



Climate impacts to SARs  
and how we can/should/must (?)  
adapt assessment science

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“... Current research and monitoring associated with MMPA and ESA mandates provides some information regarding climate change impacts on marine mammals in U.S. waters, but this is more fortuitous than by design.”



A review of climate change effects on marine mammals in United States waters: Past predictions, observed impacts, current research and conservation imperatives



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ABSTRACT

We consider the current evidence of climate change effects on marine mammals that occur in U.S. waters relative to past predictions. Compelling cases of such effects have been documented, though few studies have confirmed population-level impacts on abundance or vital rates. While many of the observed effects had been predicted, some unforeseen and relatively acute consequences have also been documented. Effects often occur when climate-induced alterations are superimposed upon marine mammals' ecological (e.g., predator-prey) relationships or coincident human activities. As they were unanticipated, some of the unpredicted effects of climate change have strained the ability of existing conservation and management systems to respond effectively. The literature is replete with cases suggestive of climate change impacts on marine mammals, but which remain unconfirmed. This uncertainty is partially explained by insufficient research and monitoring designed to reveal the connections. Detecting and mitigating the impacts of climate change will require some realignment of research and monitoring priorities, coupled with rapid and flexible management that includes both conventional and novel conservation interventions.

# Climate influences can lead us to get the assessment wrong

- Range and distribution shifts may masquerade as increases or decreases in abundance in a fixed study area (like an EEZ)

## Climate and ecosystem changes may exacerbate or greatly exceed other human-caused impacts

- Habitat compression increased humpback entanglements in crab pots
  - Prey limitations resulted in large scale die-offs of gray whales, far exceeding typical human-caused mortality

# Representation of climate impacts in current SARs

- Climate, or 'environmental change' is commonly discussed in the Habitat Issues section for migratory large whales, ice-associated cetaceans and for several stocks of pinnipeds
- Marine heat waves are implicated in changes in abundance and production rates for Stellar sea lions and Hawai'i humpback whales.
- The (forthcoming) eastern gray whale SAR will incorporate an integrated population model linking climate-associated changes to changes in population abundance and vital rates, including annually varying carrying capacity.
- Most of these populations have population-specific monitoring programs that have persisted for many decades.

# Adapting assessment science to capture climate change impacts

- We are responsible for providing assessments for hundreds of marine mammal populations with different life histories, ecologies, and with large variability in amount and quality of data available
- We can look to the Climate Vulnerability Assessments to prioritize, but should not ignore those that are data poor
- We need to expand our assessment toolbox

# Guiding Questions...

1. How can we adjust our assessment surveys to increase the likelihood of detecting range shifts?
2. How can we adjust our assessment analyses to detect and incorporate climate impacts?
3. How can we apply new technologies or tools to better measure ecosystem relationships and detect distribution changes?
4. Are there alternative assessment metrics we should explore that will make it easier to detect climate influences (or other adverse impacts)

# How do we adjust our assessment surveys?

Fiscal reality - Adding ship days or conducting more surveys isn't really an option for most stocks.

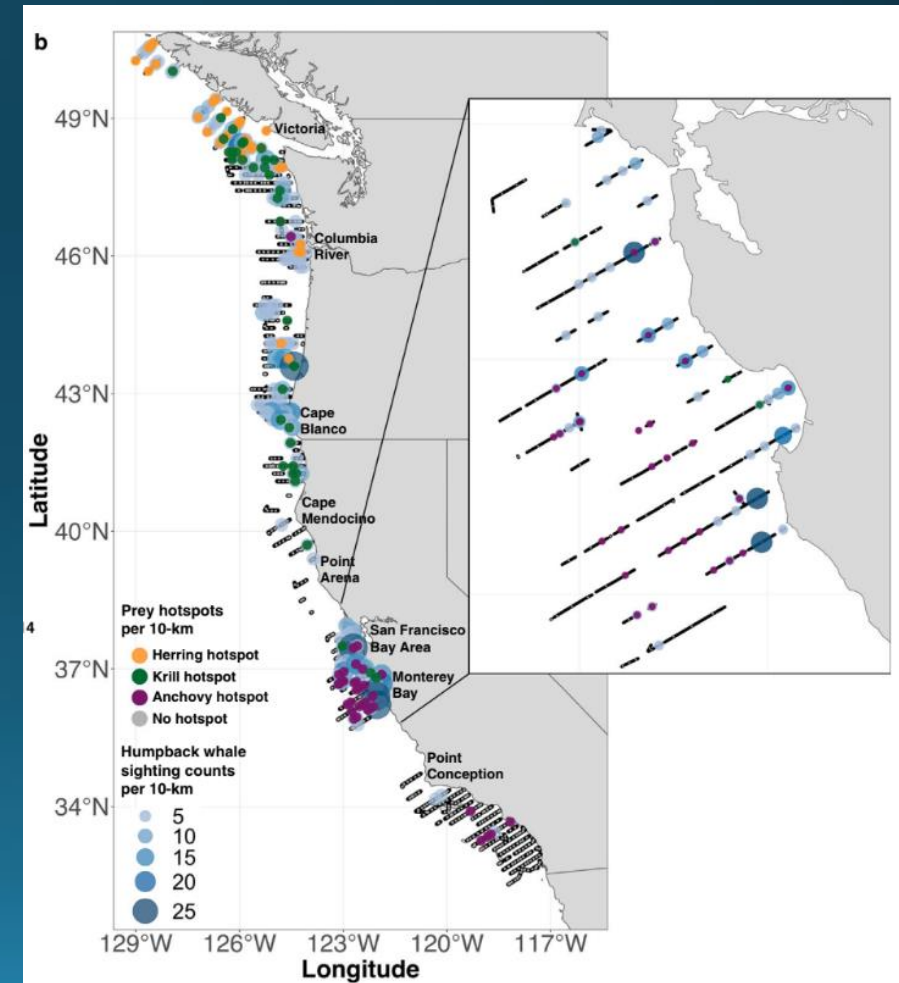
Passive acoustic monitoring can provide the temporal (and maybe even spatial) coverage needed to augment survey efforts

- Make the most of our survey opportunities
  - To include prey and environmental sampling, eDNA surveillance of food webs, etc.

ARTICLE

## Multiscale relationships between humpback whales and forage species hotspots within a large marine ecosystem

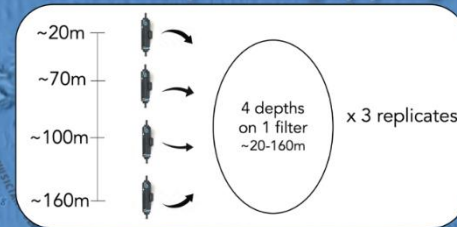
Angela R. Szescioroka<sup>1,2</sup> | David A. Demer<sup>3</sup> | Jarrod A. Santora<sup>4,5</sup> | Karin A. Forney<sup>6,7</sup> | Jeff E. Moore<sup>8</sup>



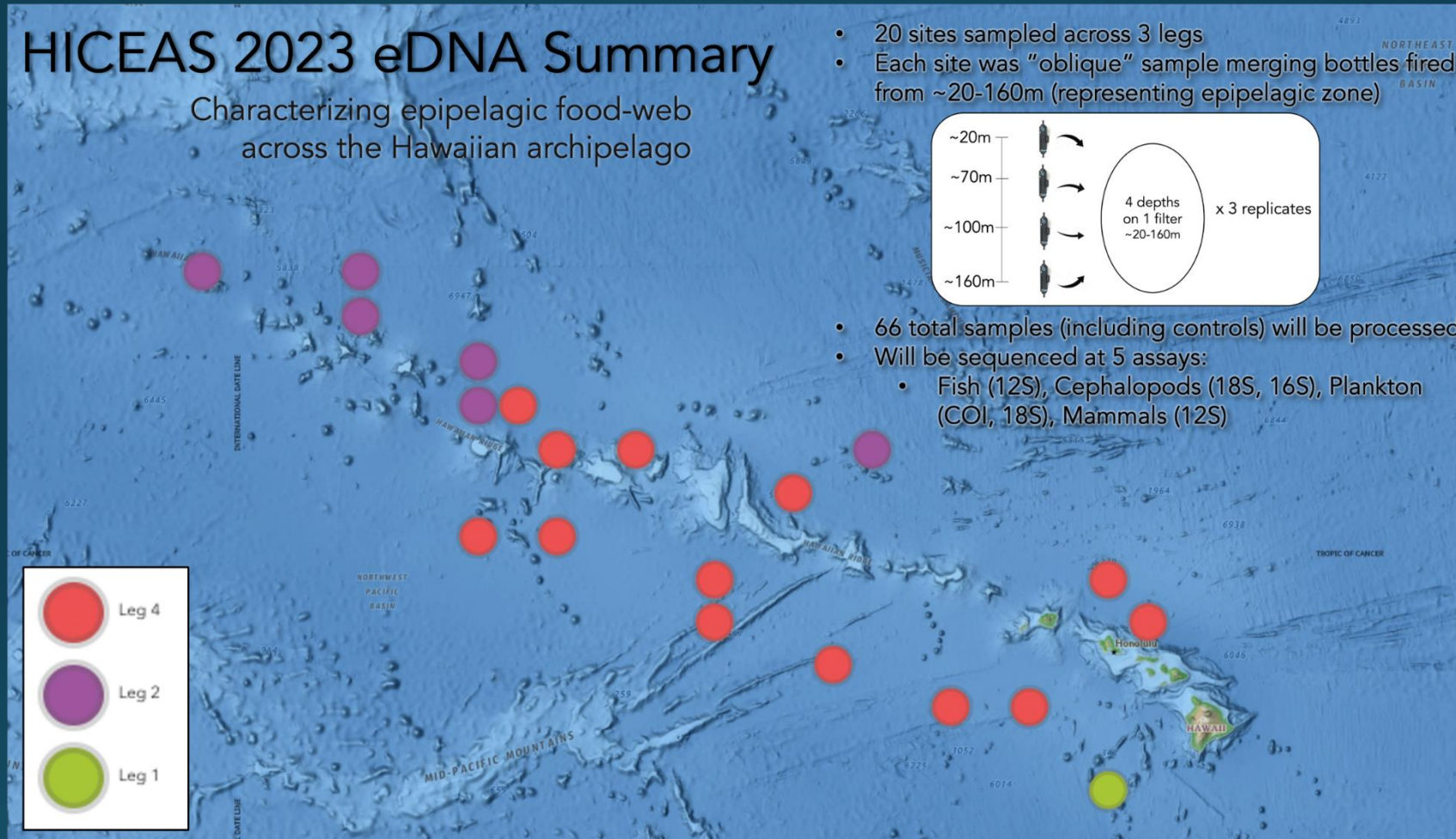
# HICEAS 2023 eDNA Summary

Characterizing epipelagic food-web  
across the Hawaiian archipelago

- 20 sites sampled across 3 legs
- Each site was "oblique" sample merging bottles fired from ~20-160m (representing epipelagic zone)



- 66 total samples (including controls) will be processed
- Will be sequenced at 5 assays:
  - Fish (12S), Cephalopods (18S, 16S), Plankton (COI, 18S), Mammals (12S)



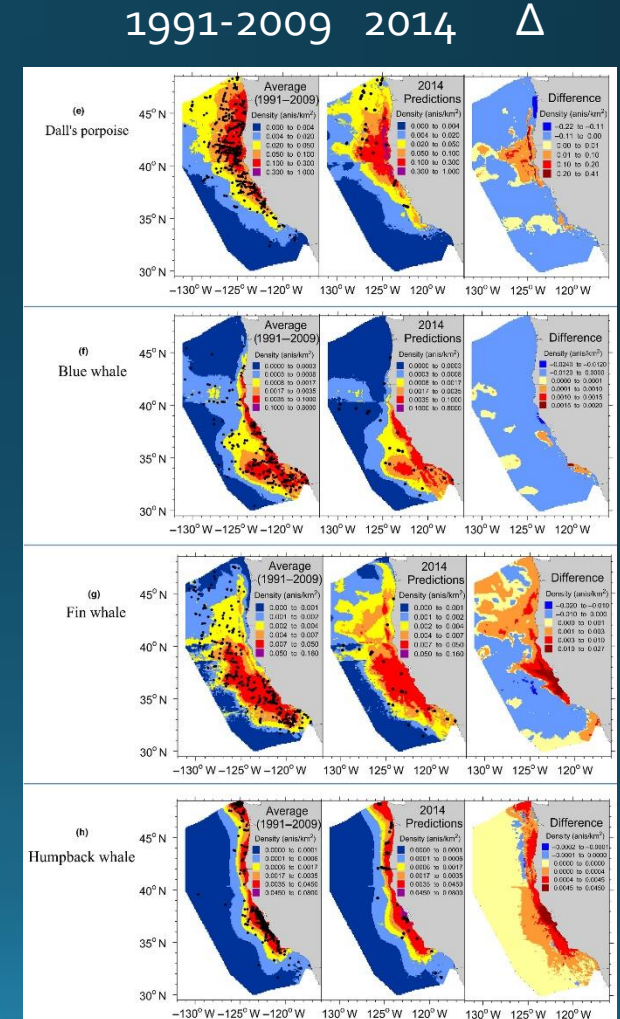
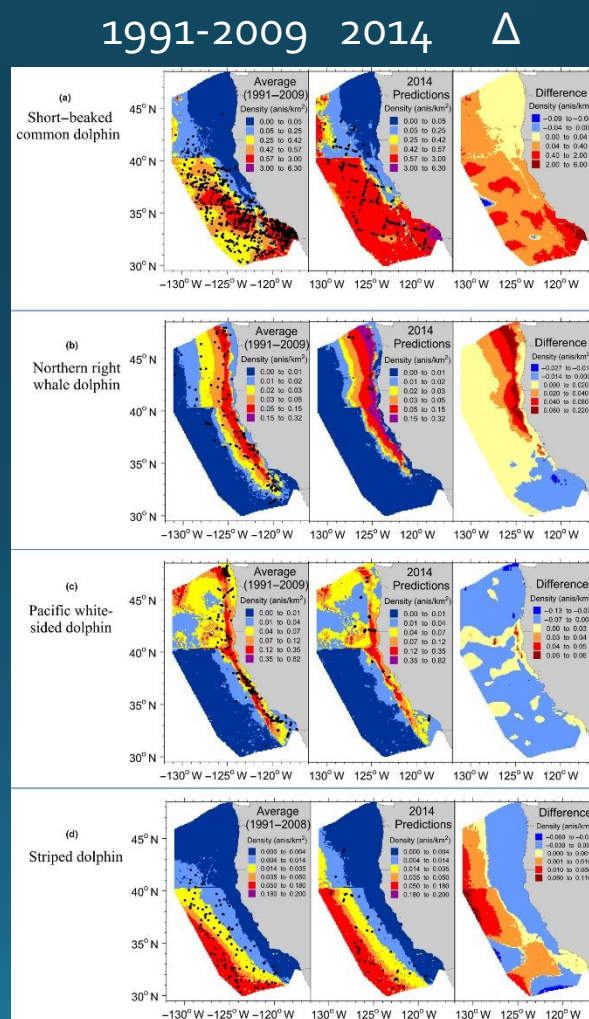


# How can we adjust our assessment analyses to detect and incorporate climate impacts?

- Density surface models have been developed for many Pacific and Atlantic stocks, but aren't universally used to inform stock assessments
- Additional marine mammal detection data could improve model precision and enable development of density models for data poor stocks

# Density surface models predict distribution changes under anomalous conditions

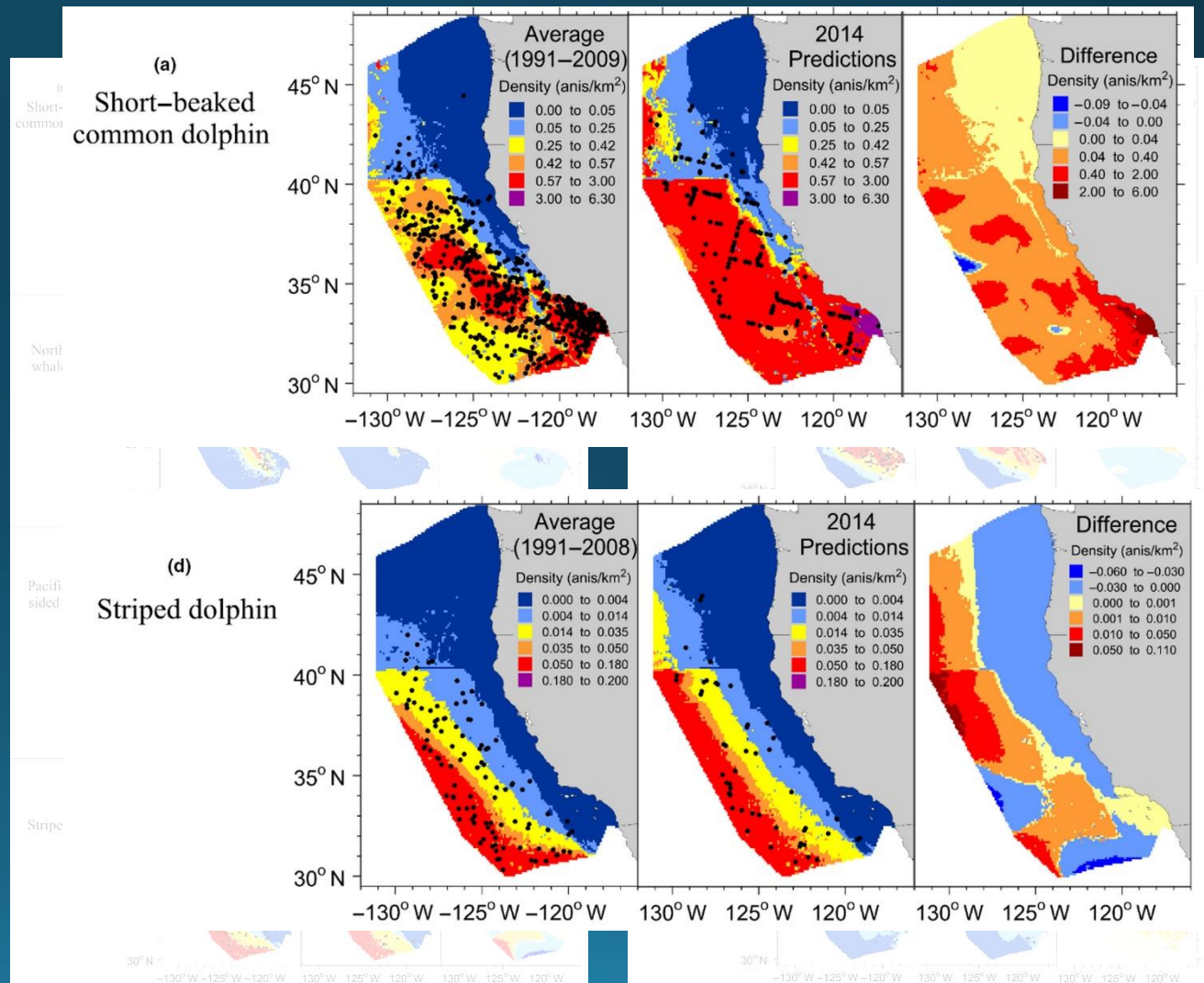
Becker et al. 2019. Predicting cetacean abundance and distribution in a changing climate. Diversity & Distributions.



# Density surface models predict distribution changes under anomalous conditions

A well-parameterized model captured 3-fold increase in density for common dolphins in 2014.

When species-habitat relationships are not well understood (or are dynamic), the model does poorly.



# Integration of passive acoustic data into distribution models can reveal important demographic and behavior differences



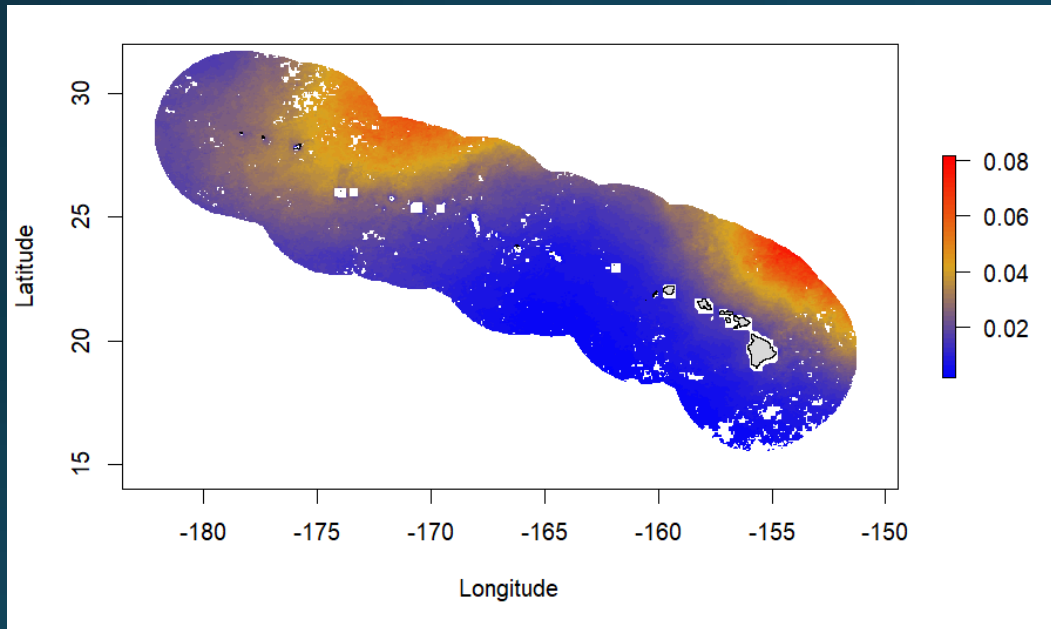
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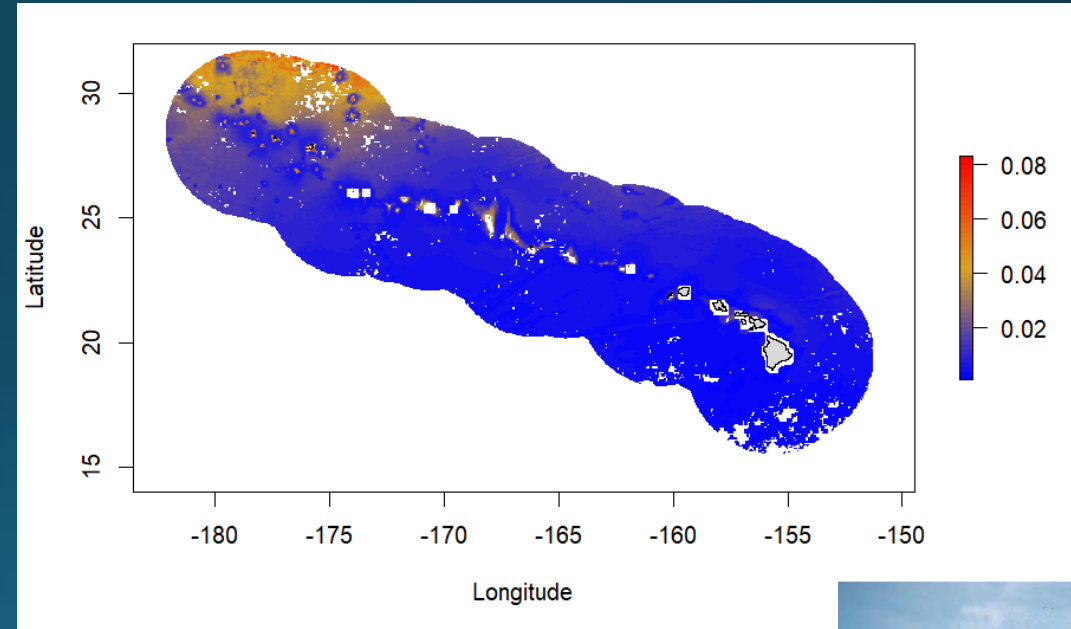
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## Examining distribution patterns of foraging and non-foraging sperm whales in Hawaiian waters using visual and passive acoustic data

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Foraging Whale Groups



Non-Foraging Whale Groups

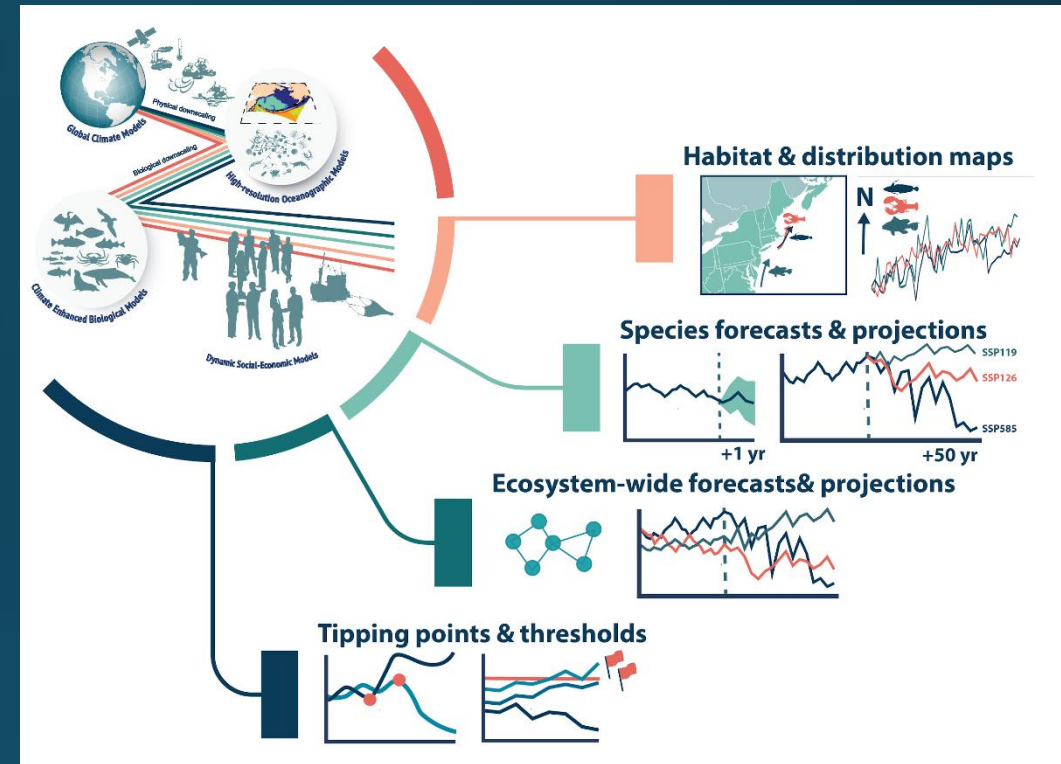


# New opportunities to detect and integrate climate-induced changes in stock assessments

- Leveraging NOAA's Climate, Ecosystems, and Fisheries Initiative (CEFI)
- Developing survey designs that employ UMS
- Advancing analysis approaches to incorporate diverse datasets

# Leveraging CEFI

Goal- operationalize regional ocean models with corresponding “decision support teams” of physical oceanographer, ecosystem experts, economists, and social scientists.



- Regional ocean models at 4-8km resolution including ocean physical parameters and lower-trophic-level ecosystem parameters (biogeochemistry, phytoplankton, and zooplankton).
- Species distribution maps and foodweb forecasts can be incorporated into modeled density and distribution and can drive survey location and focus

# Integration of uncrewed marine systems into assessment surveys



1. Multiple platform testing to inform hardware selection for future surveys
2. Validation during 2 upcoming large-scale multi-species surveys off the US west coast and Hawaii

# Data Integration to Improve Assessments





