

Risk and Resilience: Assessing multi-species climate vulnerability in the Gulf of Alaska



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NOAA
FISHERIES



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Climate change in the Gulf of Alaska

- Alaska's marine ecosystems are facing accelerated warming and cascading climate effects, including marine heatwaves.^{1,2,3}
- These changes are causing widespread shifts in the abundance, distribution, and productivity of marine species.⁴
- In the Gulf of Alaska (GOA), climatic and ecological changes are felt across commercial, recreational, and subsistence fisheries.^{4,5}
- The GOA lacks information about species-specific vulnerability to climate change that is integral to long-term planning.

Climate vulnerability assessments (CVA)

A **trait-based approach** that determines the likelihood that climate change will affect a species' abundance, distribution, and productivity.

- Indicates which species are most vulnerable to climate change
- Helps determine why different species are at risk

Building on previous work:

- Over 70 CVAs on marine fisheries internationally
- Recent CVAs include the Bering Sea⁶ and California Current⁷
- The GOA is the **last NOAA management region** to conduct a CVA for fish and invertebrates

Key outcomes:

- Information for fisheries managers and communities to respond to climate impacts and increase resilience
- Guidance on future research priorities and data gaps
- List of target species for enhanced monitoring

Vulnerability Framework and Methodology

Vulnerability is composed of sensitivity and exposure.⁸

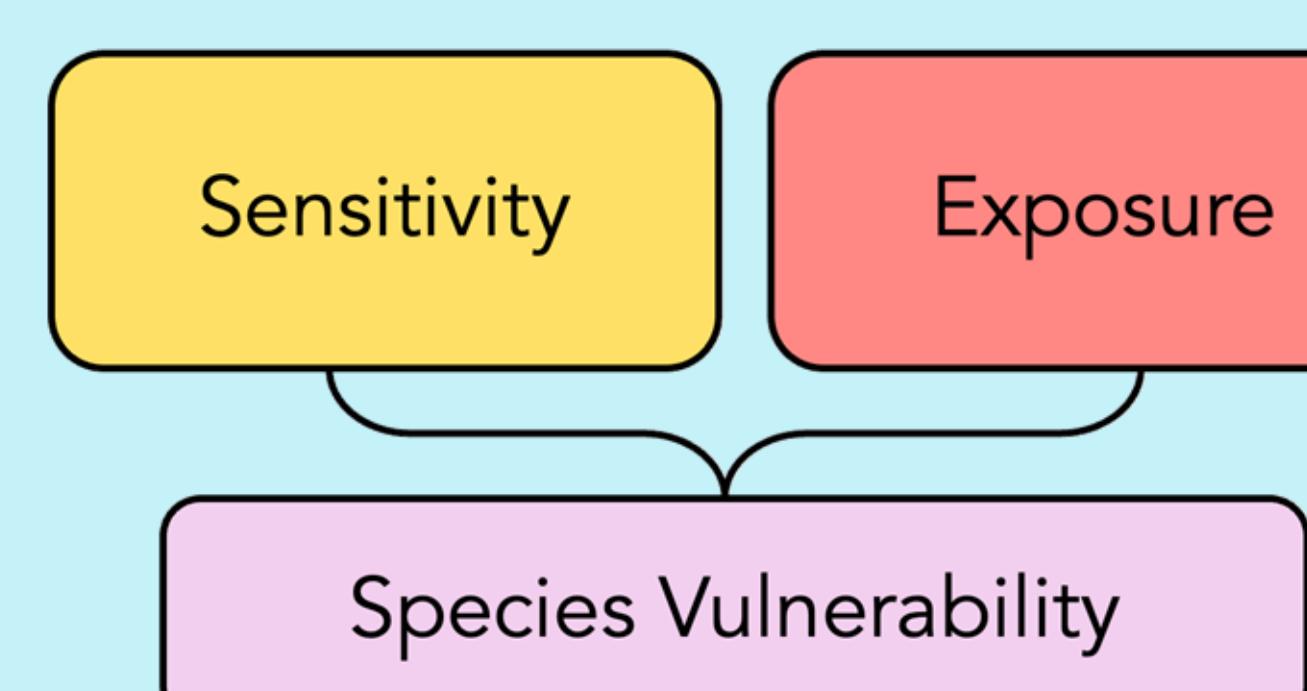
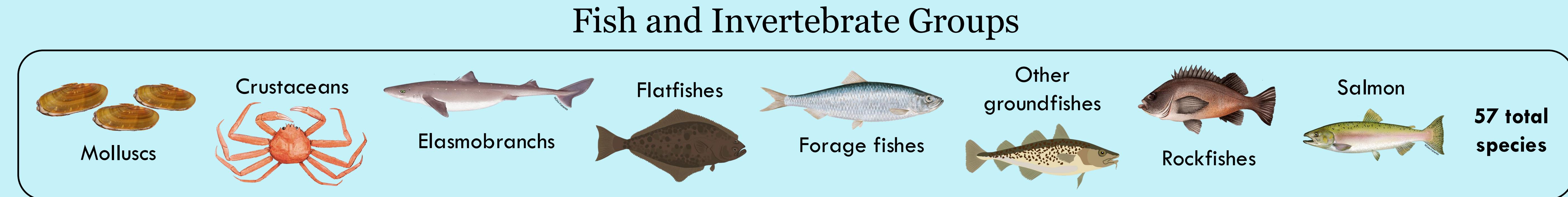


Fig. 1: Vulnerability framework.

Our methodology is semi-quantitative and rapid:

- Uses currently existing knowledge and expert opinion
- Evaluates impacts over a broad range of species
- Relyes on quantitative data when available and qualitative data otherwise



Fish and Invertebrate Groups

Sensitivity

Sensitivity: biological traits indicative of a species' ability to respond to environmental change⁹

We adapted 12 sensitivity attributes used in previous NOAA CVAs:

	Habitat Specificity		Parental Investment
	Thermal Tolerance		Reproductive Plasticity
	Sensitivity to OA		Spawning Duration
	Foraging Strategy		Life History Strategy
	Adult Movement		Stock Status
	Dispersal Capability		Genetic Diversity

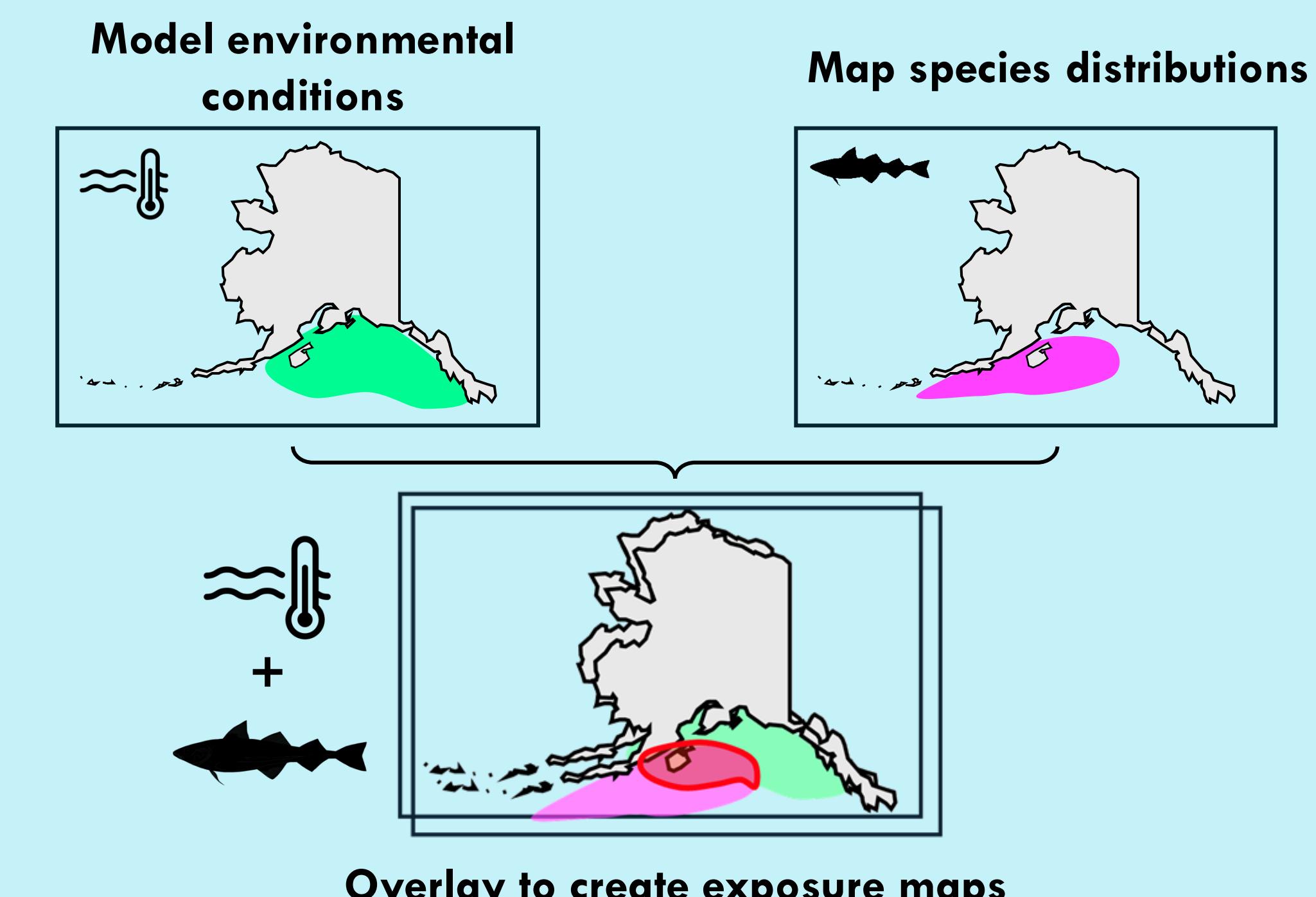
Species profiles:

- We conducted comprehensive literature reviews that summarized species-specific information for each sensitivity attribute
- We synthesized this information into "species profiles"

Exposure

Exposure: the degree to which species experience changes in their environments⁸

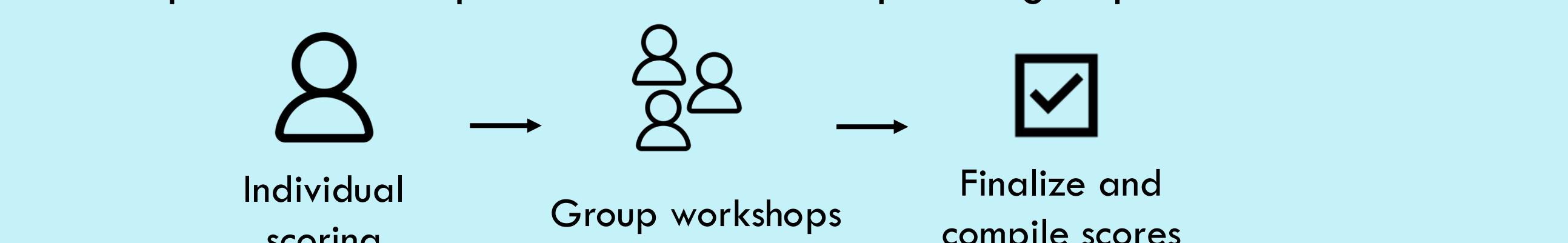
Exposure is measured as the overlap between the species distribution and the magnitude of the expected change in climate:



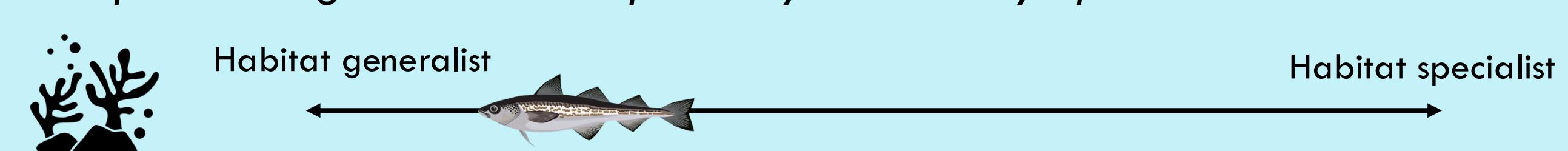
Estimating sensitivity

Sensitivity scoring process:

- Subject-matter experts to score each species group



Example: scoring of "Habitat Specificity" for walleye pollock



- Combine all sensitivity scores for each species to determine overall sensitivity

Estimating exposure

Exposure analysis:

- Quantify exposure over each species' distribution in the GOA
- Combine all exposure scores for each species to determine overall exposure

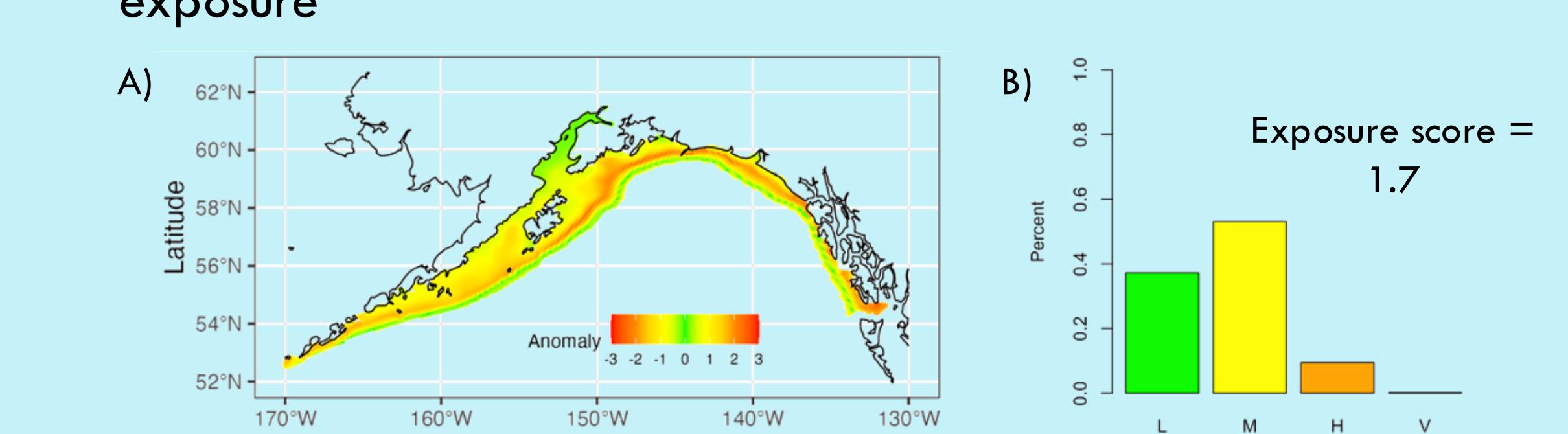


Fig. 2: A) Exposure map of bottom temperature using a 1985–2014 historical time period and a 2040–2049 future time period. B) Summarized histogram of exposure.

What's next?

Next steps:

- Hold 10 workshops to discuss sensitivity scores
- Compile model outputs and species distributions
- Combine sensitivity and exposure scores to estimate species-specific vulnerability

Future directions:

- Translate vulnerability scores into information for fisheries management (e.g., via risk tables)
- Combine results with social and economic dimensions of vulnerability to conduct a CVA for fishing communities

Project website:



References:



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