

# Projecting future change in pelagic nekton communities along the west coast of North America

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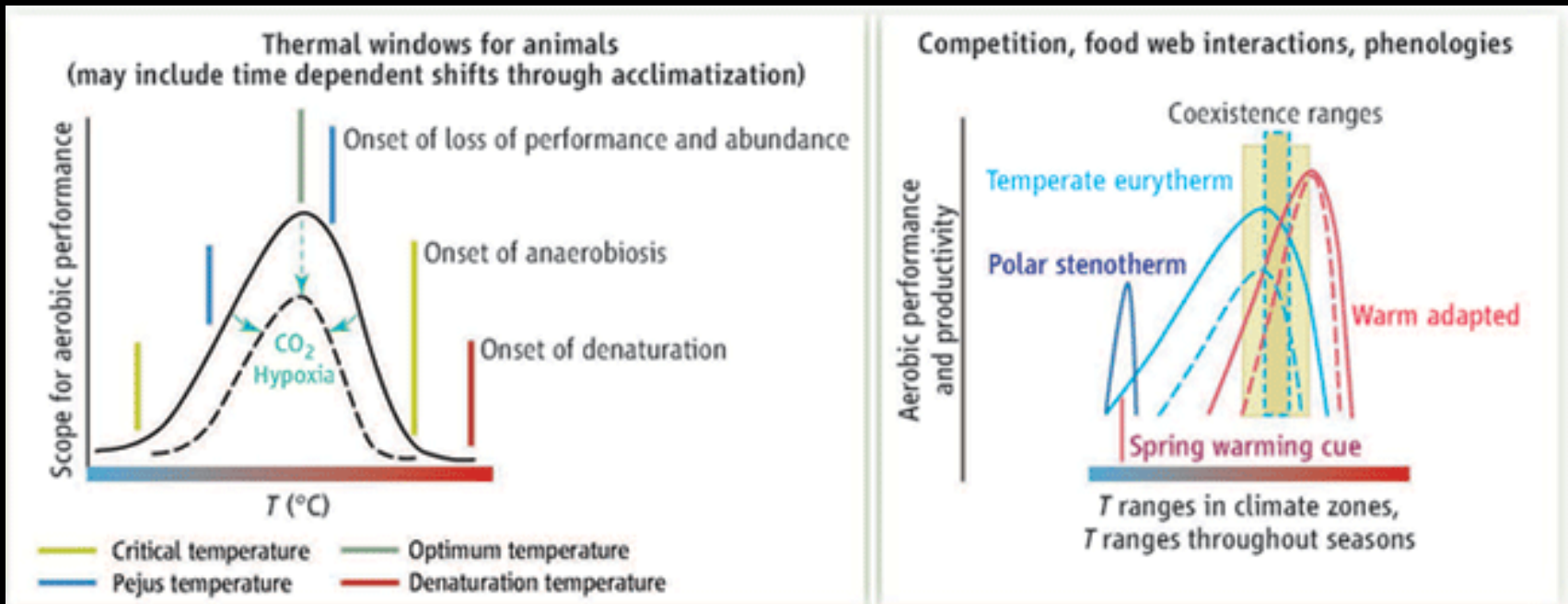
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<sup>4</sup> Northwest Fisheries Science Center, NOAA Fisheries, Hatfield Marine Science Center

Sendai, Japan

27 April 2010

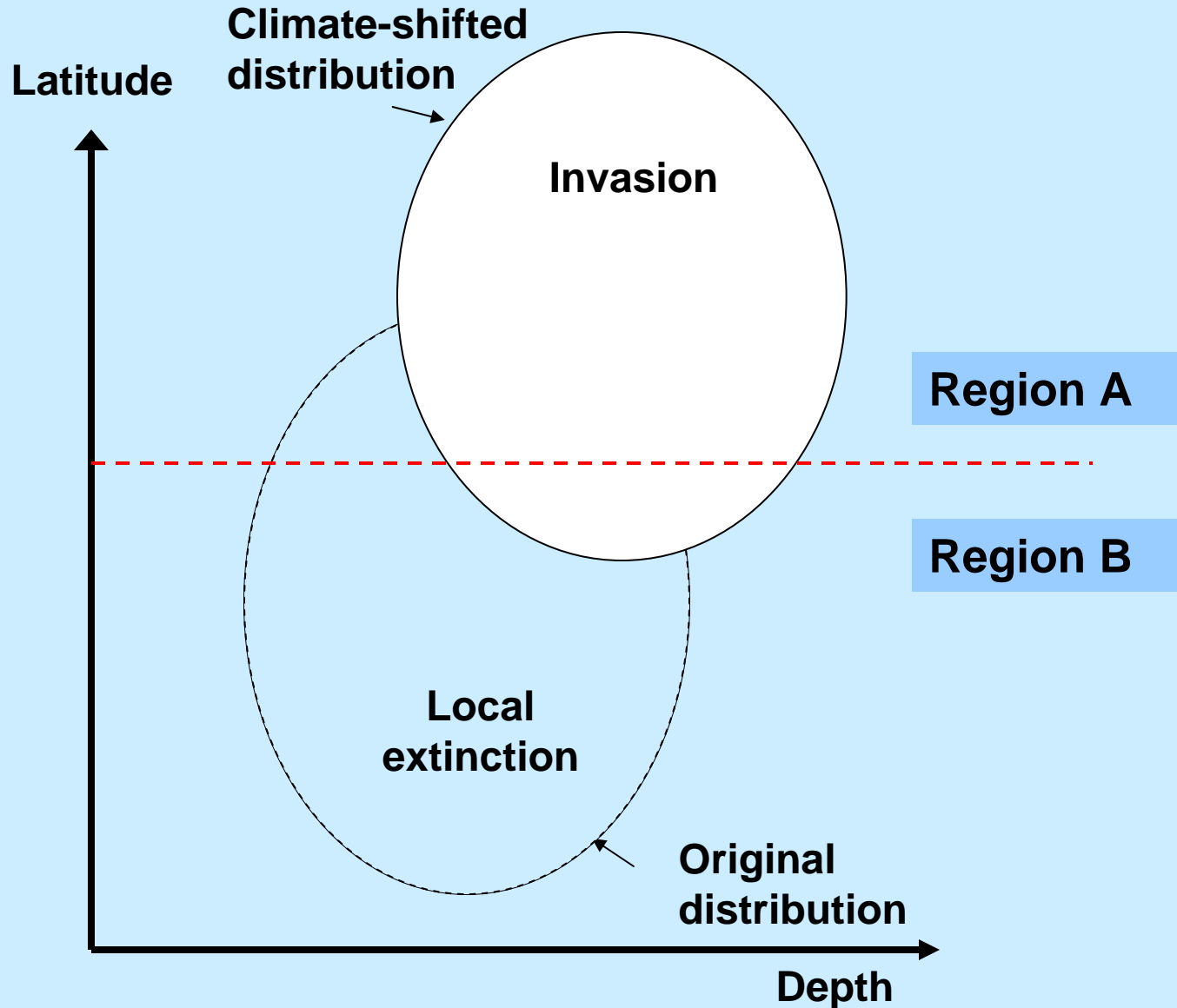
# Thermal windows of aquatic ectotherms



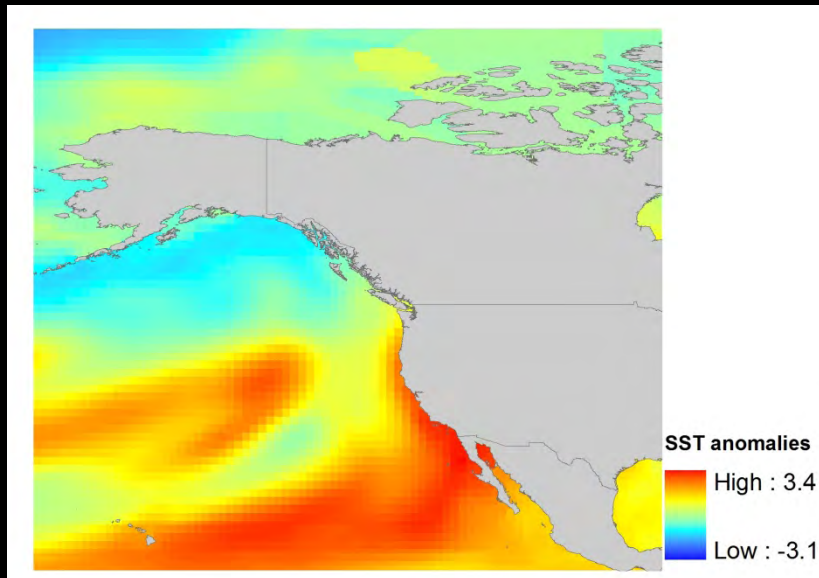
From: Pörtner & Farrell (2008) Science

- Theory predicts that aquatic ectotherms distribute themselves to maximize their growth performance.

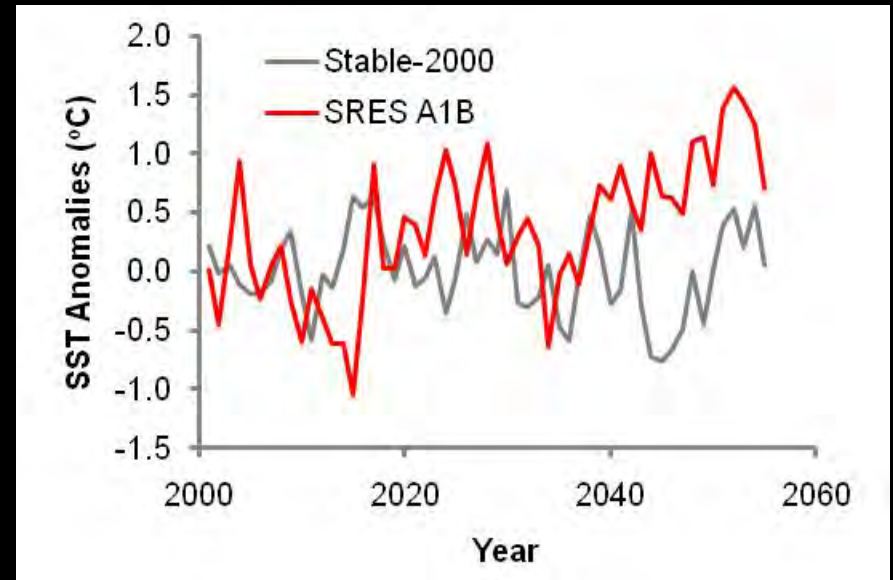
# Hypothesis of climate change impacts on species distribution and community structure



# Ocean temperature changes in NE Pacific

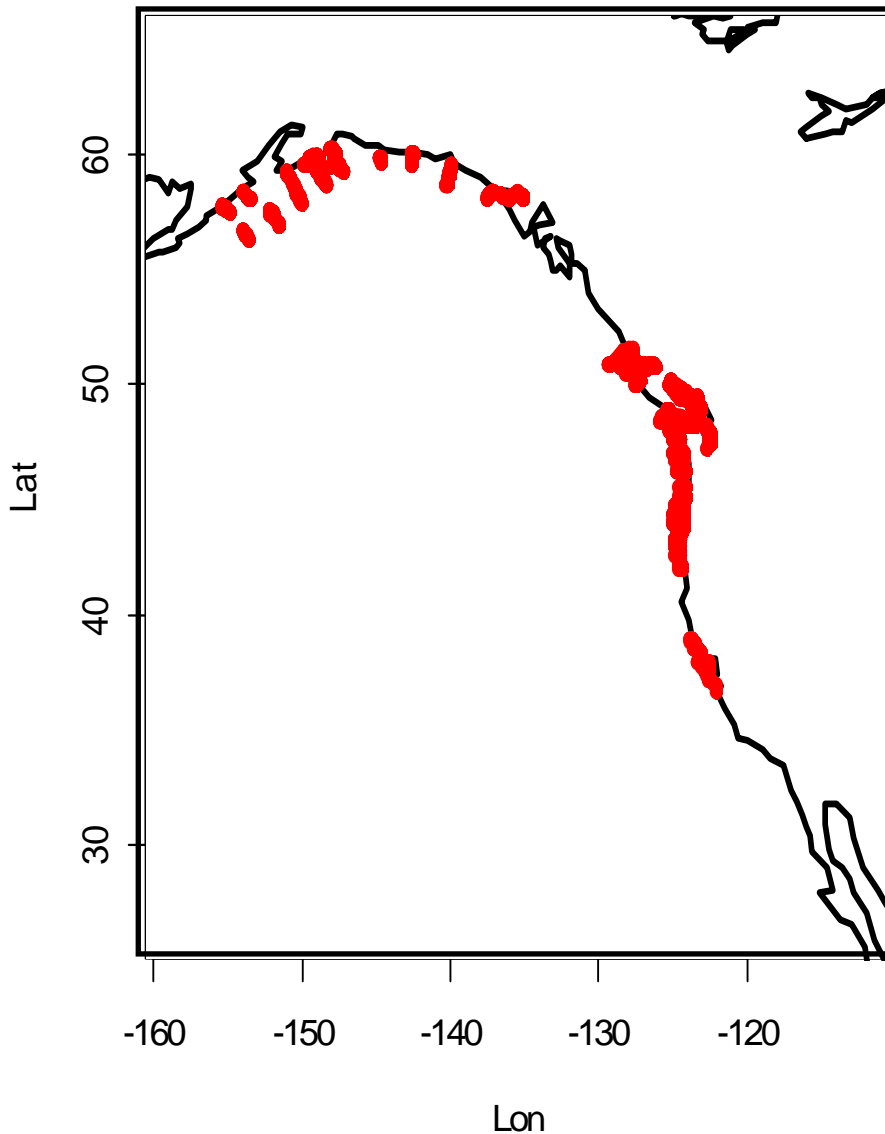


NOAA/GFDL CM 2.1 (SRES A1B)



SST anomalies relative to 2005

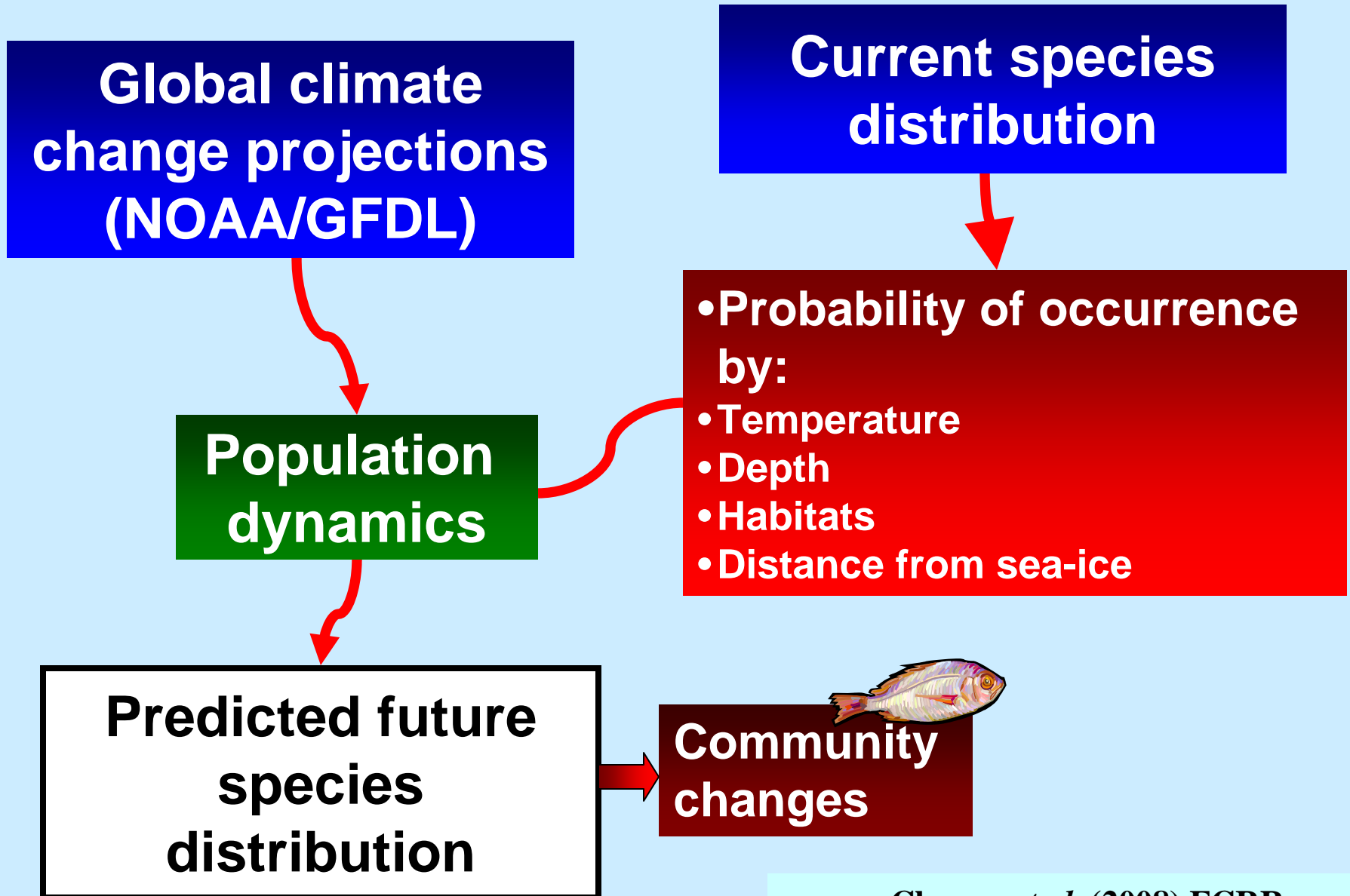
# Research surveys



## Research questions:

- How would species in NE Pacific coast response to climate change in terms of distribution range?
- What are the expected changes in community structure to be in future research survey?

# Simulation modelling

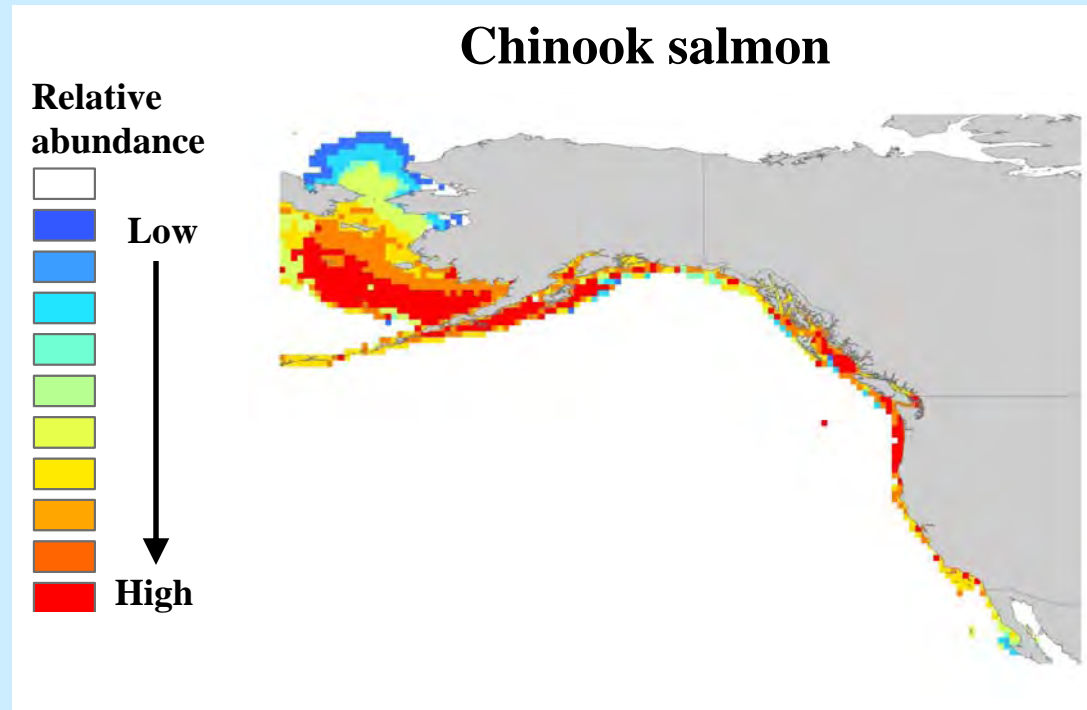


# Predicting species distributions

- Current (1980-2000) distributional ranges of 30 species of pelagic marine fishes in NE Pacific are predicted from:

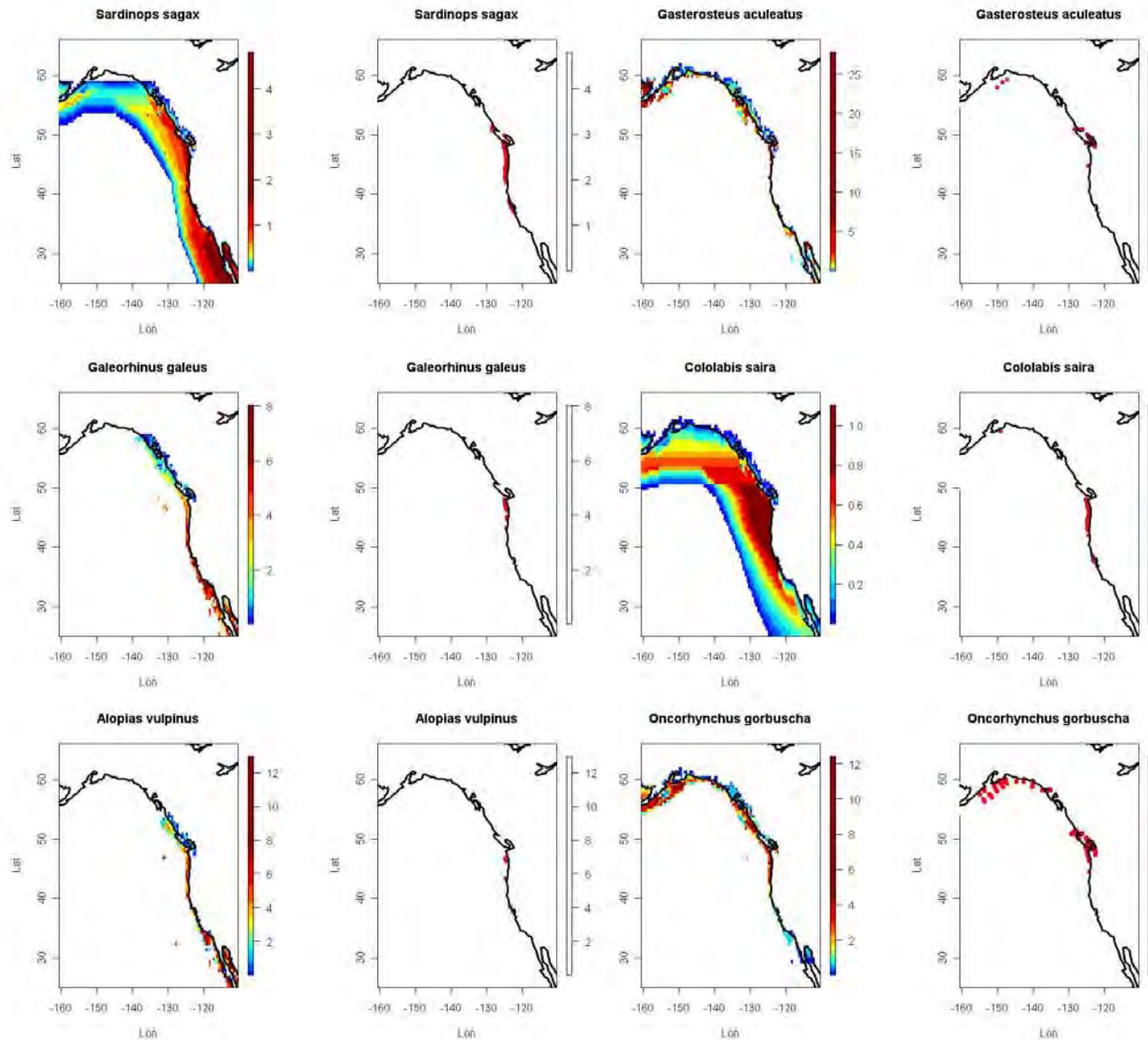
## Attributes:

- Bathymetry
- Distance from shore;
- Latitudinal limits;
- Associated habitats;
- Known range boundary.



- Distribution maps of 8 species are from Aquamap (Kaschner 2007, FishBase)

# Comparing prediction distributions with observations

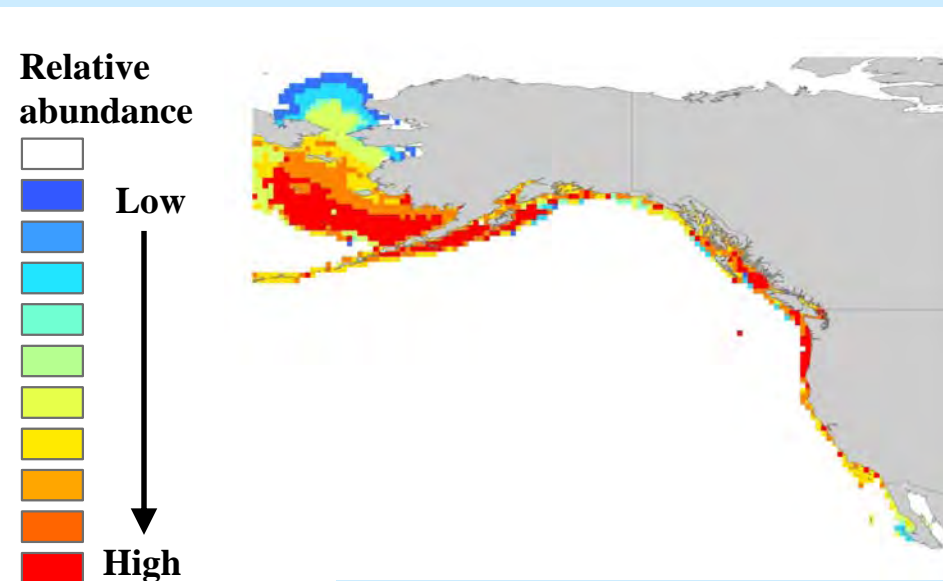


- Comparing with presence data from pelagic trawl survey along the coast (N =30);
- Observed species richness at sampling stations is significantly correlated with model prediction ( $p < 0.01$ ).

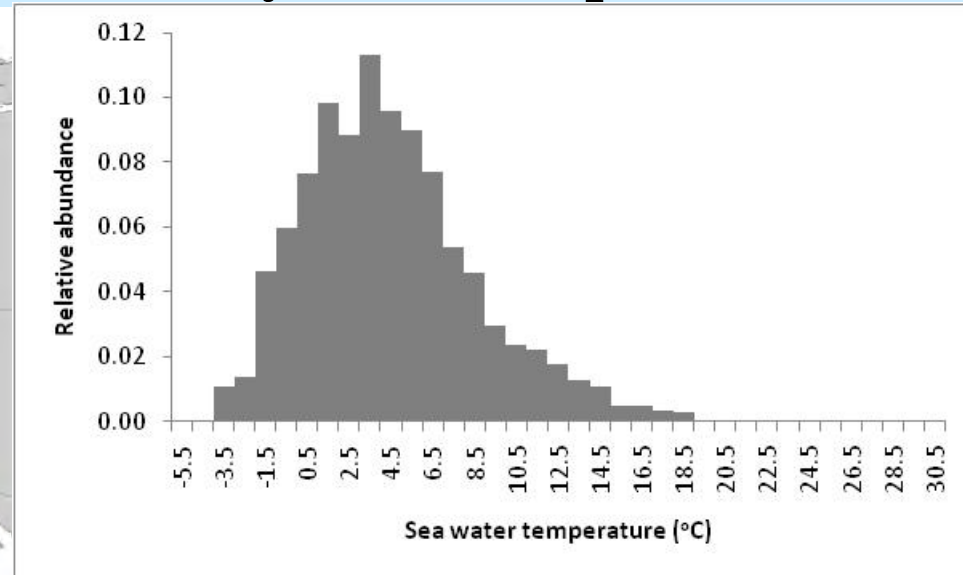


# Chinook salmon

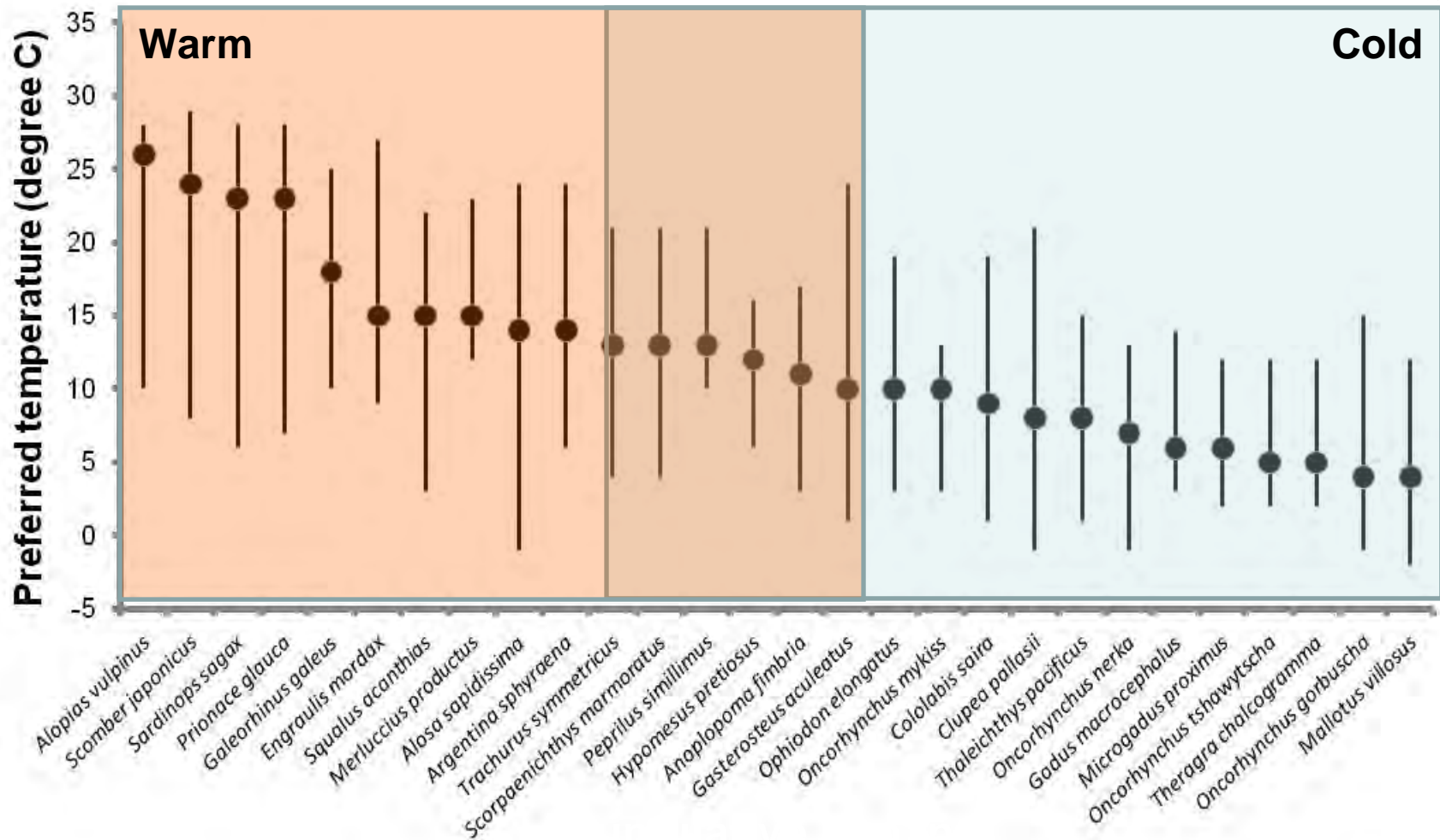
Original (static) distribution



Probability of occurrence by water temperature



# Temperature Preference Profile

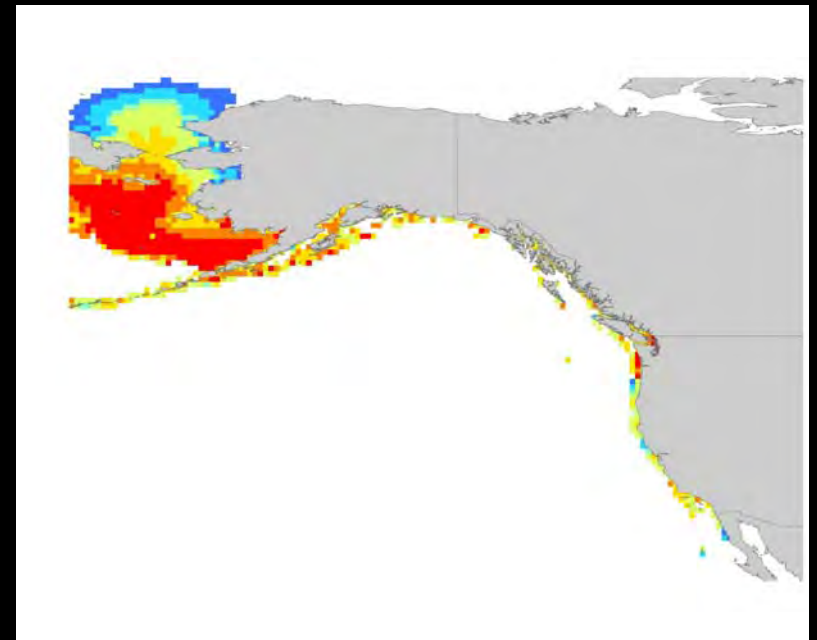
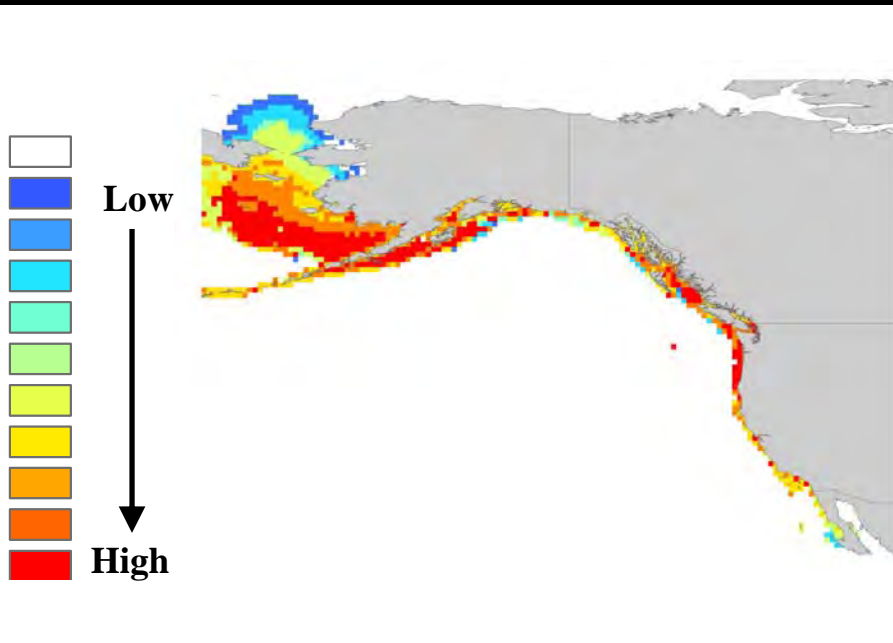


# Chinook salmon

Original (static) distribution

Distribution after 50 years

(Climate projection from NOAA/GFDL CM 2.1)

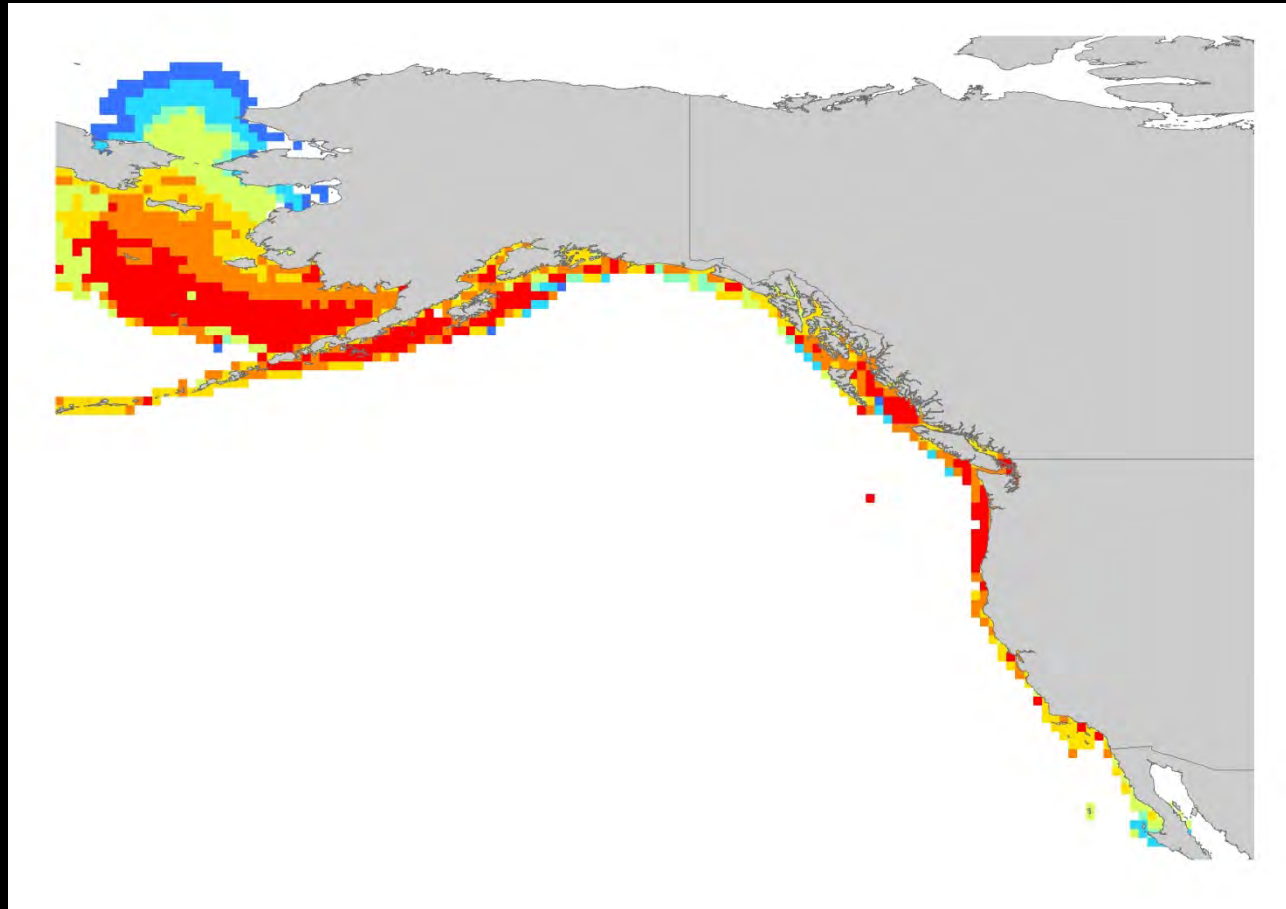
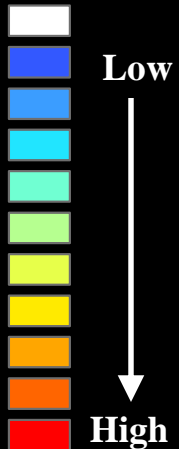


# Chinook salmon

Year 2005

• NOAA/GFDL (SRES A1B)

Relative  
abundance

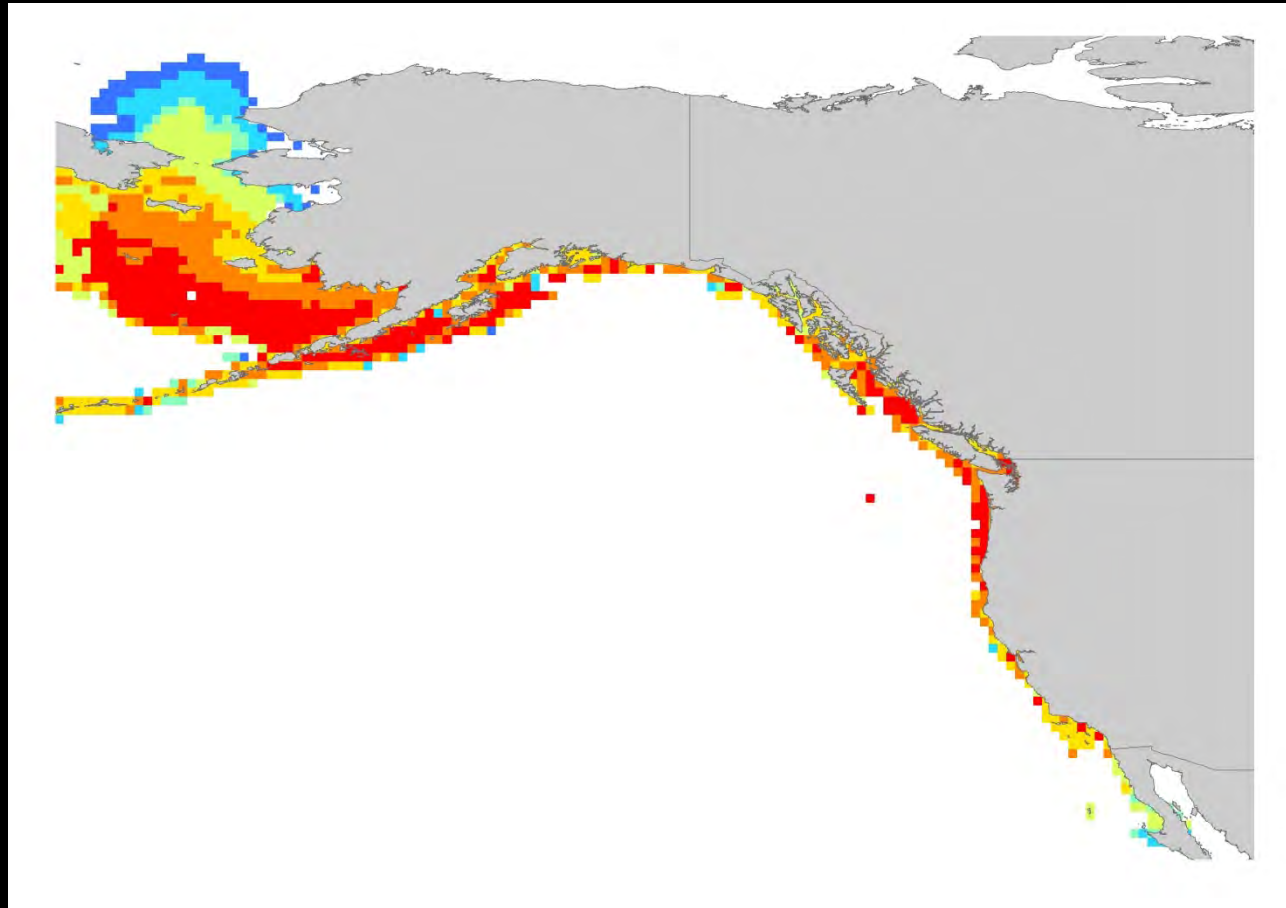
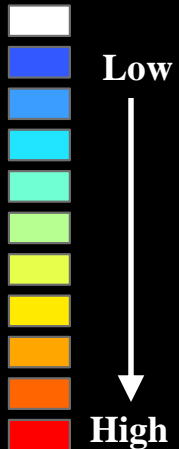


# Chinook salmon

Year 2010

• NOAA/GFDL (SRES A1B)

Relative  
abundance

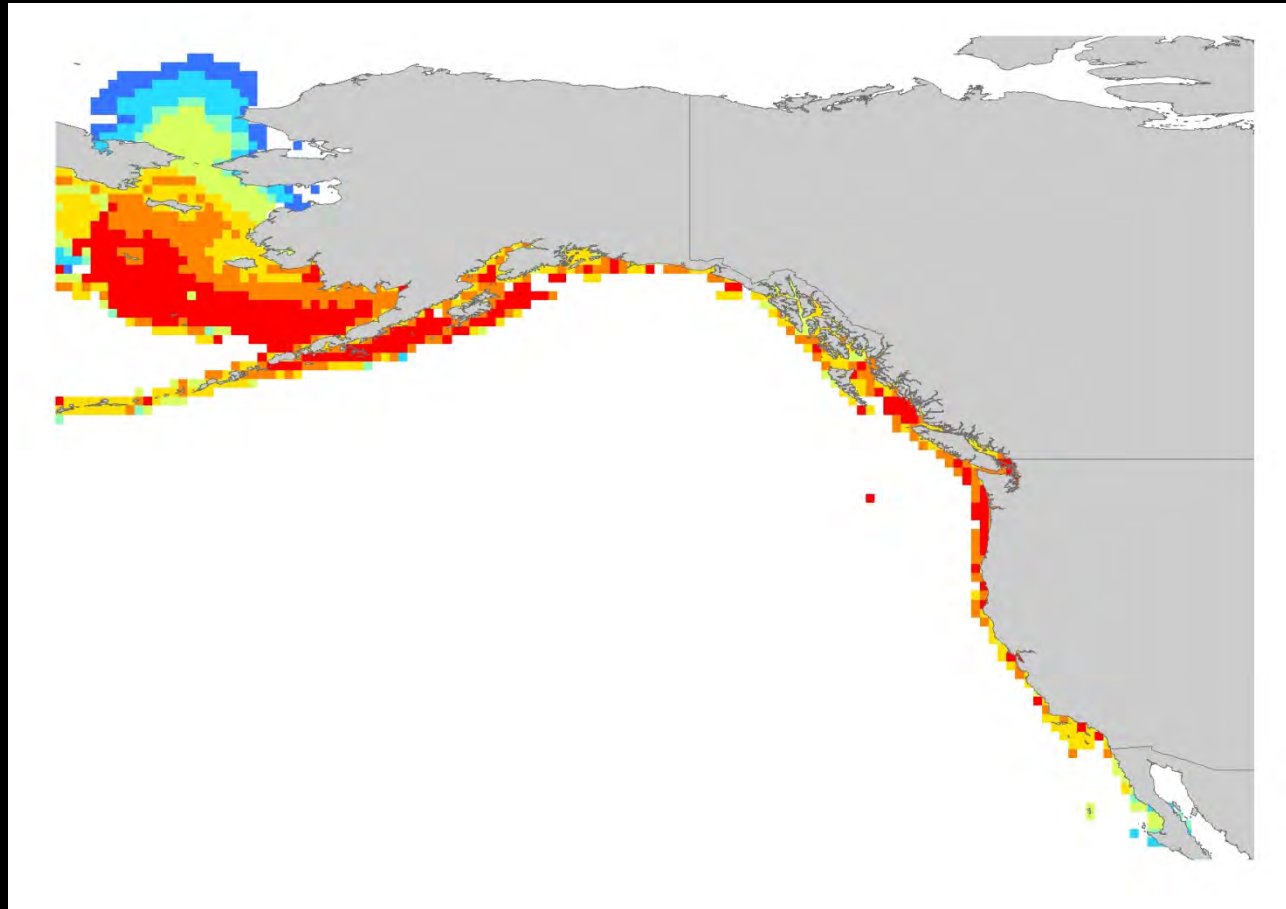
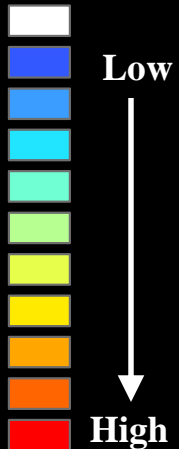


# Chinook salmon

Year 2015

• NOAA/GFDL (SRES A1B)

Relative  
abundance

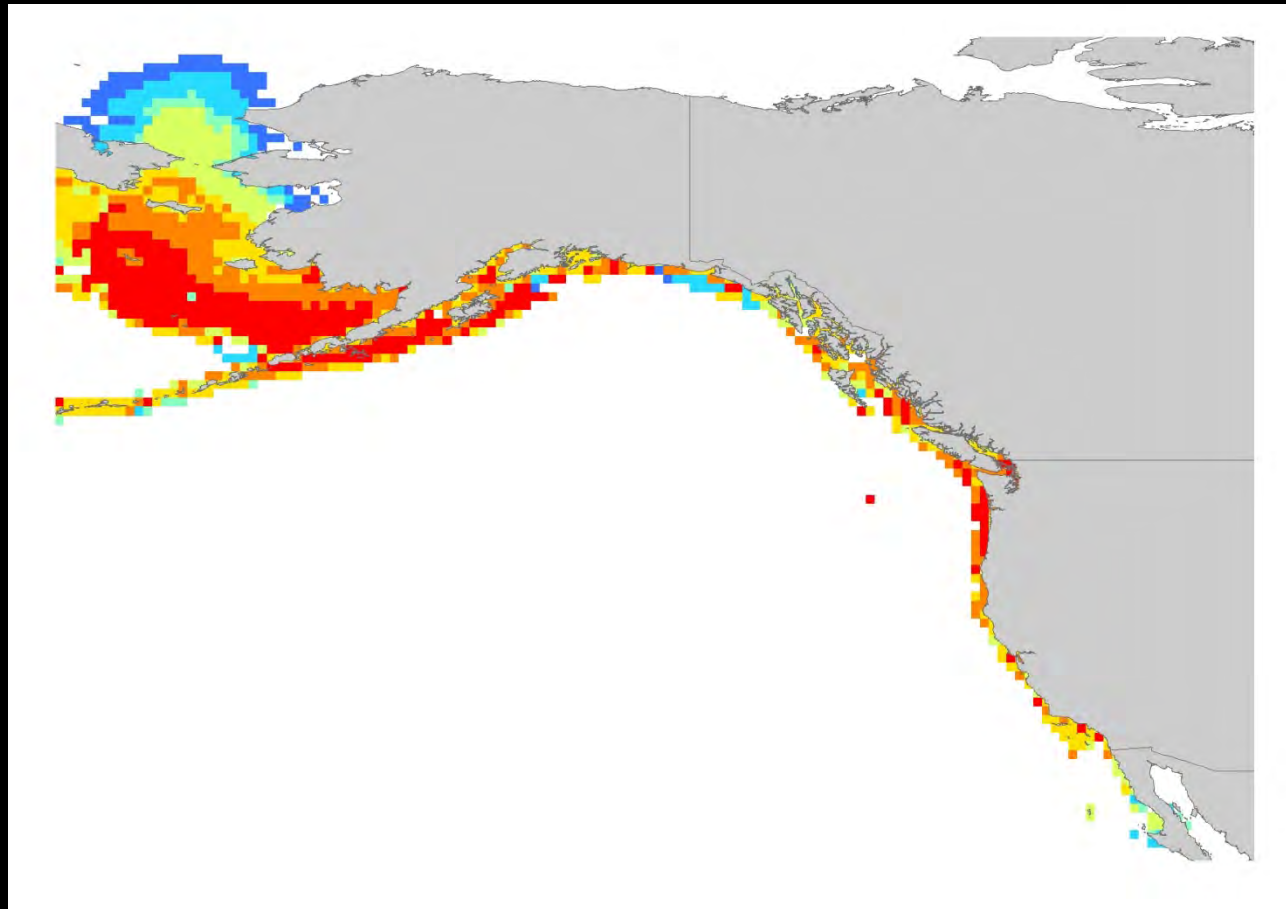
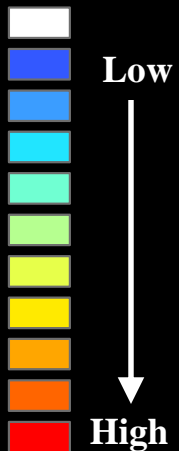


# Chinook salmon

Year 2020

• NOAA/GFDL (SRES A1B)

Relative  
abundance



# Chinook salmon

Year 2025

• NOAA/GFDL (SRES A1B)

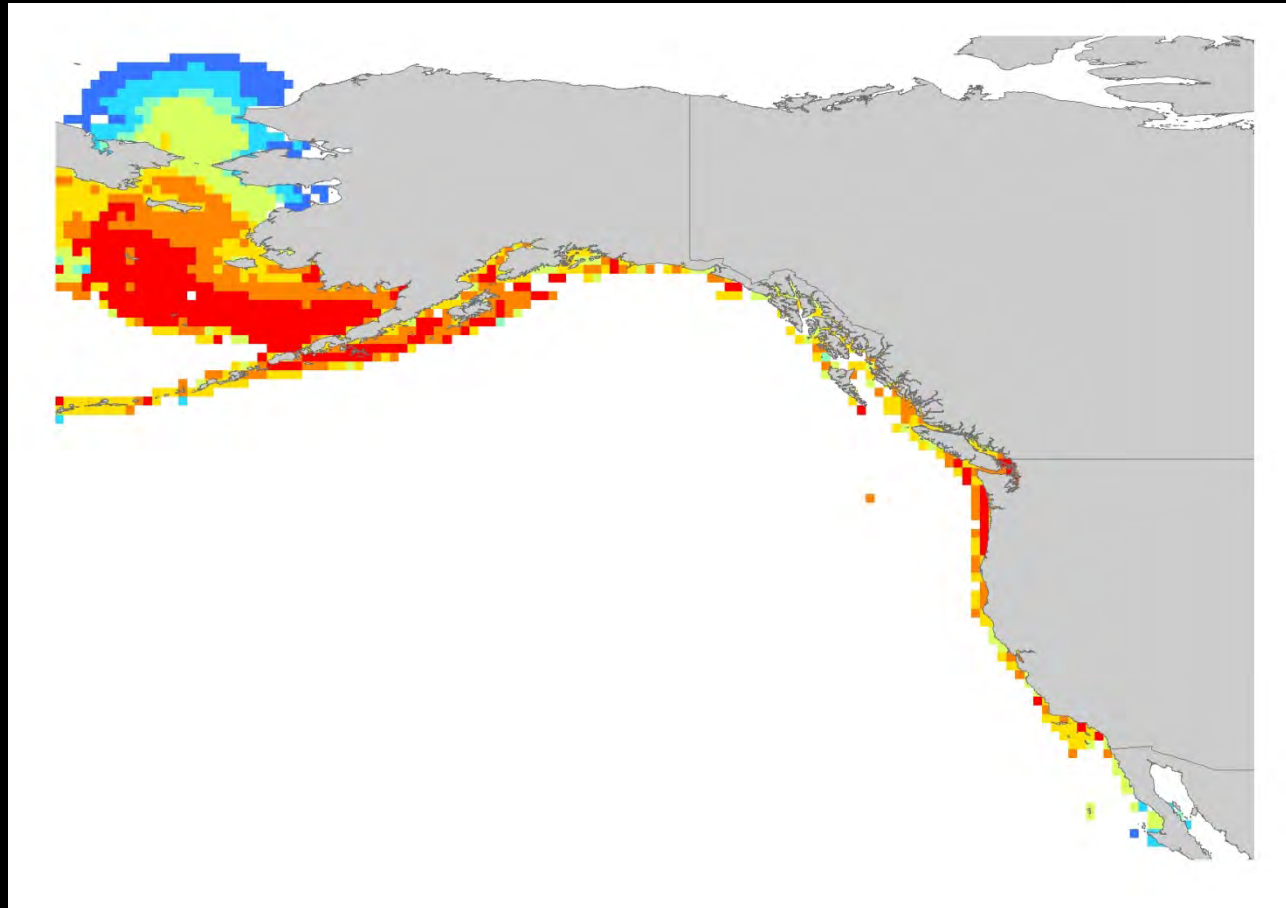
Relative  
abundance



Low



High



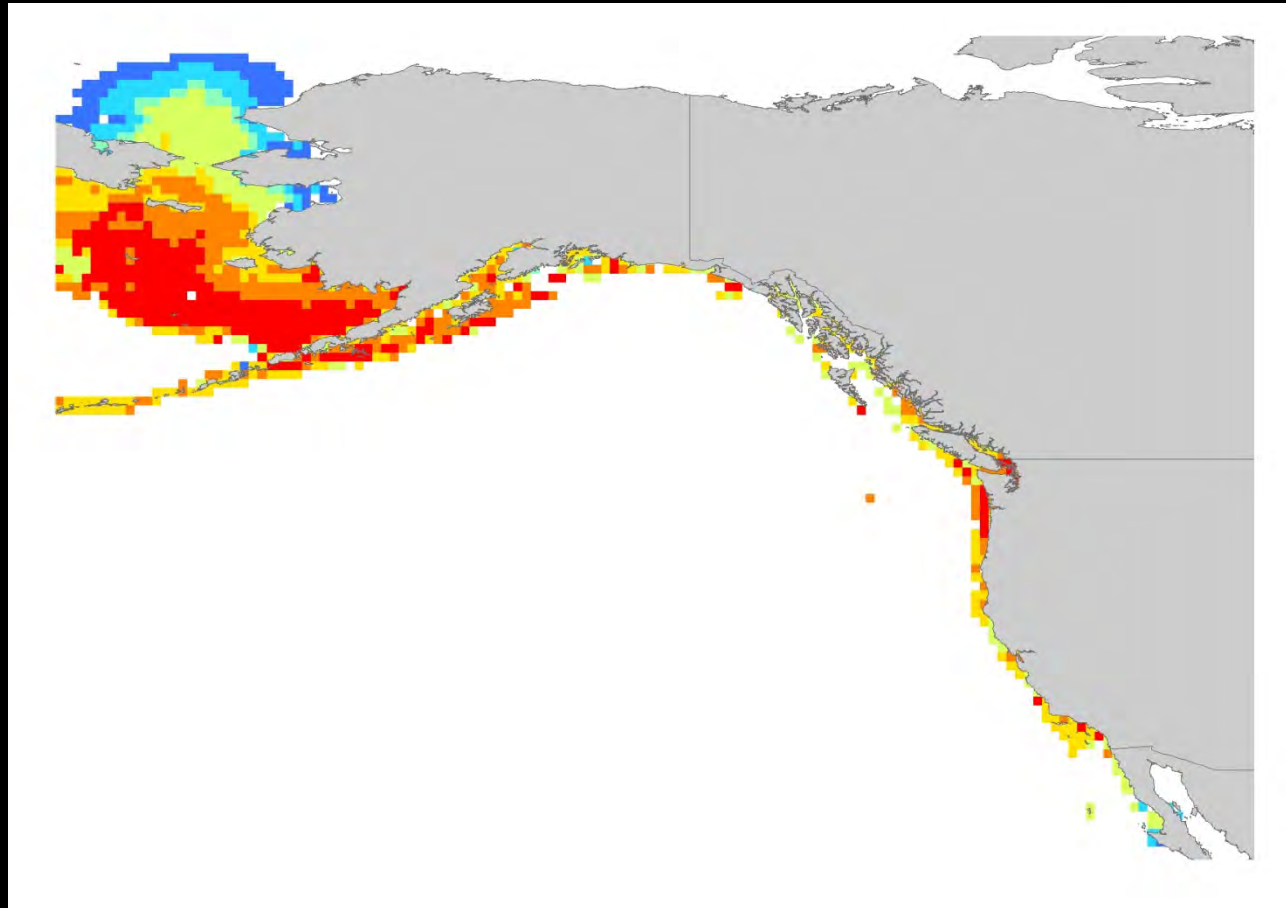
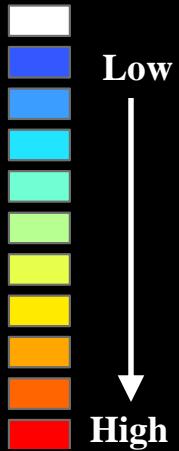


# Chinook salmon

Year 2030

• NOAA/GFDL (SRES A1B)

Relative  
abundance

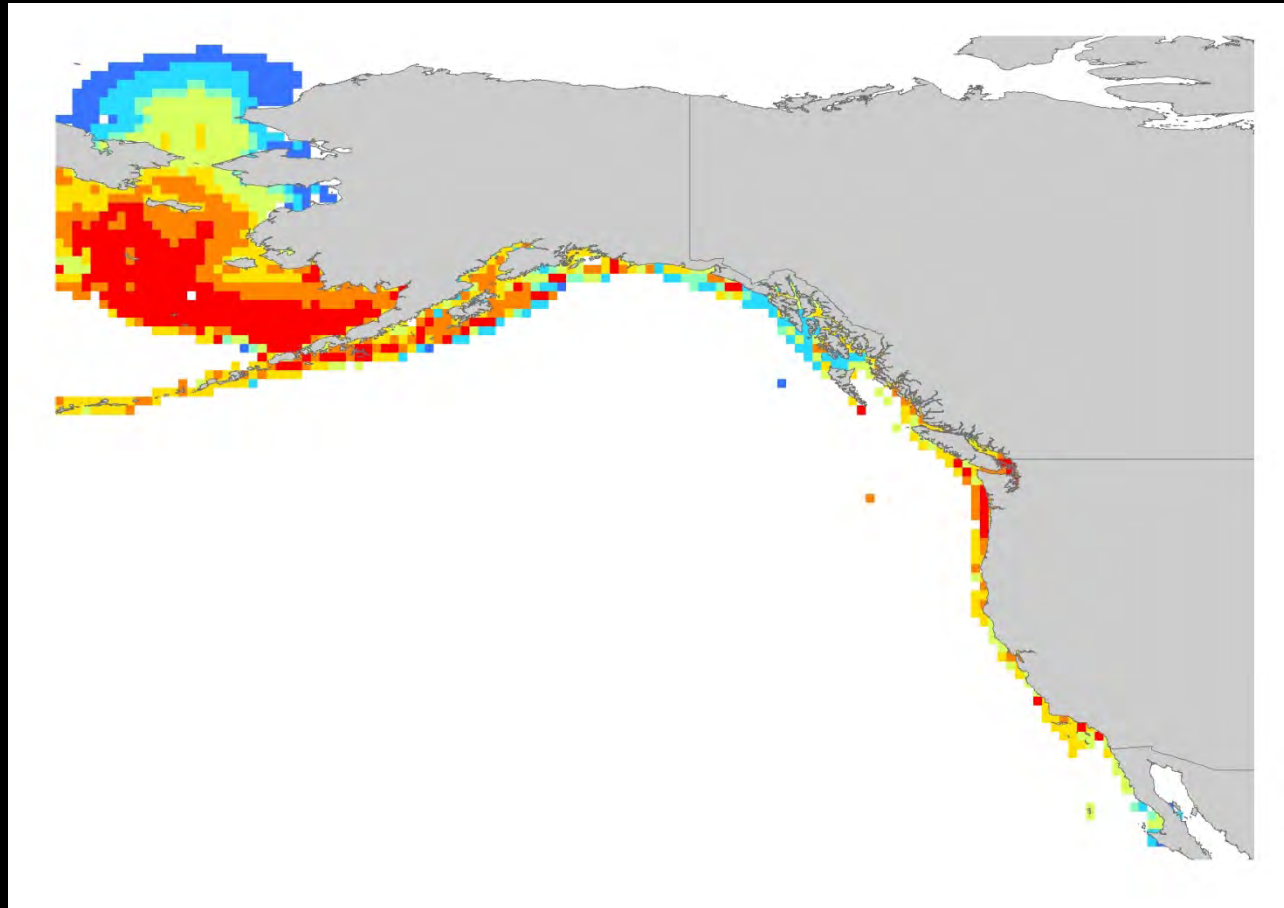
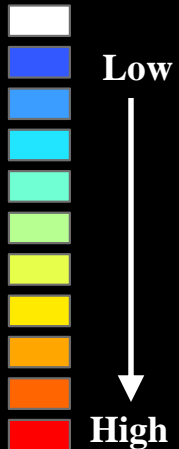


# Chinook salmon

Year 2035

• NOAA/GFDL (SRES A1B)

Relative  
abundance

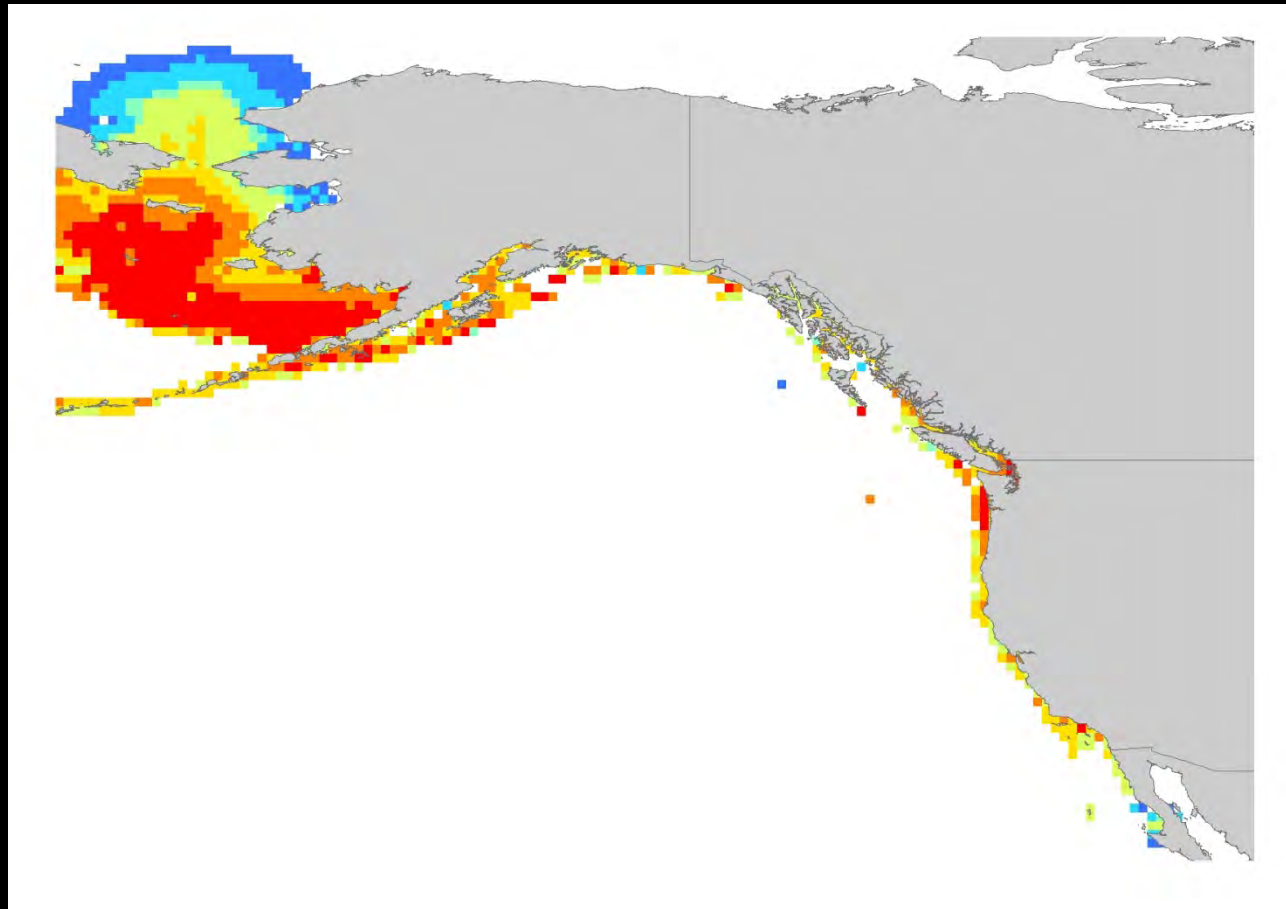
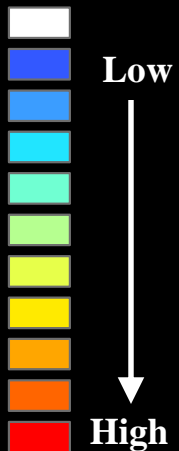


# Chinook salmon

Year 2040

• NOAA/GFDL (SRES A1B)

Relative  
abundance

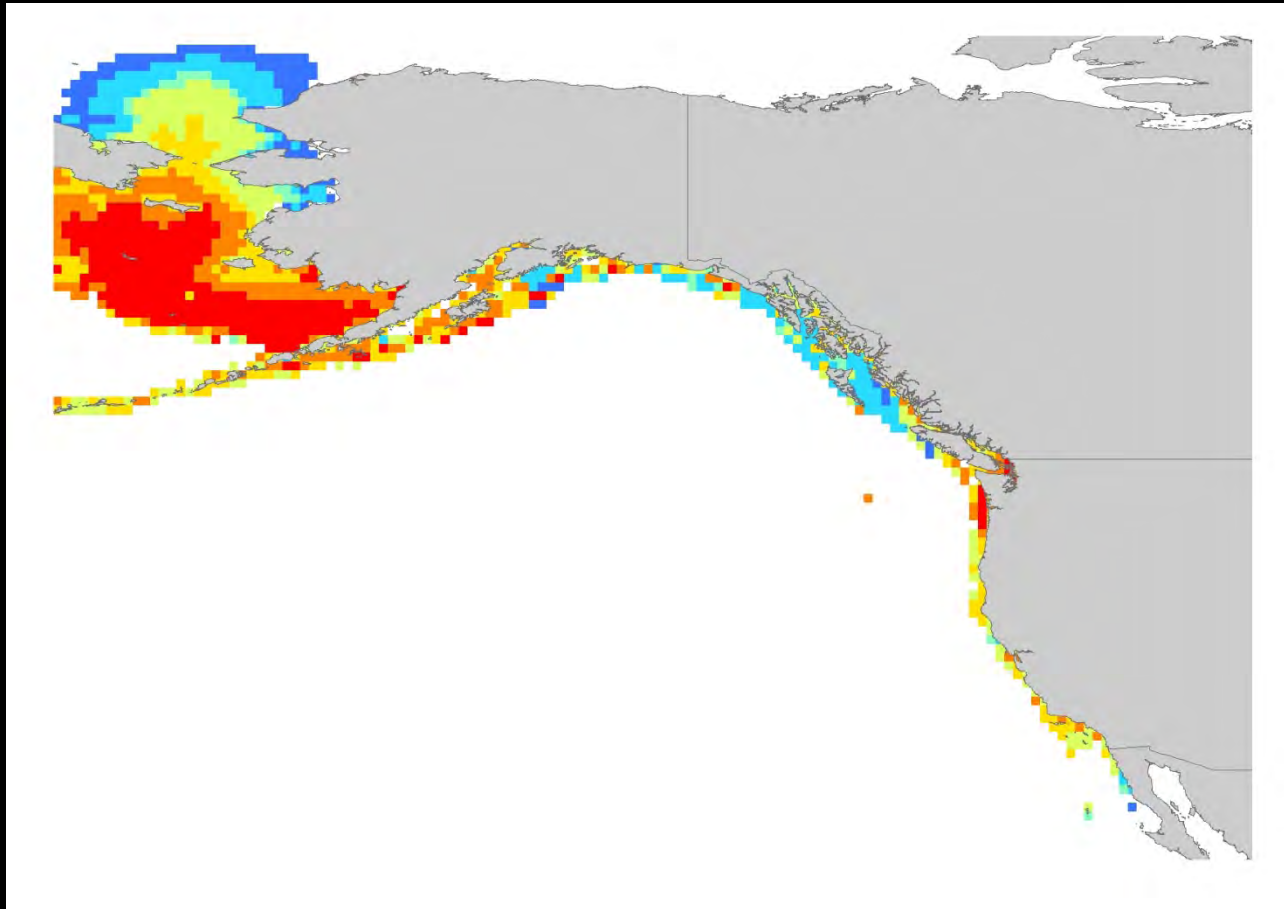
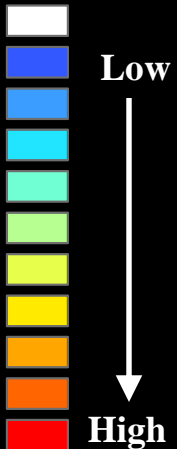


# Chinook salmon

Year 2045

• NOAA/GFDL (SRES A1B)

Relative  
abundance

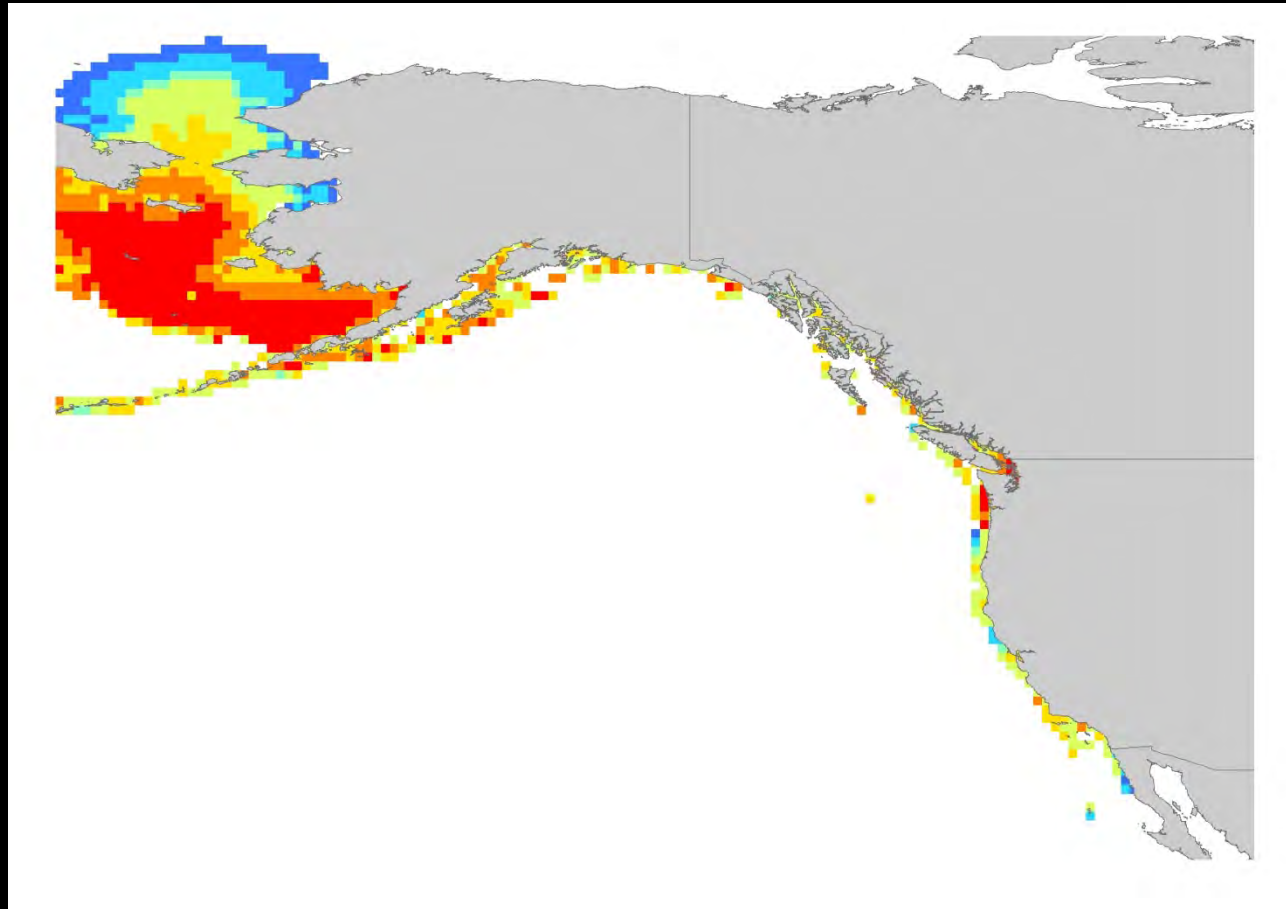
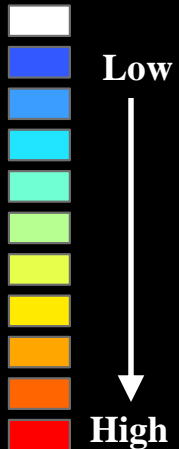


# Chinook salmon

Year 2050

• NOAA/GFDL (SRES A1B)

Relative  
abundance

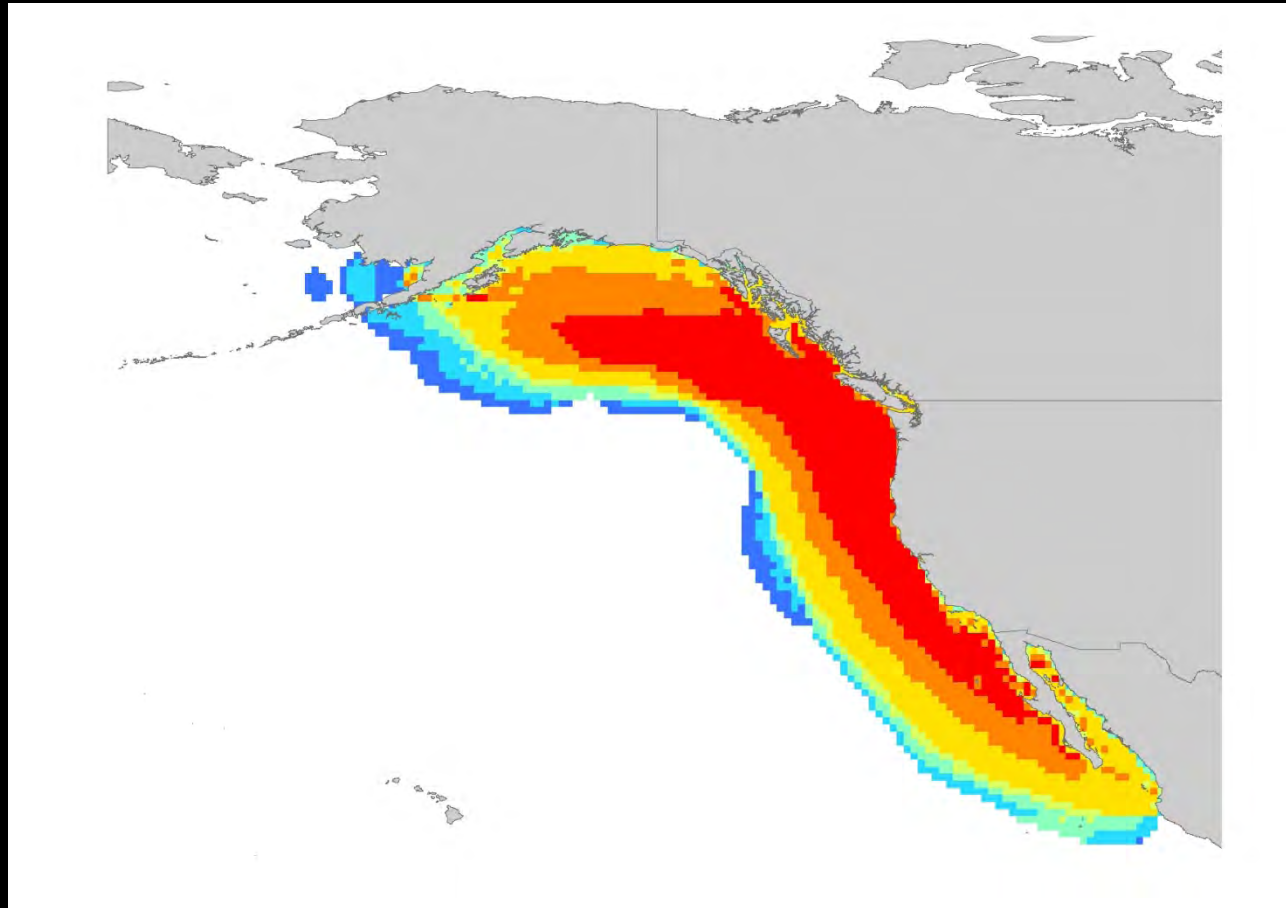
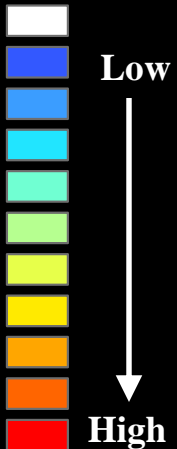


# Pacific jack mackerel

Year 2005

• NOAA/GFDL (SRES A1B)

Relative  
abundance

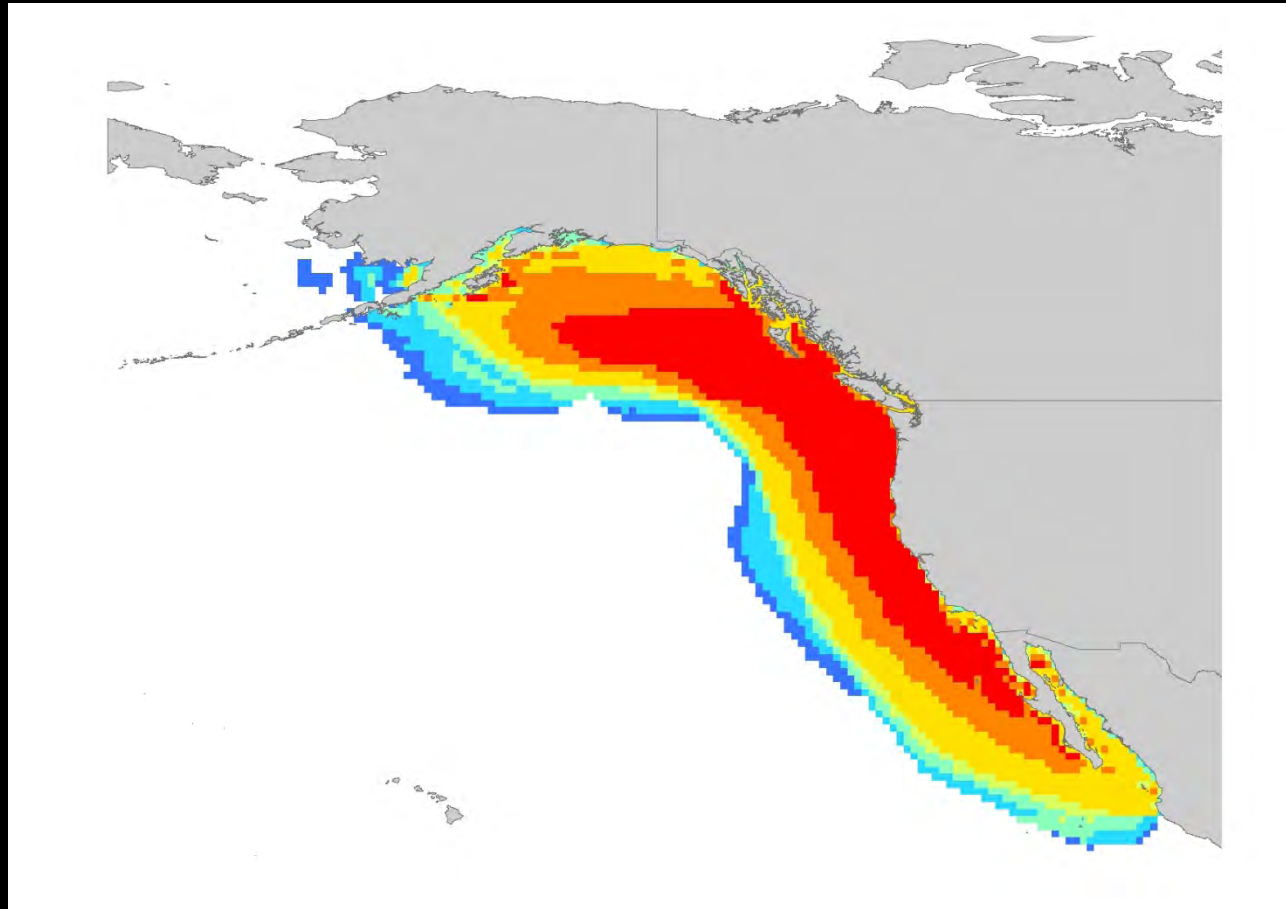
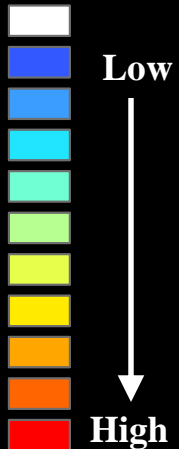


# Pacific jack mackerel

Year 2010

• NOAA/GFDL (SRES A1B)

Relative  
abundance

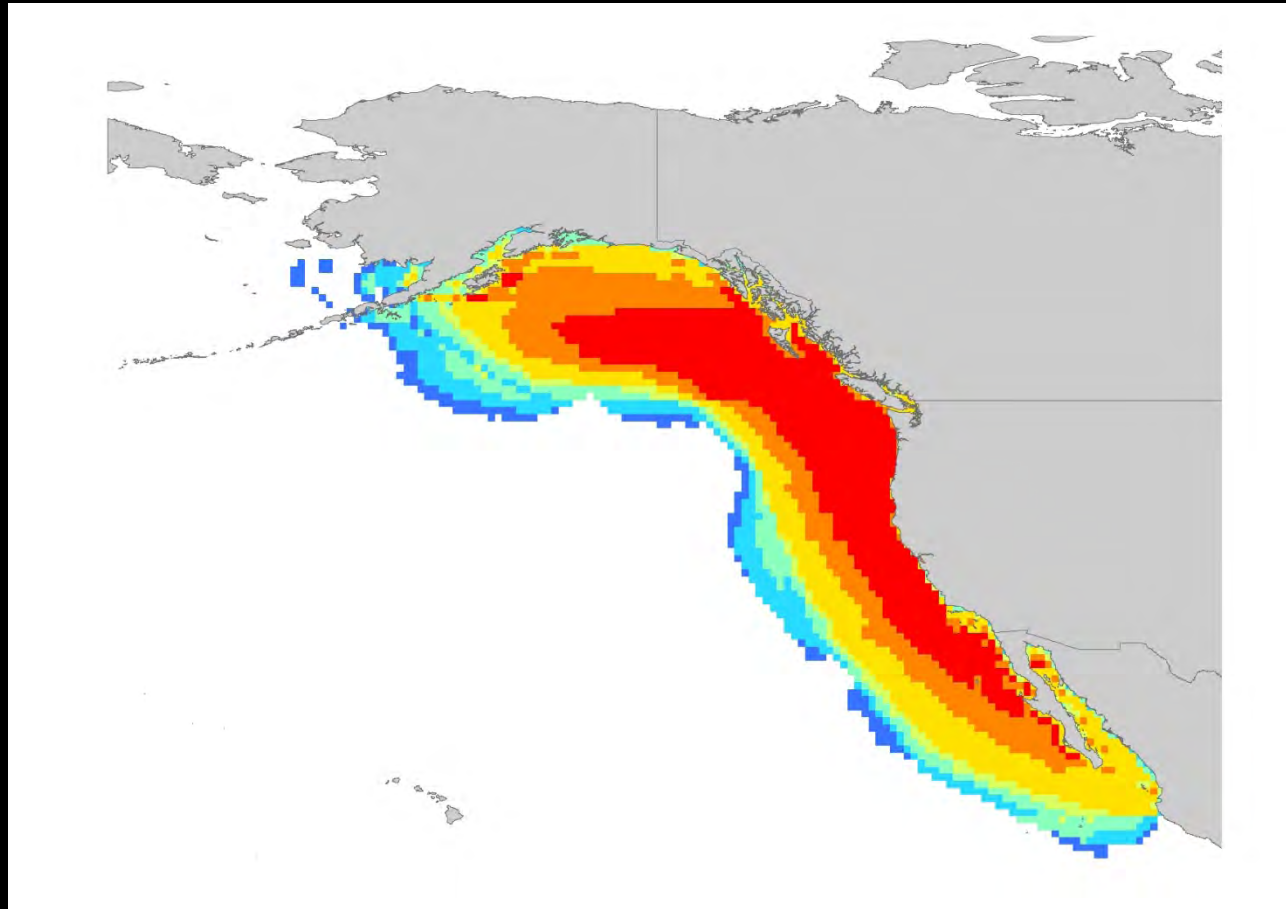
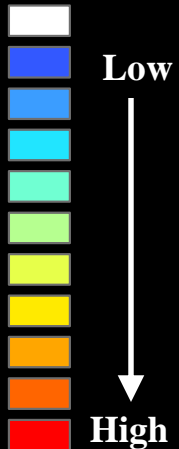


# Pacific jack mackerel

Year 2015

• NOAA/GFDL (SRES A1B)

Relative  
abundance



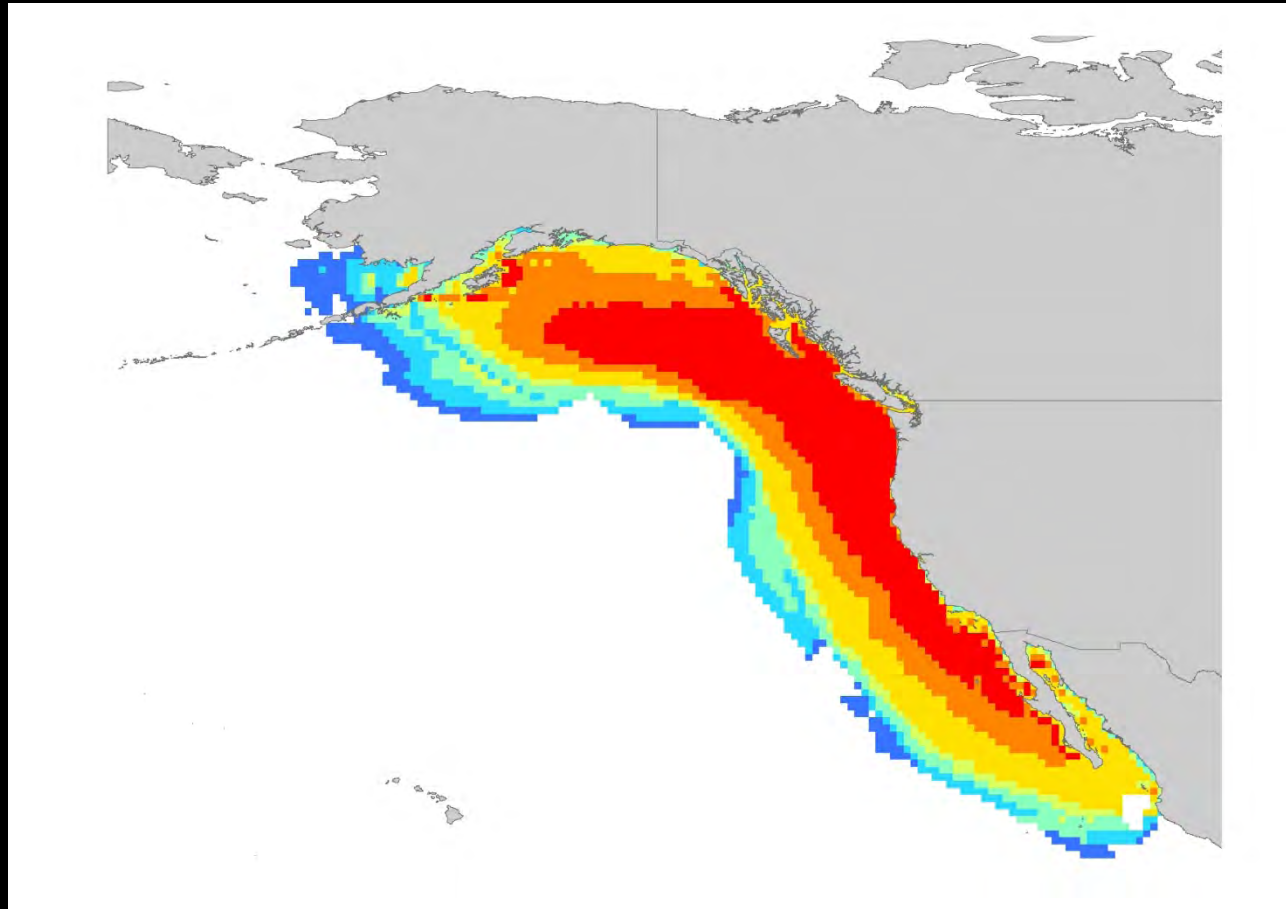
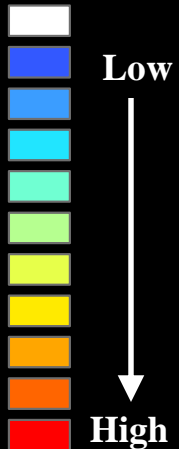


# Pacific jack mackerel

Year 2020

• NOAA/GFDL (SRES A1B)

Relative  
abundance



# Pacific jack mackerel

Year 2025

• NOAA/GFDL (SRES A1B)

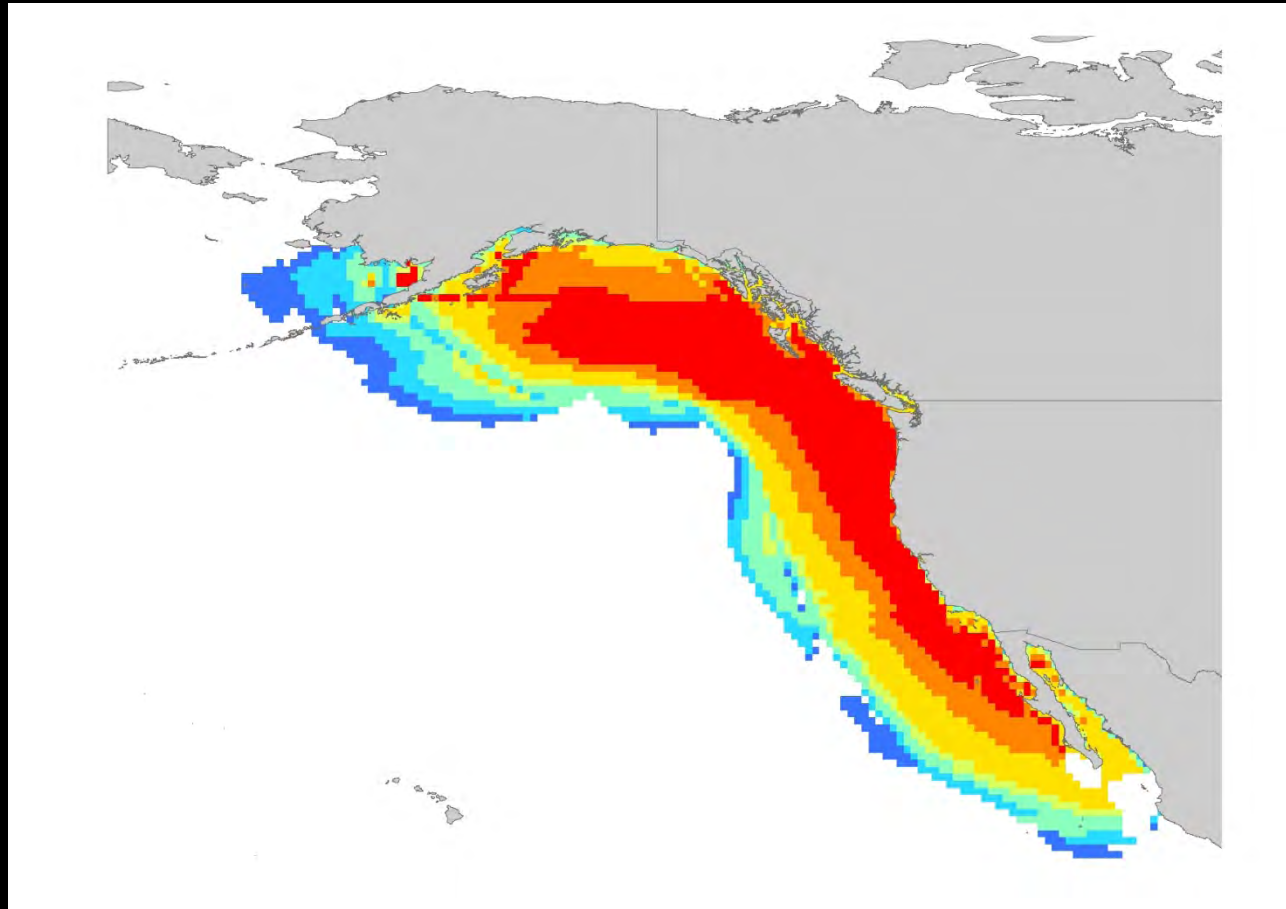
Relative  
abundance



Low



High

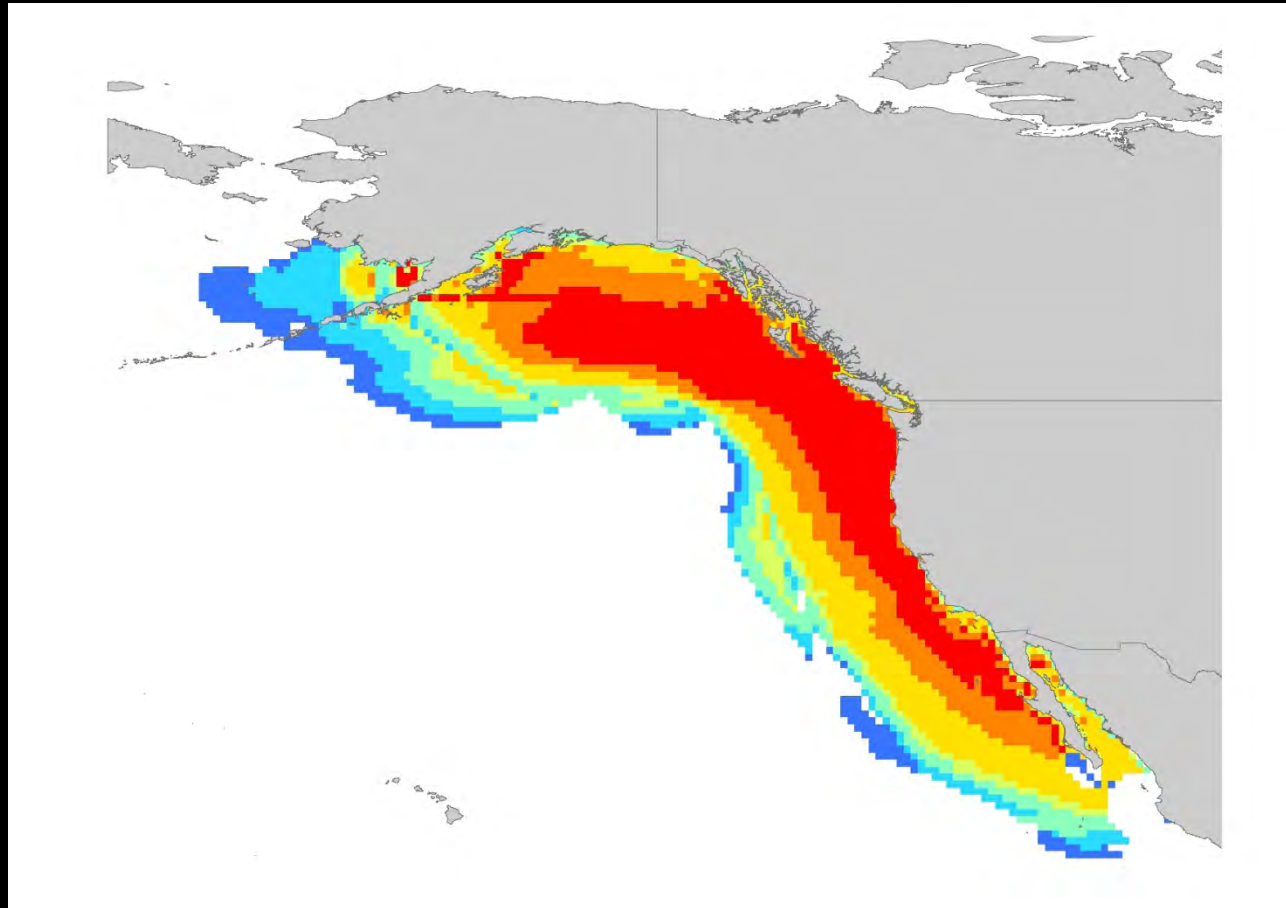
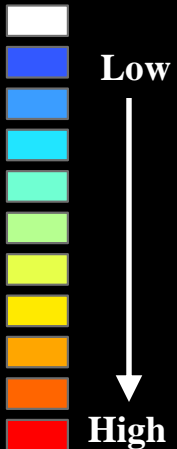


# Pacific jack mackerel

Year 2030

• NOAA/GFDL (SRES A1B)

Relative  
abundance

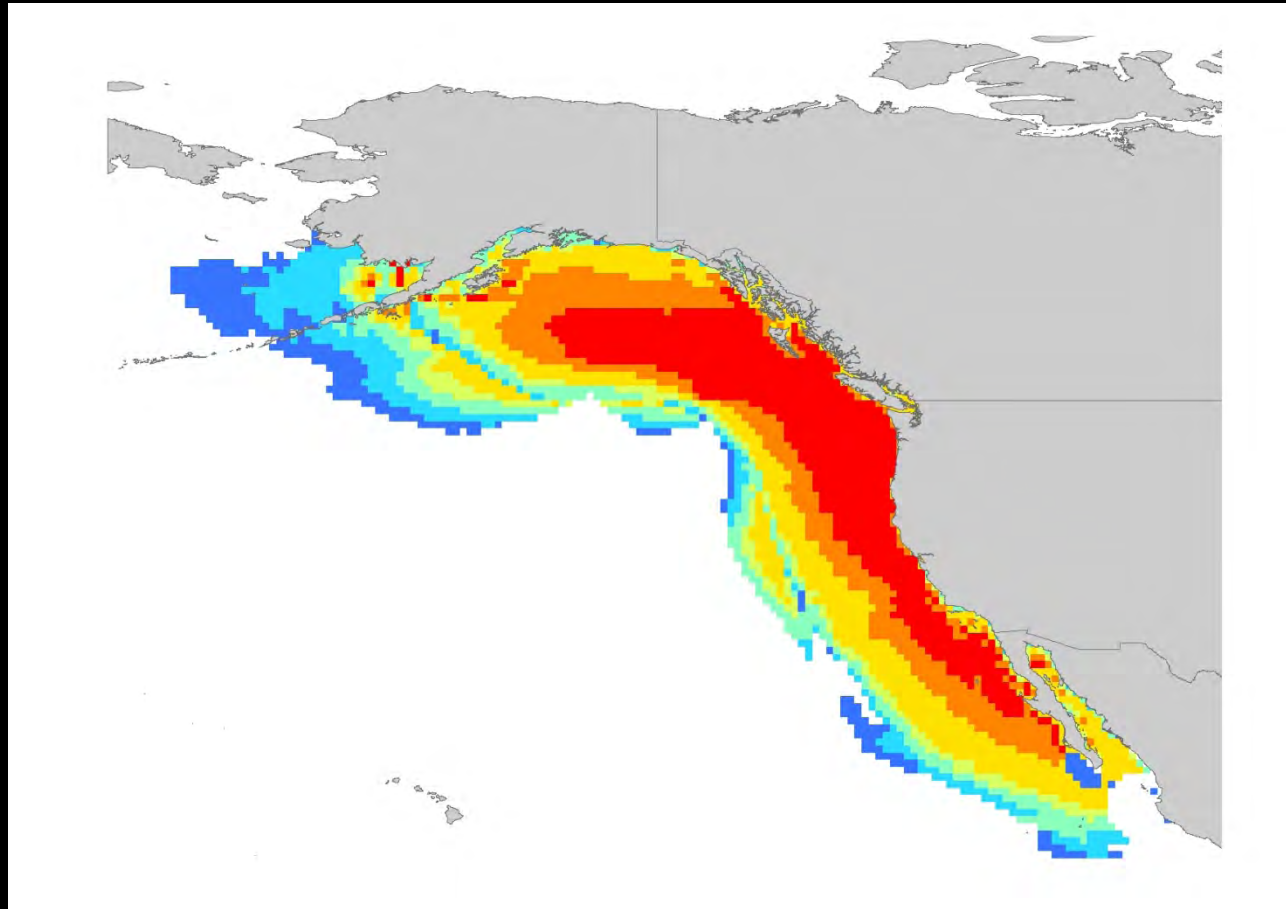
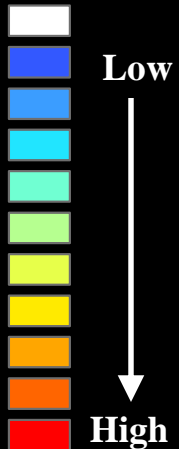


# Pacific jack mackerel

Year 2035

• NOAA/GFDL (SRES A1B)

Relative  
abundance

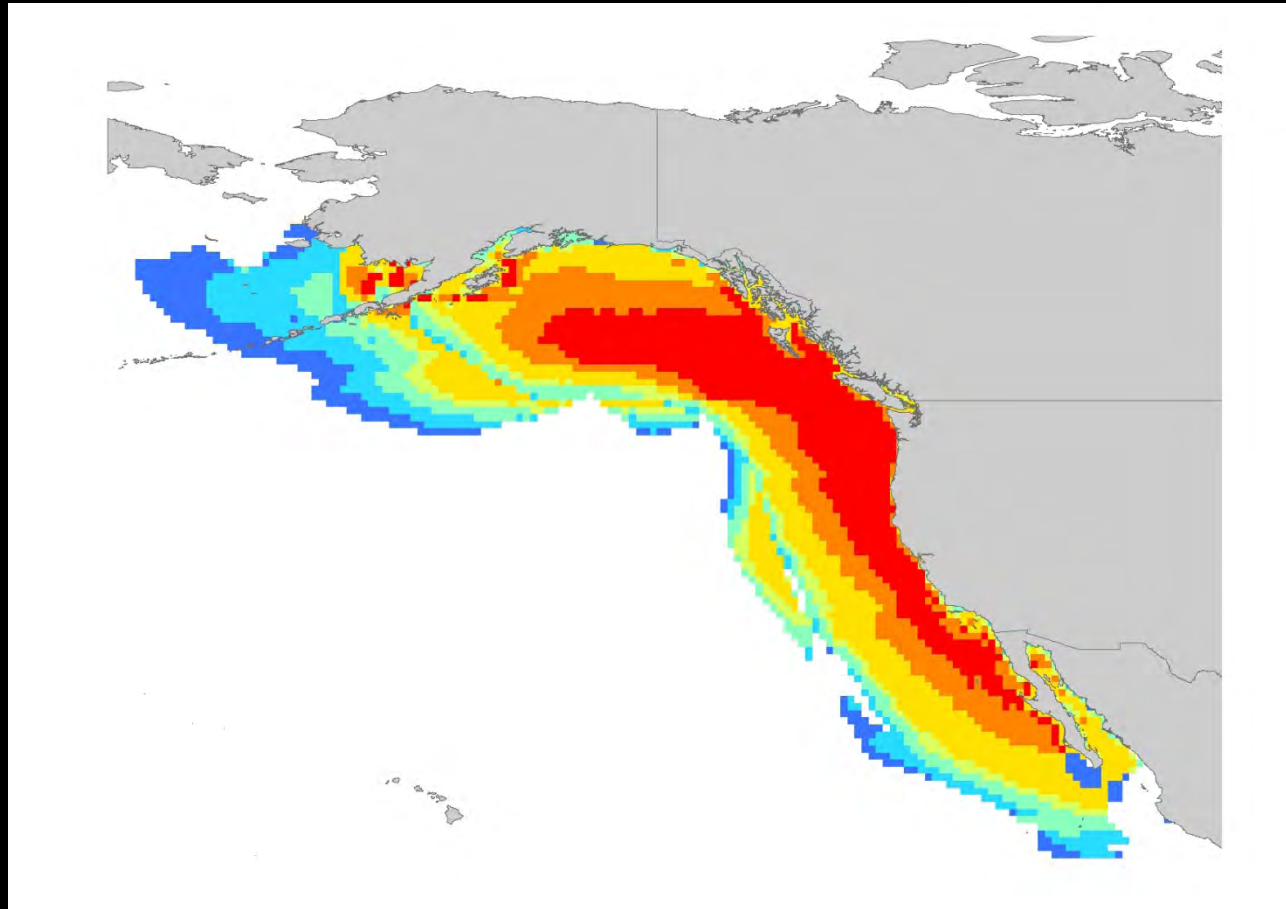
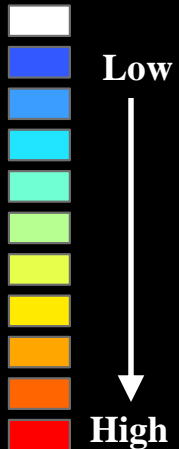


# Pacific jack mackerel

Year 2040

• NOAA/GFDL (SRES A1B)

Relative  
abundance

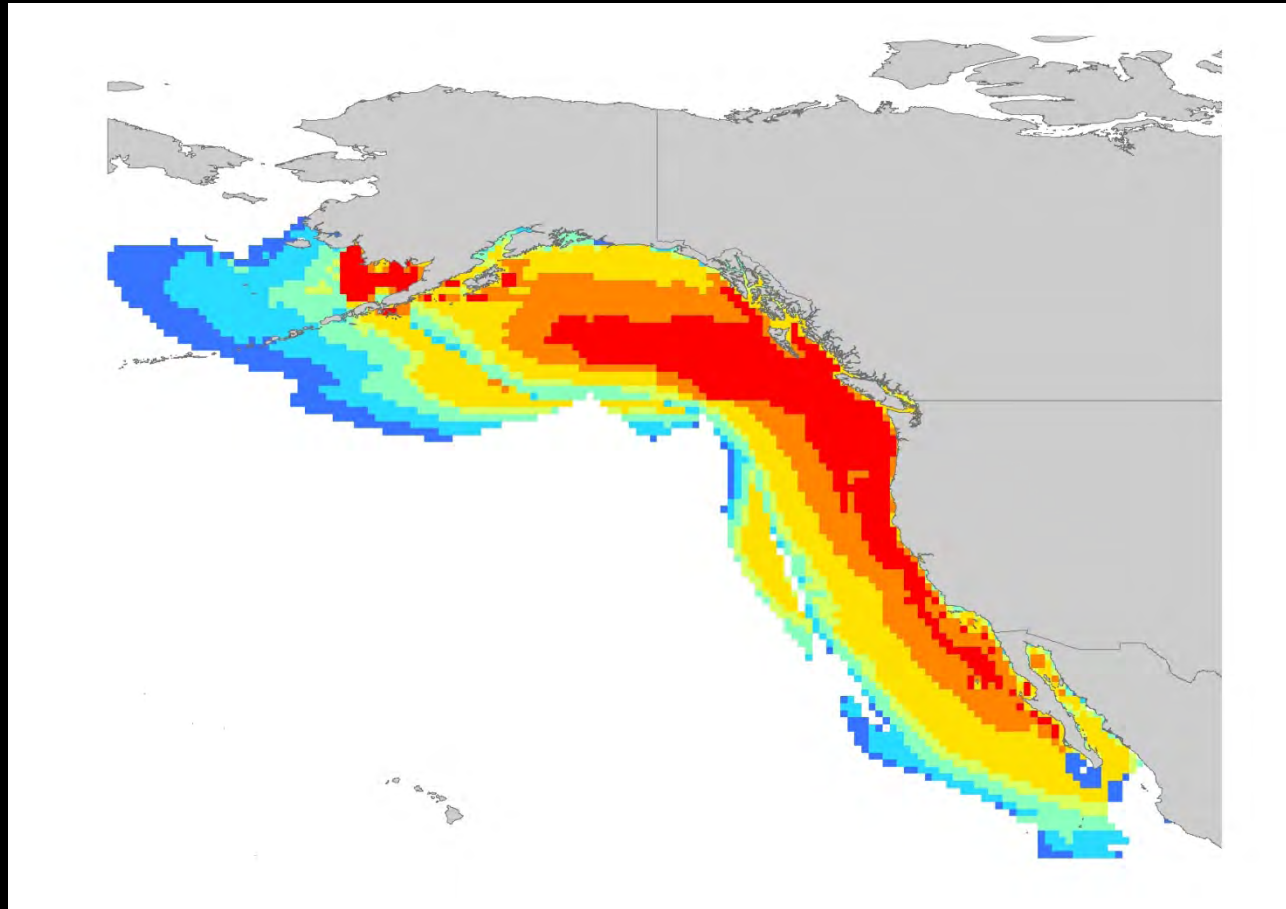
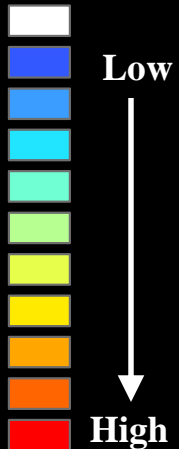


# Pacific jack mackerel

Year 2045

• NOAA/GFDL (SRES A1B)

Relative  
abundance

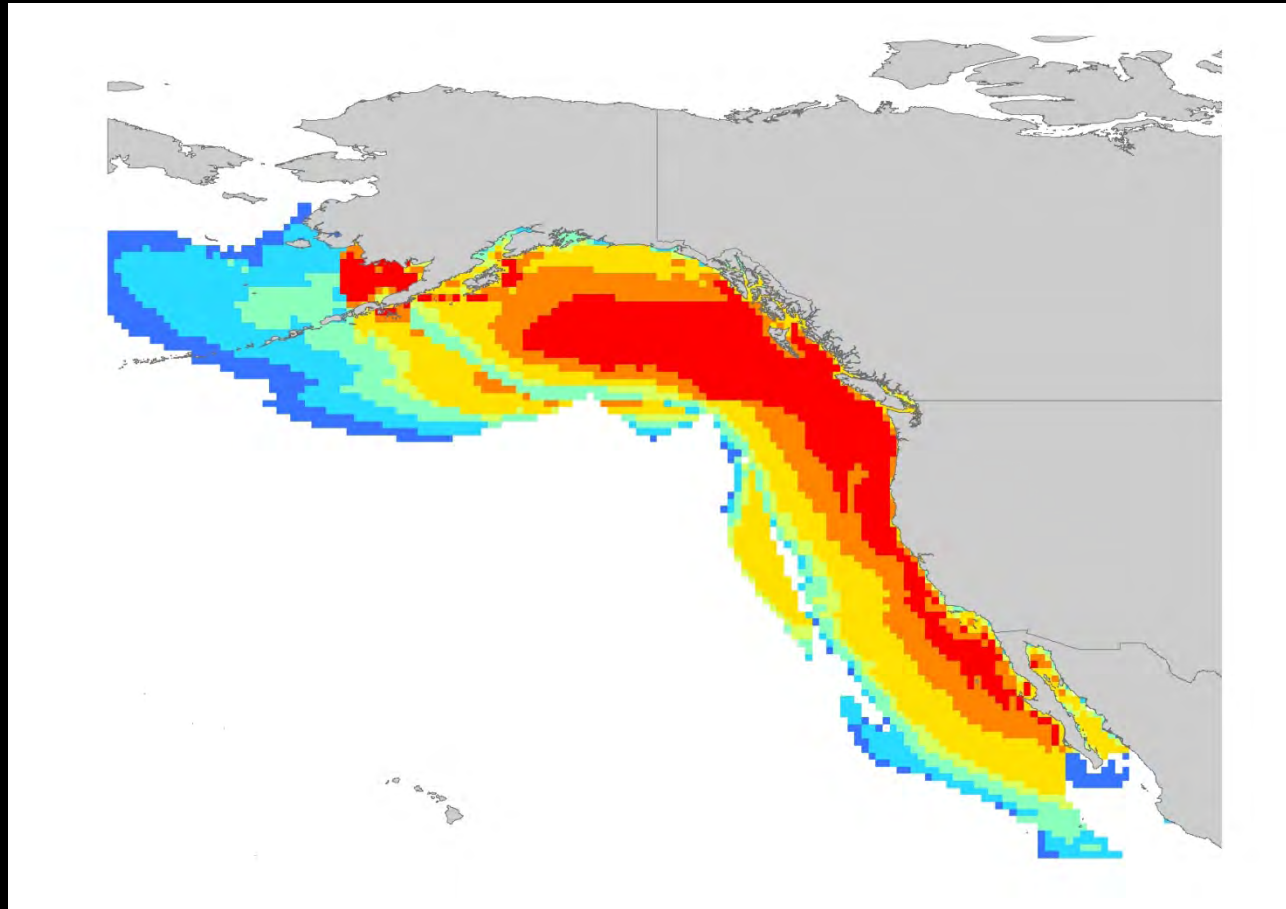
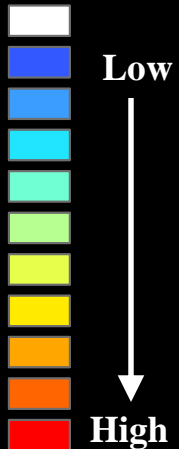


# Pacific jack mackerel

Year 2050

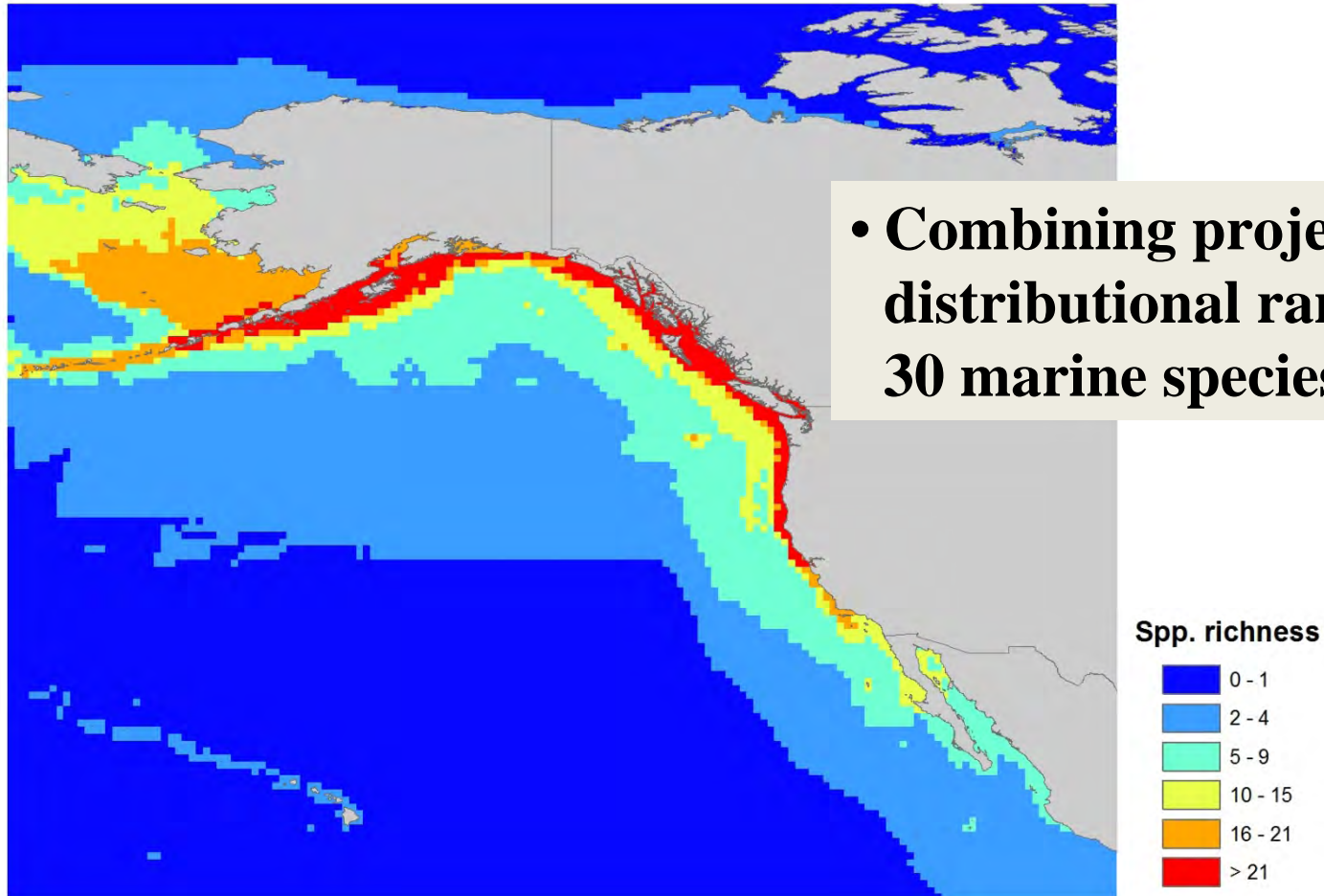
• NOAA/GFDL (SRES A1B)

Relative  
abundance





# Predicting climate change impacts on marine biodiversity

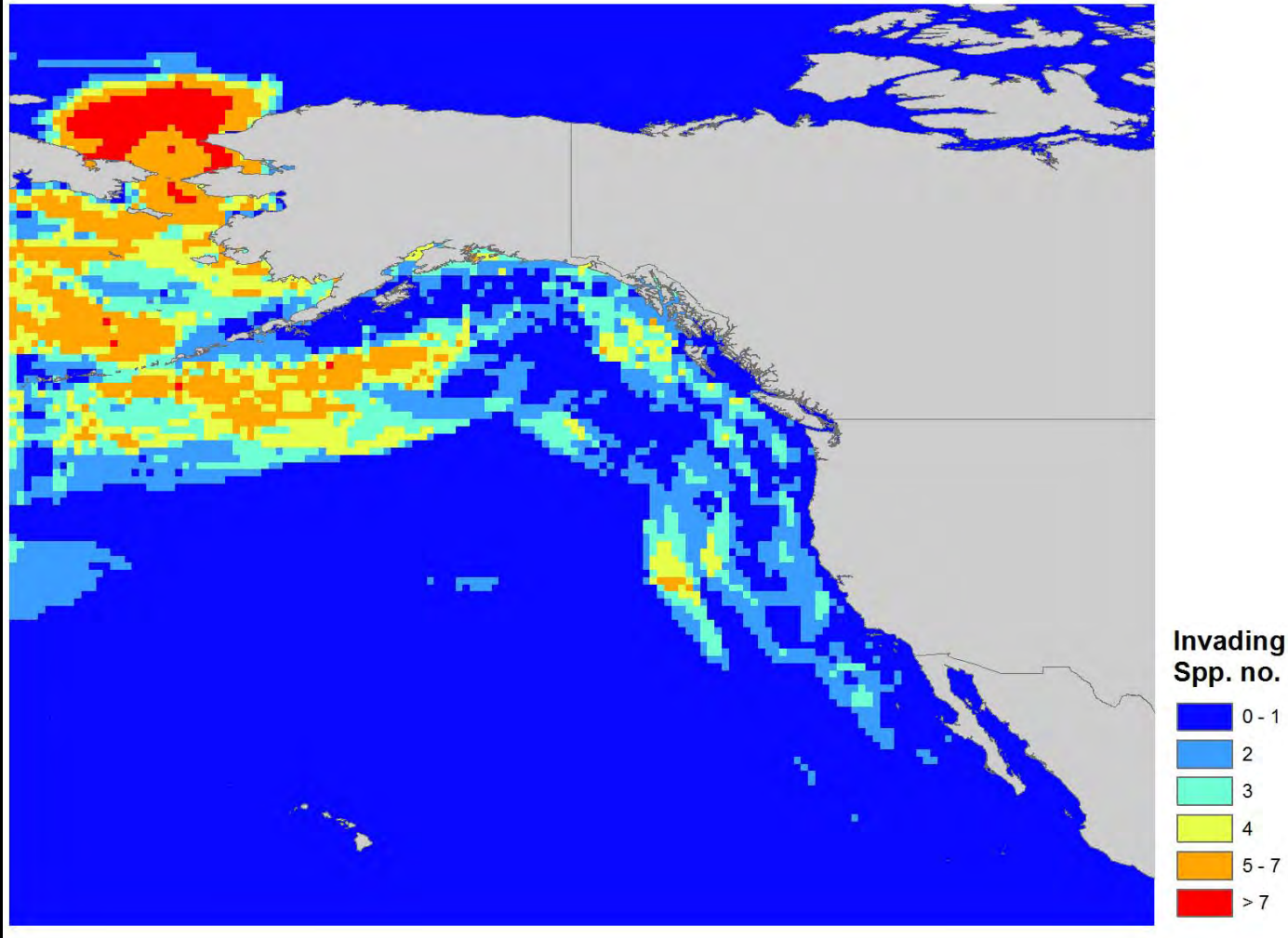


- Combining projected distributional ranges of 30 marine species.



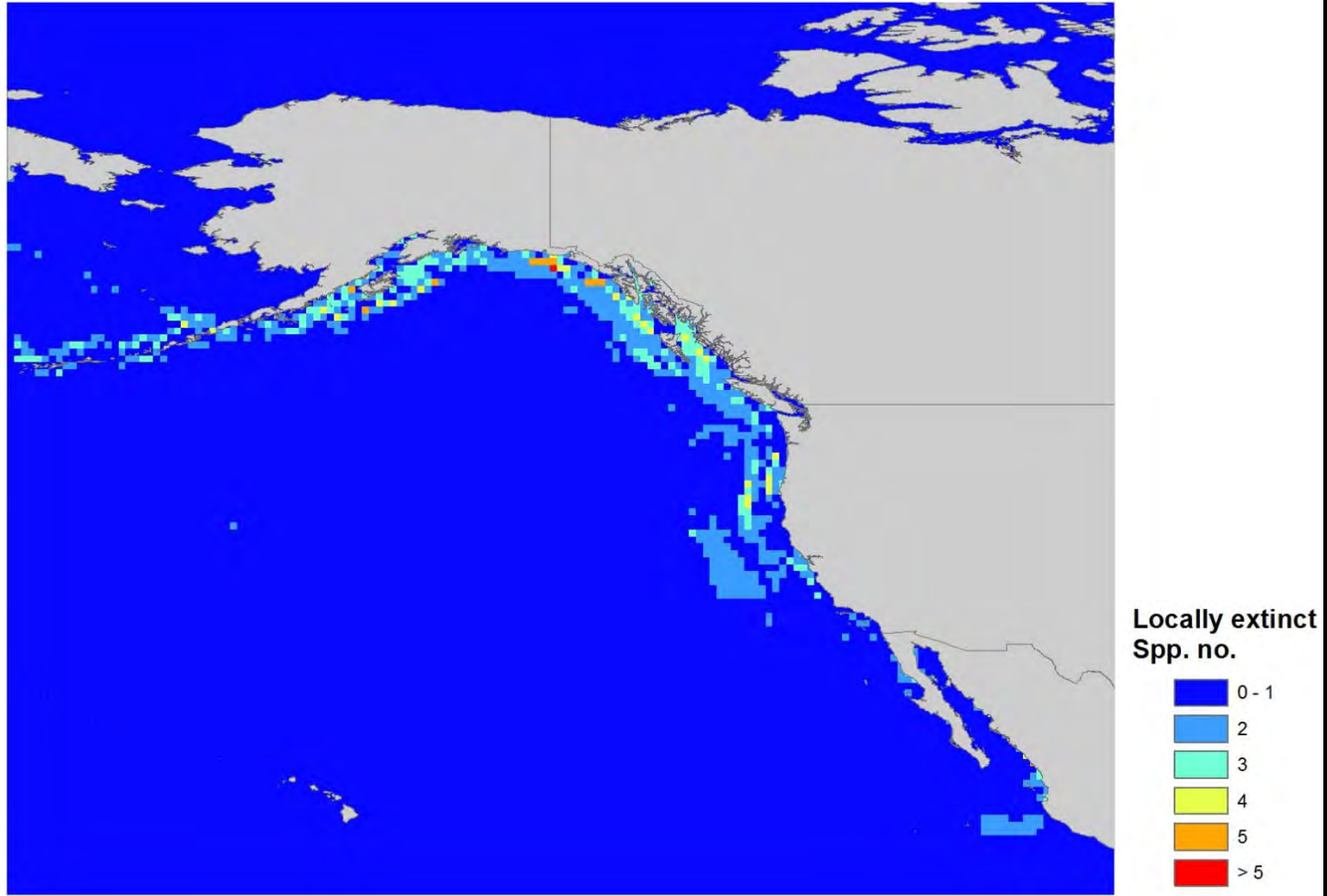
# Species invasion (spp. no.)

- NOAA/GFDL CM 2.1 (SRES A1B)

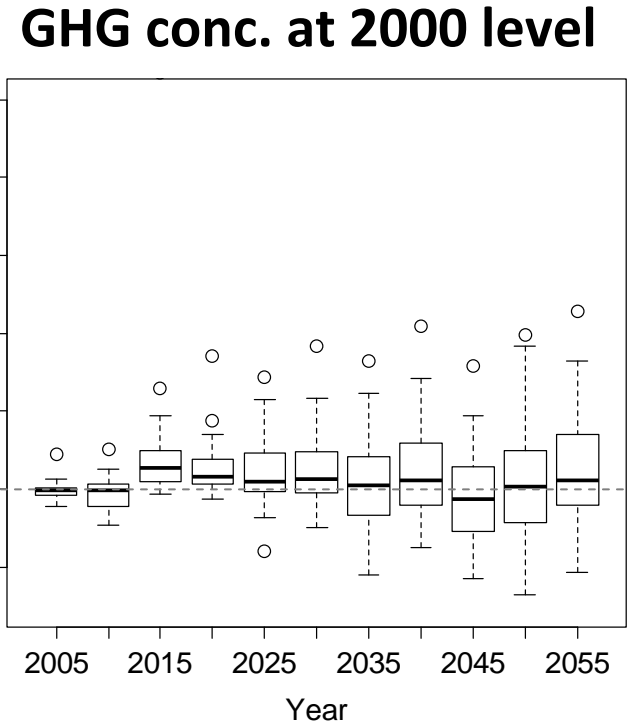
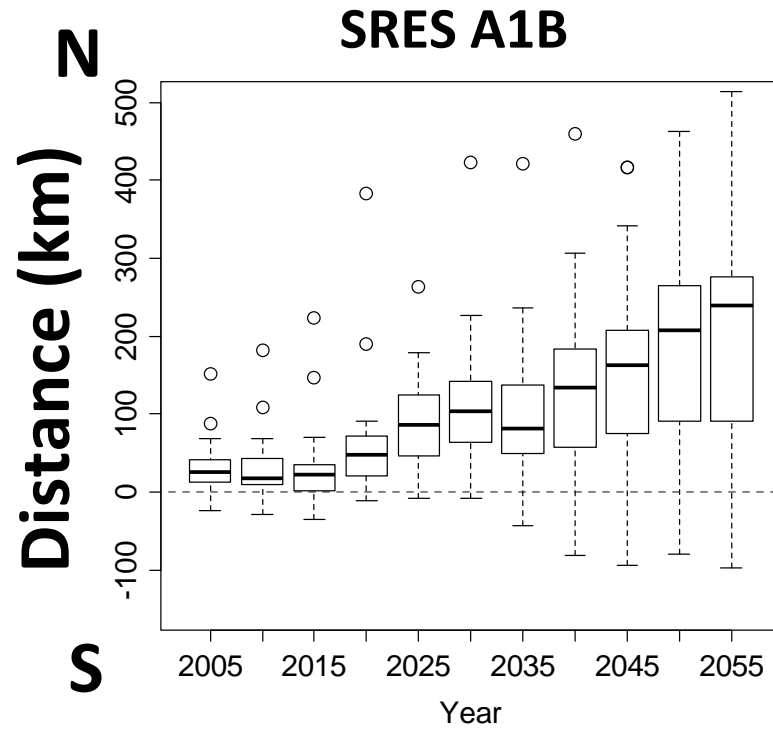


# Local extinction (spp. no.)

- NOAA/GFDL CM 2.1 (SRES A1B)

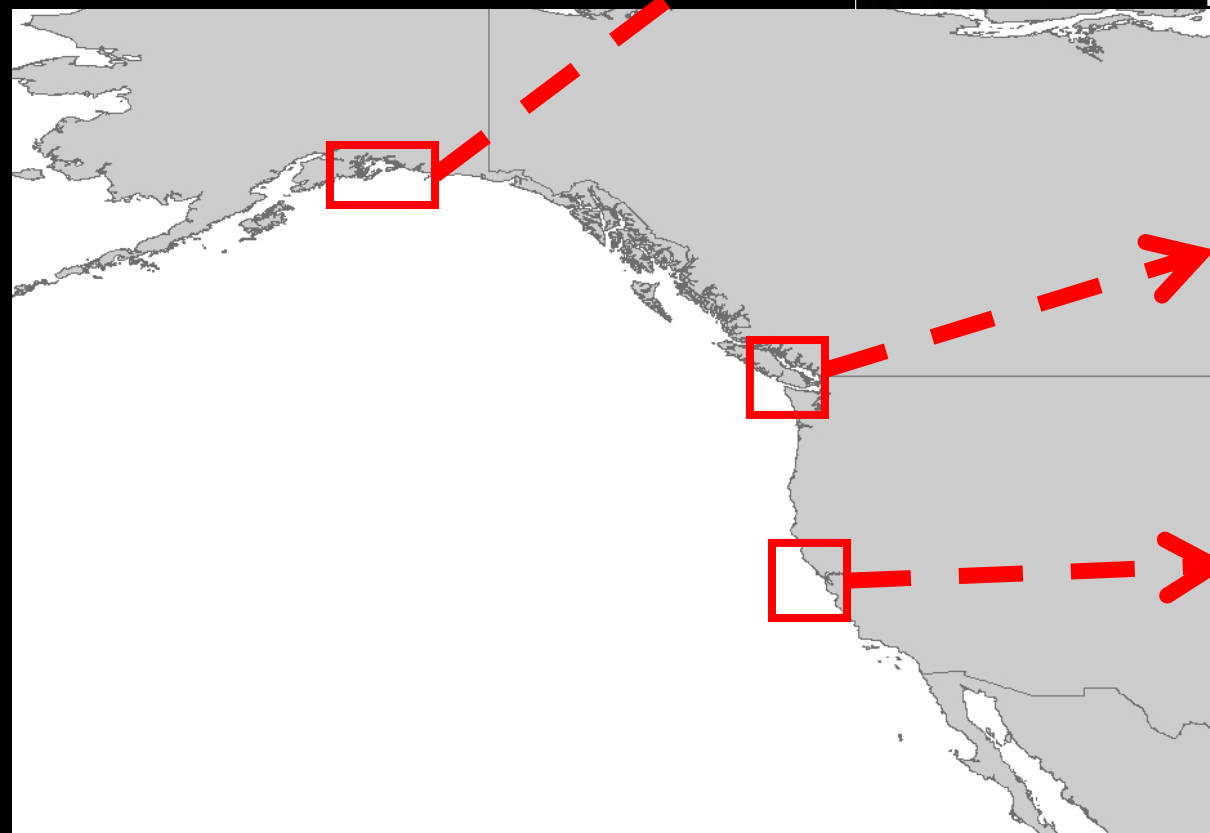
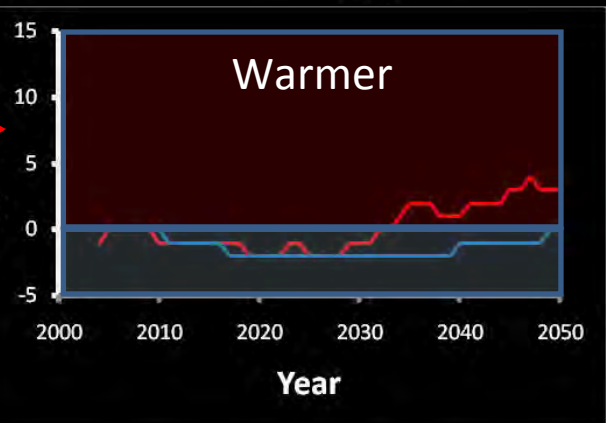
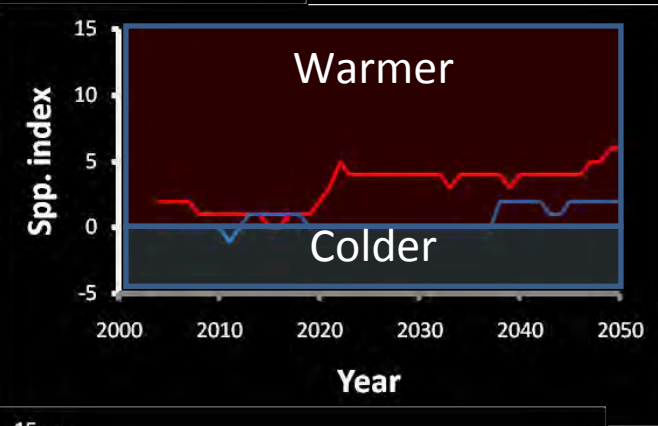
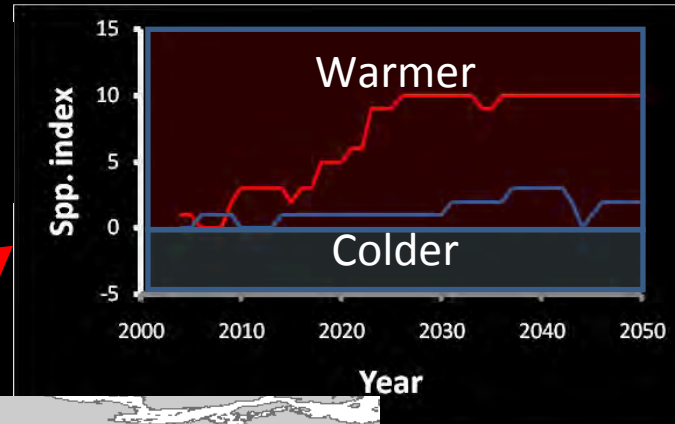


# Projected latitudinal shift of centroid



# Detecting climate change effects

**Spp. with observable change  
(out of the 30 studied spp.)**



# Summary

- **Most of the studied species may shift their distribution ranges towards the North;**
- **Medium rate of shift is around 30 – 40 km decade<sup>-1</sup>;**
- **Broad-scale pattern generally follows global trends;**
- **Expected to see climate-induced changes in relative abundance of species in existing monitoring stations;**
- **The results provide guidance to design monitoring programme for climate change impacts;**
- **Potentially large implications to commercial, recreational and indigenous fisheries.**

# Acknowledgement

- Joe Orsi
- Jeff Harding
- Lewis Haldorson
- Jamal Moss
- Dick Beamish
- Marc Trudel
- Bob Emmett

**Thank you**