Trait-based climate vulnerability assessments for marine taxa in the Gulf of Alaska

Isabelle Galko[1*], Cheryl L. Barnes[1], Paul D. Spencer[2], Jodi L. Pirtle[3], Marysia Szymkowiak[2], Al Hermann[4], Alberto Rovellini[4], Mason Smith[3,] Benjamin Williams[2]

*presenting author; [1]Coastal Oregon Marine Experiment Station, Oregon State University; [2]Alaska Fisheries Science Center, NOAA; [3]Alaska Regional Office, NOAA; [4]School of Aquatic and Fishery Sciences, University of Washington

Climate impacts in the Gulf of Alaska

Alaska's marine ecosystems are particularly susceptible to changing climatic conditions, including cascading effects of recent marine heat waves.[1,2,3]

Despite its economic and ecological importance, the Gulf of Alaska region lacks information about which stocks are most vulnerable to changes in climate.

A semi-quantitative approach

Climate vulnerability assessments (CVAs) use **existing information** and **expert opinion** to:

- Indicate **which** species are at risk
- Help determine **why** species are at risk
- Identify sources of uncertainty and data gaps

Estimates of vulnerability are used to identify research priorities and potential climate change adaptation strategies.

Analytical framework

Vulnerability: the degree to which a stock is susceptible to or unable to cope with effects of climate change[4]

- **Sensitivity**: species' intrinsic resilience to climate change, considering adaptive capacity[5]
- **Exposure:** the nature and degree to which a system is exposed to significant climatic variations[4]

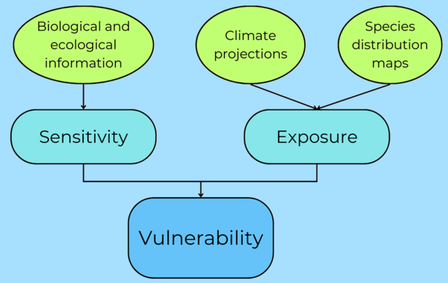


Fig. 1: Workflow used to assess climate vulnerability in the Gulf of Alaska.

Example: Walleye pollock

1. Select focal species

Includes ~50 fish and invertebrates that:

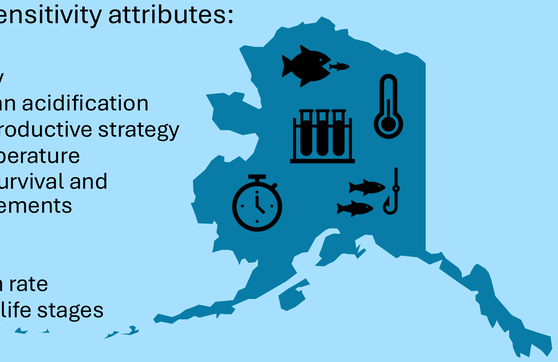
- ✓ Support important recreational or commercial fisheries landings
- ✓ Are assessed by federal or state agencies or included in a regional Fishery Management Plan (FMP)
- ✓ Maintain an ecologically important niche (e.g., as forage fish)

Fig. 2: Walleye pollock *(Gadus chalcogrammus)*

2. Synthesize species-specific sensitivities

Compile available information based on the following sensitivity attributes:

- Prey specificity
- Habitat specificity
- Sensitivity to ocean acidification
- Complexity in reproductive strategy
- Sensitivity to temperature
- Early life history survival and settlement requirements
- Stock size/status
- Other stressors
- Population growth rate
- Dispersal of early life stages
- Adult mobility
- Spawning cycle



3. Map exposure risk

Approximate spatiotemporal overlap between a species' distribution and the magnitude of exposure:

- Sea surface temperature
- Air temperature
- Salinity
- Ocean acidification
- Precipitation
- Ocean currents
- Bottom temperature
- Subsurface oxygen
- Phytoplankton biomass
- Zooplankton biomass
- Marine heat waves
- Mixed layer depth

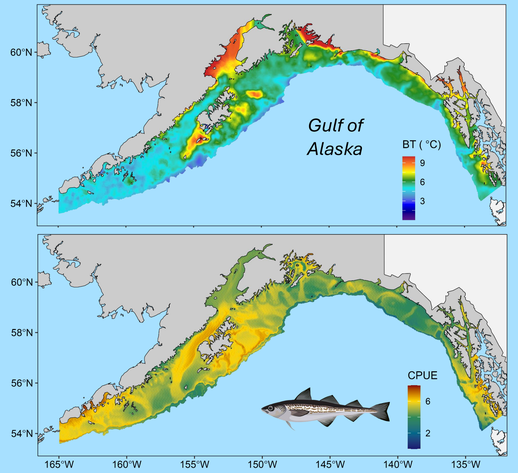


Fig. 3: Mean bottom temperature (BT) in the Gulf of Alaska[6] (above); predicted catch-per-unit-effort (CPUE; number per km^2)[7] (below).

4. Score sensitivity & exposure

- Range: low to very high
- Uncertainty: five-tally scoring system
  - E.g., very certain:

Low	Moderate	High	Very High
	I	IIII	

  - E.g., fairly uncertain:

Low	Moderate	High	Very High
I	I	II	I

5. Estimate relative vulnerability

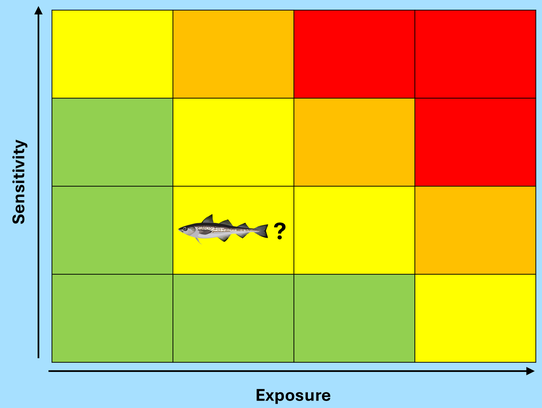


Fig. 4: Relative vulnerability matrix. Green = low; yellow = moderate; orange = high; red = very high

6. What's next?

- Identify stock-specific data gaps to prioritize future research on climate impacts throughout the region
- Use sensitivity attributes to develop new ecological indicators for ecosystem and socioeconomic profiles (ESPs)
- Translate vulnerability scores into information for fisheries management (e.g., via risk tables)

References:

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