

*Science, Service, Stewardship*



# Developing ocean ecosystem indicators for marine turtle juvenile recruitment

NMFS

**Dr. Kyle Van Houtan**

Director's Office

Pacific Islands Fisheries Science Center

NOAA Fisheries







## Incorporating Climate Science in Applications of the U.S. Endangered Species Act for Aquatic Species

MICHELLE M. MCCLURE,\* MICHAEL ALEXANDER,† DIANE BORGGAARD,‡ DAVID BOUGHTON,§  
LISA CROZIER,\* ROGER GRIFFIS,\*\* JEFFREY C. JORGENSEN,\* STEVEN T. LINDLEY,§  
JANET NYE,†† MELANIE J. ROWLAND,‡‡§§ ERIN E. SENEY,\*\*\*\*\* AMY SNOVER,†††  
CHRISTOPHER TOOLE,‡‡‡ AND KYLE VAN HOUTAN§§§\*\*\*\*

\*National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard, East, Seattle, WA 98112, U.S.A., email michelle.mcclure@noaa.gov

†NOAA Earth System Research Laboratory, 325 Broadway, Boulder, CO 80305, U.S.A.

‡National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office, 55 Great Republic Drive, Gloucester, MA 01930, U.S.A.

§National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060, U.S.A.

\*\*National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Science and Technology, 1315 East-West Highway, Silver Spring, MD 20910, U.S.A.

††School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794-5000, U.S.A.

‡‡National Oceanic and Atmospheric Administration, Office of the General Counsel, Northwest Section, Seattle, WA, U.S.A. (retired)

§§Melanie J. Rowland Consulting, Twisp, WA 98856, U.S.A.

\*\*\*Erin SENEY Consulting, LLC, Woodbridge, VA 22192, U.S.A.

†††Climate Impacts Group, University of Washington, 3737 Brooklyn Avenue NE (Wallace Hall), Seattle, WA 98105, U.S.A.

‡‡‡National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region, 1201 Northeast Lloyd Boulevard, Suite 1100, Portland, OR 97232-1274, U.S.A.

§§§National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Science Center, 1601 Kapiolani Boulevard, Honolulu, HI 96814, U.S.A.

\*\*\*\*Nicholas School of the Environment and Earth Sciences, Duke University, Durham, NC 27708, U.S.A.

**Abstract:** *Aquatic species are threatened by climate change but have received comparatively less attention than terrestrial species. We gleaned key strategies for scientists and managers seeking to address climate change in aquatic conservation planning from the literature and existing knowledge. We address 3 categories of conservation effort that rely on scientific analysis and have particular application under the U.S. Endangered Species Act (ESA): assessment of overall risk to a species; long-term recovery planning; and evaluation of effects of specific actions or perturbations. Fewer data are available for aquatic species to support these analyses, and climate effects on aquatic systems are poorly characterized. Thus, we recommend scientists conducting analyses supporting ESA decisions develop a conceptual model that links climate, habitat, ecosystem, and species response to changing conditions and use this model to organize analyses and future research. We recommend that current climate conditions are not appropriate for projections used in ESA analyses and that long-term projections of climate-change effects provide temporal context as a species-wide assessment provides spatial context. In these projections, climate change should not be discounted solely because the magnitude of projected change at a particular time is uncertain when directionality of climate change is clear. Identifying likely future habitat at the species scale will indicate key refuges and potential range shifts. However, the risks and benefits associated with errors in modeling future habitat are not equivalent. The ESA offers mechanisms for increasing the overall resilience and resistance of species to climate changes, including establishing recovery goals requiring increased genetic and phenotypic diversity, specifying critical habitat in areas not currently occupied but likely to become important, and using adaptive management.*

**Keywords:** climate change, conservation planning, effects analysis, population models, recovery planning, risk assessment, vulnerability

Paper submitted July 31, 2012; revised manuscript accepted May 27, 2013.

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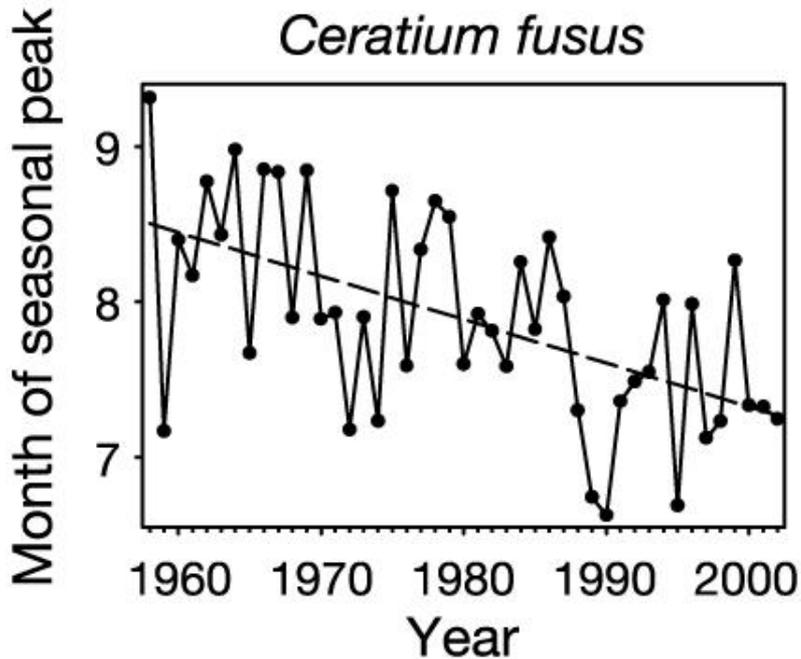
Conservation Biology, Volume 27, No. 6, 1222–1235

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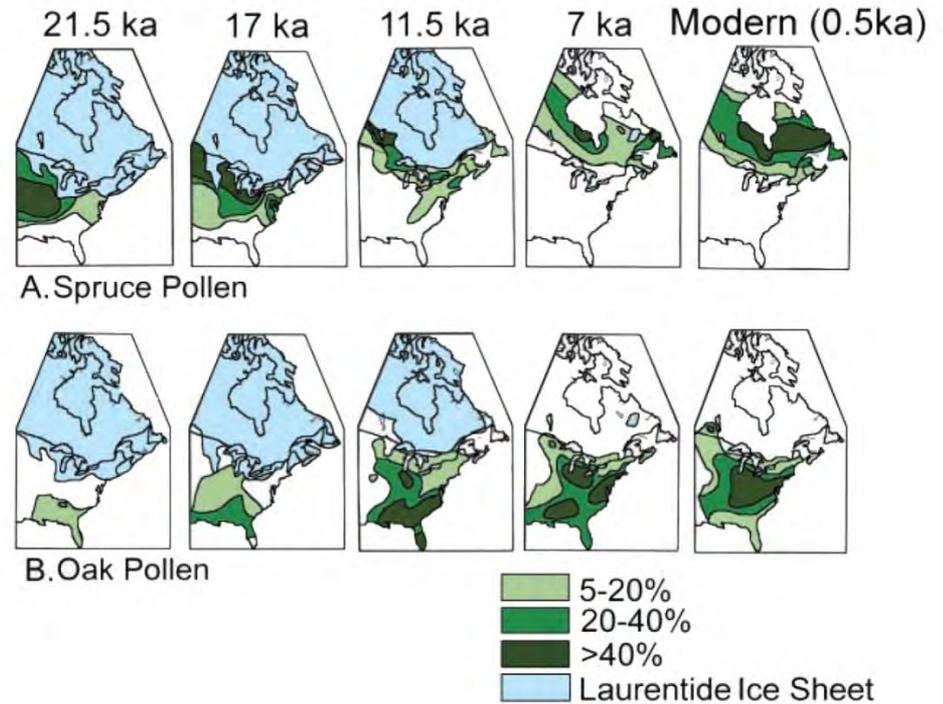
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# Being Climate Ready

# Climate envelopes



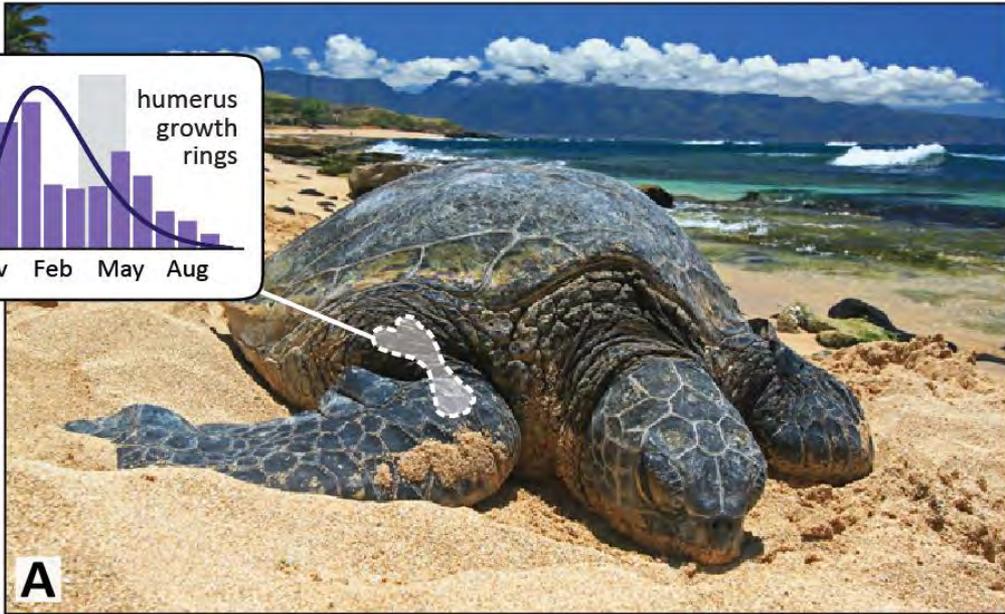
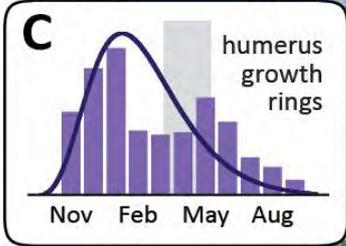
Edwards & Richardson (2004)



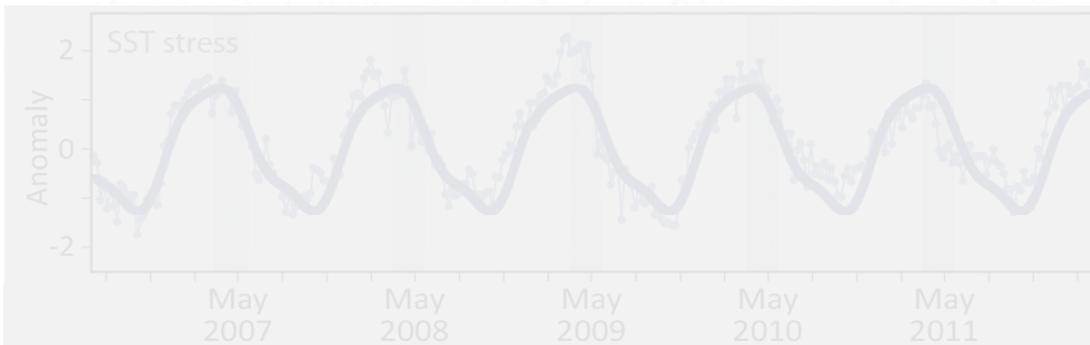
Davis & Shaw (2001)

# Climate envelopes





# Climate envelopes

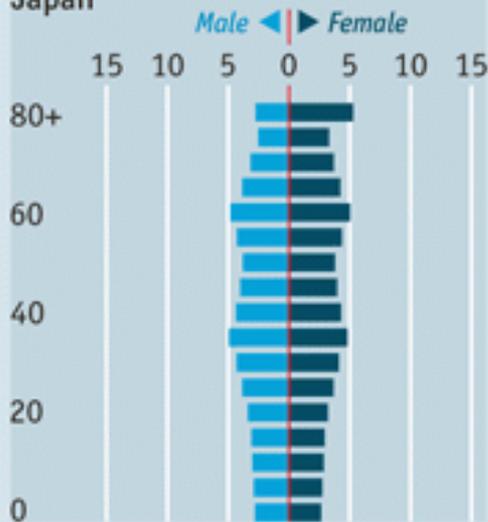


# If turtles were a country...

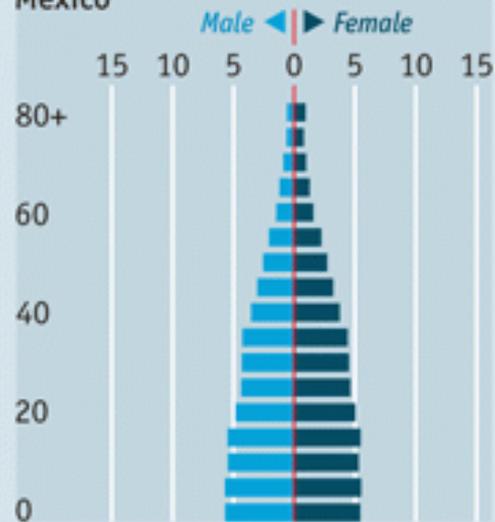
## Ageing Asia, middle-aged Americas, youthful Africa

Population by age group, 2010, m

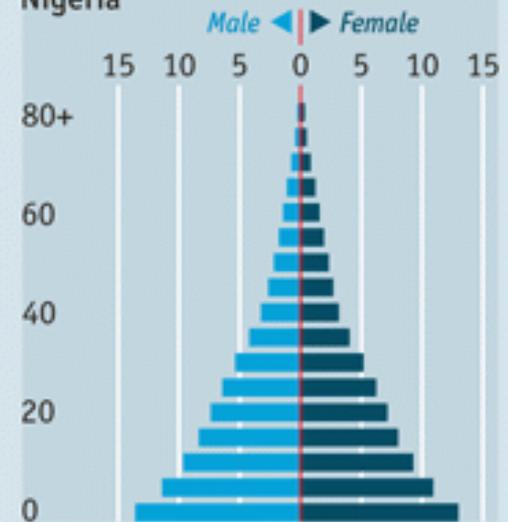
Japan



Mexico

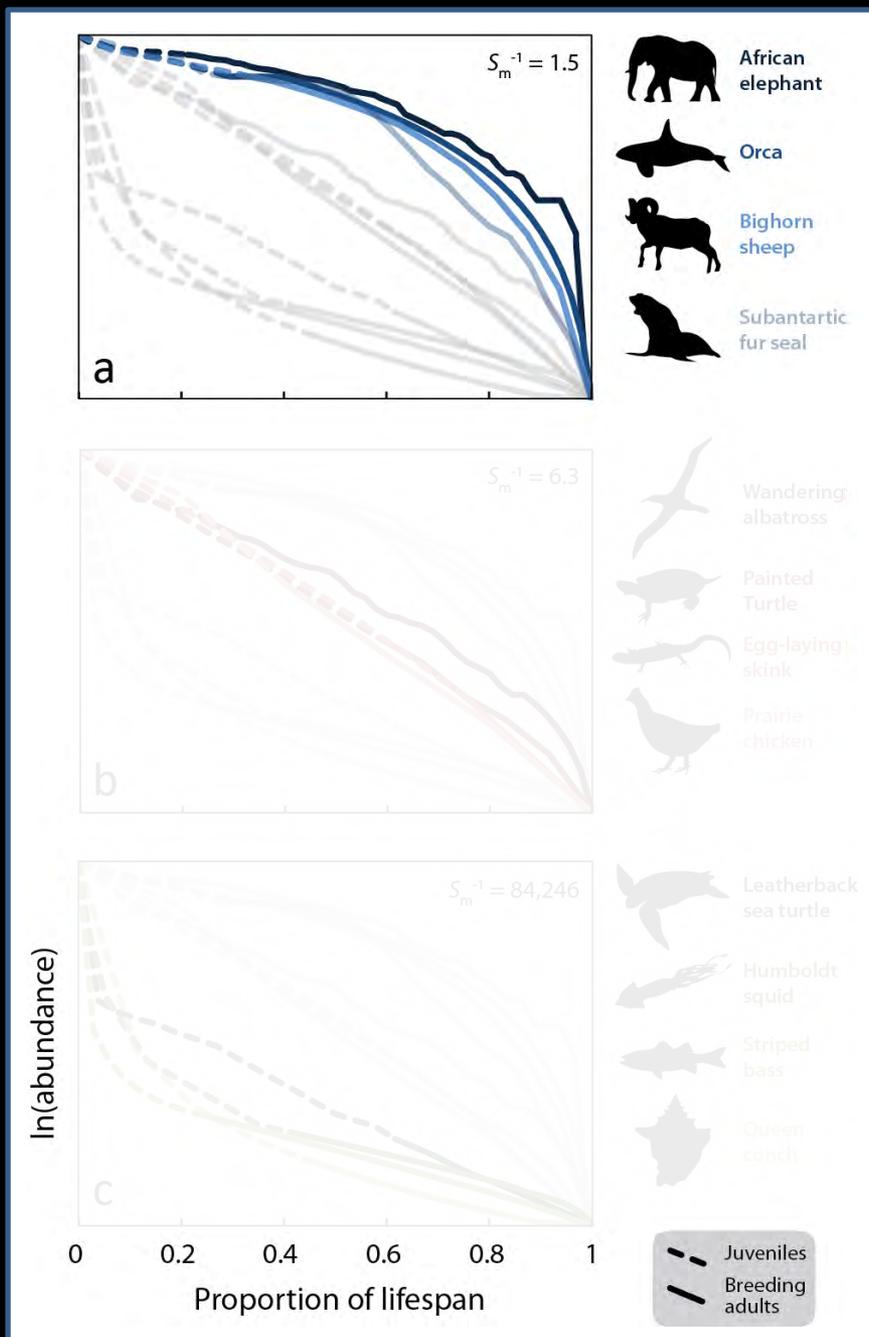


Nigeria

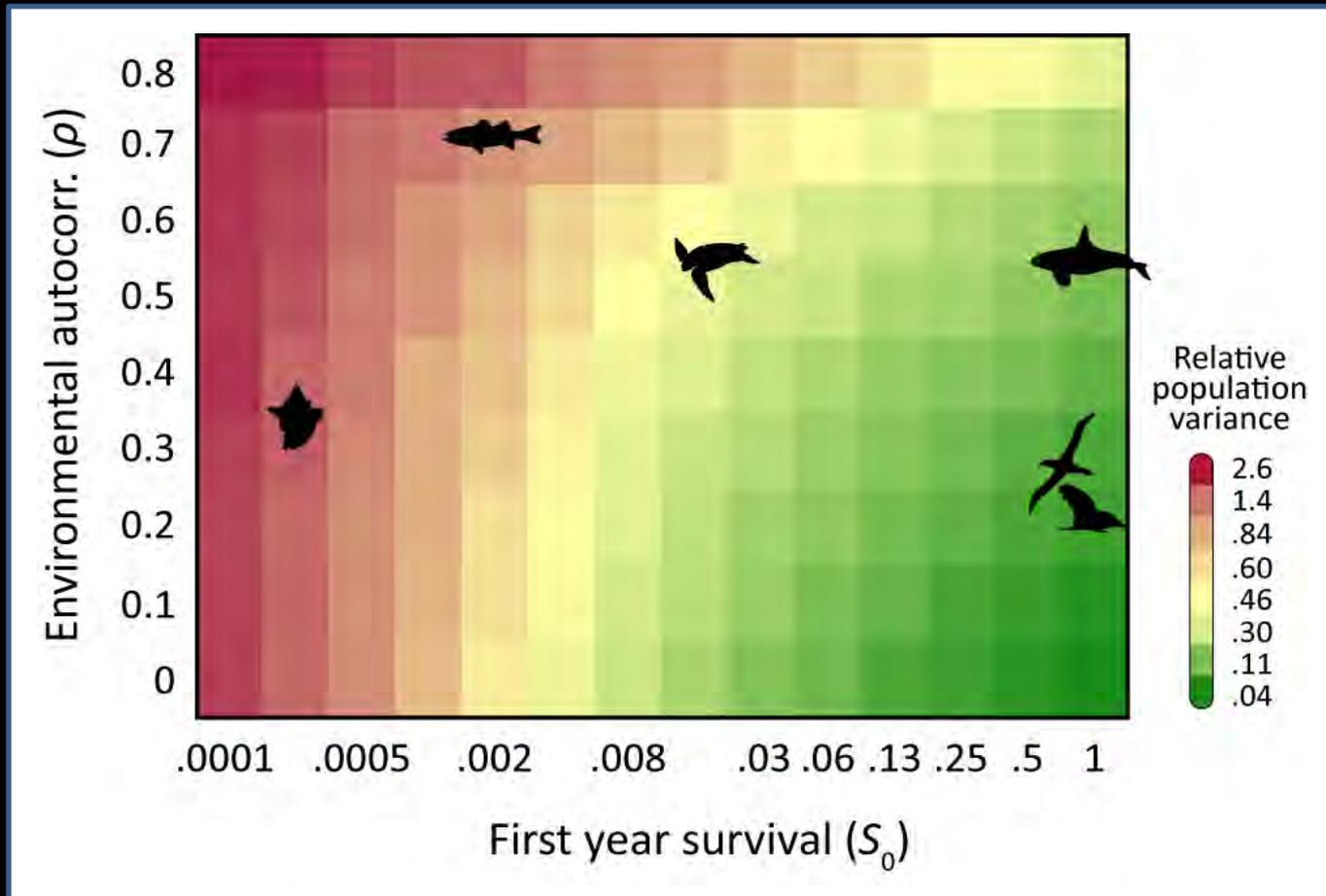


Source: UN

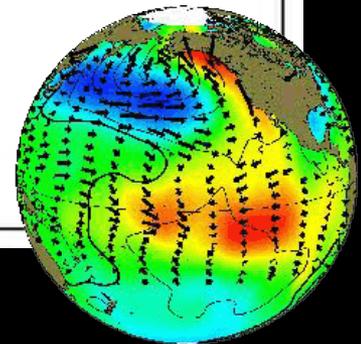
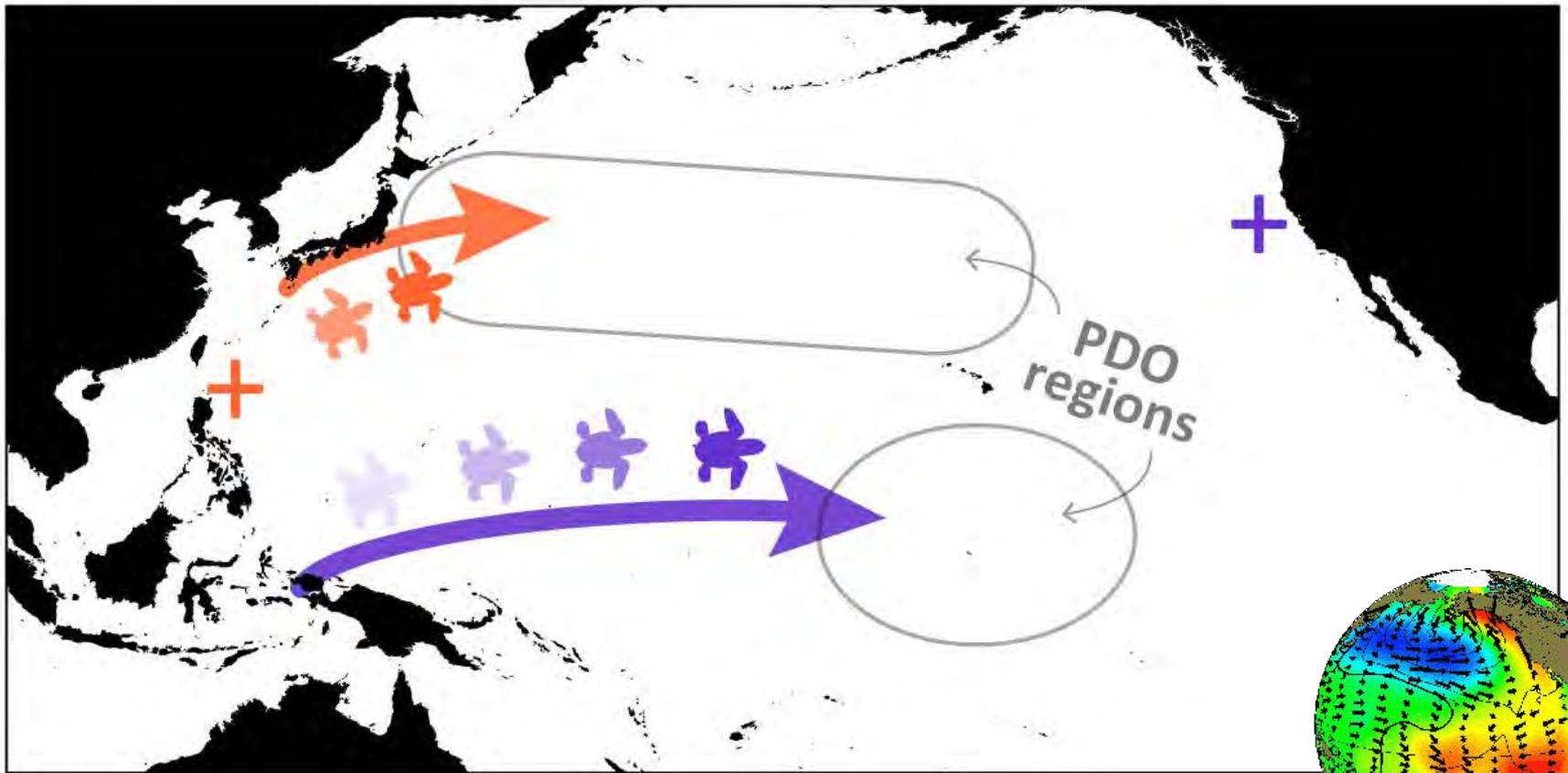
# Climate Sensitivity



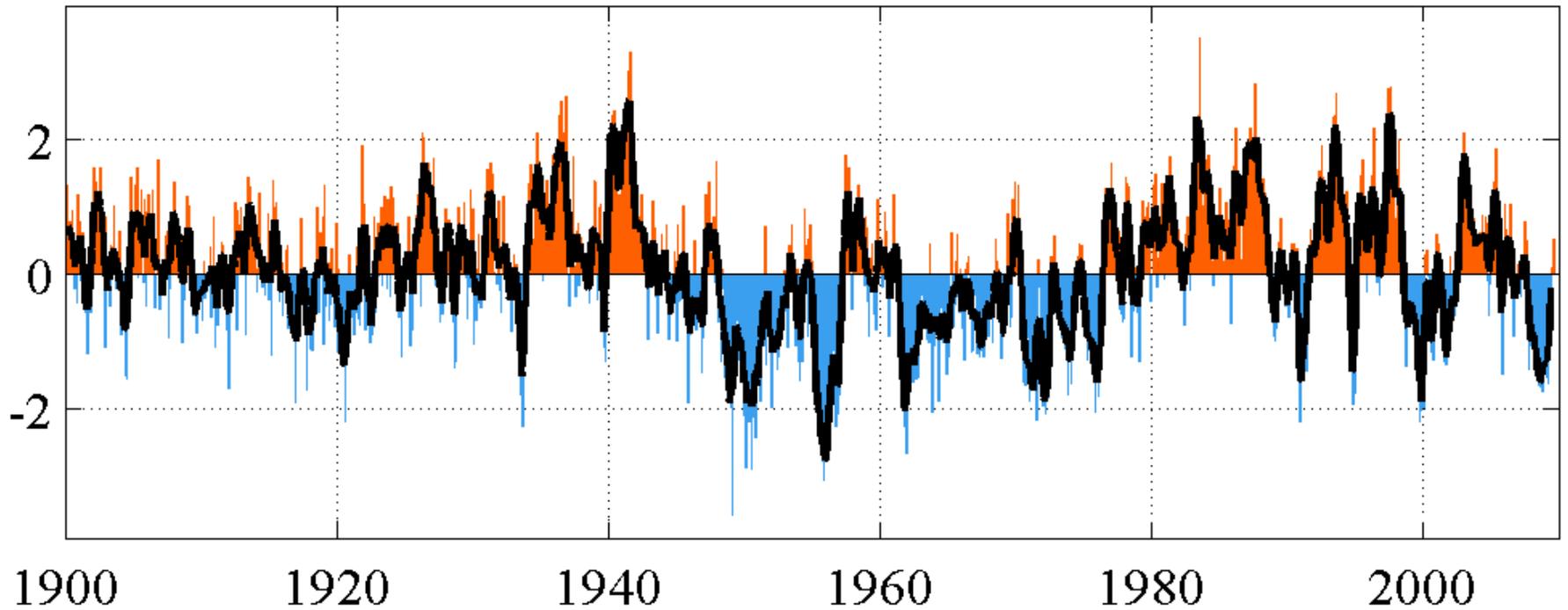
# Climate sensitivity



# Spatial structure

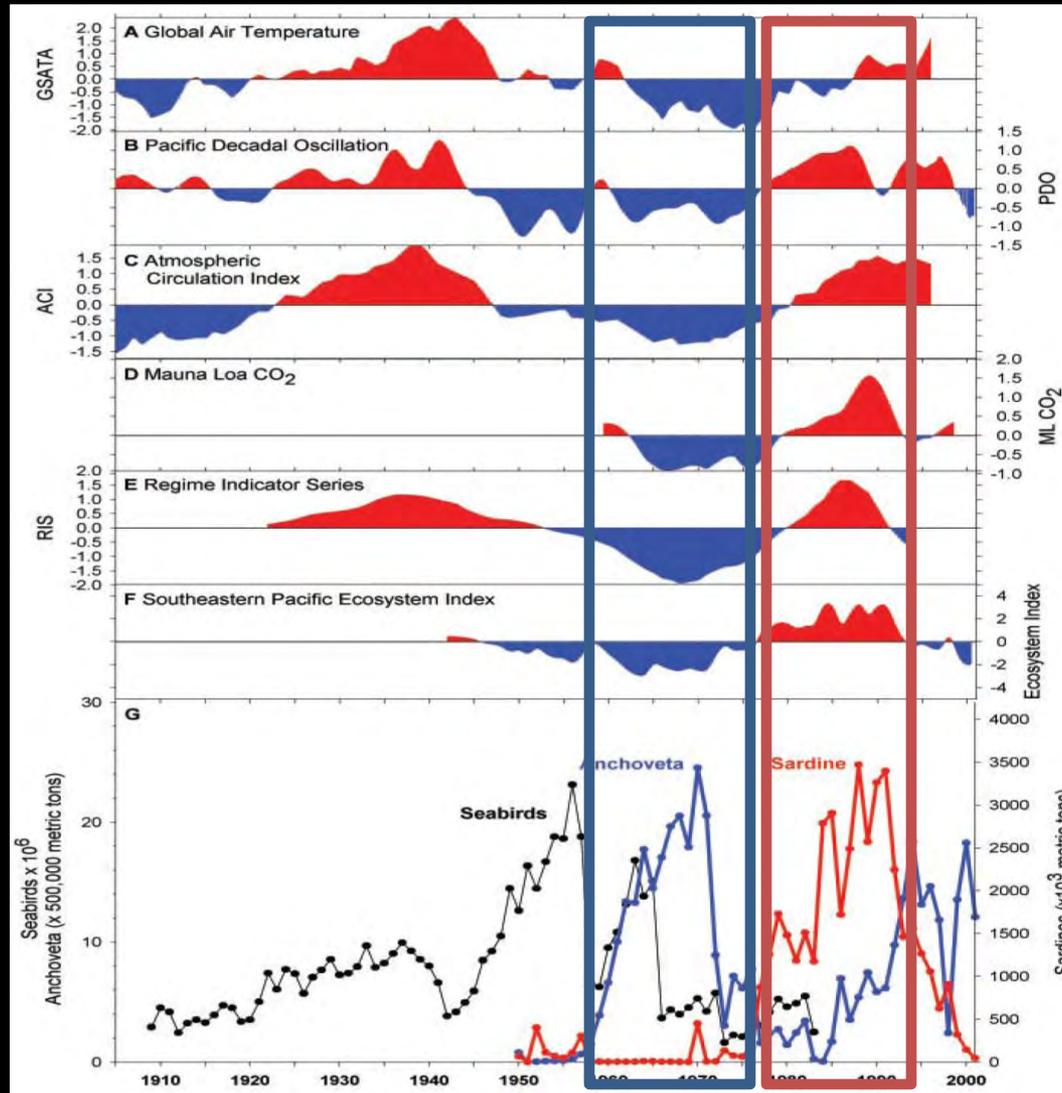


# Temporal structure



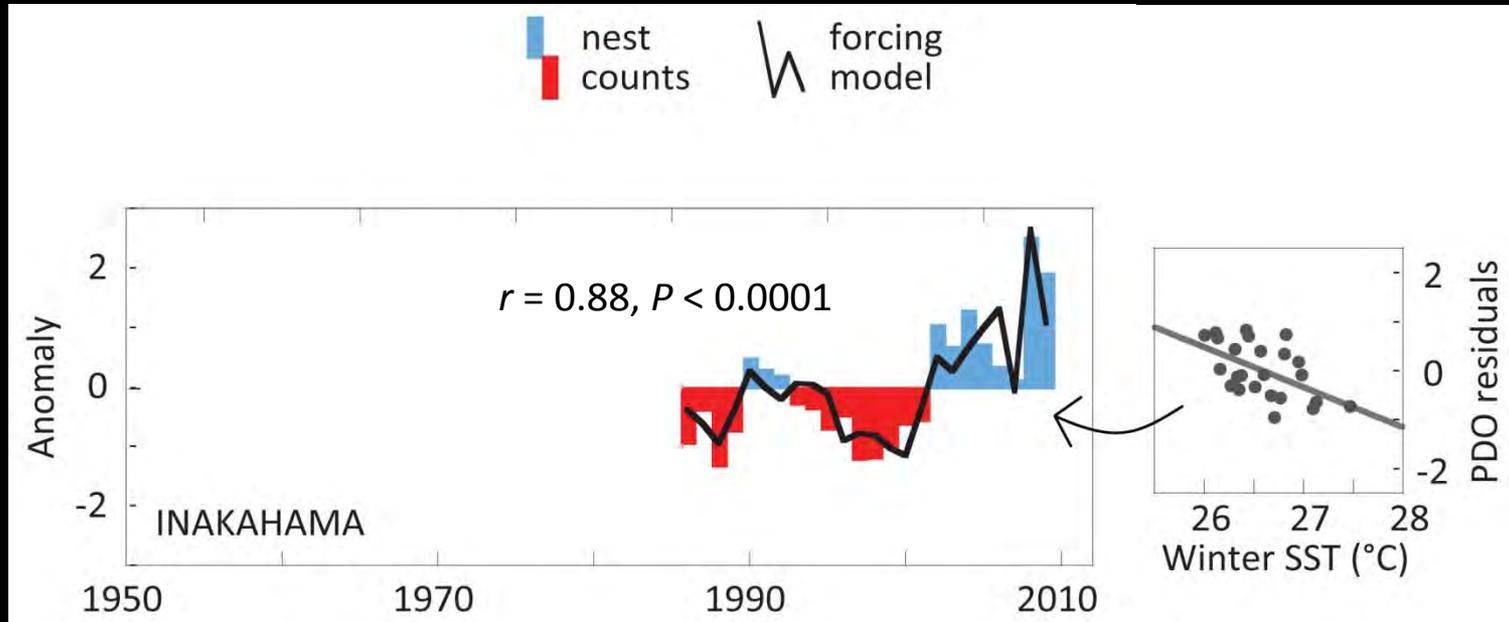
# Survival follows climate

Pacific  
salmon  
sablefish  
flatfish  
gadids  
anchoveta  
sardine  
capelin  
shrimp  
seabirds

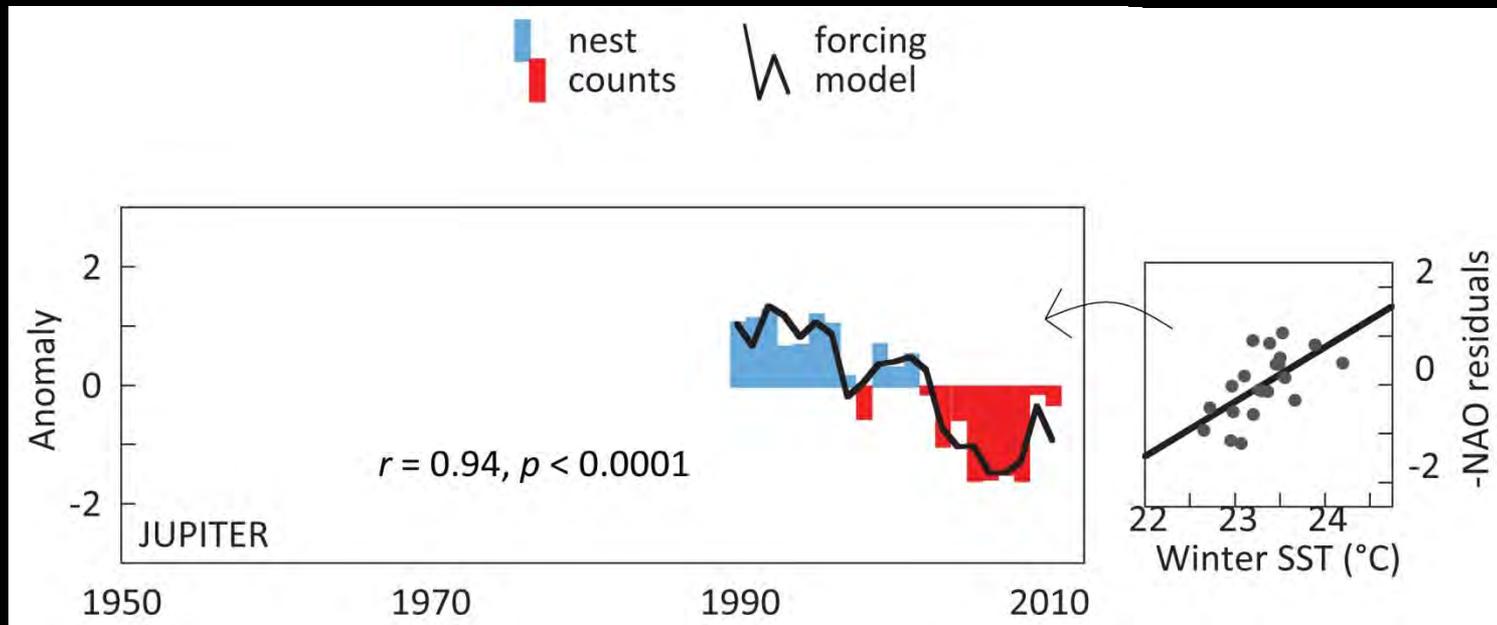


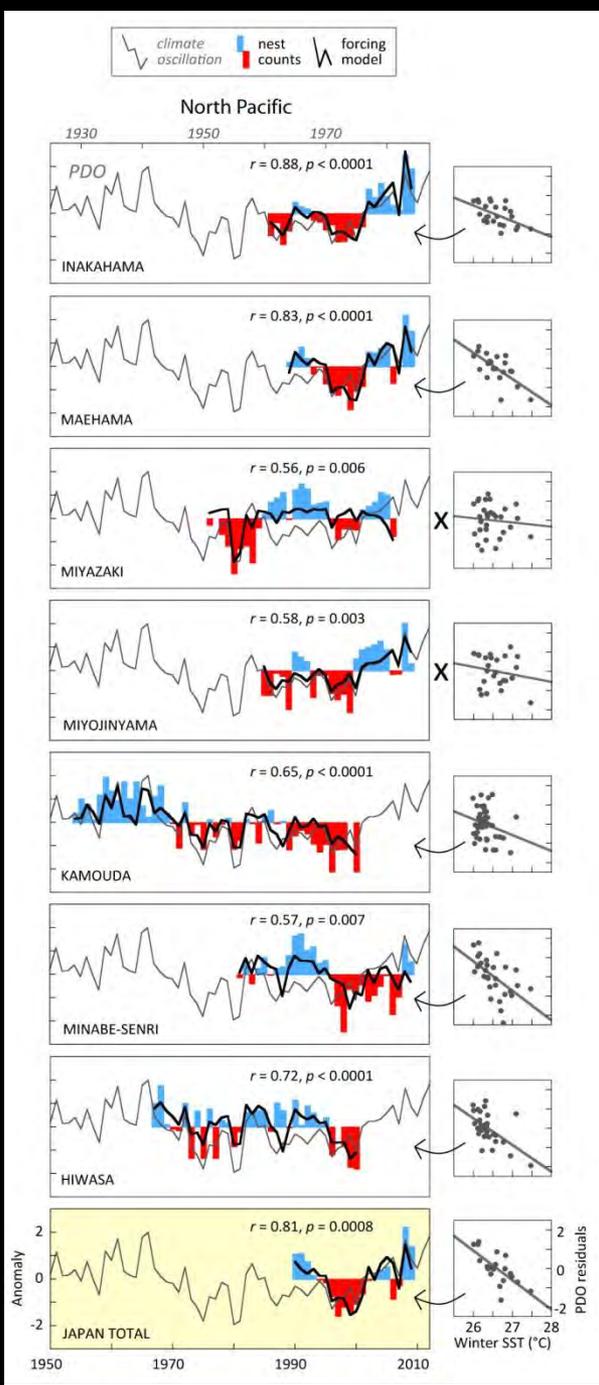
Atlantic  
salmon  
gadoids  
herring  
plankton  
cod  
Lobster  
shrimp  
snow crab  
striped bass

# Japan loggerheads



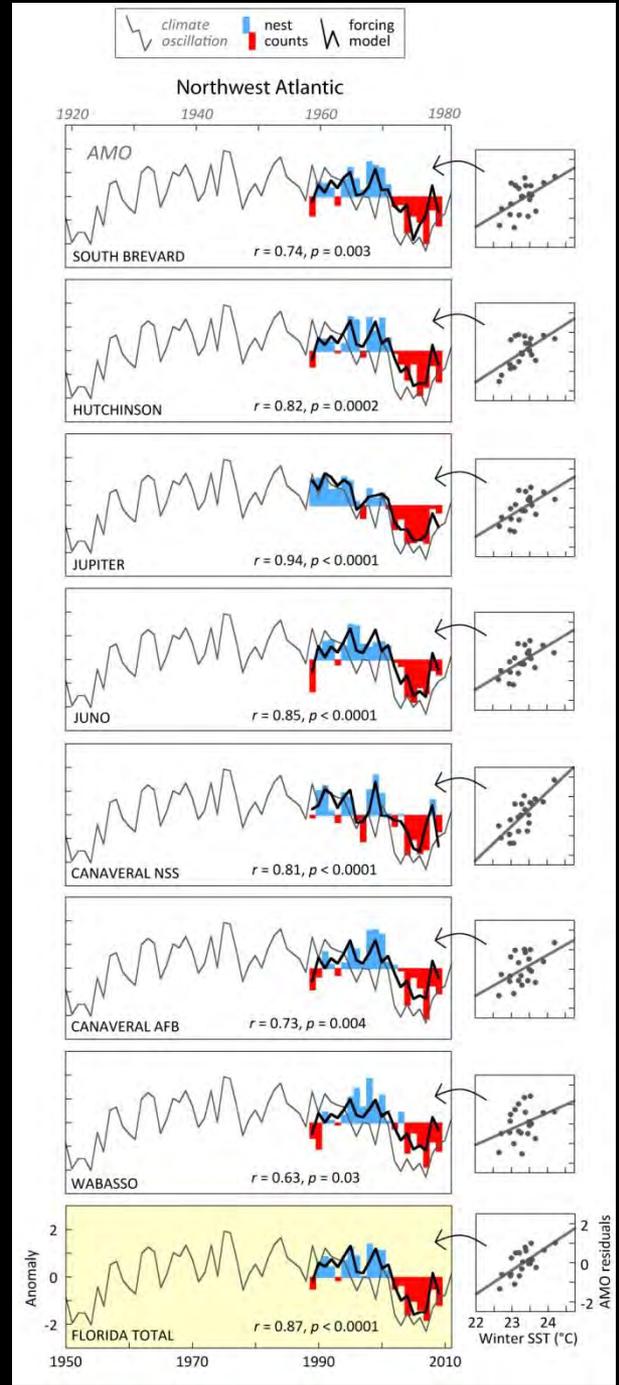
# Florida loggerheads



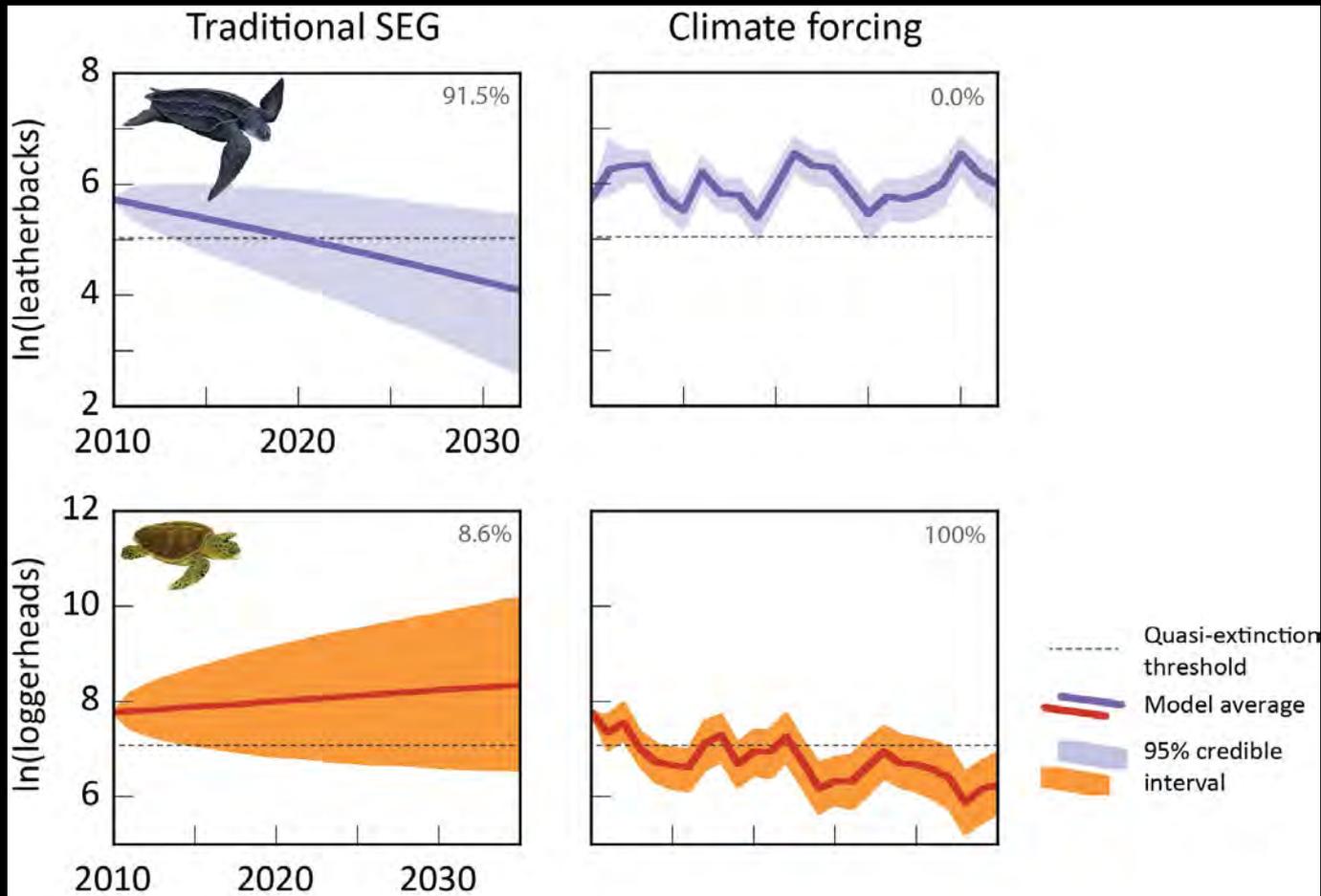


← Pacific

Atlantic →



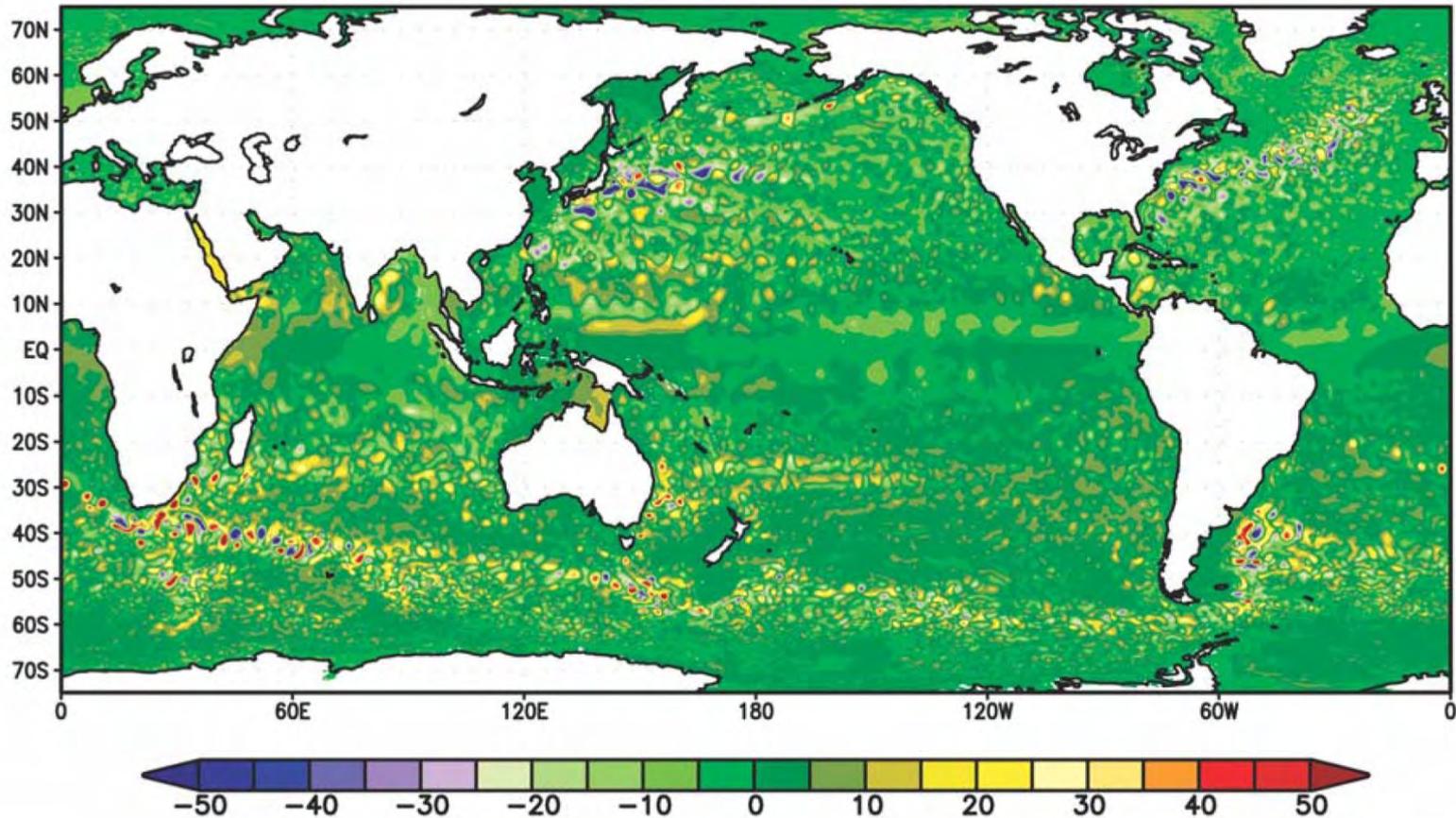
# Climate-based PVA



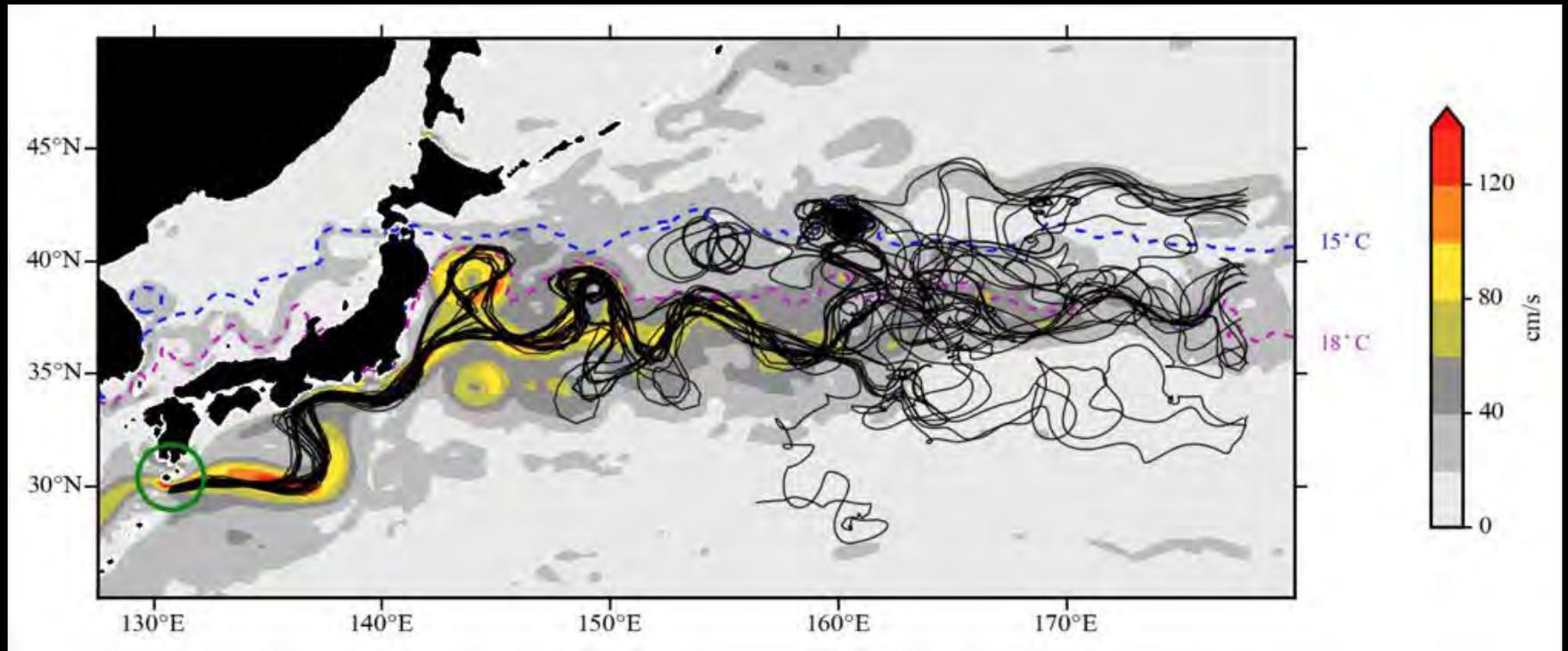


# OFES models

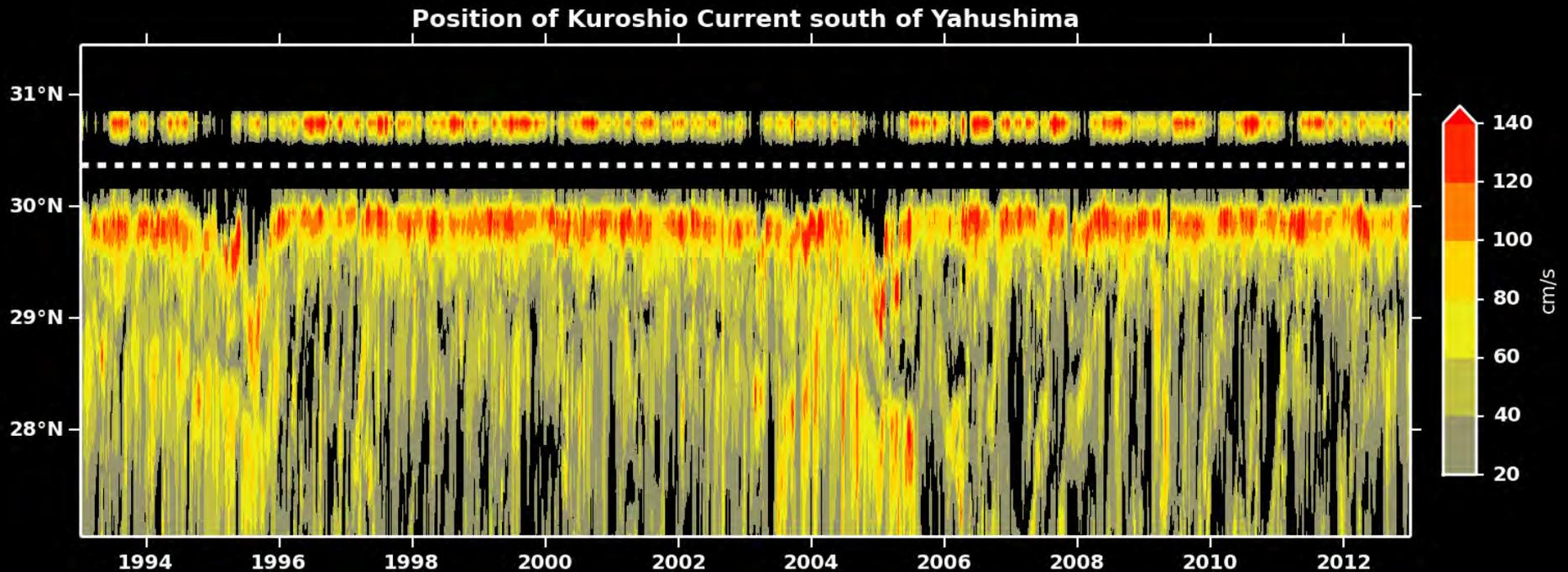
SSH Anomaly 04/01/50



# Kuroshio Current



# Proximity of KC

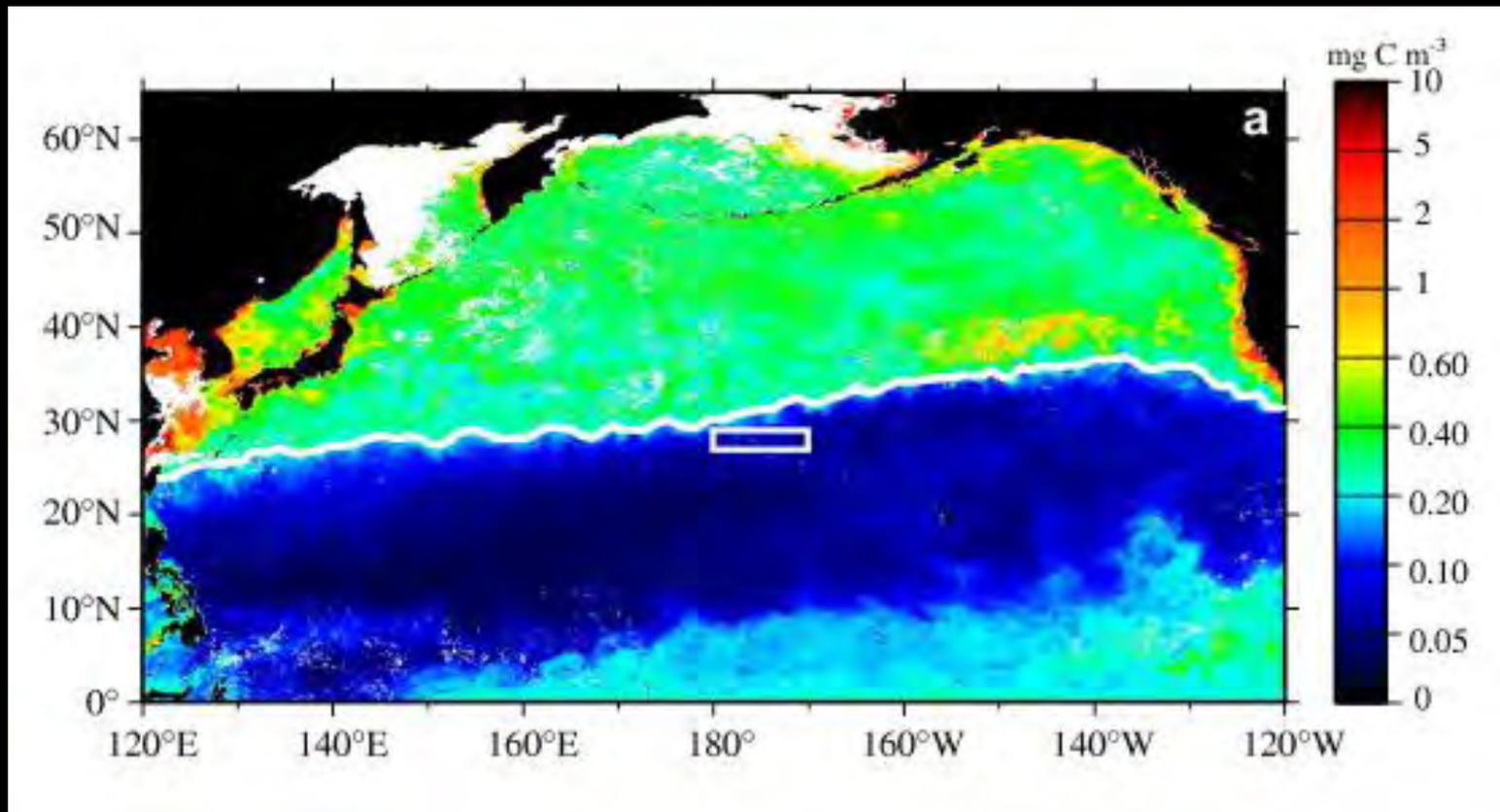


Ascani et al (*in revision*)

# Trajectory releases



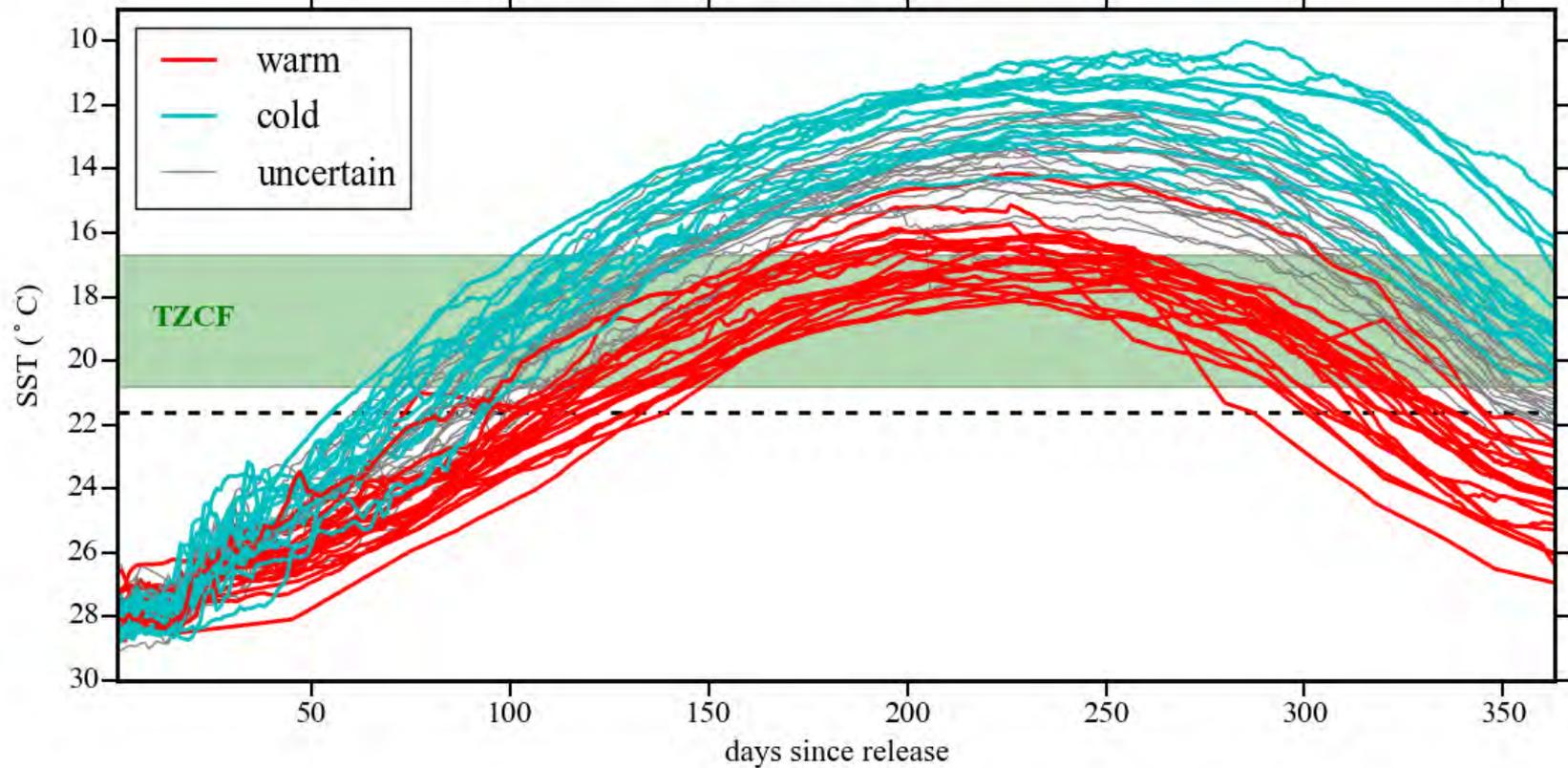
# T Z C F



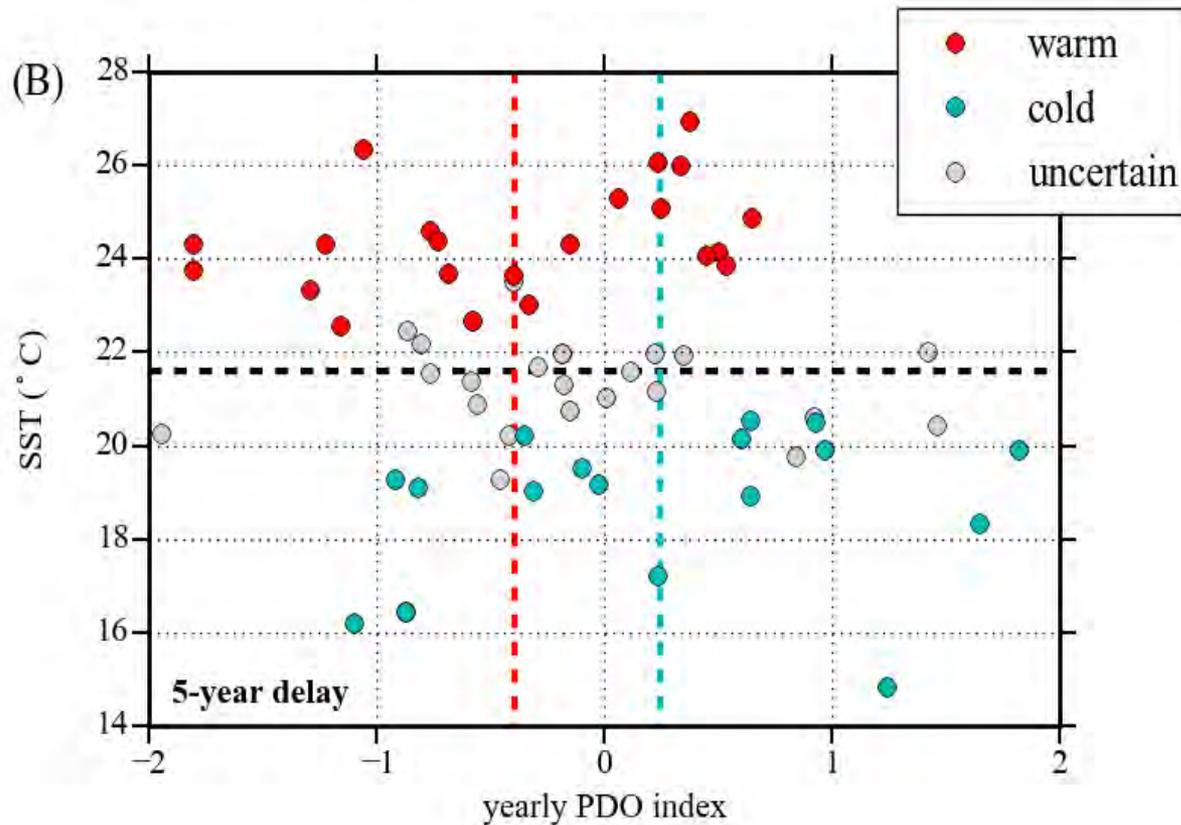
Polovina *et al* (2008)

# Trajectory results

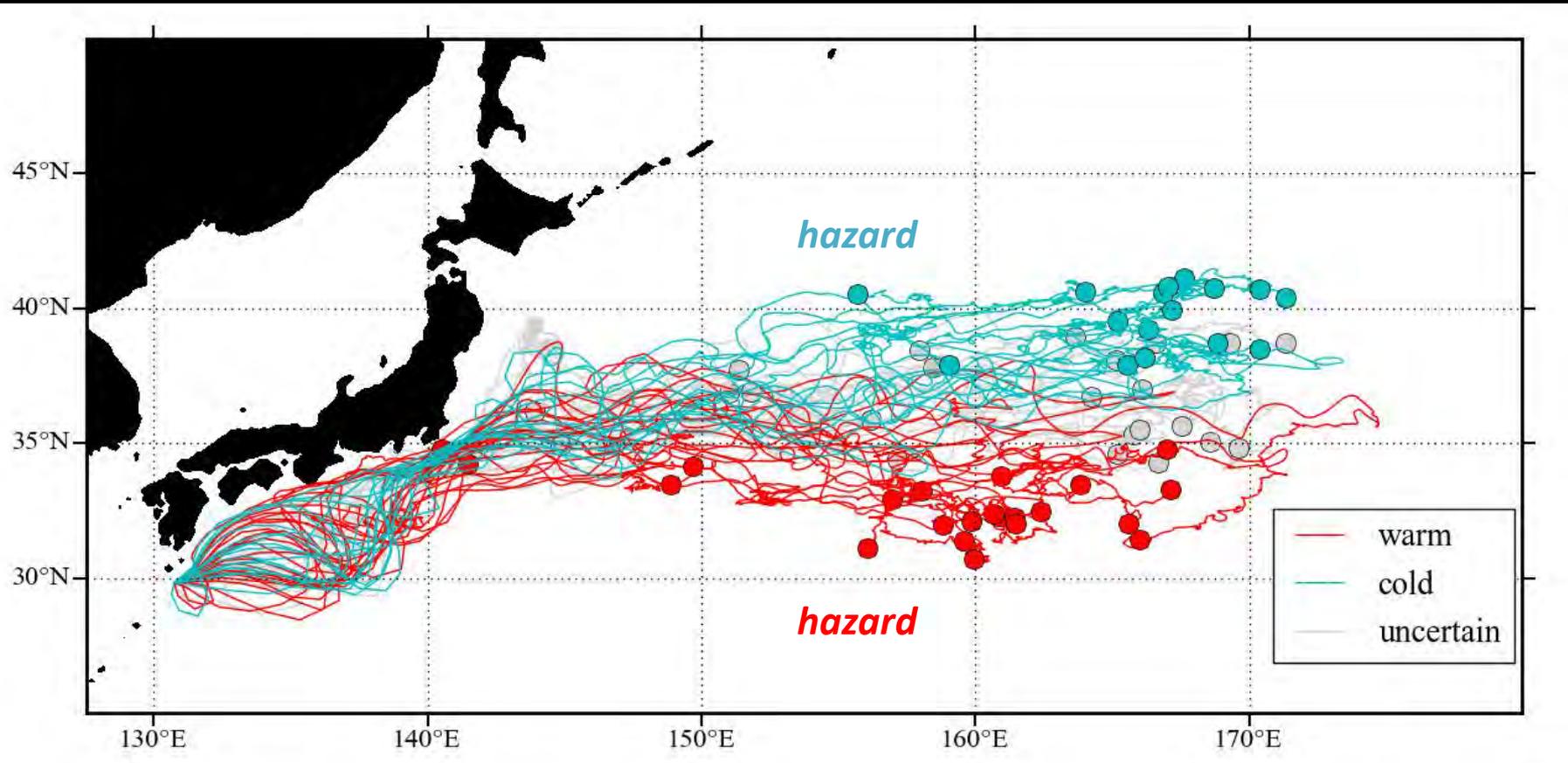
Record of median SST for each annual cohort



# Trajectories + PDO



# Trajectory results



$$MR * food = S$$

