



NOAA
FISHERIES

Eastern Bering Sea Climate Vulnerability Assessment

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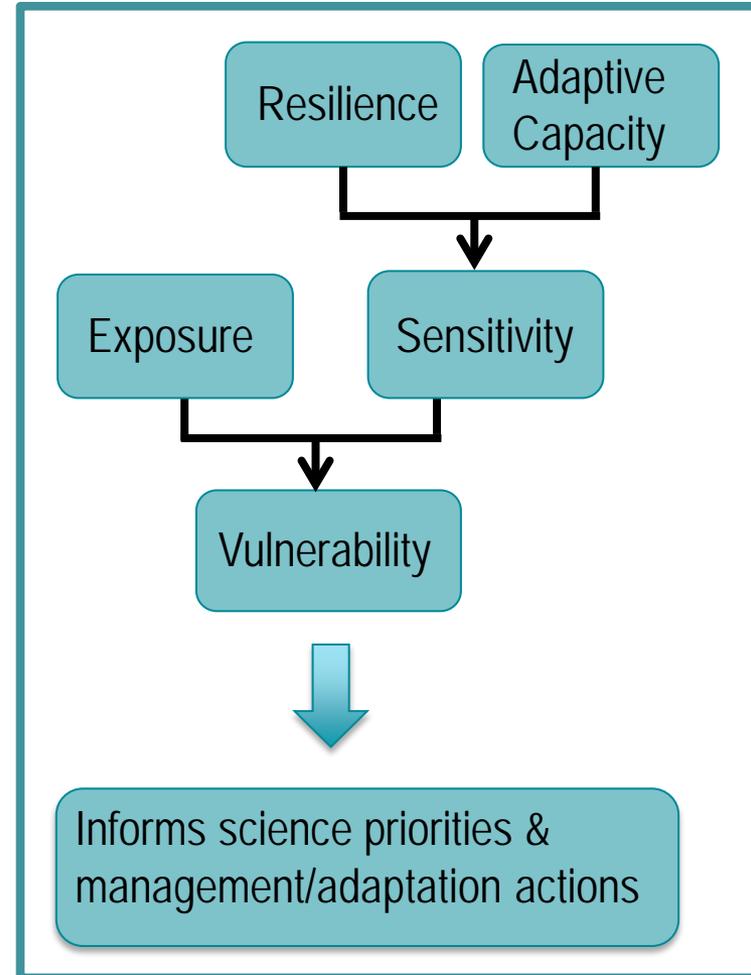
¹Office of Sustainable Fisheries, NMFS

Assessing Vulnerability

Vulnerability to climate change is defined as a function of sensitivity to climate change and exposure to climate change (i.e., “exposure factors”)

Goals:

1. Determine which stocks are vulnerable and why
2. Identify data gaps and research priorities



<http://www.st.nmfs.noaa.gov/ecosystems/climate/activities/assessing-vulnerability-of-fish-stocks>

Eastern Bering Sea



A diversity of stocks and analysts for EBS study

36 stocks

4 elasmobranchs

9 flatfish

5 salmon

4 crab stocks

3 cephalopods

2 forage species

4 rockfish

5 other 'roundfish'

34 analysts for sensitivity scores

19 NOAA-Fisheries

4 Other management agencies
(ADFG, IPHC)

11 Academia (U. of Alaska, Oregon
State U., UC-Santa Barbara, U. of
Washington)

Process (for scoring, and preparation for scoring)

1. Develop species profiles (*completed summer, 2015*)
2. Identify climate variables and projections (*completed summer 2016*)
3. Identify species distributions (overlap with EFH work - *completed summer 2016*)
4. Preliminary and final scoring, sensitivity attributes (*completed summer, 2015*)
5. Preliminary and final scoring, exposure factors (*preliminary scores completed fall 2016, final scores in progress*)
6. Compute and bootstrap results, write final report

Methodology – Framework

Species Vulnerability

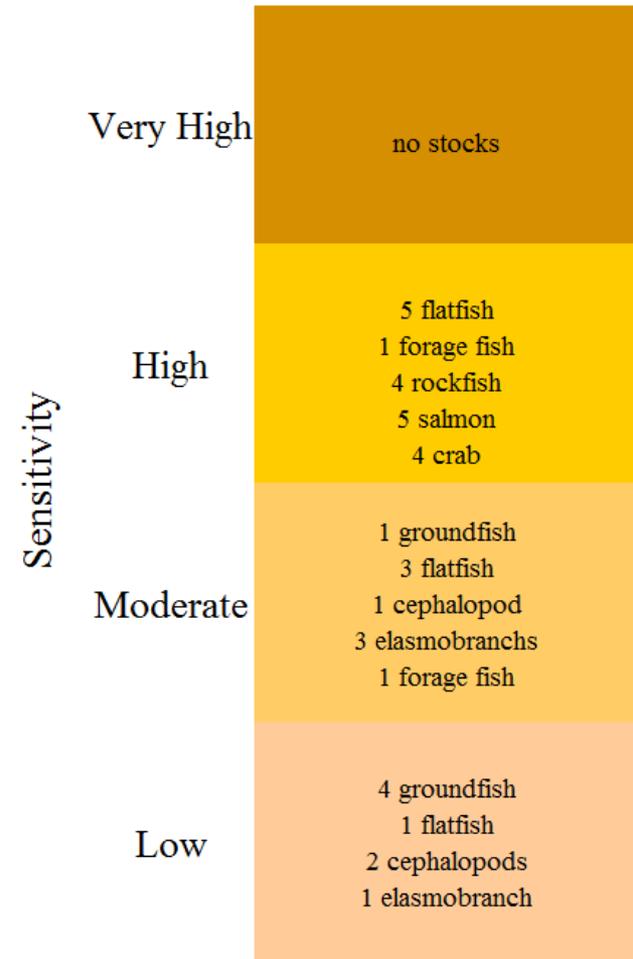
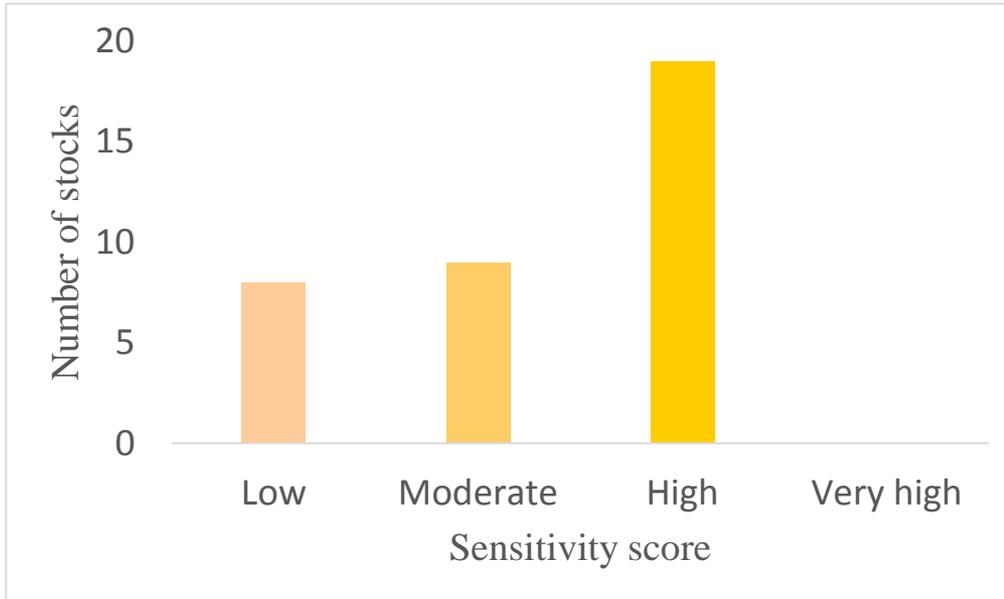
Exposure

- Sea surface temperature
- Bottom temperature
- Air temperature
- Salinity
- Ocean acidification (pH)
- Precipitation
- Currents
- Sea surface height
- Large zooplankton biomass
- Phytoplankton biomass and bloom timing
- Ice coverage

Sensitivity

- Habitat Specificity
- Prey Specificity
- Sensitivity to Ocean Acidification
- Sensitivity to Temperature
- Stock Size/Status
- Other Stressors
- Adult Mobility
- Spawning Cycle
- Complexity in Reproductive Strategy
- Early Life History Survival and Settlement Requirements
- Population Growth Rate
- Dispersal of Early Life Stages

Sensitivity scores



Vulnerability Assessment Methodology

Climate Exposure

- Projections of future climate conditions (for most variables) were obtained from 3 downscaled Global Climate models (produced by Dr. Al Hermann, Pacific Marine Environmental Laboratory)

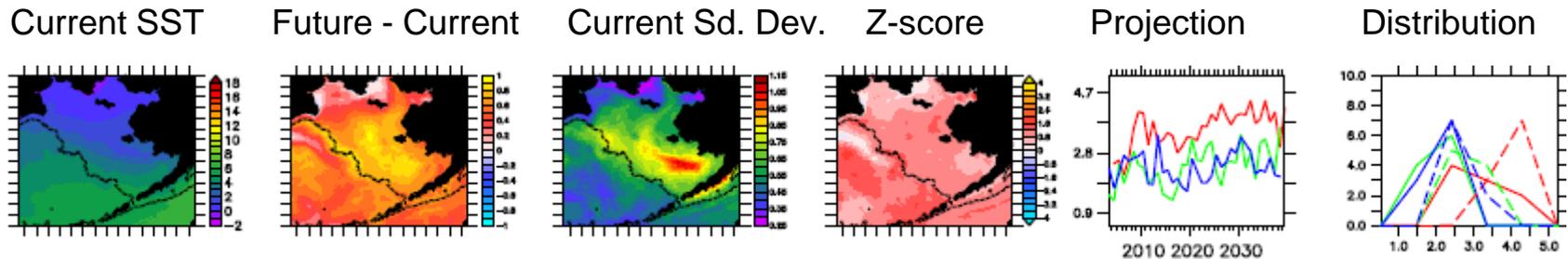
CCCma – high degree of warming, MIROC – intermediate warming, ECHO-G – least warming

- We are interested in comparing the change between projected future (2030-2039) conditions and current (2003-2012) conditions.
- For each stock, we will need to consider which environmental variables affect the stock dynamics

Vulnerability Assessment Methodology

Climate Exposure

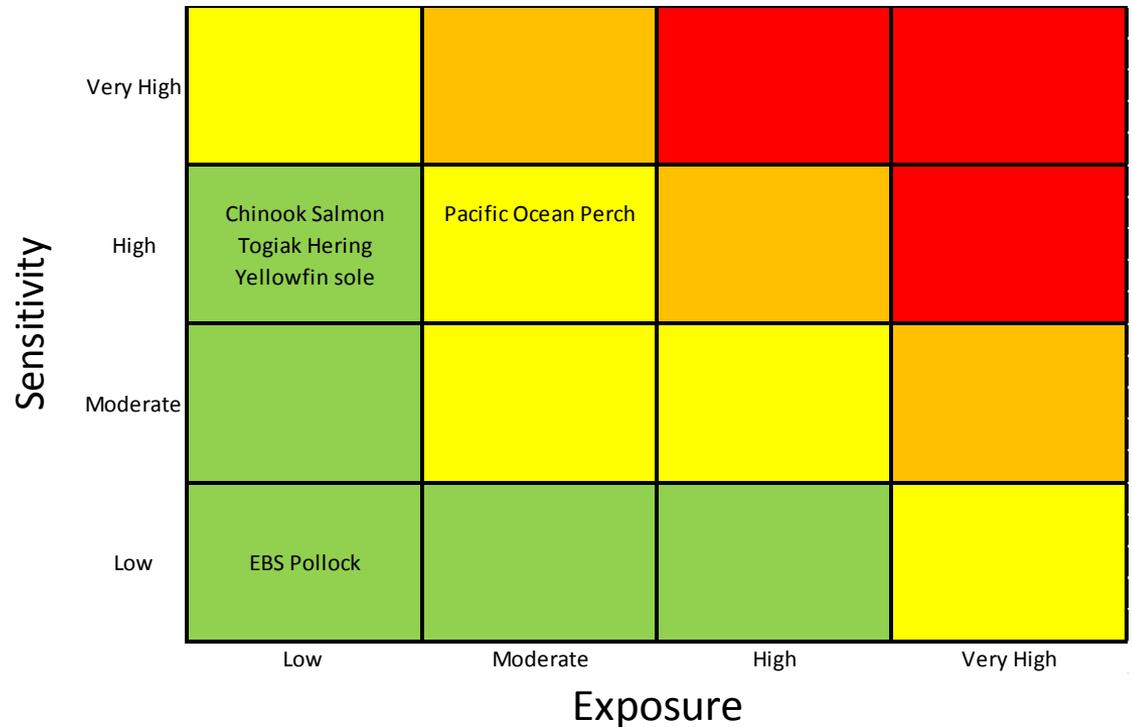
Example – sea surface temperature



- Z-score is $(\text{Future} - \text{Current}) / (\text{Current SD})$ [i.e., column2 / column 3]
- For each stock, we will compare the overlap of the current species distribution and the expected change in the exposure factor.
- The time series of 3 projections are shown because stock dynamics may be influenced by short-term “spikes” in exposure factors
- The frequency distributions of current (solid line) and future (dashed line) are shown to summarize the change in absolute units for the three projection models (shown by color)
- The graphs/maps above will be produced for seasonal and annual measures of the exposure factor

Preliminary Results (for initial set of stocks)

- Relative vulnerability rankings
- Identify key regional drivers
- Species specific vulnerability narratives



Conclusions

- 1) A series of workshops involving a wide range of NOAA and non-NOAA experts were held in summer, 2015, to produce the species profiles and stock sensitivity scores.
- 2) Preliminary scores for exposure have been produced, and development of final exposure scores are in progress.
- 3) Analysis of results and writing manuscripts/reports is expected to occur winter/spring 2017.