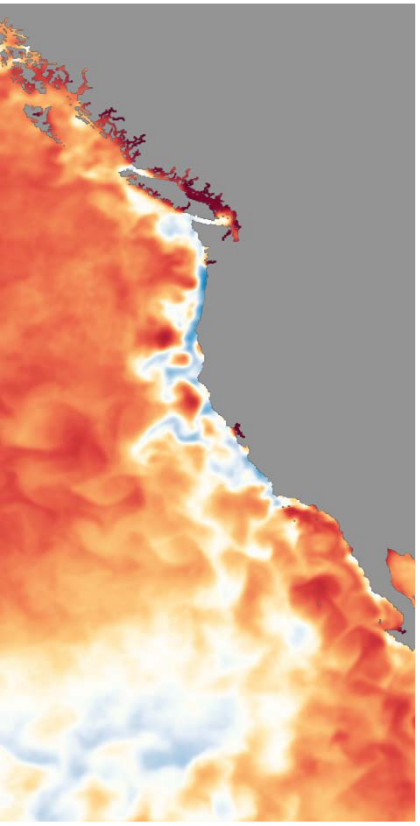
Using climate-ready information in decision making for multiple stakeholders

Elliott Hazen, PhD – Research Ecologist at the SWFSC's Environmental Research Division

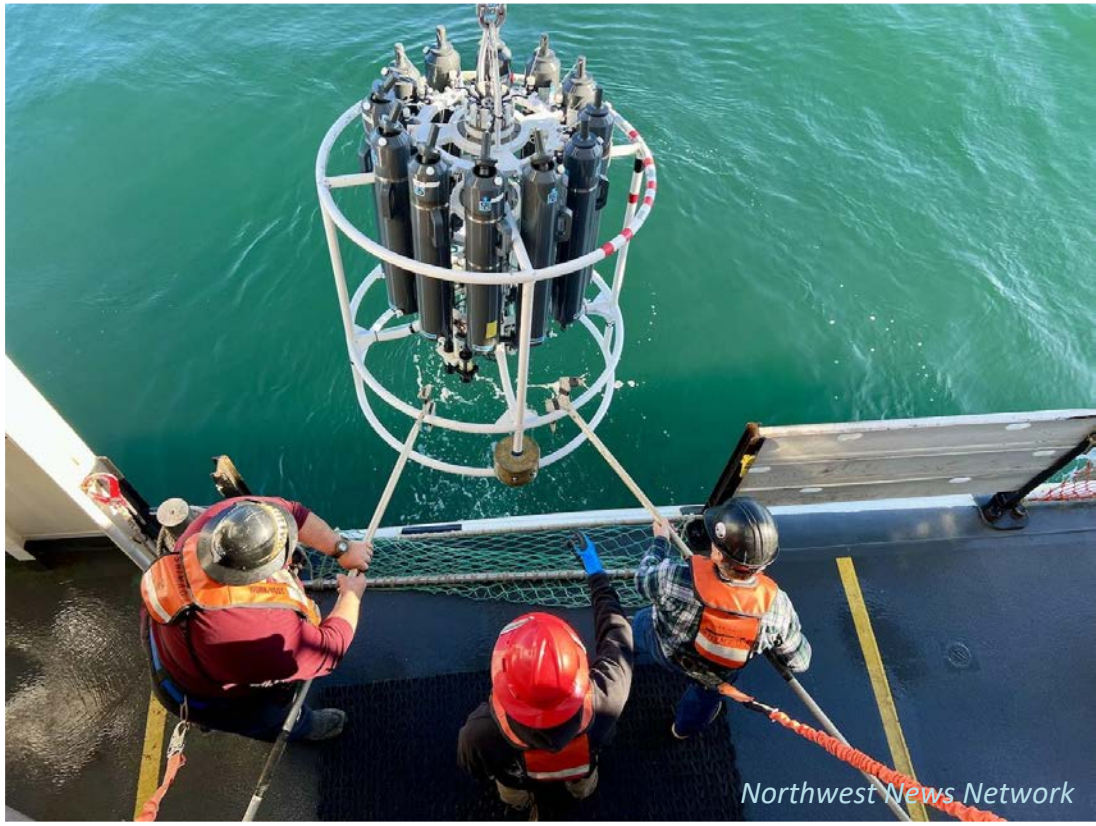
Slides from: Chris Harvey, Andrew Leising, Yvonne DeReynier, and Barb Muhling



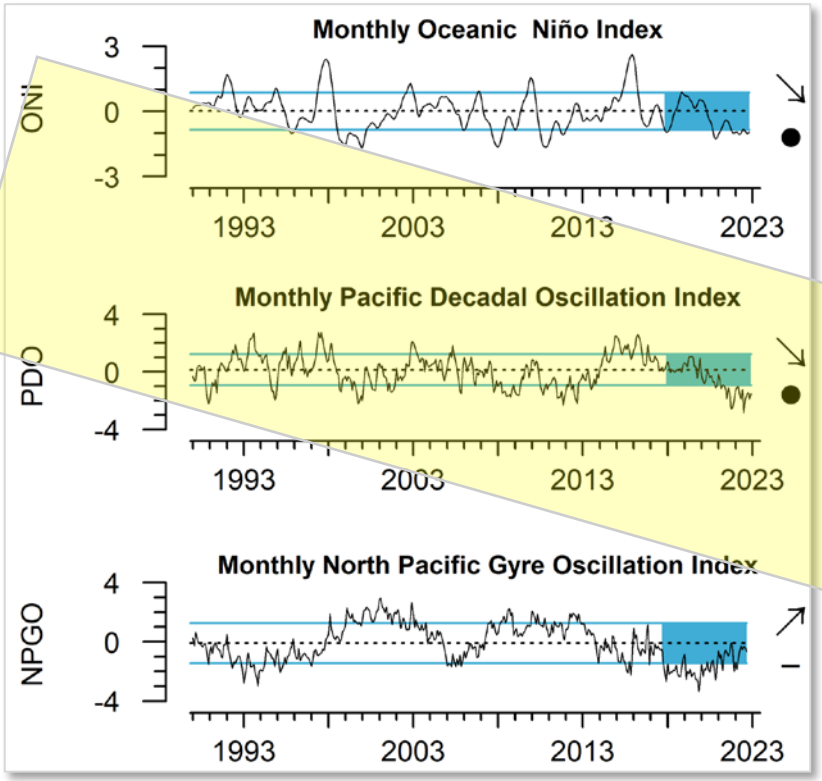
The IEA Ecosystem Status Report

Delivered annually at the March council meeting.

Now incorporating monthly status and a climate-change appendix.

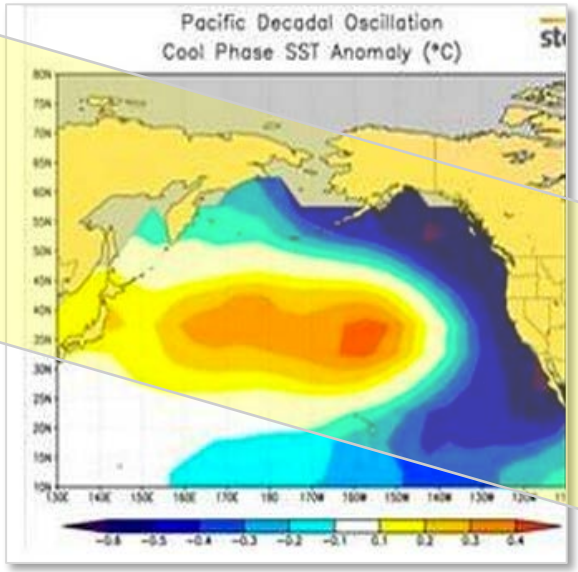


2022, Physical Summary: what we expected…

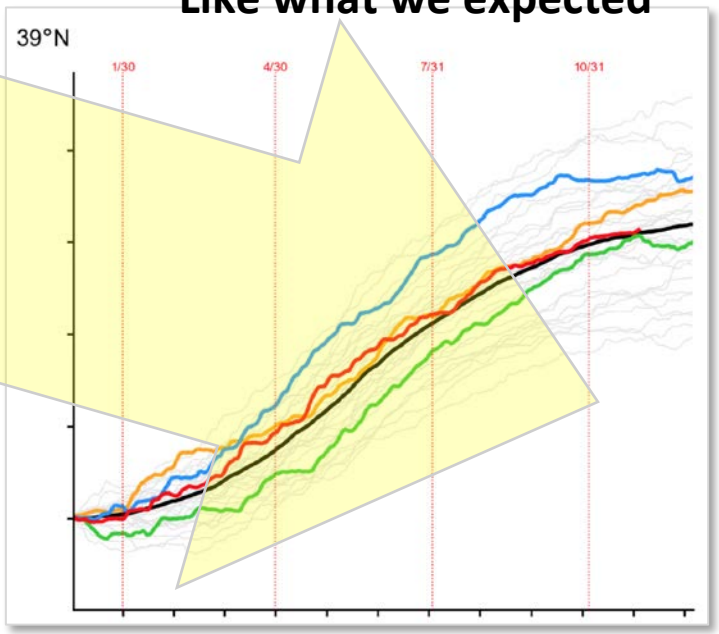


Broad-scale indices were encouraging

Generally Favorable Cool Coastal Conditions



Cumulative Upwelling Like what we expected

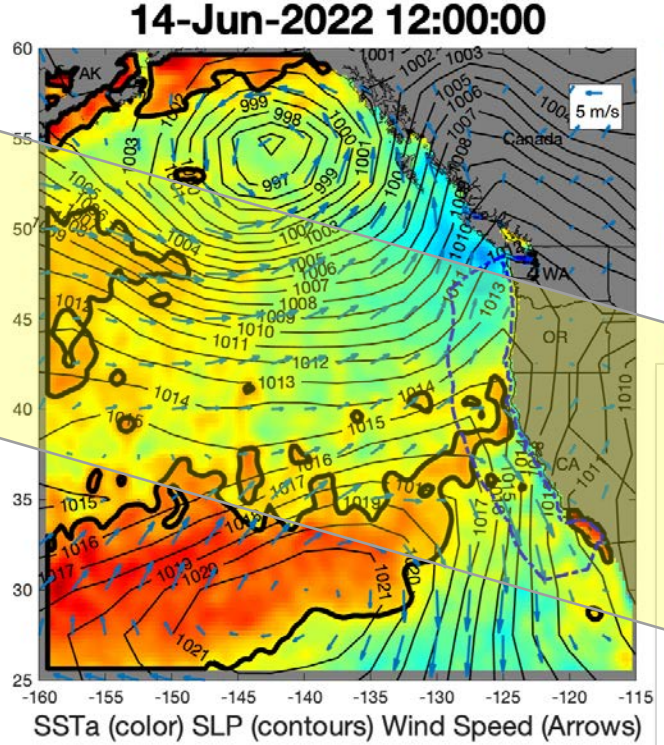


Total looks "average" for 2022

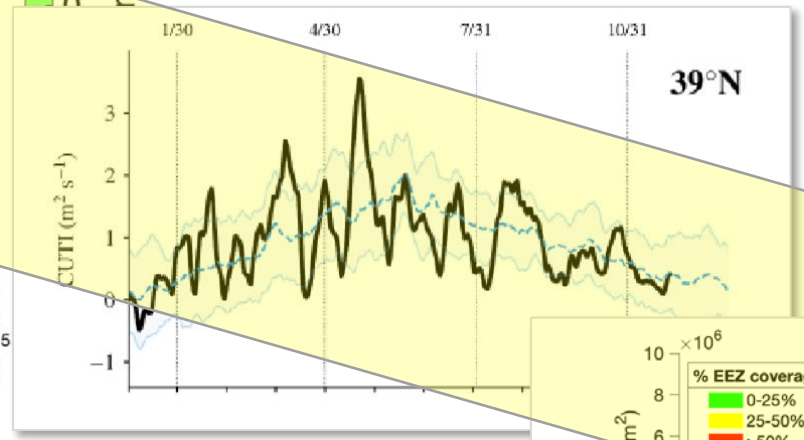
2019 2020 2021 2022

2022, Physical Summary: What we got…

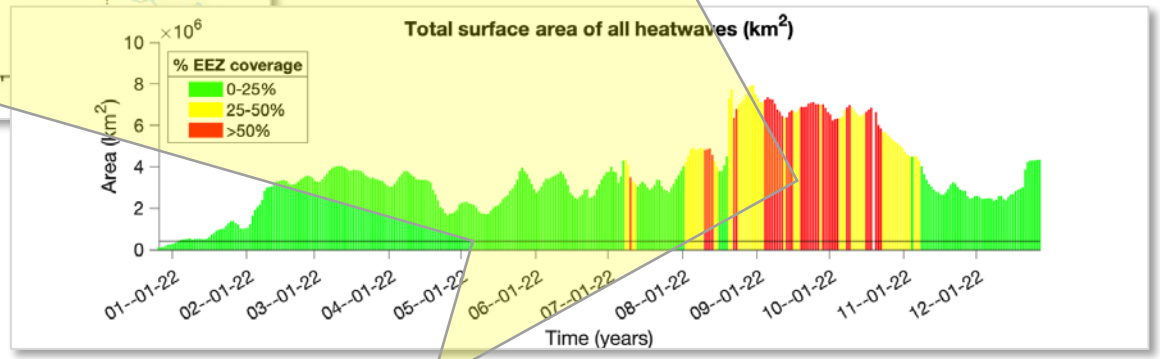
Atmospheric Anomalies
(Strong summer Aleutian Low)



Extremely Variable
upwelling/downwelling



Disruptions to system (heatwaves, etc.),
mostly to the North



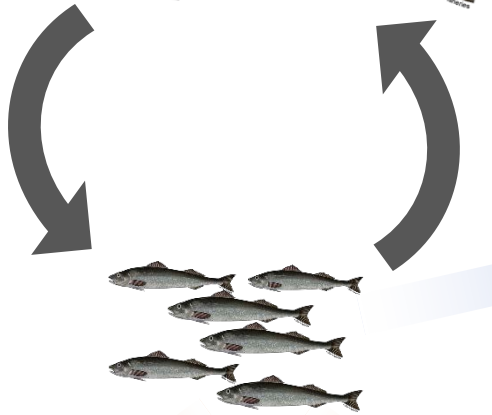
Case study: climate-driven impacts on bycatch

Sablefish (*Anoplopoma fimbria*)

Shelf and upper slope groundfish

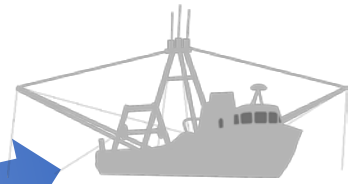
Valuable fixed gear and trawl fisheries

Episodic strong year classes, linked to climate variability



Bottom trawl and fixed gear fisheries

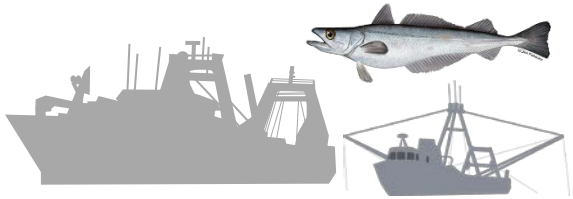
Leading indicator of sablefish harvest conditions in 3-4 yr



Incidental catch of juvenile sablefish

Unexpectedly high juvenile sablefish bycatch in 2022

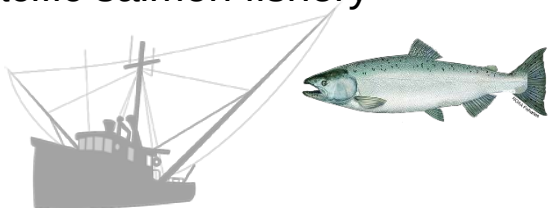
Pacific whiting fishery



“Large concentrations of small sablefish were reported by all sectors...There were many reports of vessels moving from productive fishing grounds in order to avoid sablefish.”

—US/Canada Joint Technical Committee, 2023

Pacific salmon fishery



Accounts from salmon fishermen of high catch rates of juvenile sablefish near thermocline in 2022

“We’ve never seen them there before.”

—Commercial fisherman, March 2023

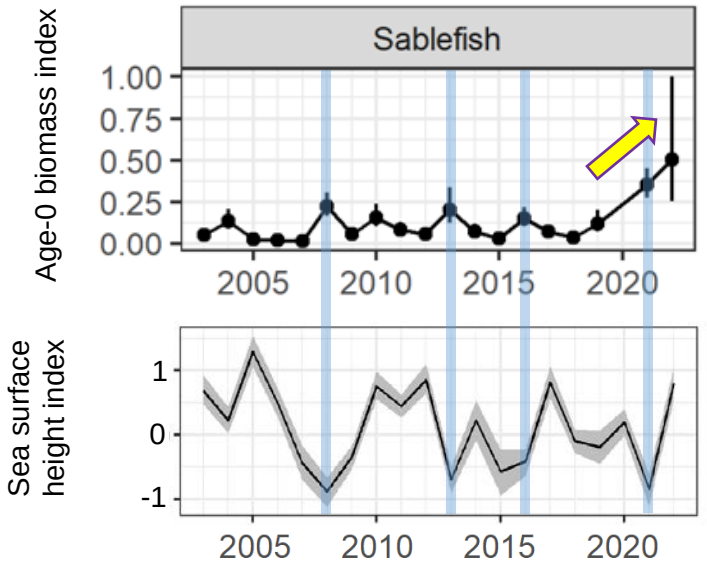
Case study: climate-driven impacts on bycatch

Ecological indicators were consistent with qualitative accounts of juvenile sablefish encounters

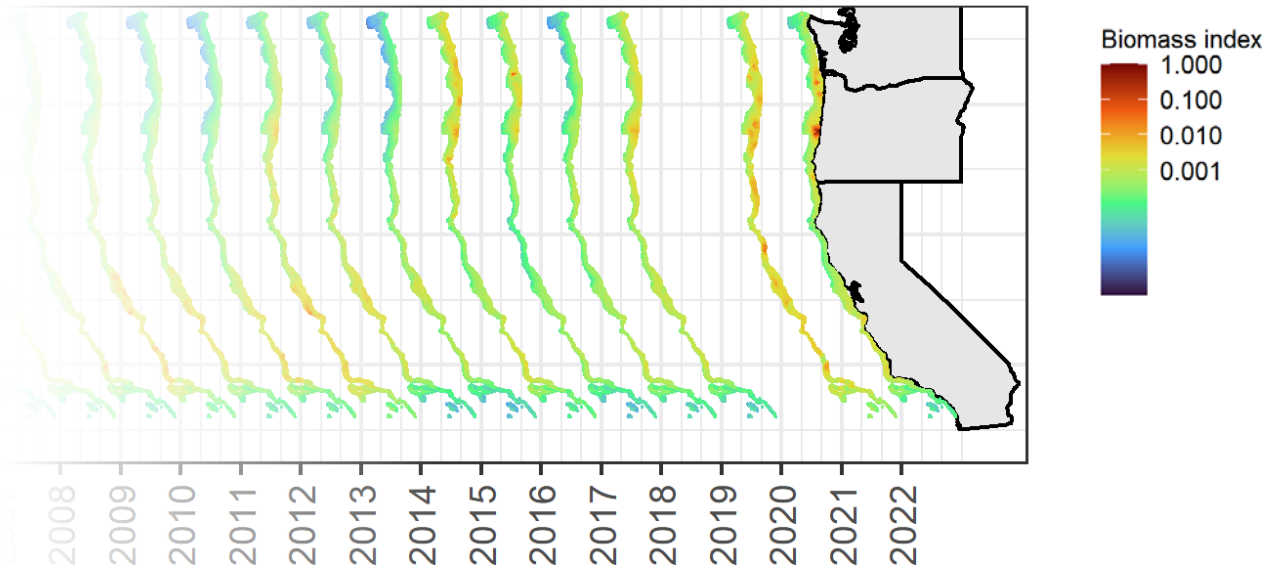
Large, spatially patchy sablefish recruitment events in 2021 and 2022:

Very strong sablefish year classes in 2021 and 2022 based on survey data:

Partly consistent with physical indicator of sablefish recruitment variability:

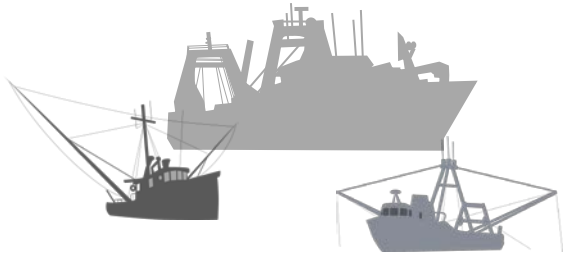


Species distribution model: age-0 sablefish hotspots in 2021 & 2022

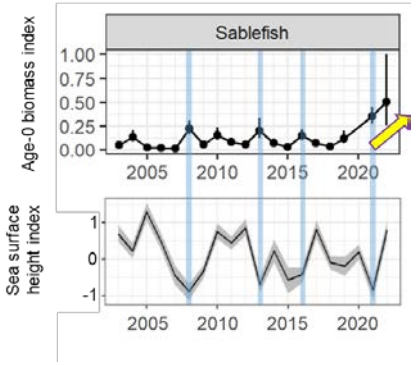


Case study: climate-driven impacts on bycatch

Information flow, management responses, and National Standard 8



Quantitative indicator collection and analysis



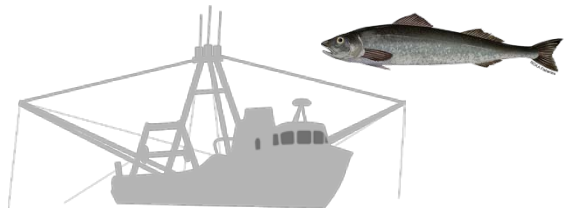
Annual ecosystem status report

Pacific Fishery Management Council

Potential NS-8 outcomes

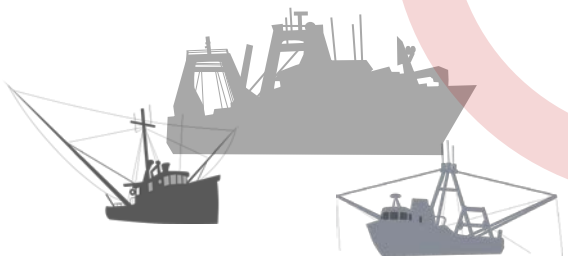
Sablefish quota adjustments help keep bycatch fisheries open, reduce costs, etc.

Hopefully, balanced with conserving the new year class for future sablefish catch



Request for rapid update sablefish assessment

Qualitative validation and additional information



Ecosystem Initiative 4: Ecosystem and Climate Information for Species, Fisheries, and FMPs

www.pcouncil.org/briefing-book/march-2023-briefing-book/

Slides from Yvonne deReynier

Received: 7 March 2019 | Revised: 6 September 2019 | Accepted: 19 October 2019
DOI: 10.1111/fog.12459

ORIGINAL ARTICLE

FISHERIES OCEANOGRAPHY WILEY

Oceanographic drivers of petrale sole recruitment in the California Current Ecosystem

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Abstract

This paper investigates environmental drivers of U.S. West Coast petrale sole (*Eopsetta jordani*) recruitment as an initial step toward developing an environmental recruitment index that can inform the stock assessment in the absence of survey observations of age-0 and age-1 fish. First, a conceptual life history approach is used to generate life-stage-specific and spatio-temporally specific mechanistic hypotheses regarding oceanographic variables that likely influence survival at each life stage. Seven life history stages are considered, from female spawner condition through benthic recruitment as observed in the Northwest Fisheries Science Center West Coast Groundfish Bottom Trawl Survey (age-2 fish). The study area encompasses the region from 40 to 48°N in the California Current Ecosystem. Hypotheses are tested using output from a regional ocean reanalysis model outputs and model selection techniques. Four oceanographic variables explained 73% of the variation in recruitment not accounted for by estimates based exclusively on the spawning stock size. Recruitment deviations were (a) positively correlated with degree days during the female precondition period, (b) positively correlated with mixed-layer depth during the egg stage, (c) negatively correlated with cross-shelf transport during the larval stage, and (d) negatively correlated with cross-shelf transport during the benthic juvenile stage. While multiple mechanisms likely affect petrale sole recruitment at different points during their life history, the strength of the relationship is promising for stock assessment and integrated ecosystem assessment applications.

KEYWORDS
California Current, *Eopsetta jordani*, oceanic drivers, petrale sole, recruitment

1 | INTRODUCTION

Petrale sole (Family: *Pleuronectidae*, *Eopsetta jordani*) has consistently been the most commercially valuable flatfish targeted in the California Current Ecosystem. During the 1980s through the 2000s, the petrale sole spawning biomass was around or below 10% of the unexploited stock size (Haltuch, Ono, & Valero, 2013). More recently, the fishery has depended on infrequent above average recruitments, generally followed by several years of low recruitments, that drive fluctuations in the spawning biomass (Figure 1; Haltuch et al., 2013). This dependence of the fishery on relatively few strong recruitment events makes understanding the drivers of petrale sole recruitment a priority.

The horizontal-advection bottom-up forcing paradigm provided a mechanistic framework for testing the hypothesis that climate-driven changes in cross-shelf and alongshore advection drive petrale sole recruitment strength (Di Lorenzo, Mountain, Batchelder, Bond, & Hofmann, 2013; Parrish, Nelson, & Bakun, 1981). This paradigm suggested that large-scale climate forcing drives regional changes in alongshore and cross-shelf ocean transport that directly

This new ecosystem initiative would:

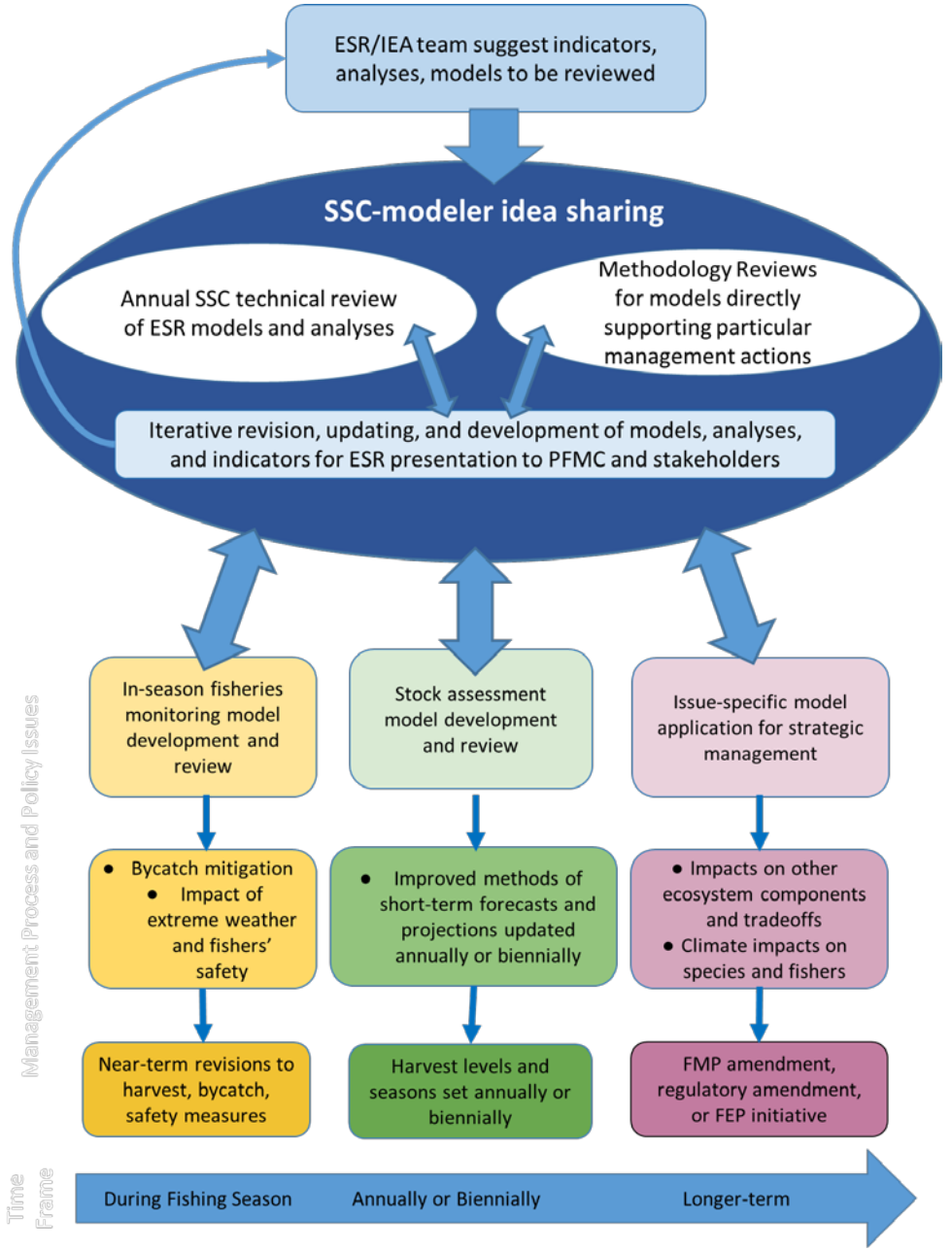
(i) review the incorporation of ecosystem and climate information into the Council's harvest-setting and fisheries management processes,

(ii) determine the need and appropriate timing for additional fisheries management plan (FMP)-specific ecosystem and climate information, and

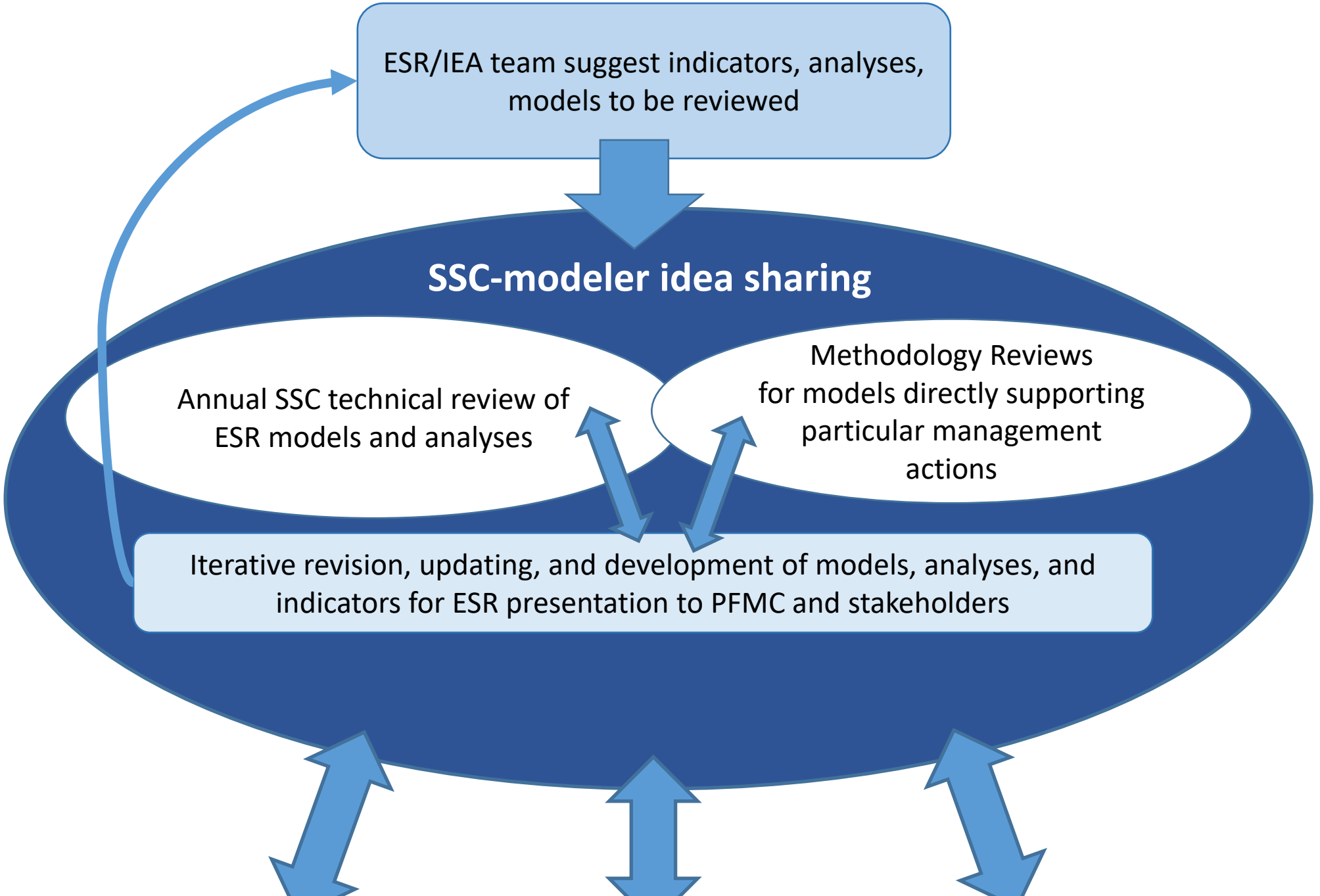
(iii) where there is a need for additional ecosystem and climate information, develop clear pathways for it to be used in the setting of scientific uncertainty and harvest policy.

This new ecosystem initiative would:

(i) review the incorporation of ecosystem and climate information into the Council's harvest-setting and fisheries management processes…



Tommasi et al. 2021, Figure 3


ESR/IEA team suggest indicators, analyses, models to be reviewed
SSC-modeler idea sharing
Annual SSC technical review of ESR models and analyses
Methodology Reviews for models directly supporting particular management actions
Iterative revision, updating, and development of models, analyses, and indicators for ESR presentation to PFMC and stakeholders

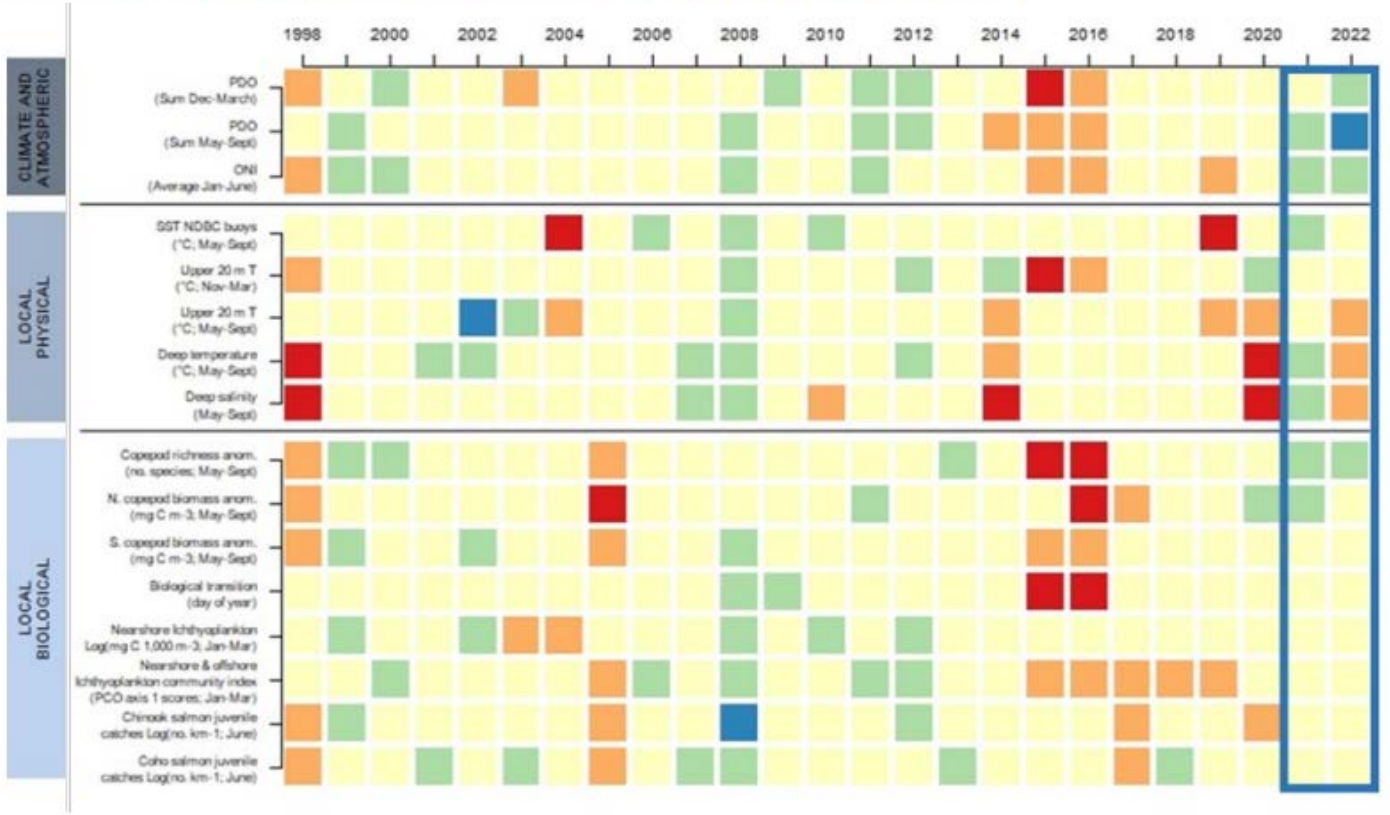
Management Process and Policy Issues

In-season fisheries monitoring model development and review

- Bycatch mitigation
- Impact of extreme weather and fishing safety

Near-term revisions to harvest, bycatch, safety measures

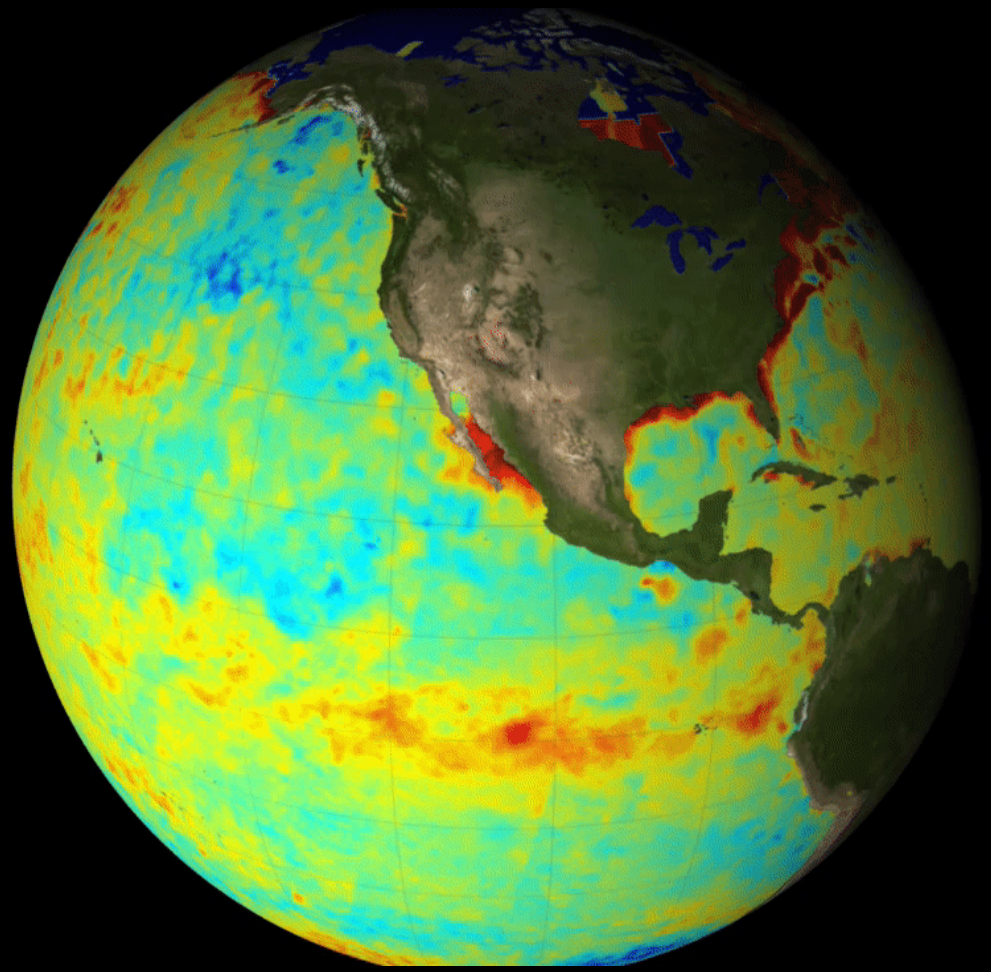
Table 3.1: Stoplight table of conditions for smolt years 1998-2022 for coho salmon originating in coastal Oregon and Chinook salmon from the Columbia Basin. Colors represent a given year's indicator relative to the reference period (1998-2020). Blue: >2 s.d. above the mean; green: >1 s.d. above the mean; yellow: ±1 s.d. of the mean; orange: >1 s.d. below the mean; red: >2 s.d. below the mean. Chinook salmon from smolt year 2021 and coho salmon from smolt year 2022 (outlined in blue) represent the dominant adult age classes in 2023.

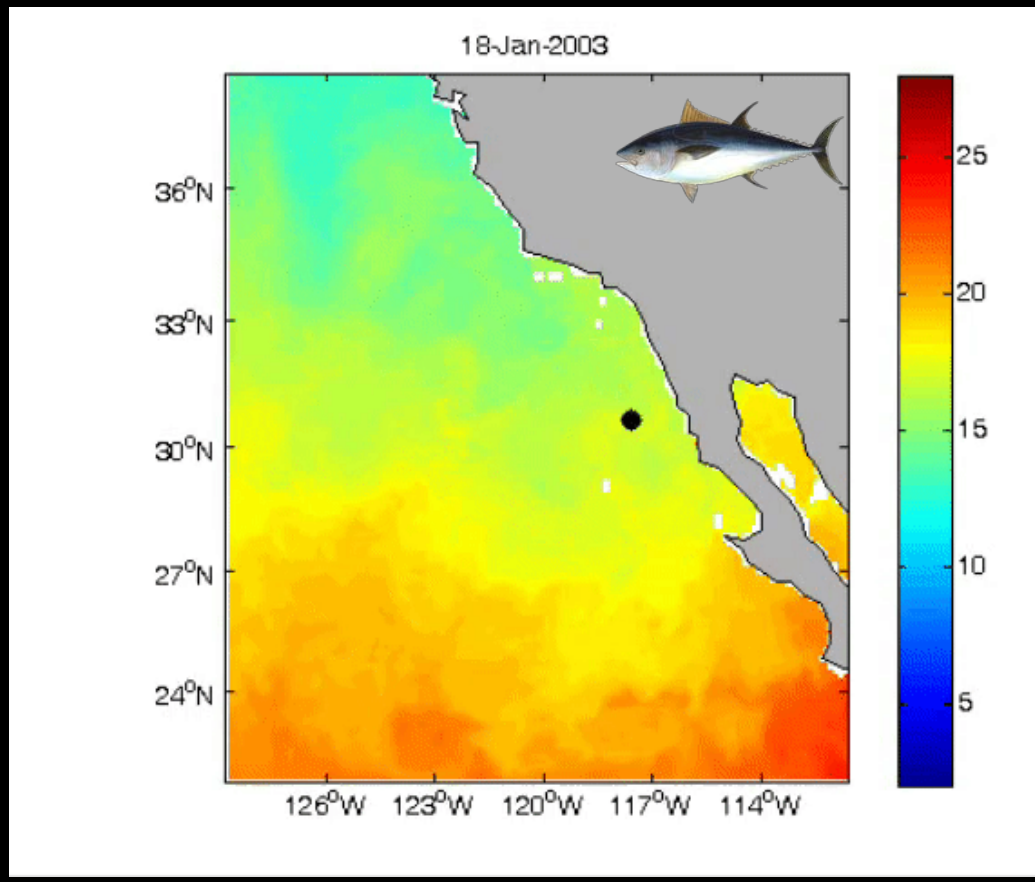


Time Frame

During Fishing Season | Annually or Biennially | Longer-term

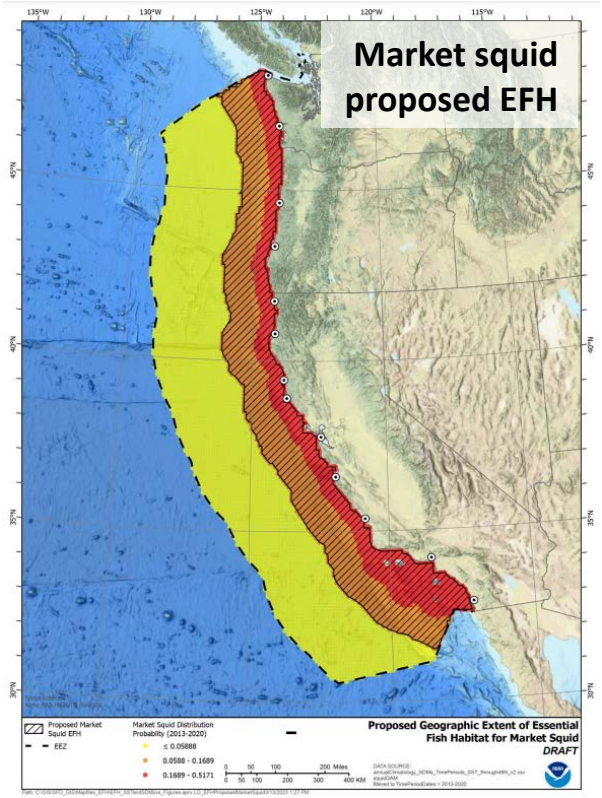
Dynamic oceans and dynamic ecosystems

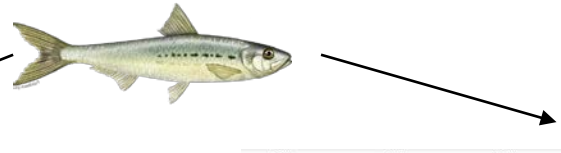


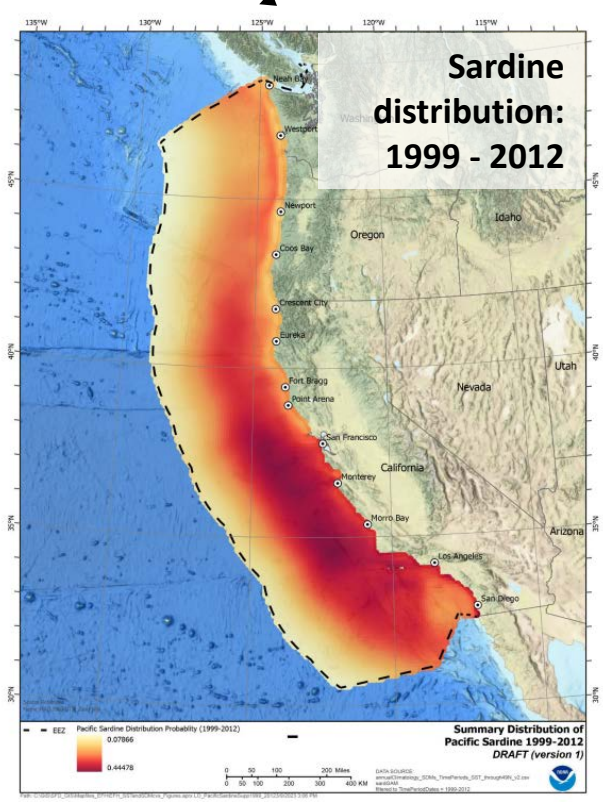


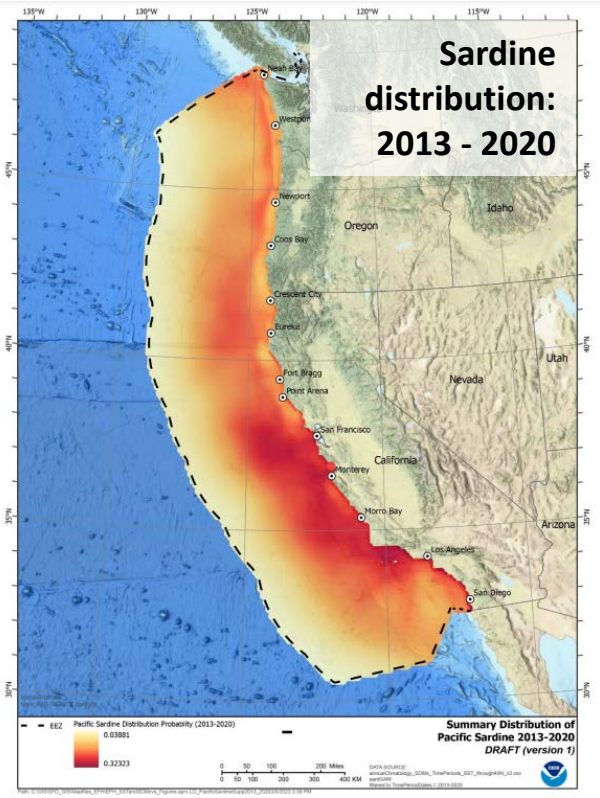
Use of Species Distribution Models to define Essential Fish Habitat (EFH)

- EFH is currently being updated for Coastal Pelagic Species
- Statistical Species Distribution Models proposed for use in a new EFH Appendix to the Fishery Management Plan to:
  - Define EFH (market squid)
  - Define overall distributions (sardine, anchovy, Pacific mackerel, jack mackerel)
    - Results summarized for historical (1999 – 2012) and post marine heatwave (2013 – 2020) time periods







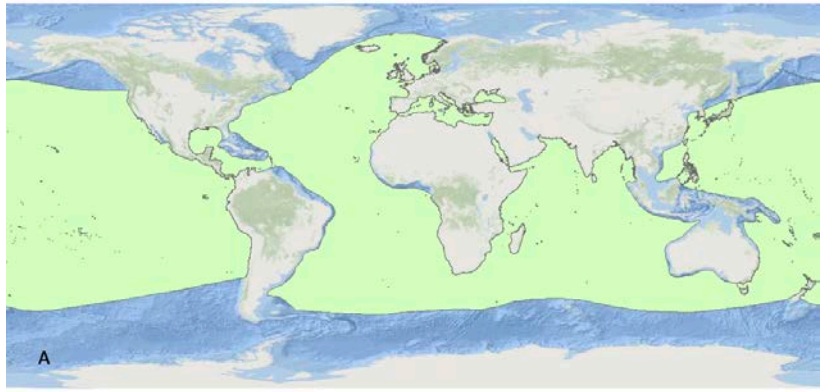


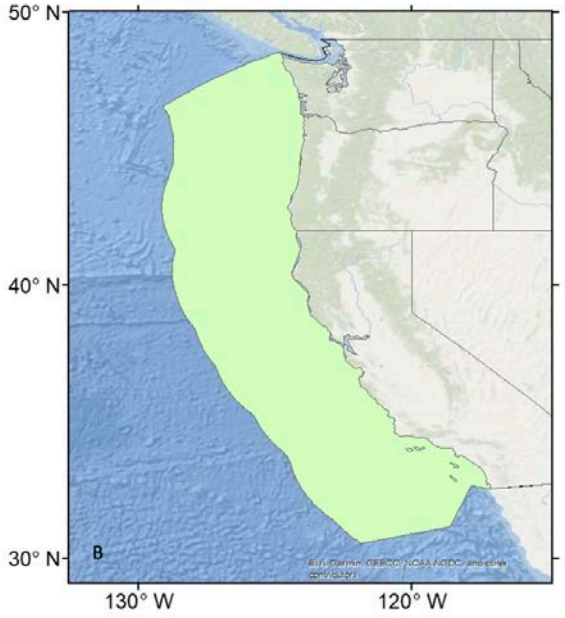
Credit: Emmanis Dorval (SWFSC/Lynker), Kerry Griffin (PFMC), Eric Chavez (NMFS WCRO), Pacific Fishery Management Council CPS Management Team

See https://www.pcouncil.org/documents/2023/03/h-5-supplemental-attachment-2-electronic-only-essential-fish-habitat-appendix-to-the-cps-fishery-management-plan-april-2023-draft.pdf/, final approval pending June 2023 PFMC meeting

Dynamic Swordfish EFH

Figure 18. Broadbill Swordfish (a) Global range and (b) Essential Fish Habitat. Global range source Collette et al. 2022b.





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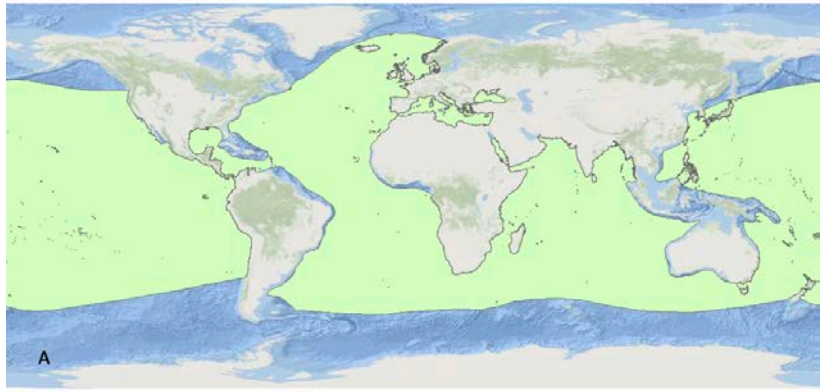

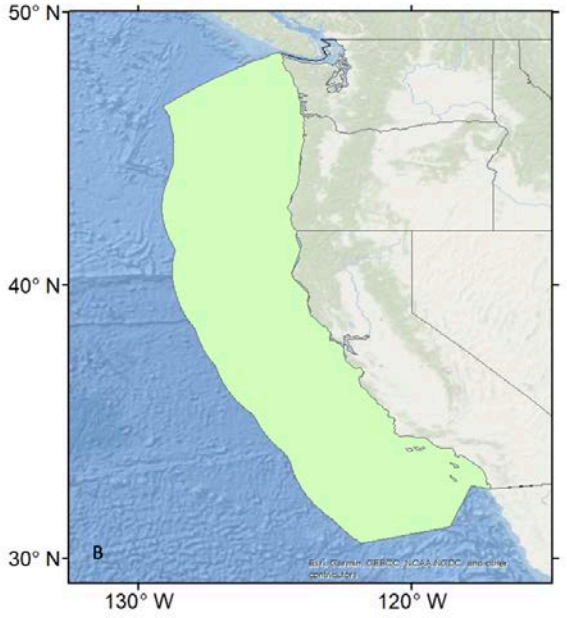

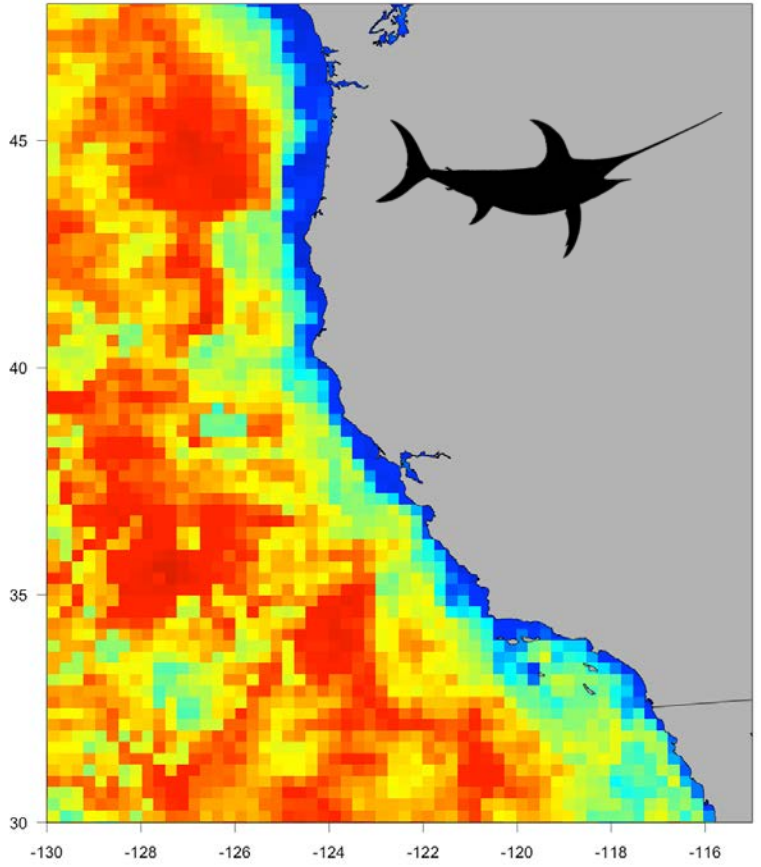

EFH summarized by:

- **Season**
- **Regime-based climatology**
- *Climate projections*
- *Daily*

Hazen et al. 2018 *Science Advances*

https://coastwatch.pfeg.noaa.gov/ecocast/

Dynamic Swordfish EFH

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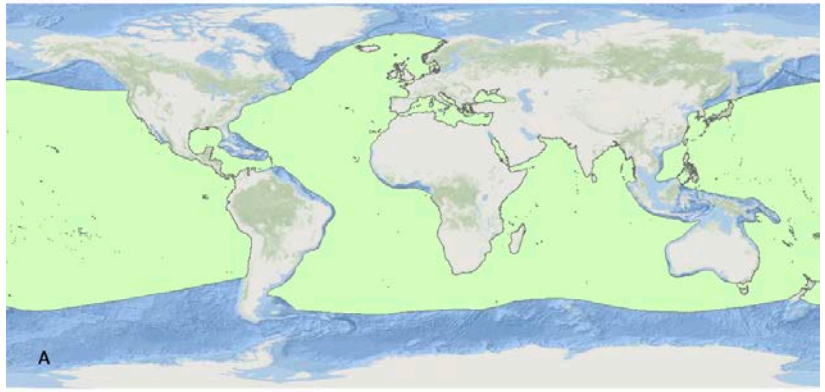

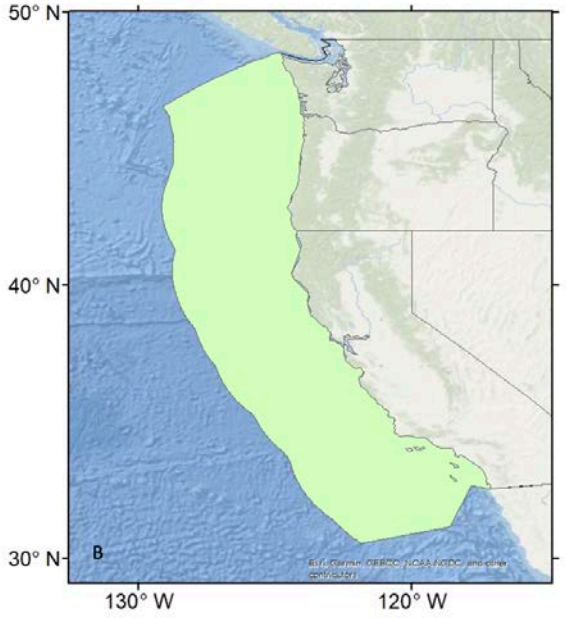

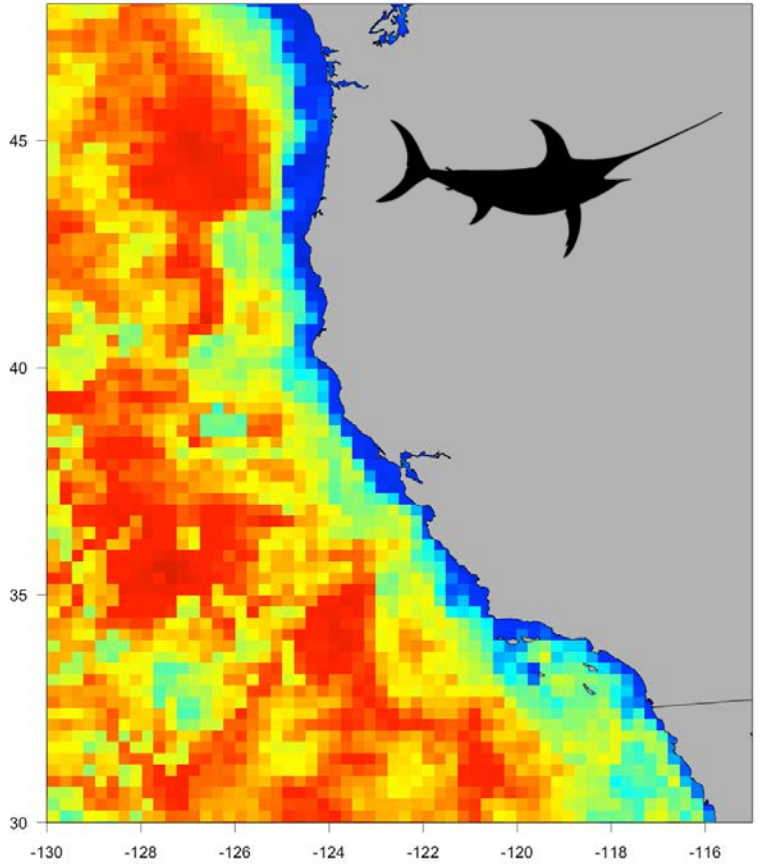

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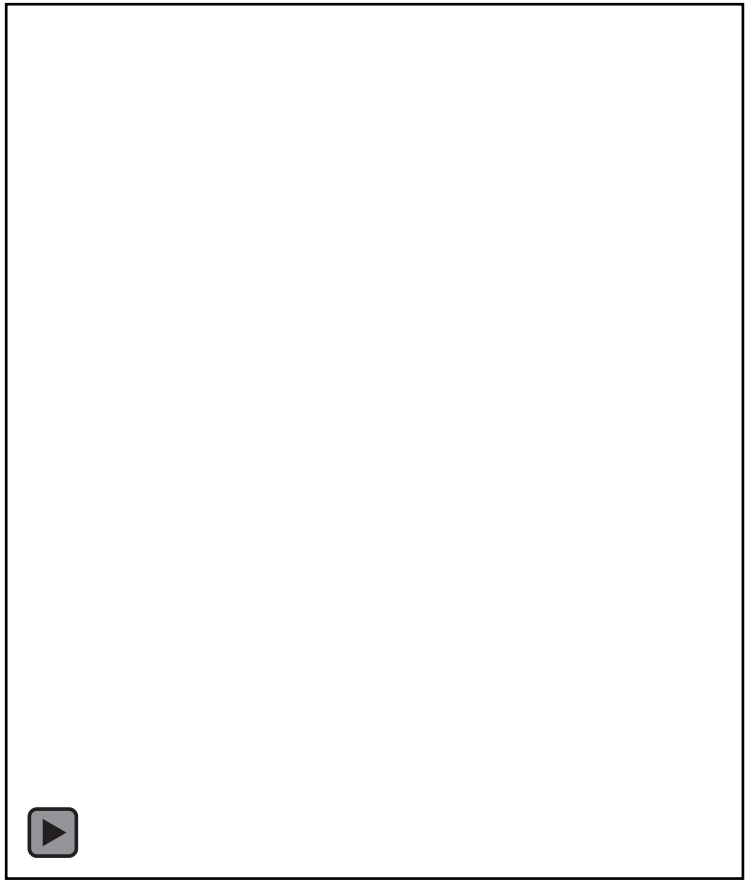
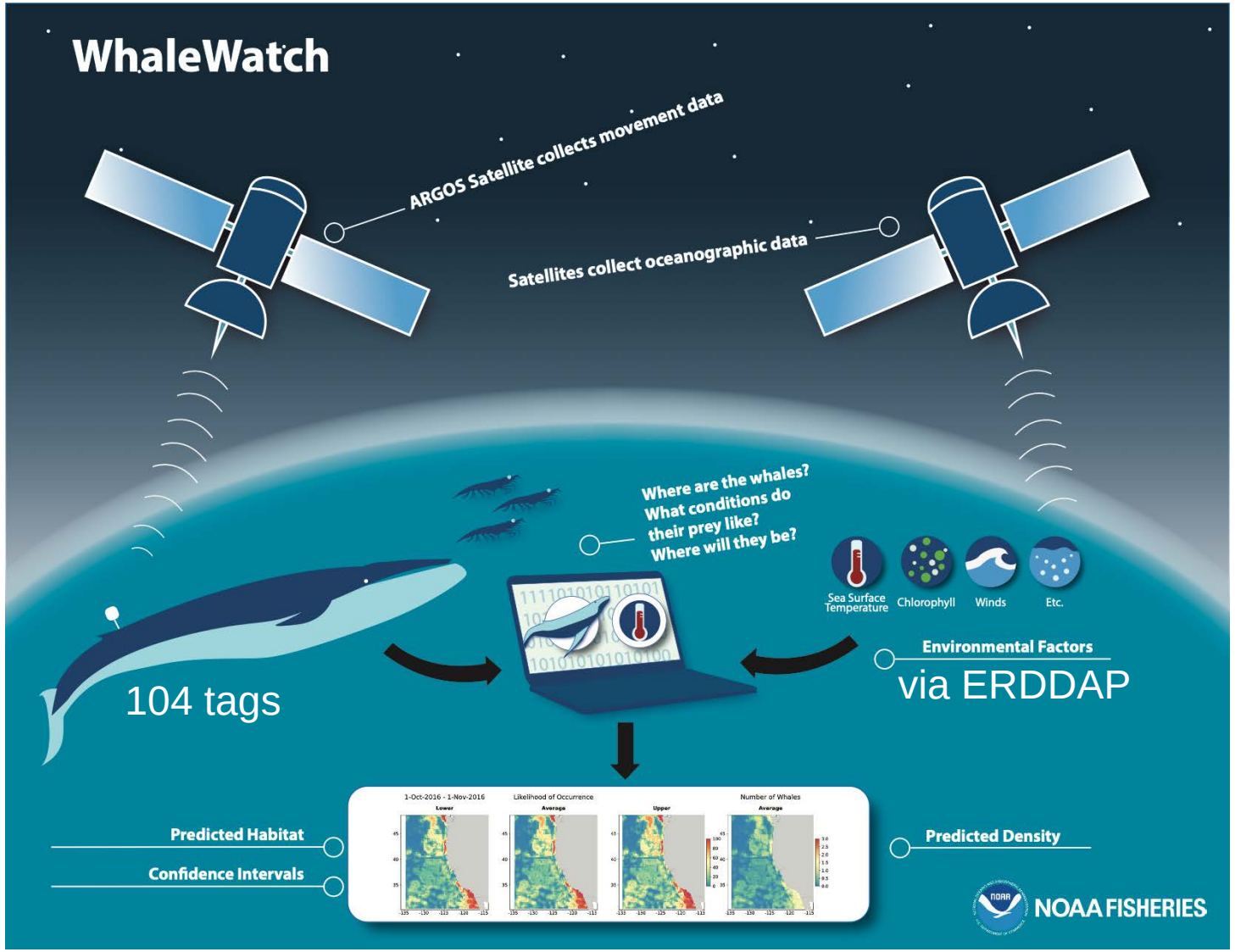


- *Ocean model based*
- *Multi-species EFH*

Hazen et al. 2018 *Science Advances*

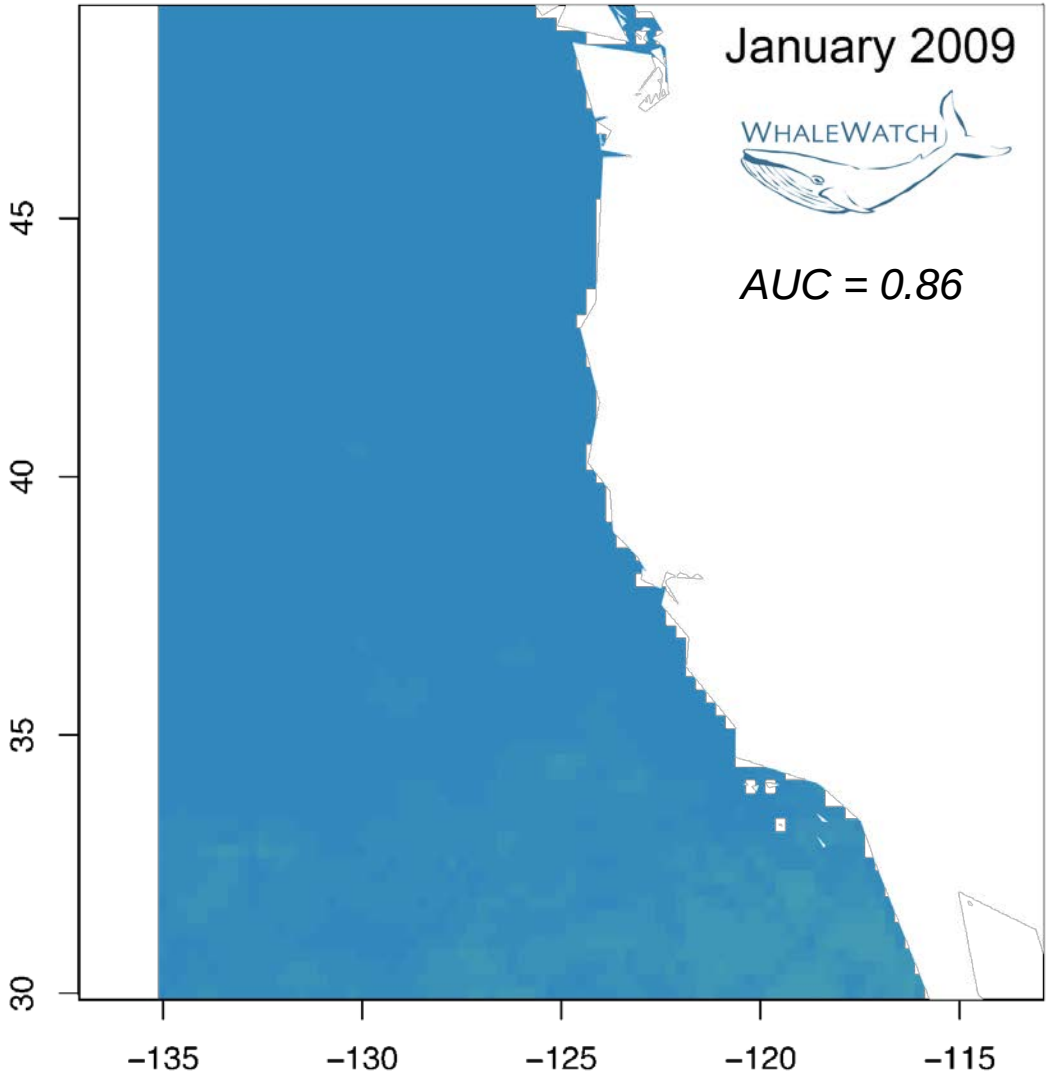
https://coastwatch.pfeg.noaa.gov/ecocast/

WhaleWatch: Near real-time models for dynamic management of blue whales in the North Pacific

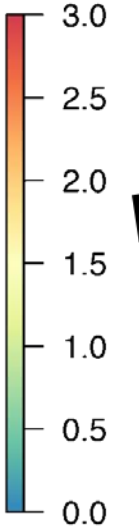


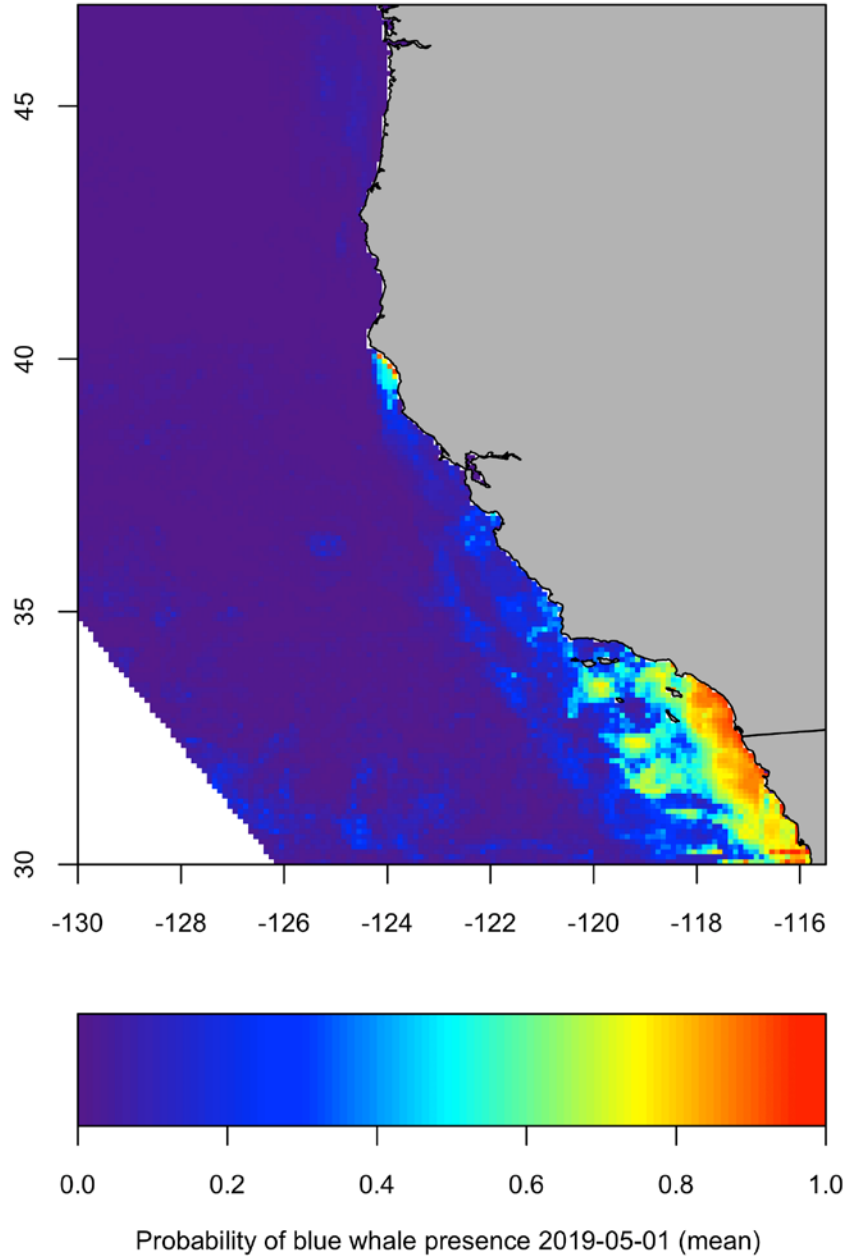
WhaleWatch 1.0 to 2.0

https://coastwatch.pfeg.noaa.gov/projects/whalewatch2/



Hazen et al. 2017 J. Appl. Ecol





WhaleWatch 2.0 to end-users

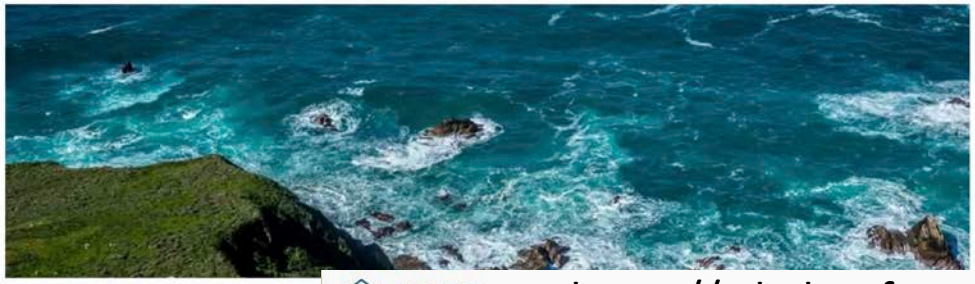
https://coastwatch.pfeg.noaa.gov/projects/whalewatch2/

Risk Assessment and Mitigation Program (RAMP)

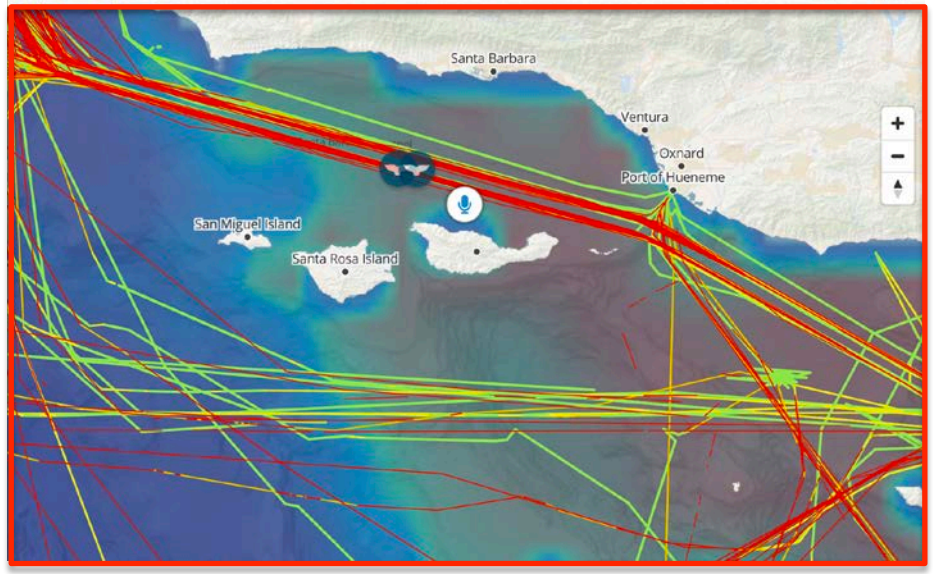
Since September 2015, the California Dungeness Crab Fishing Gear Working Group (Working Group) has been taking steps to actively identify and be responsive to elevated risks of whale entanglements in California Dungeness crab fishing gear. This unique coalition of diverse stakeholders—which includes commercial and recreational fishermen, environmental organization representatives, members of the whale entanglement response network and state and federal agencies—is committed to developing solutions that support thriving whale populations along the West Coast and a thriving and profitable Dungeness crab fishery. For a Fact Sheet about the Working Group and other background information, visit the California Dungeness Crab Fishing Gear Working Group webpage.

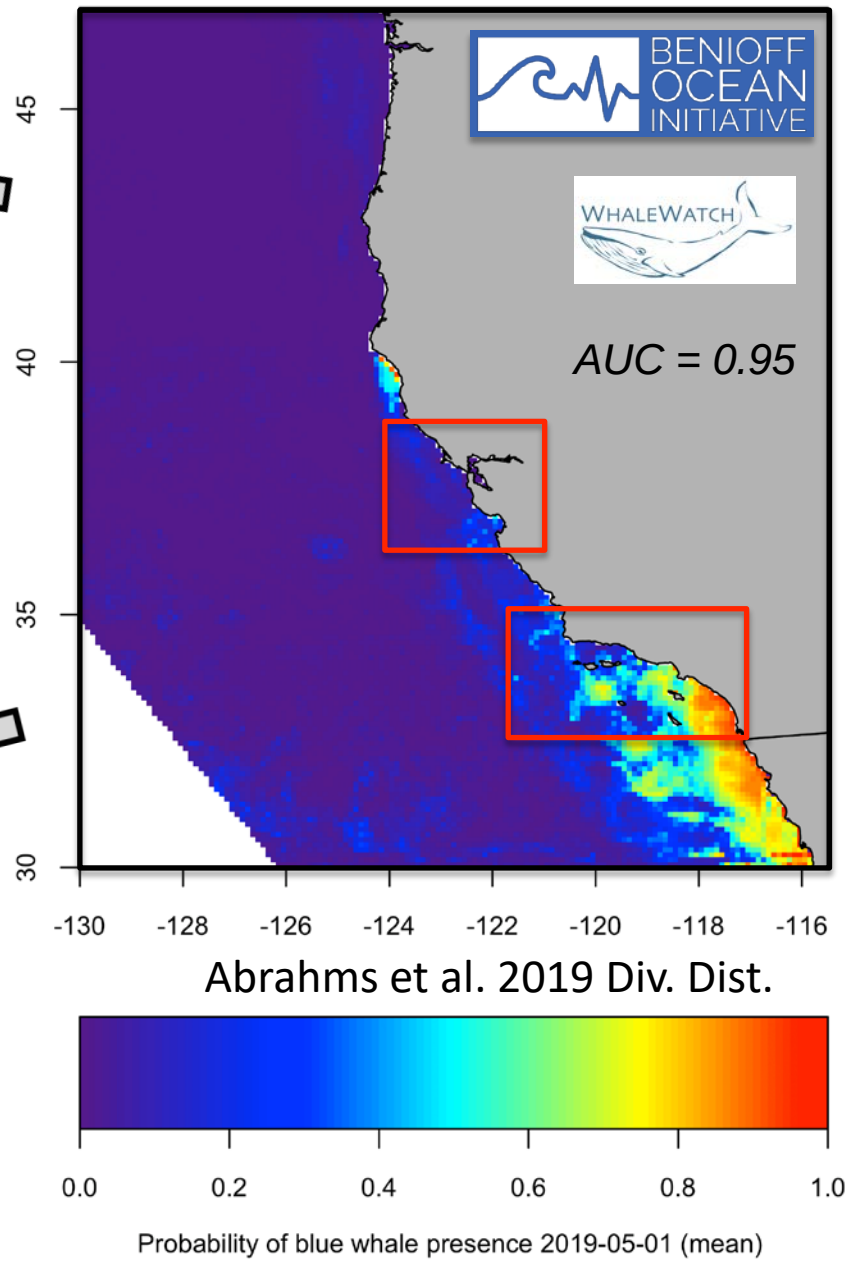
Risk Assessment and Mitigation Program (RAMP)

A Risk Assessment and Mitigation Program (RAMP) has been developed by the Working Group to assess circumstances where entanglement risk may be elevated and, as needed, identify a possible management measures for the CDFW's Director's consideration (see Senate Bill 1309 here.) The program is designed to be flexible and responsive to considering new information, technologies, and approaches to reducing the risk of entanglements.



WHALE SAFE https://whalesafe.com/ MAP MENU





Summary and synthesis

Climate variability and change are increasing the need for climate-ready tools and management approaches

- Reporting ecosystem status at finer temporal scales can help the council make more targeted and responsive decisions.
- Ecosystem initiative 4 is targeting ways to get ecosystem and climate information, such as Future Seas, into the council process.
- Dynamic tools can inform multiple management decision targets **and** can serve as climate-ready species and the humans that depend on them shift