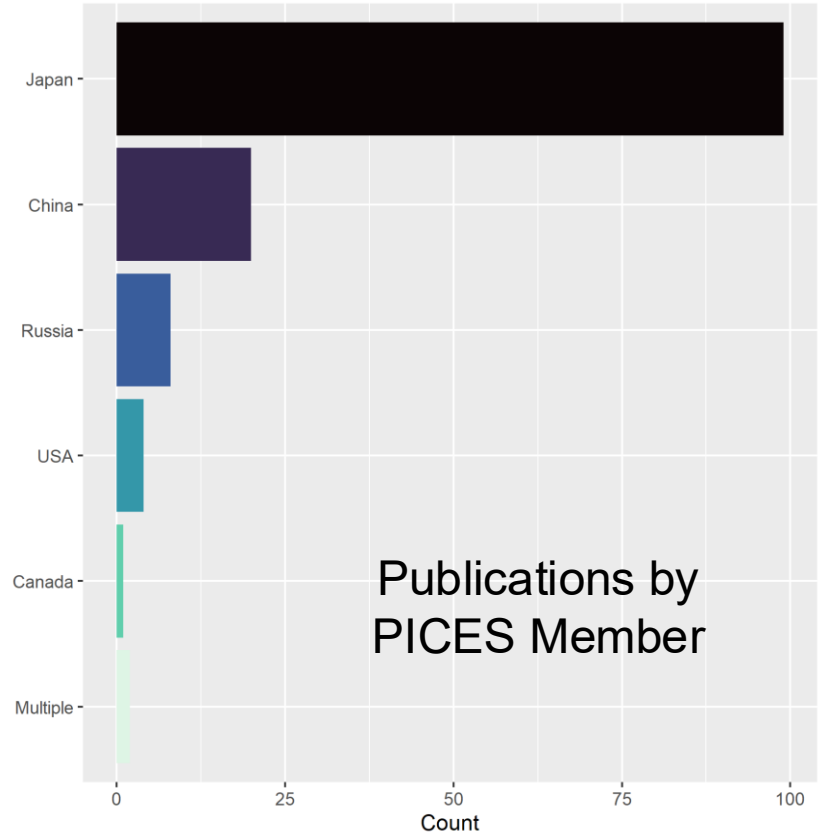
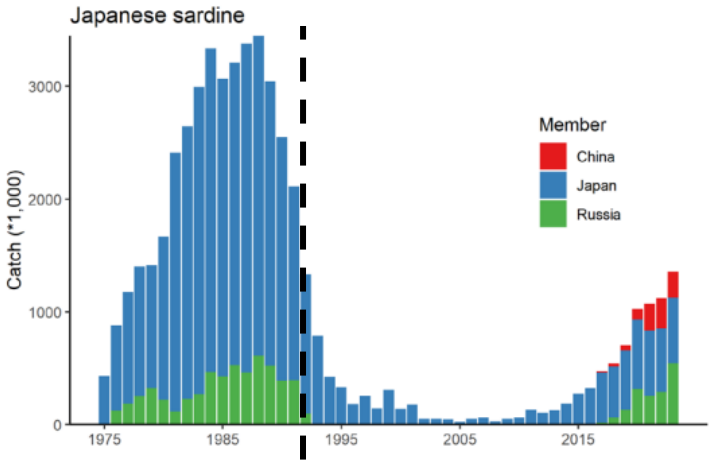
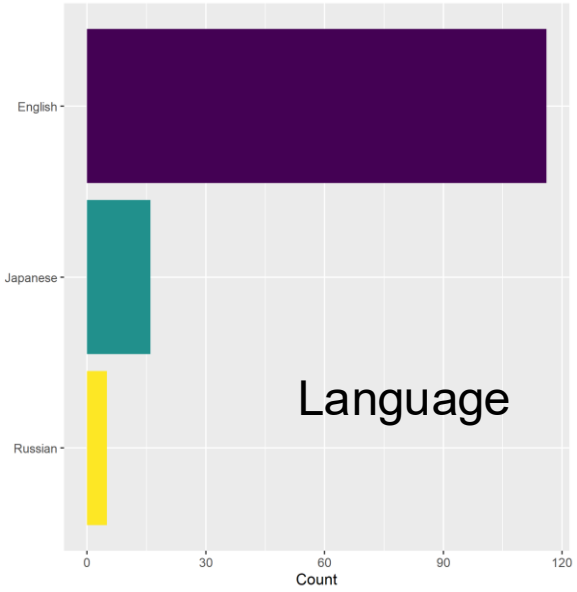
Basic Statistics



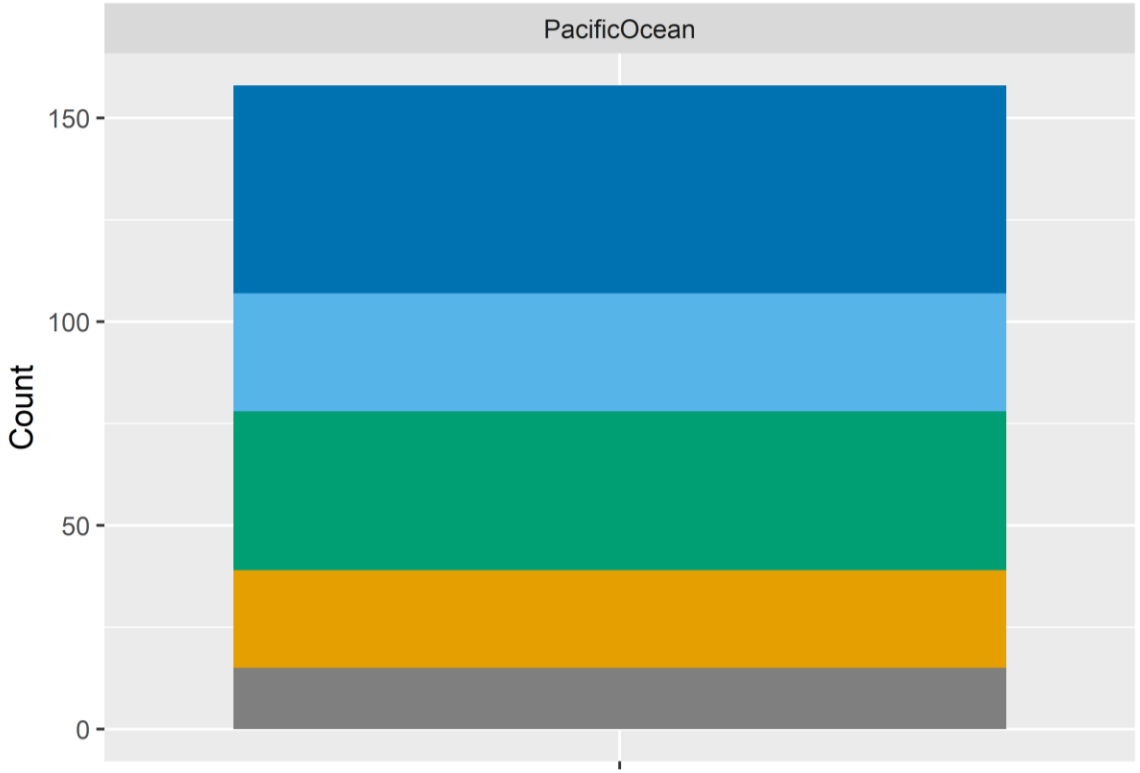




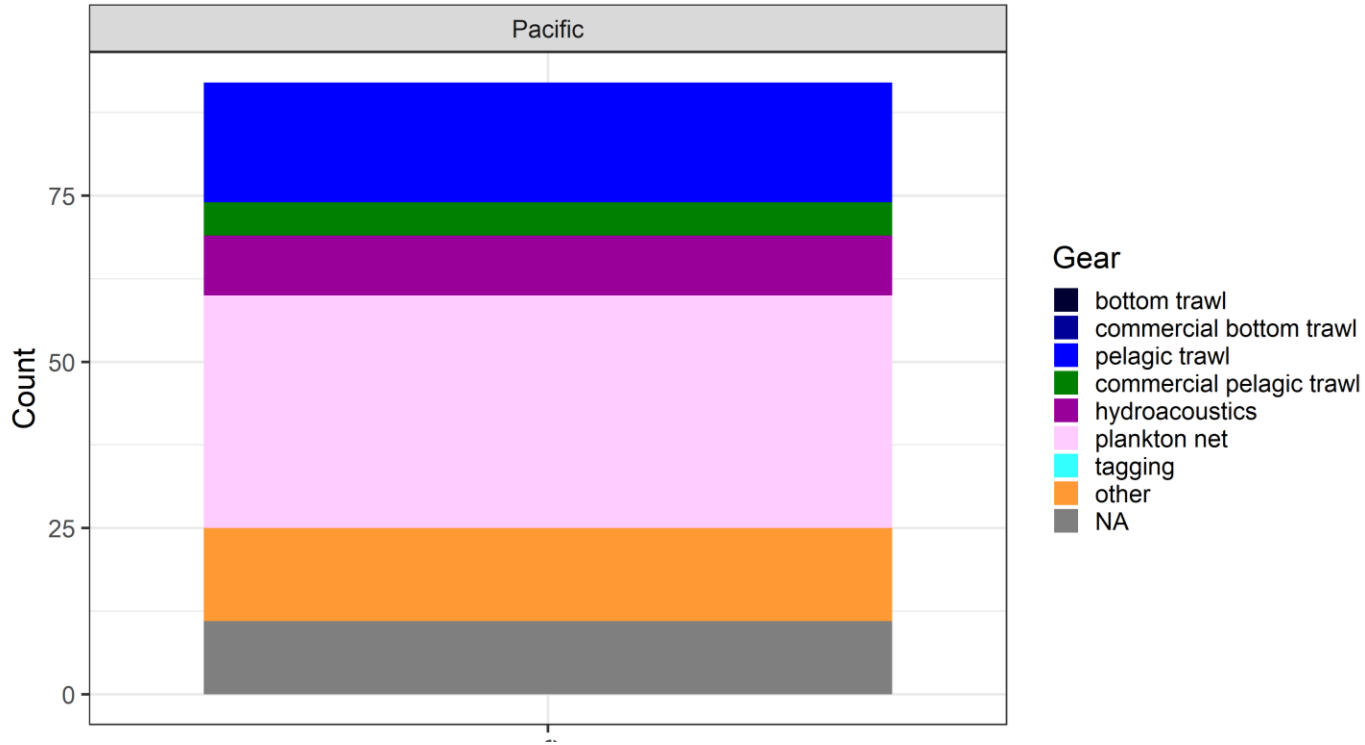




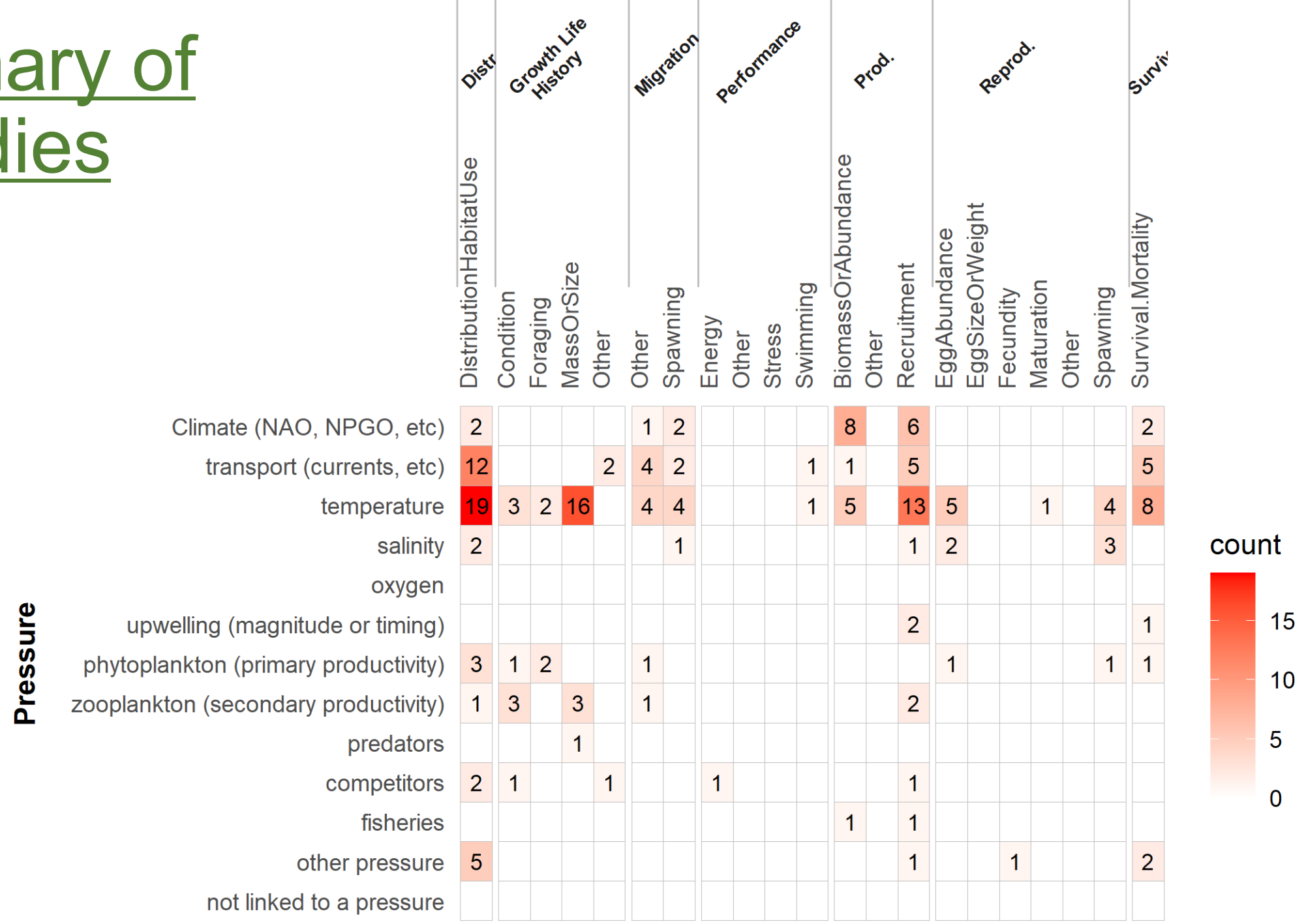
By life history stage



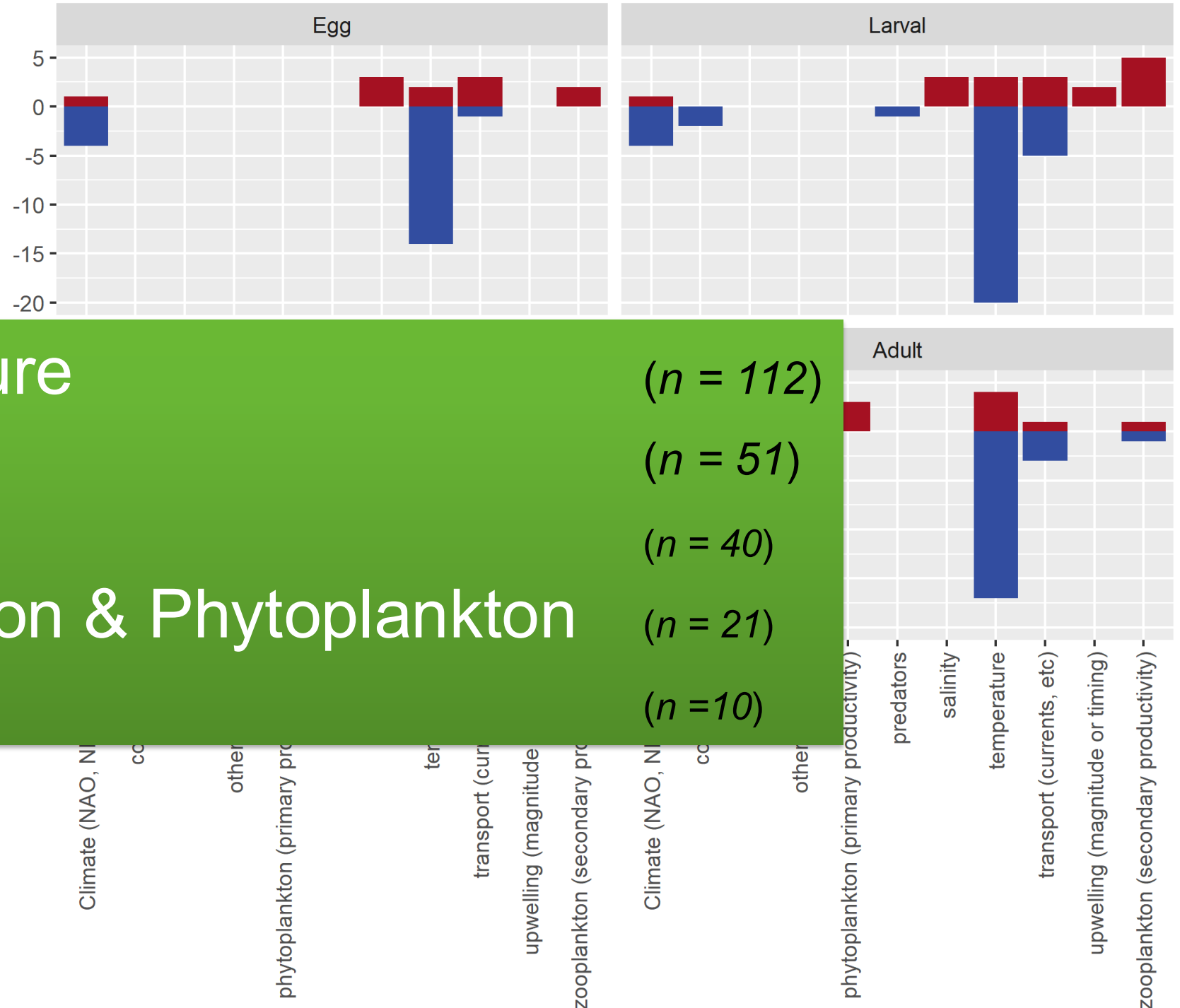
By gear type



Summary of studies



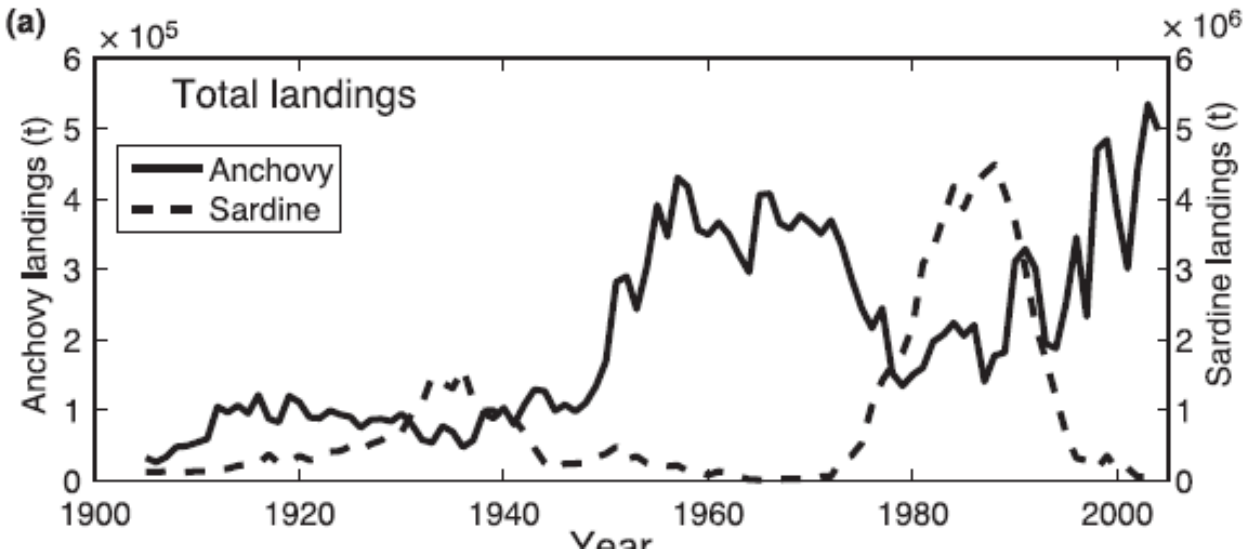
Key Findings

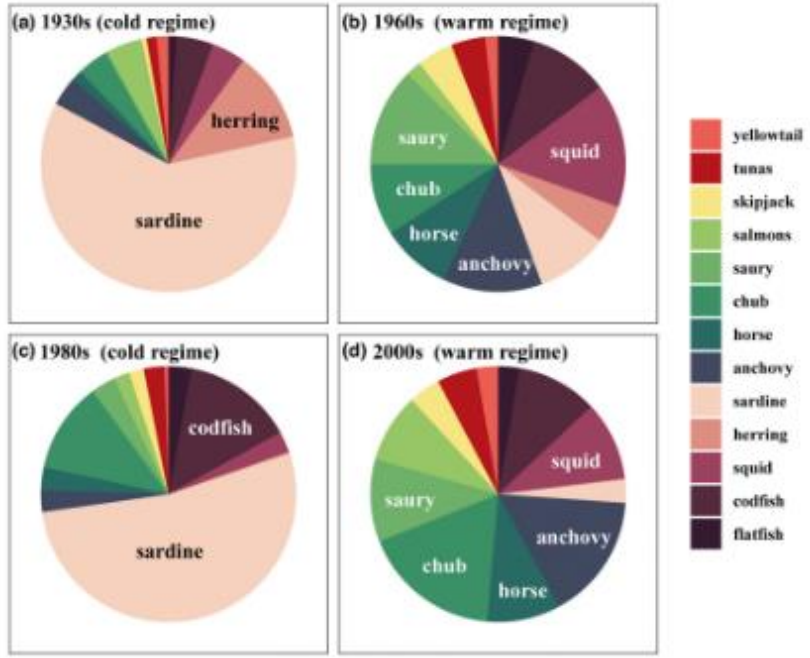


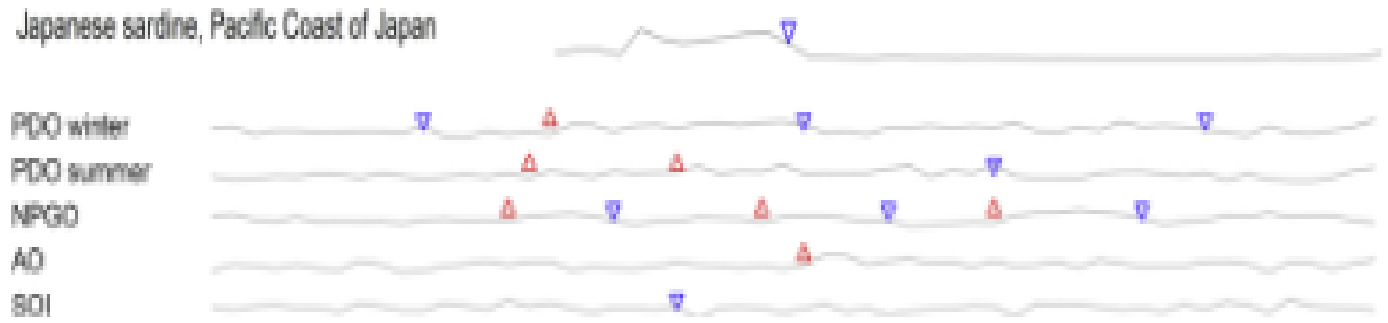
Temperature (*n = 112*)
Climate (*n = 51*)
Transport (*n = 40*)
Zooplankton & Phytoplankton (*n = 21*)
Salinity (*n =10*)

Climate Regime shifts

- From Itoh et al. (2009), Kuroda et al. (2020) and Tian et al. (2023)







Optimal growth hypothesis

- Takasuka et al. (2007)

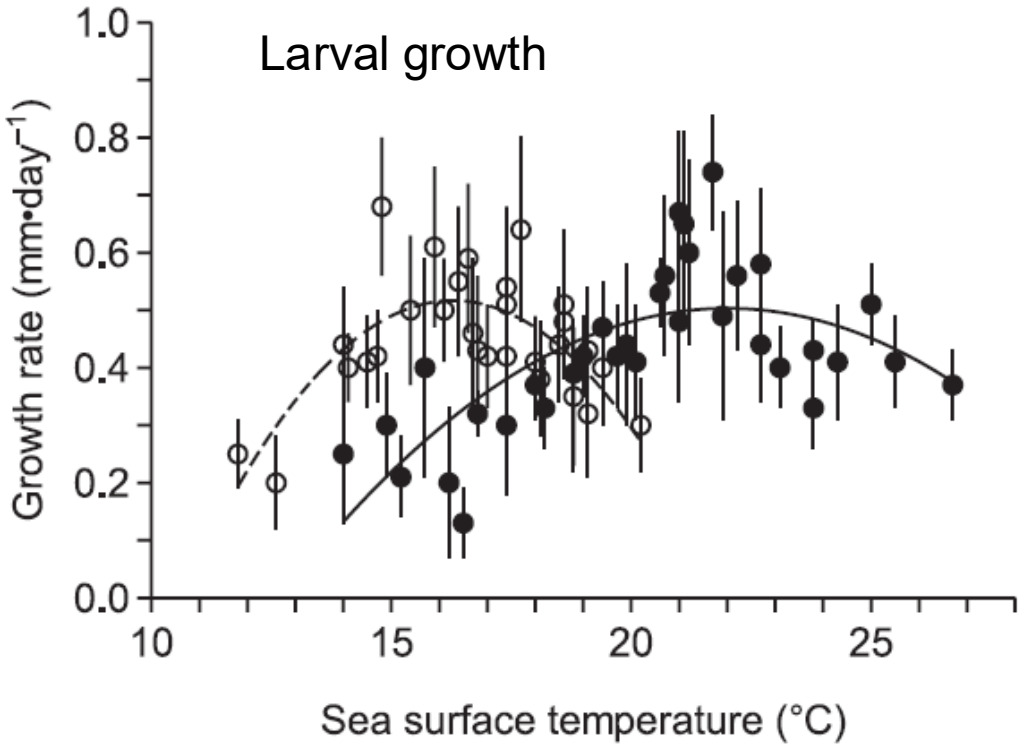
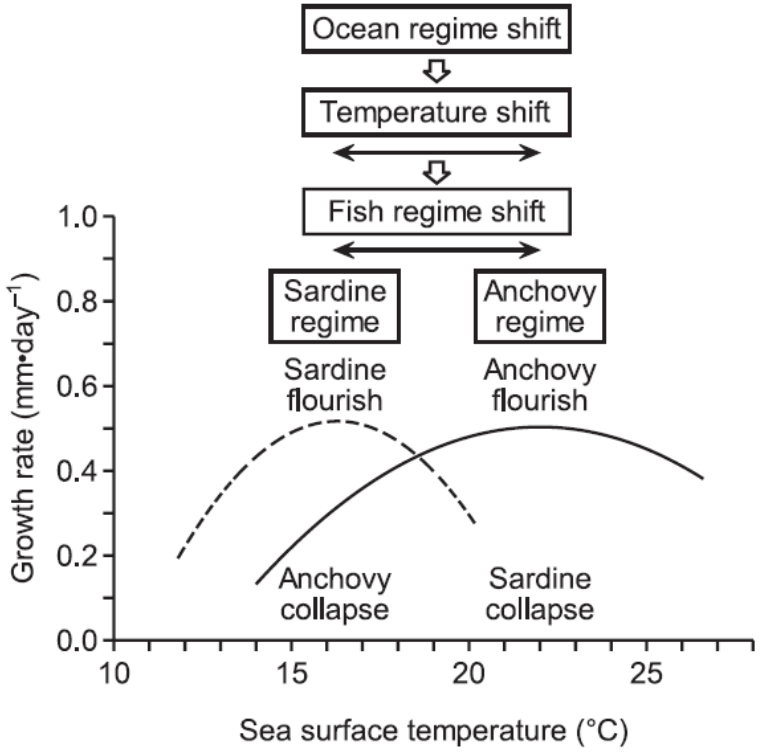
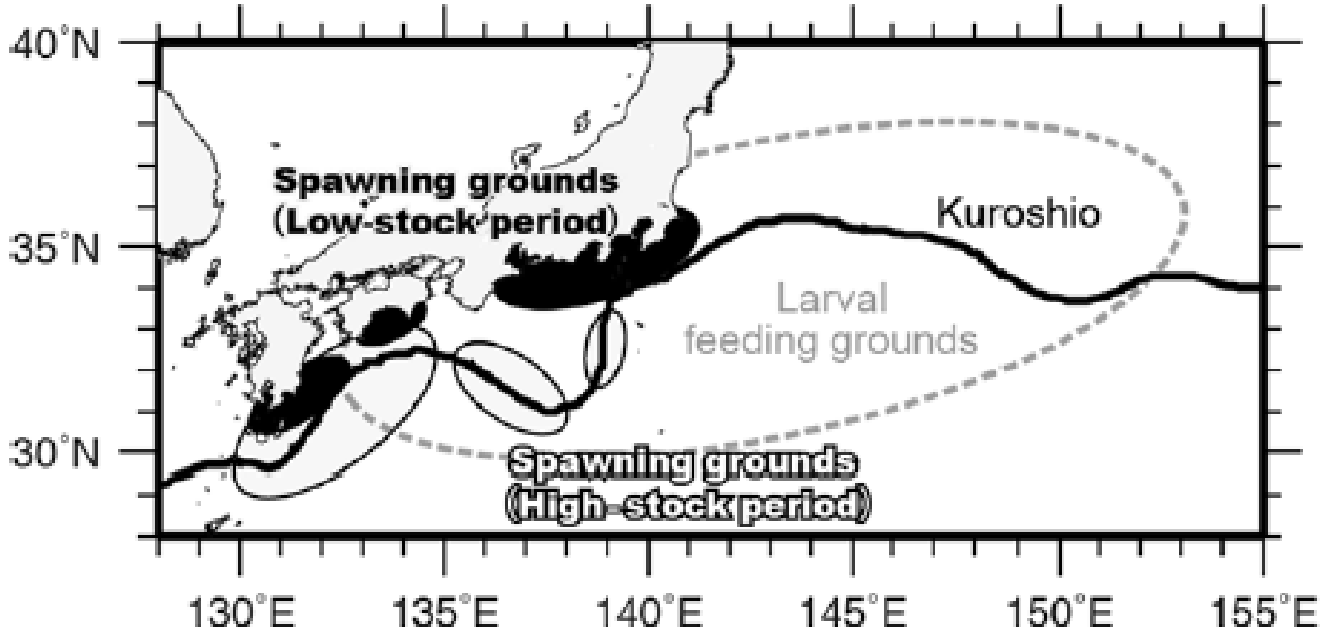


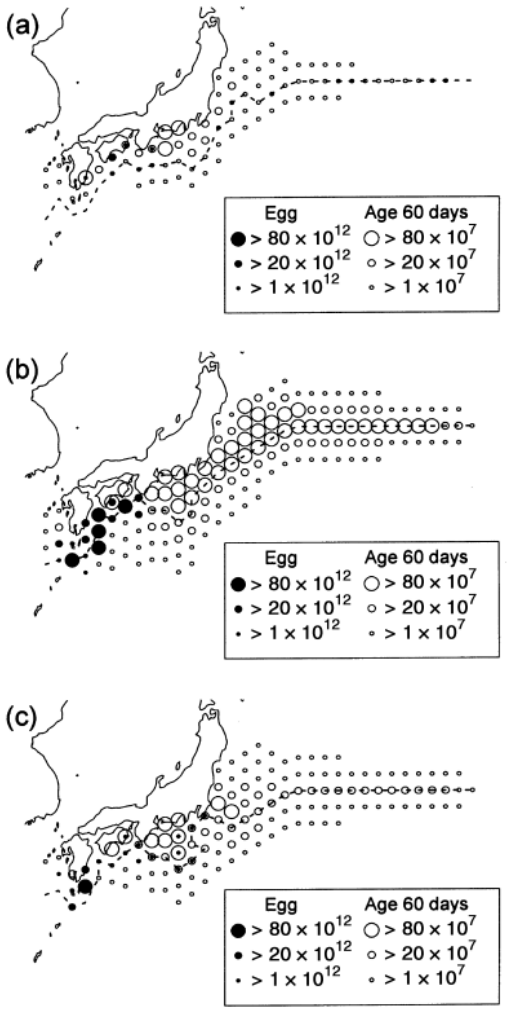
Fig. 6. Conceptual framework of the optimal growth temperature hypothesis: a potential biological mechanism for the anchovy and sardine regime shifts under the assumption that both types of larvae experience similar temperatures during the same period. Quadratic functions for Japanese anchovy (*Engraulis japonicus*, solid curve) and Japanese sardine (*Sardinops melanostictus*, broken curve) were derived from Fig. 4.



Transport to larval feeding grounds

- Suda and Kishida (2003) and Nishikawa (2018)





Shifts in distribution of spawning/feeding grounds

- Yatsu et al. (2008) and Okunishi et al. (2012)

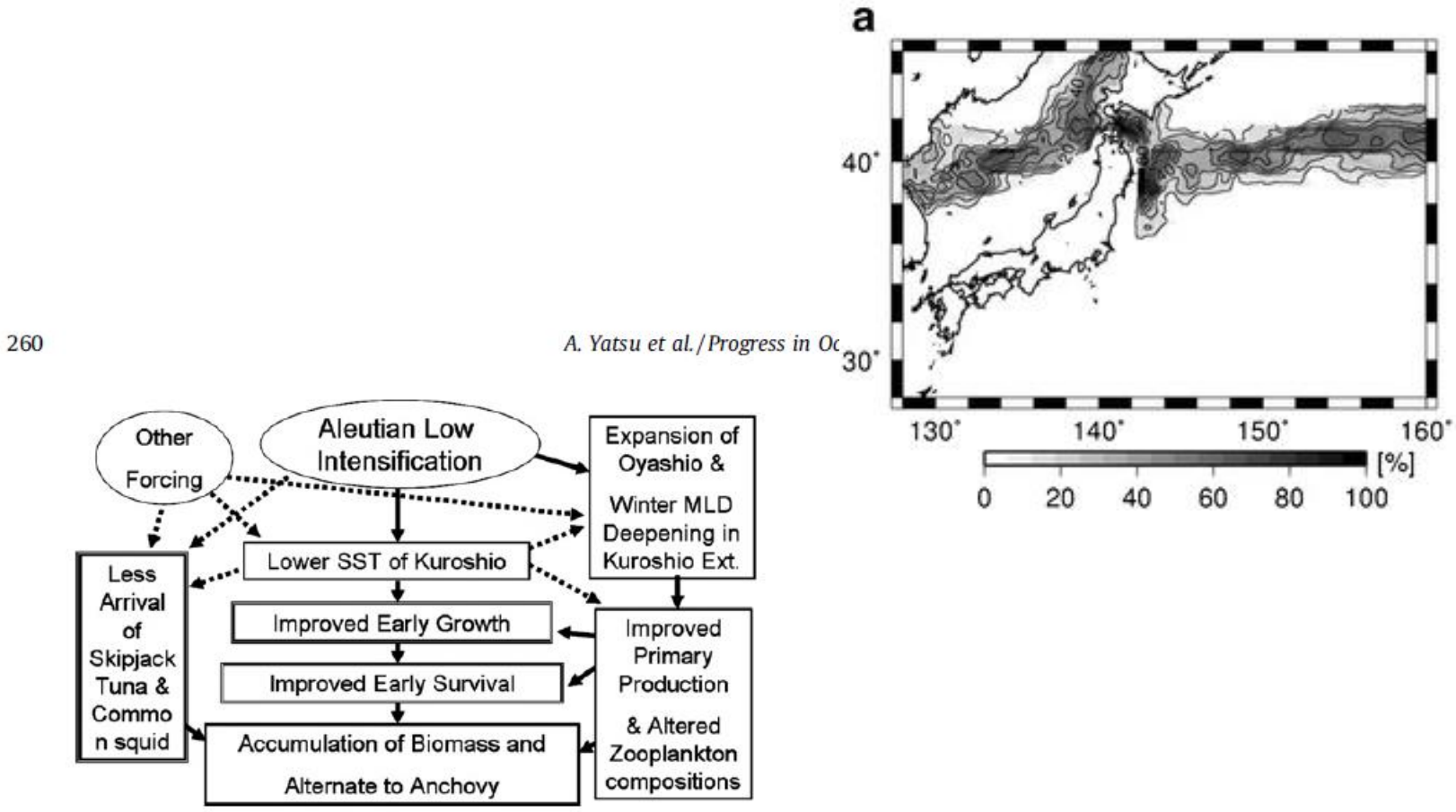
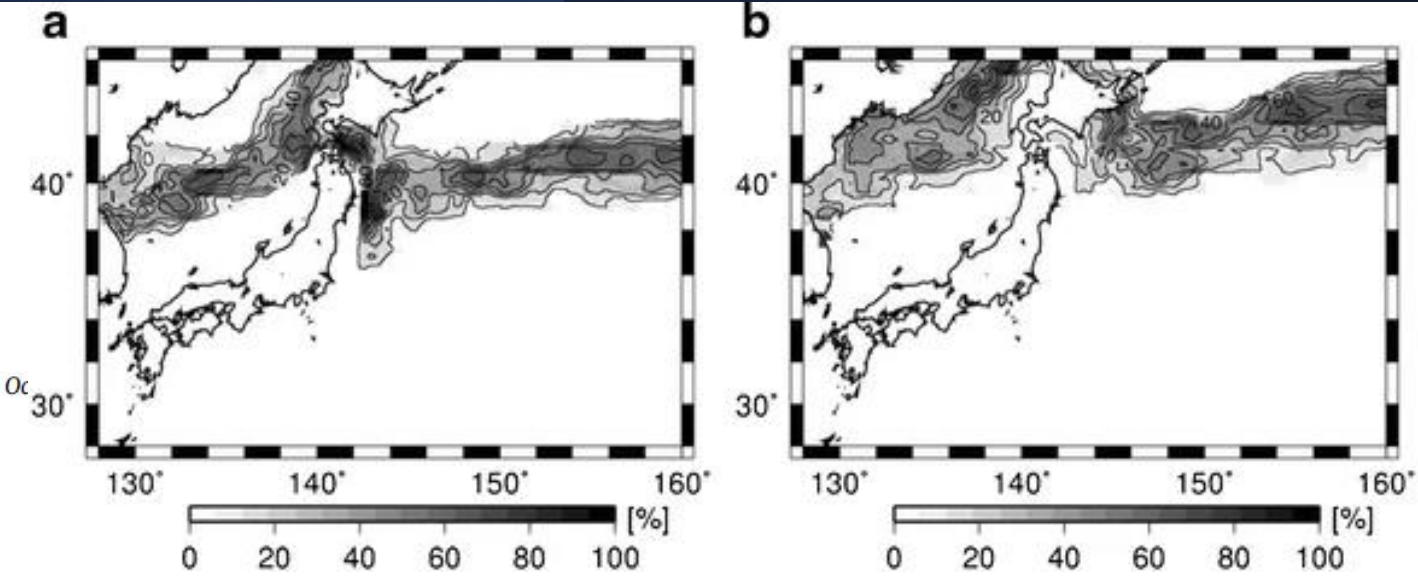
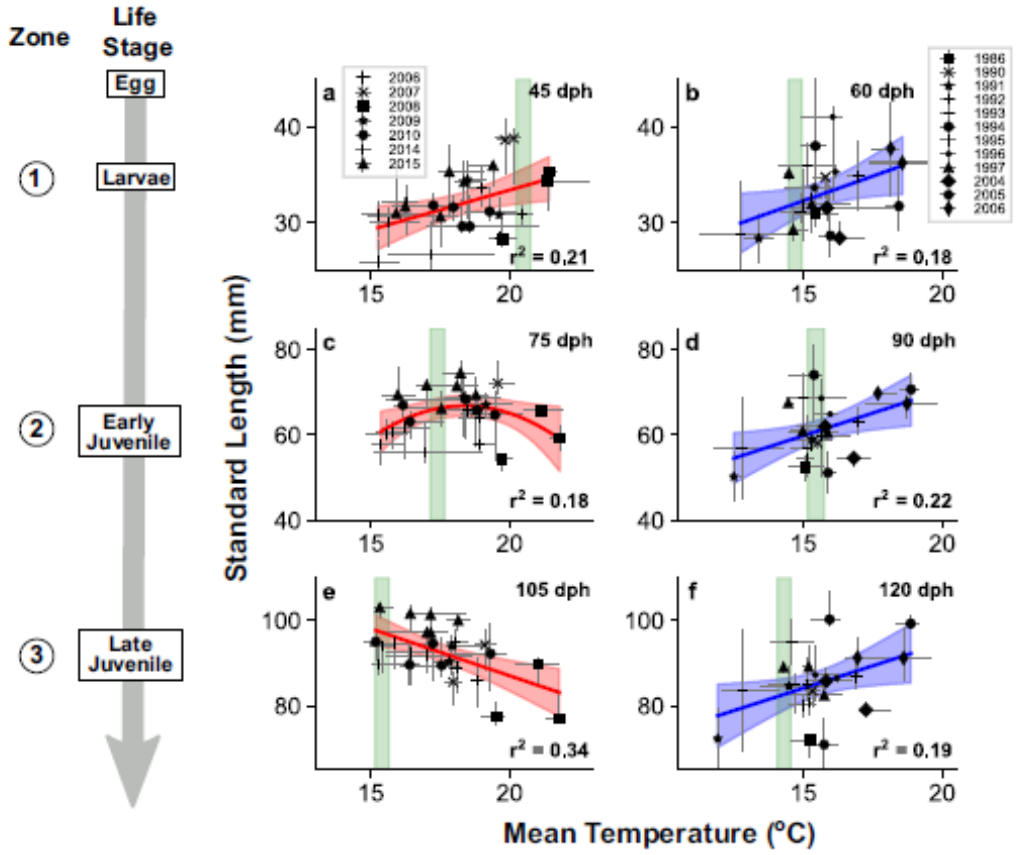


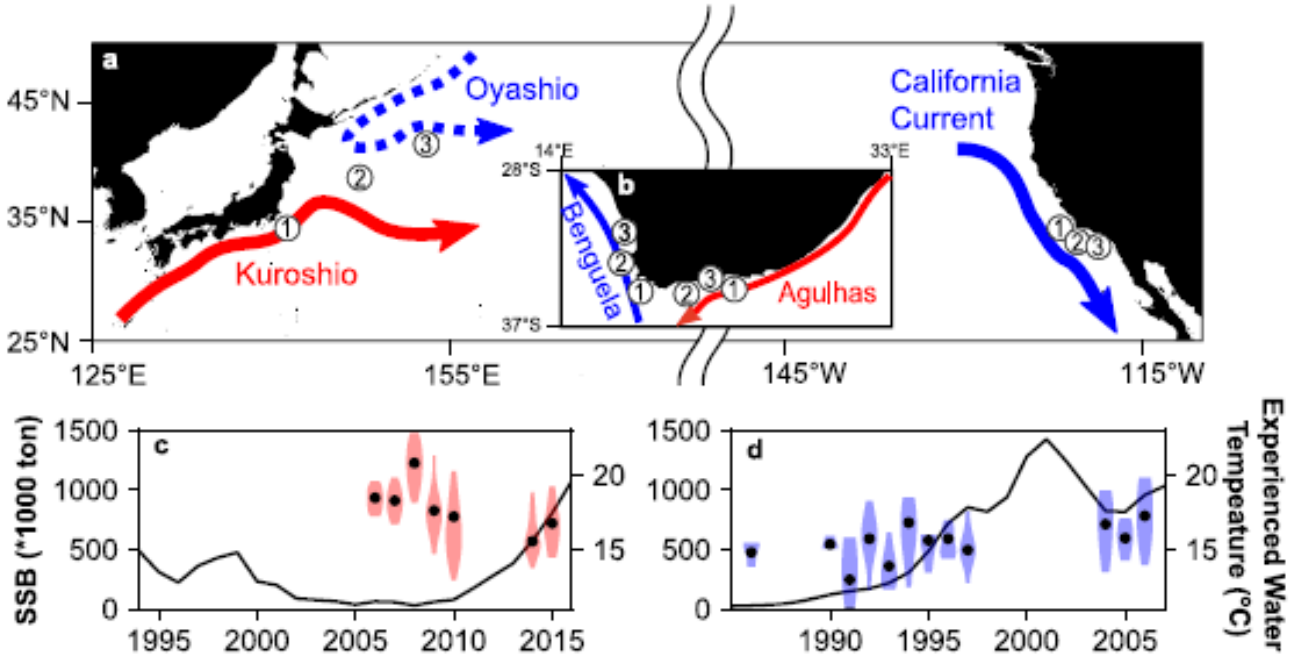
Fig. 6. Conceptual model of stock fluctuation of the Pacific stock of Japanese sardine. Solid arrows: statistically or mechanistically significant relations; Dashed arrows: unproven but plausible relations.



Combinations of temperature/feeding/space

- Sakamoto et al. (2022)





Potential environmental indicators for NPFC to monitor

1. Sea surface temperature in the Kuroshio transition zone (larval growth)

1. PDO and other climate indicators (linked to overall abundance/productivity)

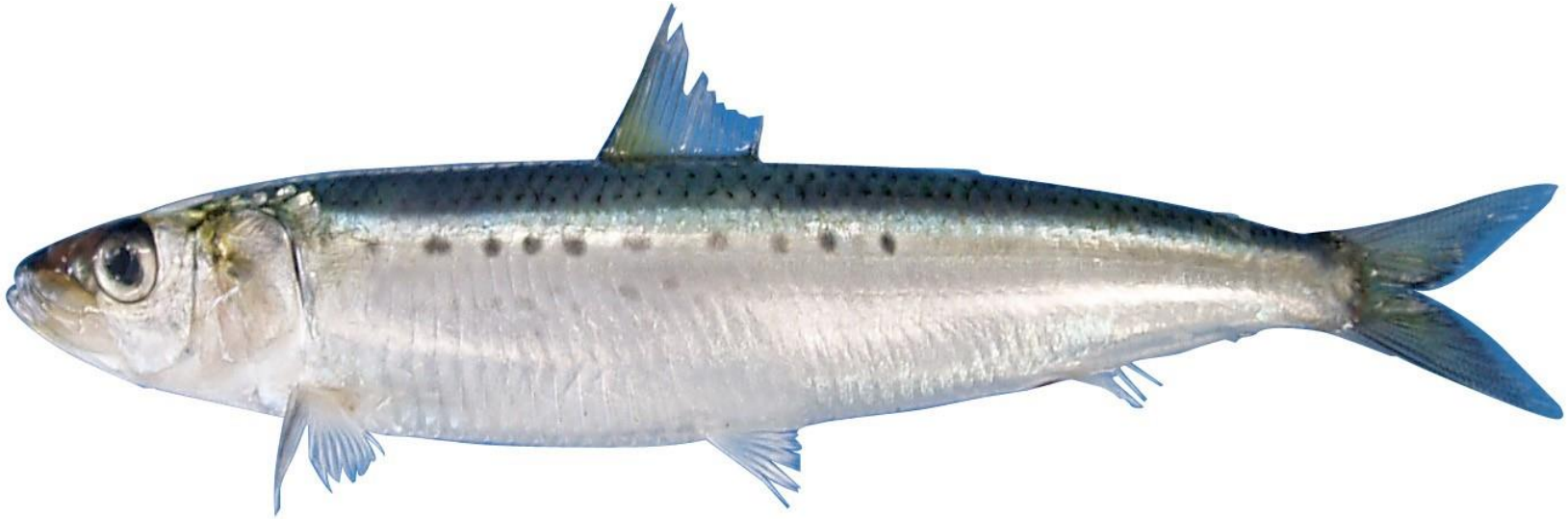
1. Currents (successful transport to the larval feeding areas)

1. Winter mixed layer depth (zooplankton production/composition)

1. Spring primary production (larval growth survival)
    1. Chlorophyll
    2. Zooplankton biomass

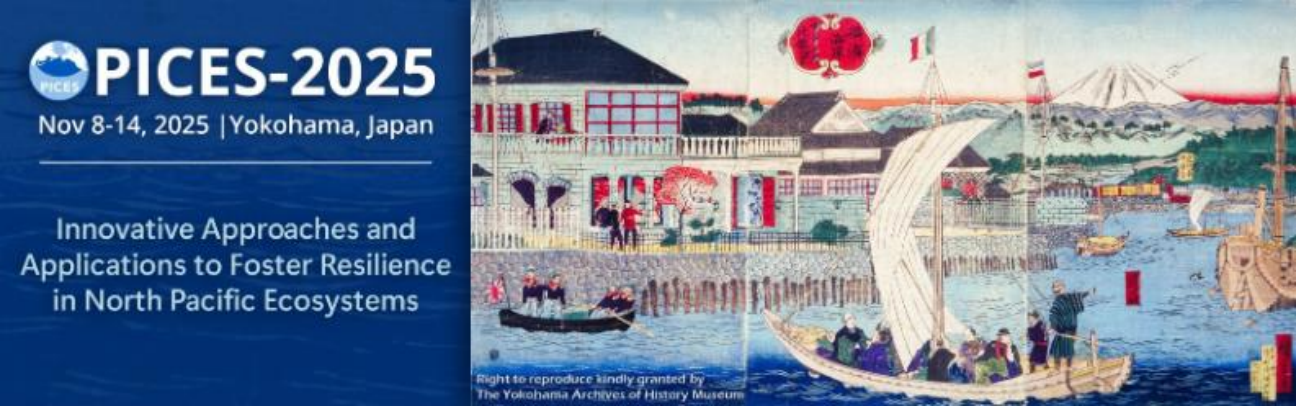
1. Sea surface salinity

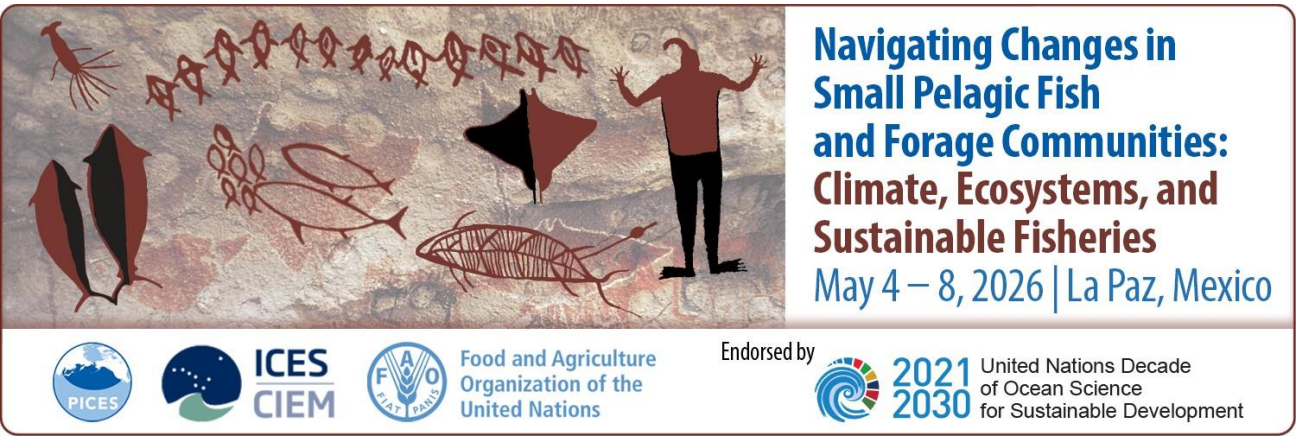
NPFC



Indicator trends – J

- SST, KE
- Chloroph
- Unfortuna





Future work

- Identify more/better/relevant ecosystem indicators
- Incorporate indicators into stock assessments or MSE process
- Identify data gaps and research that is needed
- Explore areas for “actionable” collaboration with PICES community
- Eight more priority species

NPFC

Acknowledgements

- Dr. Kazunari Higashiguchi (Japan)
- Maddie Lavery (Canada)
- Researchers of Japanese Sardine
- Members of the NPFC Small Working Group on Pelagic Fishes
- Dr. Larry Jacobson
- Dr. Joel Rice

Chris.Rooper@dfo-mpo.gc.ca

North Pacific Fisheries Commission – Travel Funding

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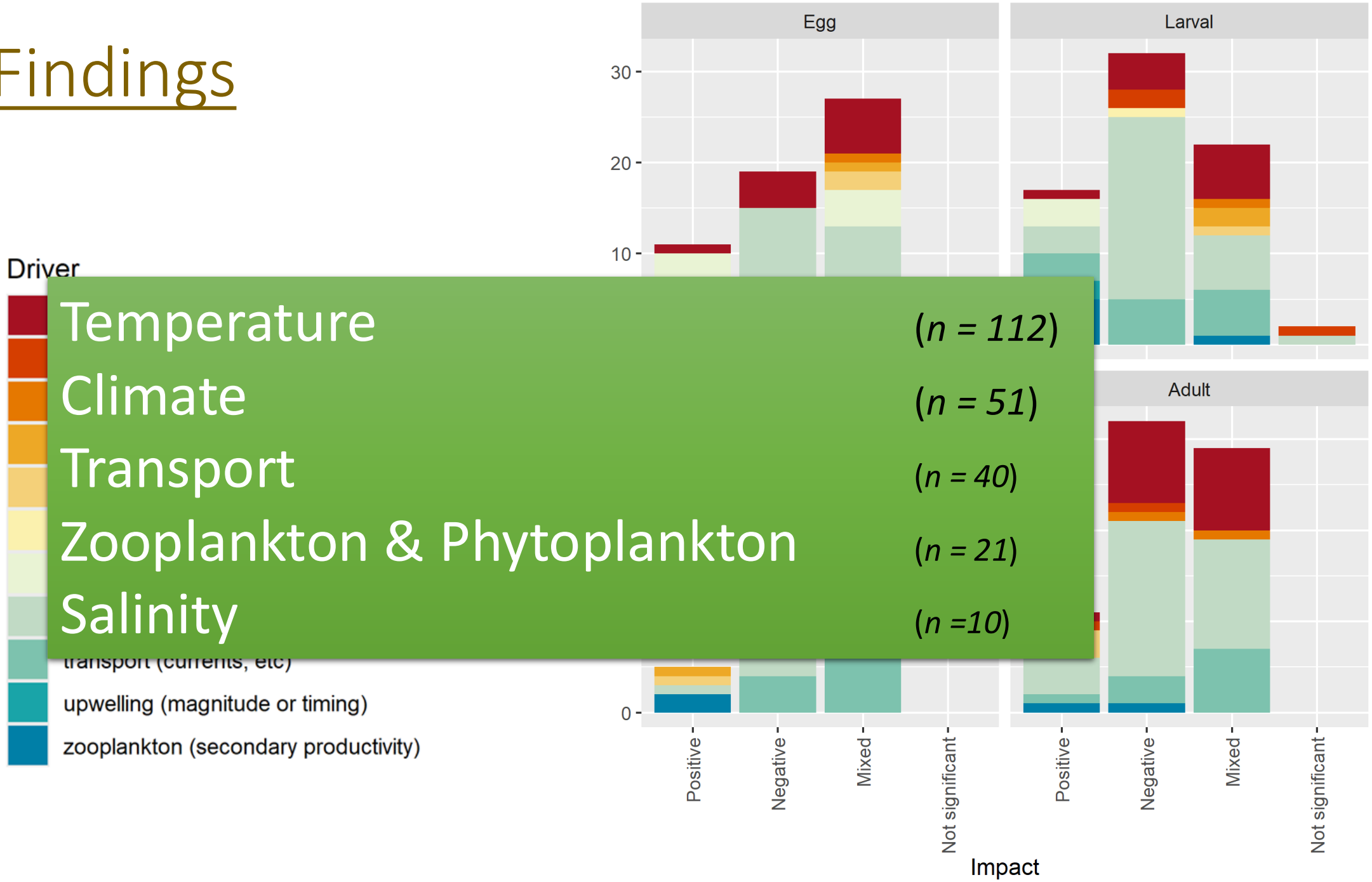
終わり

Key Findings



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