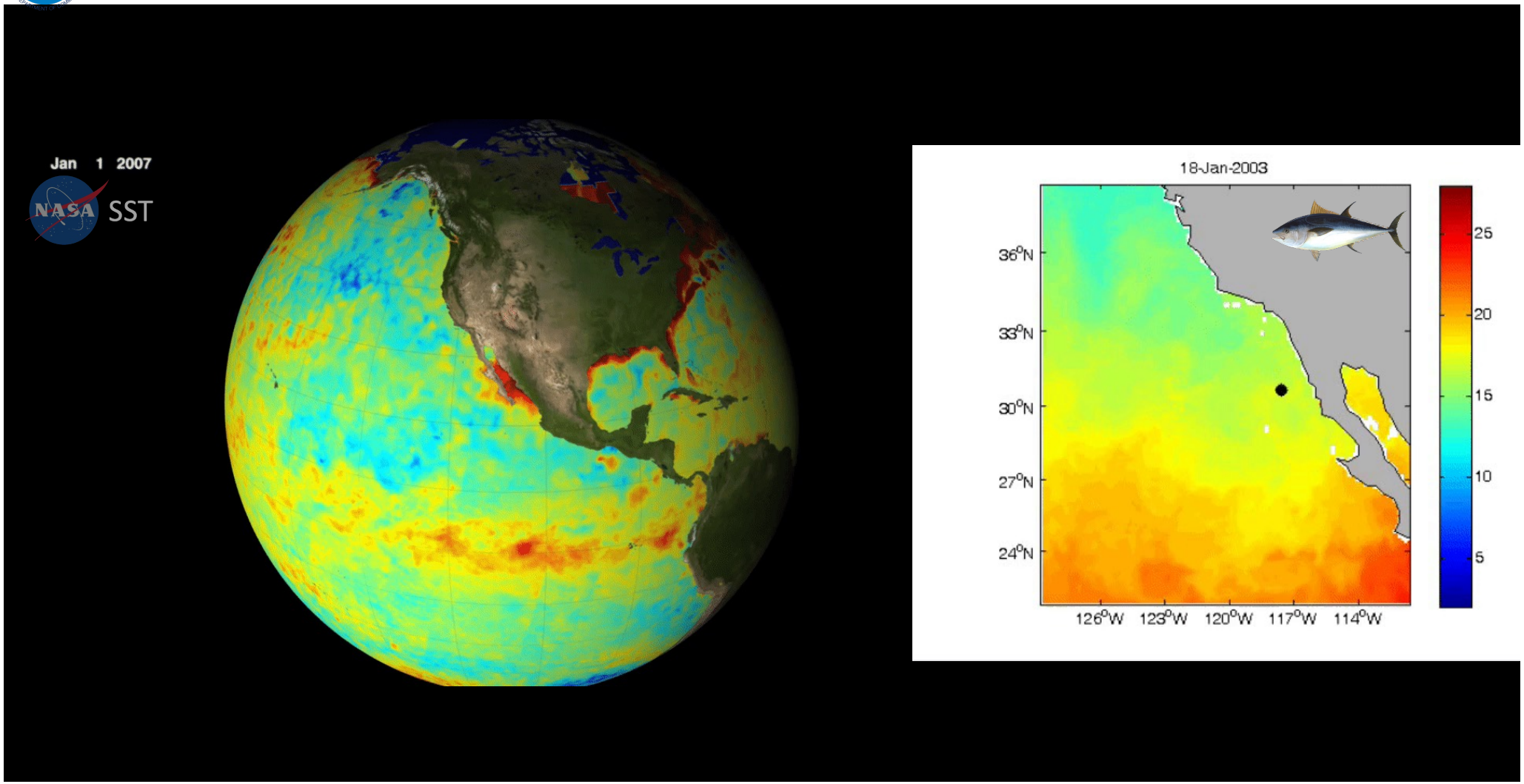
Using climate-ready information in decision making for multiple stakeholders

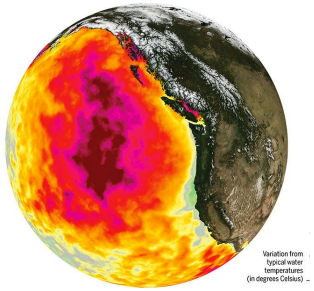
Elliott Hazen, PhD – Supervisory Research Ecologist at the SWFSC's Ecosystem Science Division

Slides from: Andrew Leising, Heather Welch, and Barb Muhling

Dynamic oceans and dynamic ecosystems



Our climate impacts species distributions across multiple timescales



Ephemeral features that concentrate prey

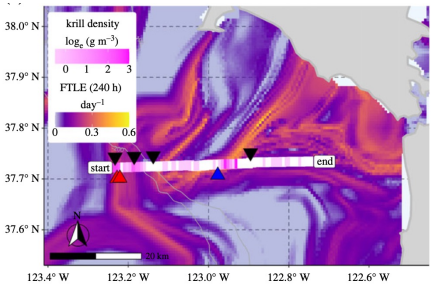
ENSO cycles, PDO

0 -10 days

Weeks to months

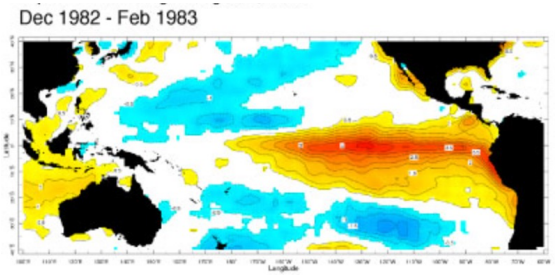
Year to decade

Decades to century

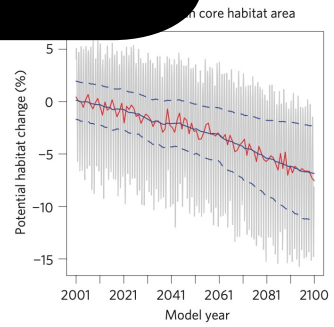


Fahlbusch et al. 2022, 2024

Marine heatwaves



Climate change



Hazen et al. 2013

Conservation and management decision-making also occurs across multiple timescales

Vessel speed reductions

Permitting for seismic surveys

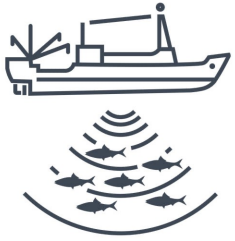
0 -10 days

Weeks to months

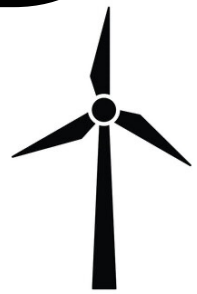
Year to decade

Decades to century

Fishing zone closures

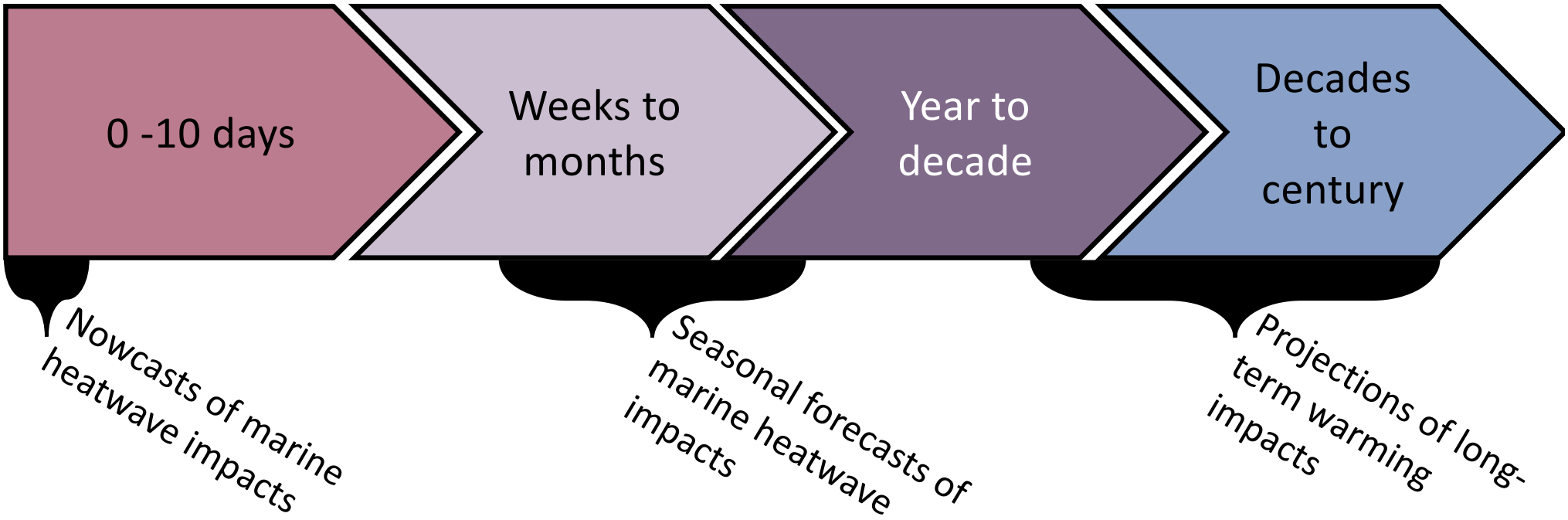


MPA planning; Semi-permanent structures e.g. wind farms



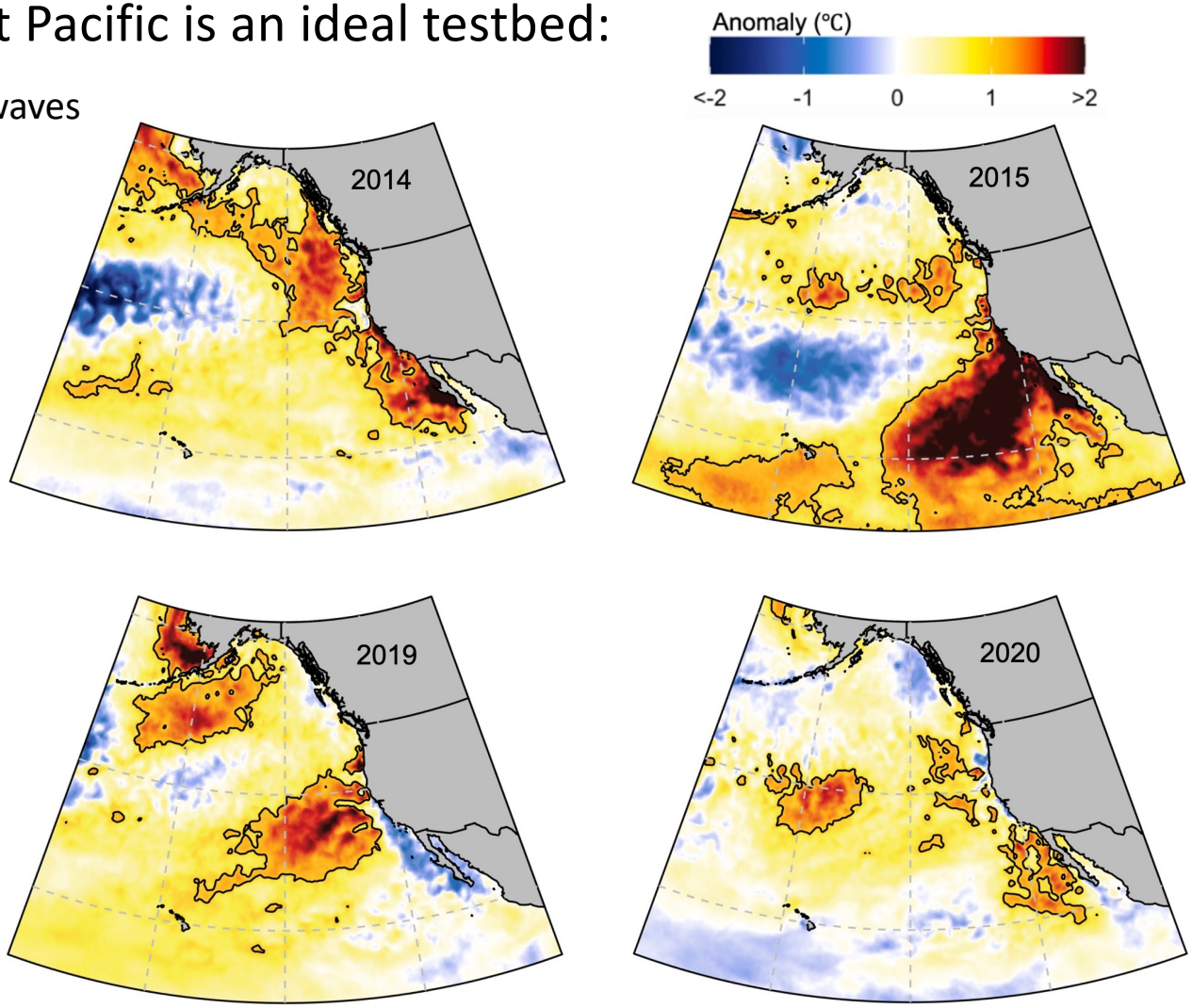
Thus, accurate predictions of distributions across multiple time-scales can support climate-ready decision-making

Three California Current case-studies:



The northeast Pacific is an ideal testbed:

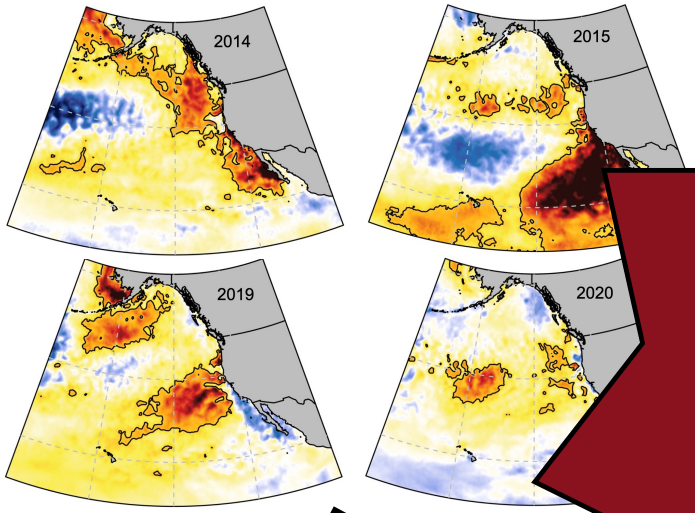
Many recent heatwaves



Welch et al 2023.
Nat Comms

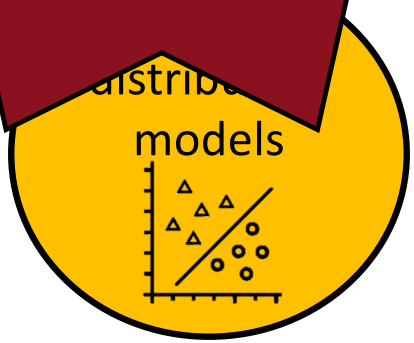
The northeast Pacific is an ideal testbed:

Four marine heatwaves



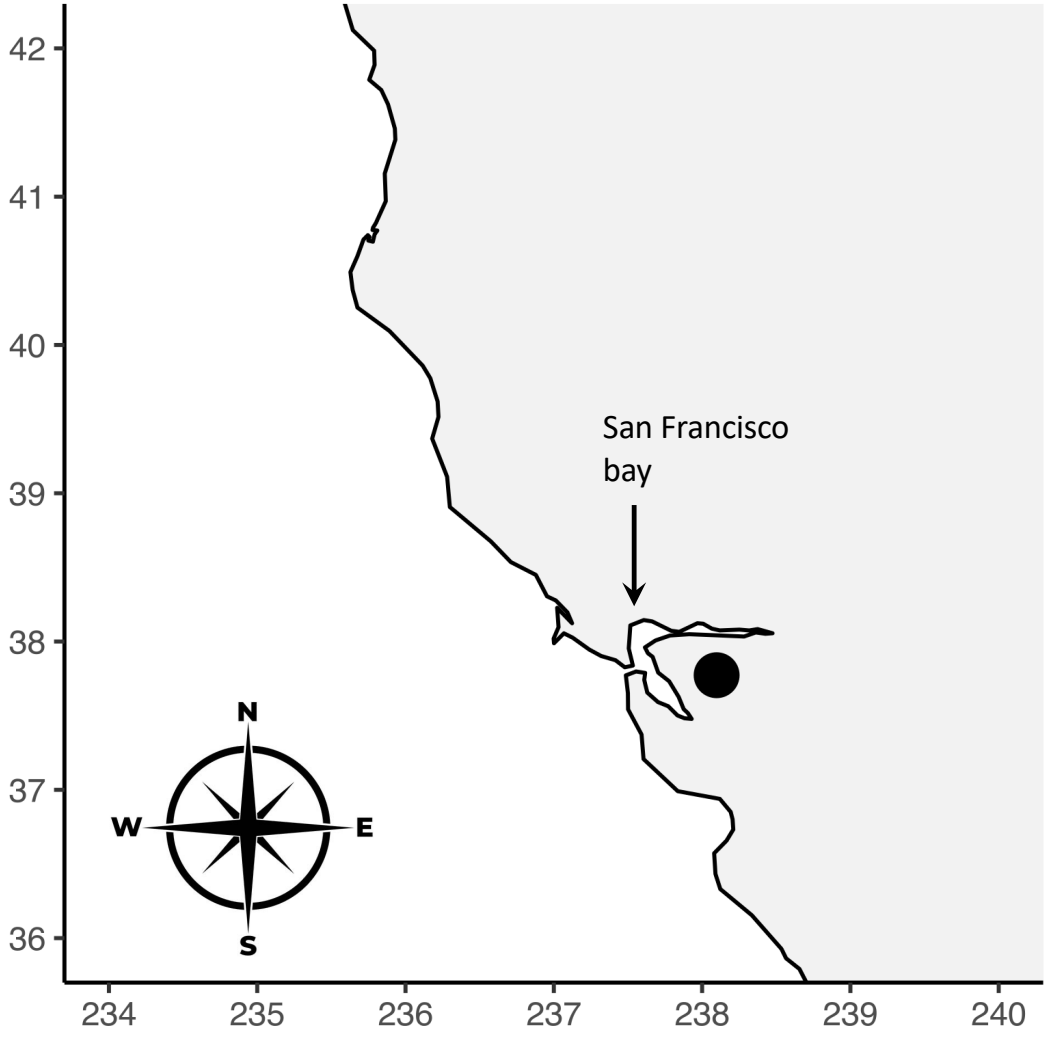
Blue whale tagging data

Results are **inferences** from models as opposed to direct observations



Welch et al 2023. Nat Comms

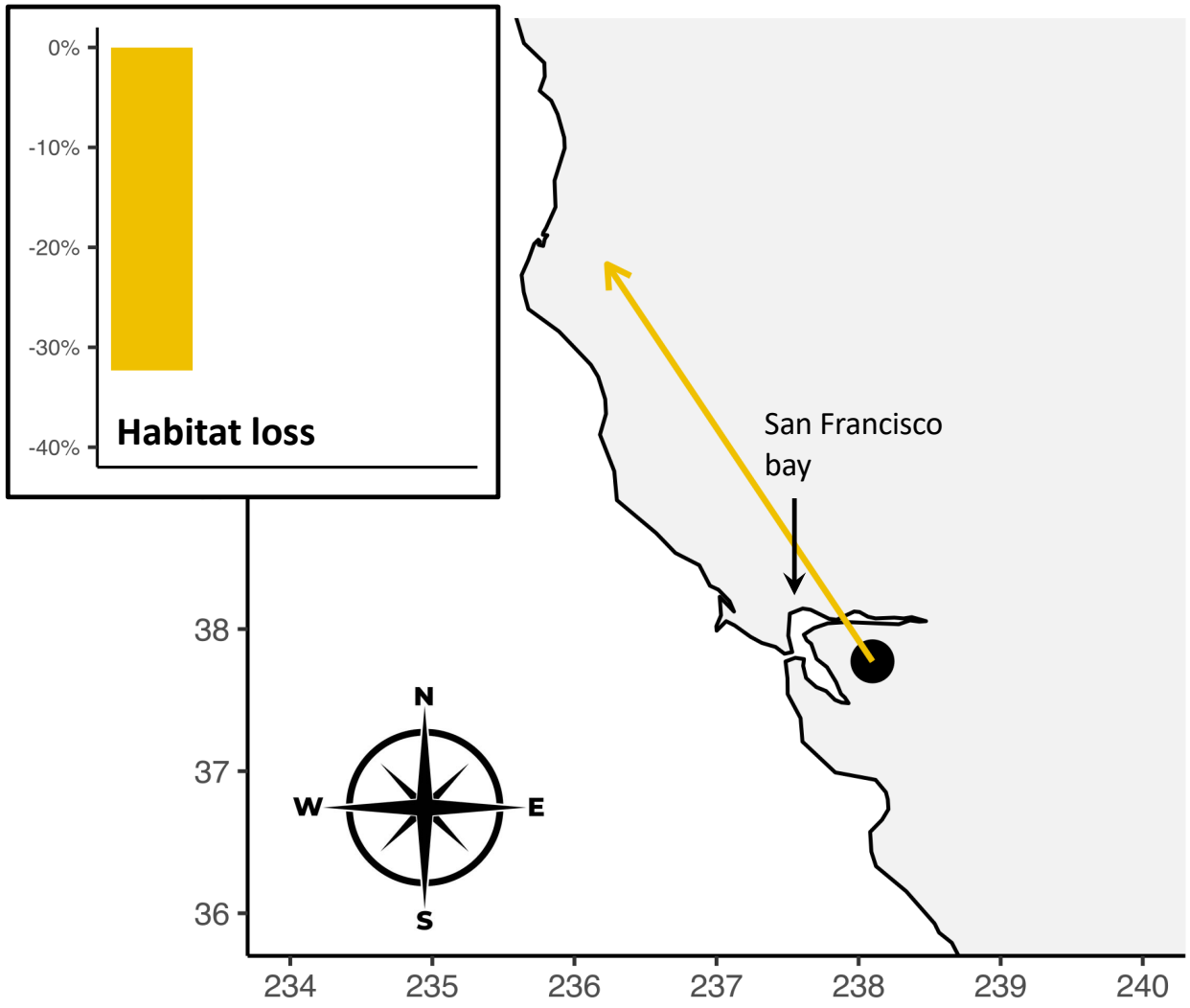
Marine heatwave impacts on blue whales are surprisingly diverse



● Average location of habitat
Aug-Oct 2000-2020

Welch et al 2023.
Nat Comms

Marine heatwave impacts on blue whales are surprisingly diverse



● Average location of habitat Aug-Oct 2000-2020

Displacement of habitat during the → 2014 heatwave

Welch et al 2023. Nat Comms

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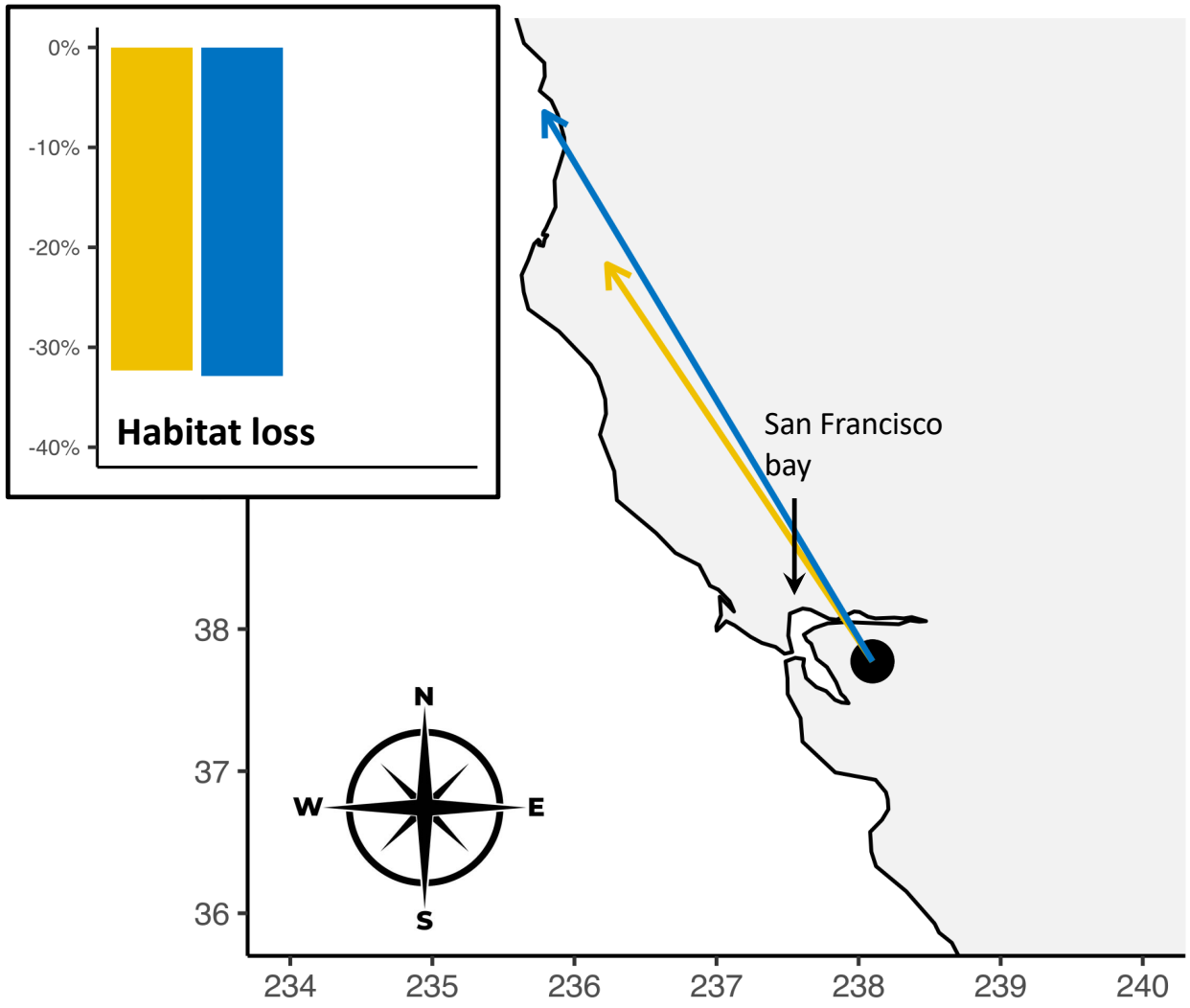

● Average location of habitat Aug-Oct 2000-2020

Displacement of habitat during the

→ 2014 heatwave

→ 2015 heatwave

Welch et al 2023. Nat Comms

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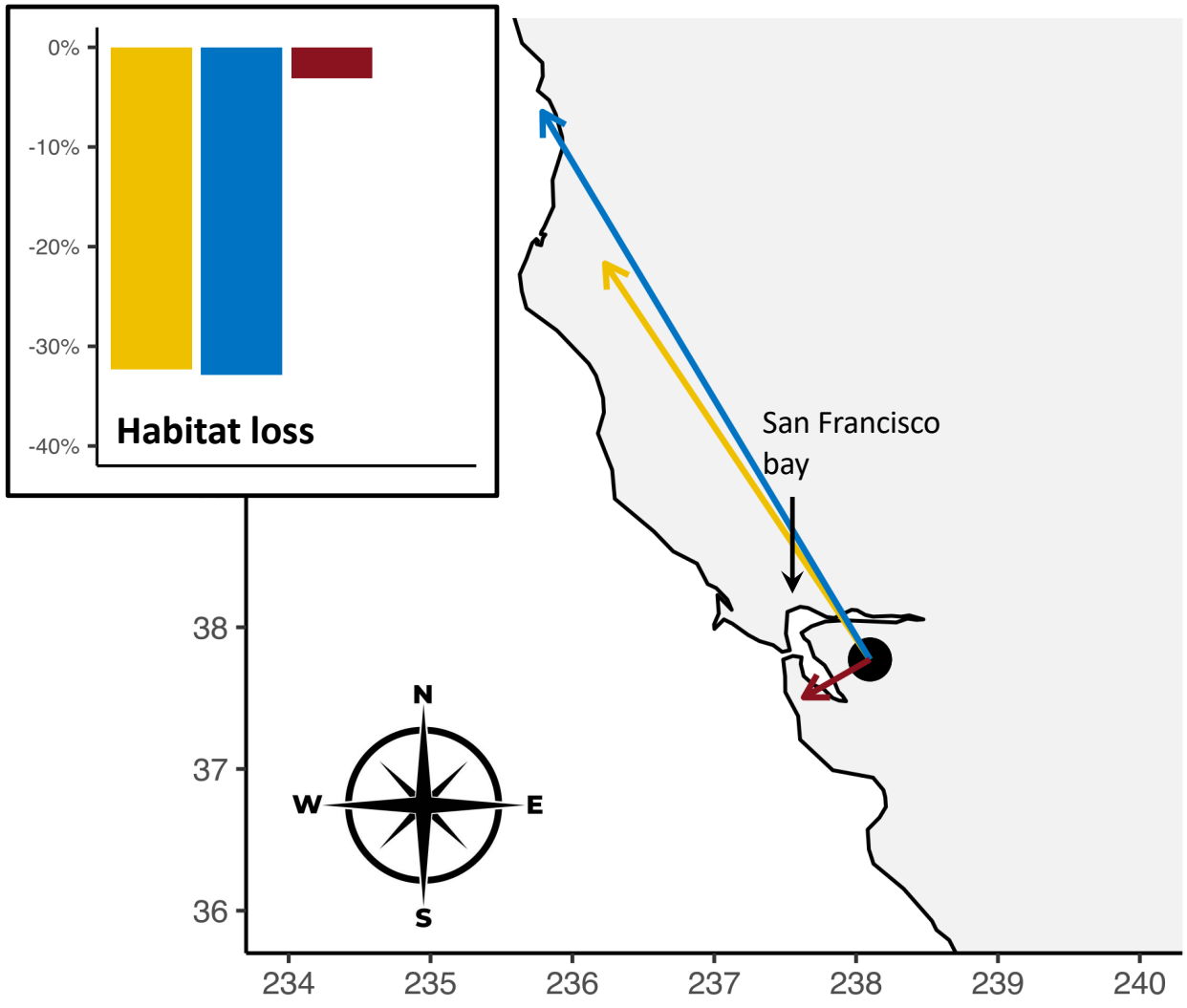


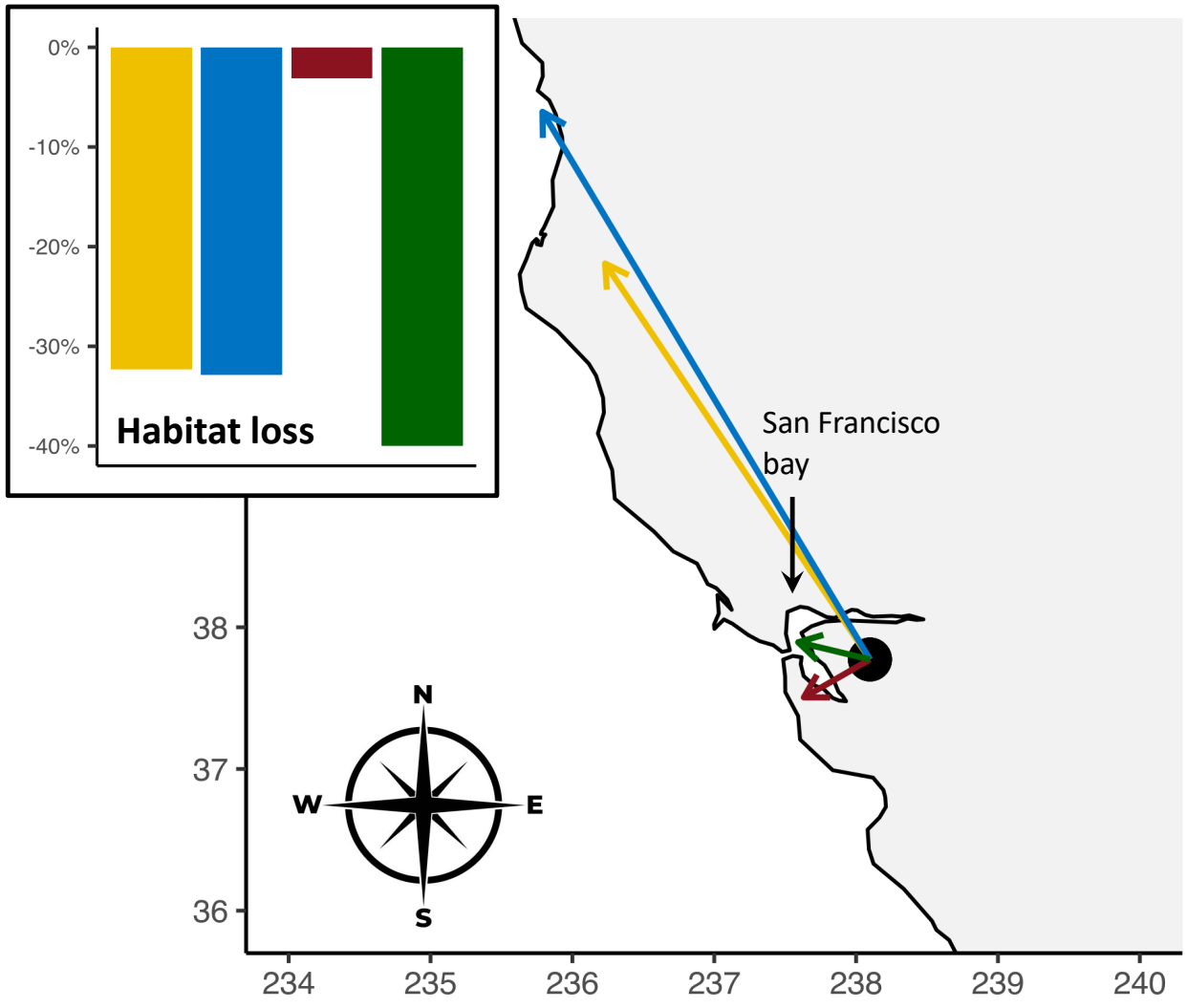
- Average location of habitat Aug-Oct 2000-2020

Displacement of habitat during the

- 2014 heatwave
- 2015 heatwave
- 2019 heatwave

Welch et al 2023.
Nat Comms

Marine heatwave impacts on blue whales are surprisingly diverse



- Average location of habitat Aug-Oct 2000-2020

Displacement of habitat during the

- 2014 heatwave
- 2015 heatwave
- 2019 heatwave
- 2020 heatwave

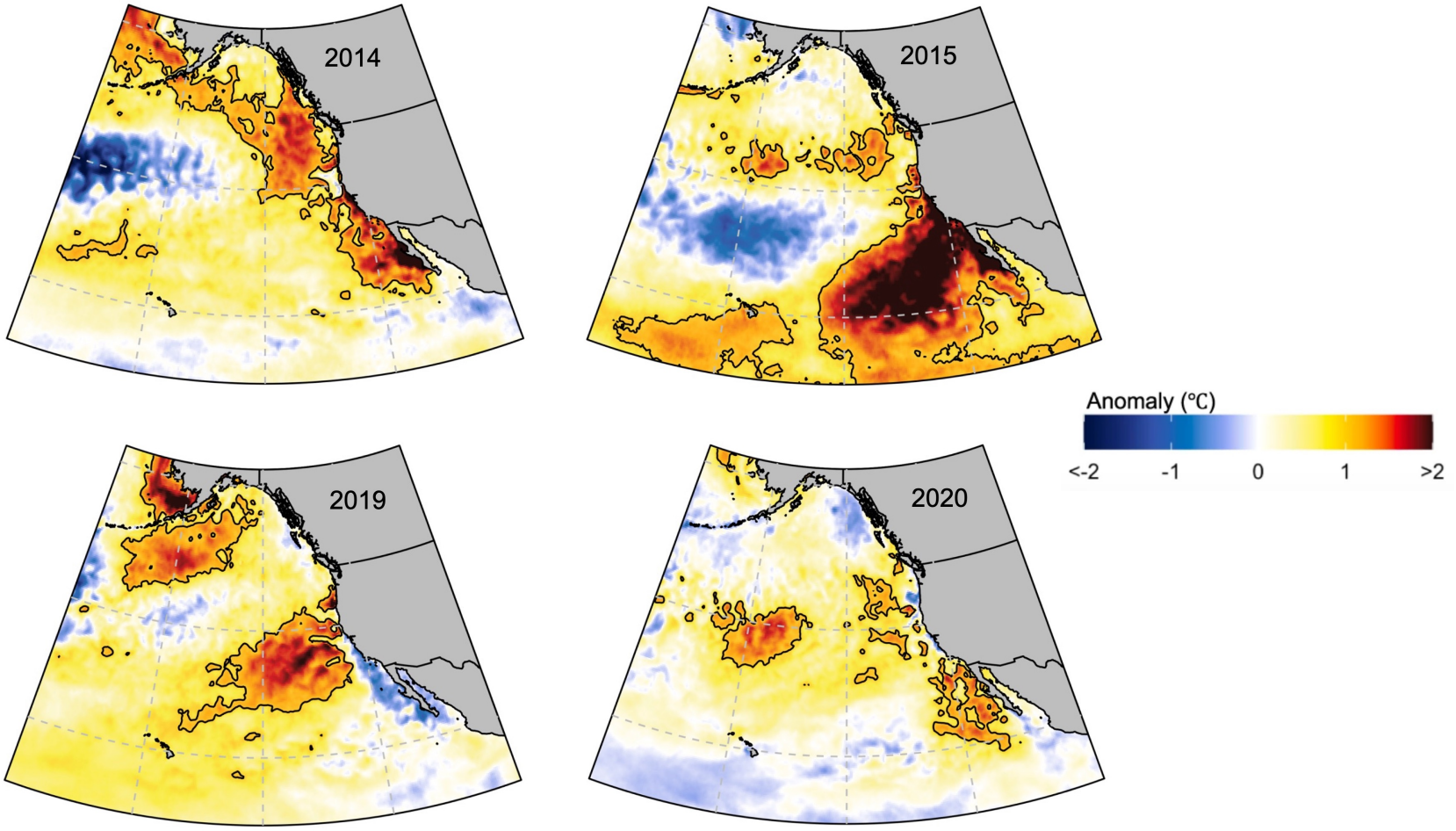
Welch et al 2023.
Nat Comms

Marine heatwave impacts are surprisingly diverse

Can't assume future marine heatwaves will have the same impact as past events

However, marine heatwave impacts are highly predictable in modeling space

And we can predict impacts in real-time as marine heatwaves unfold



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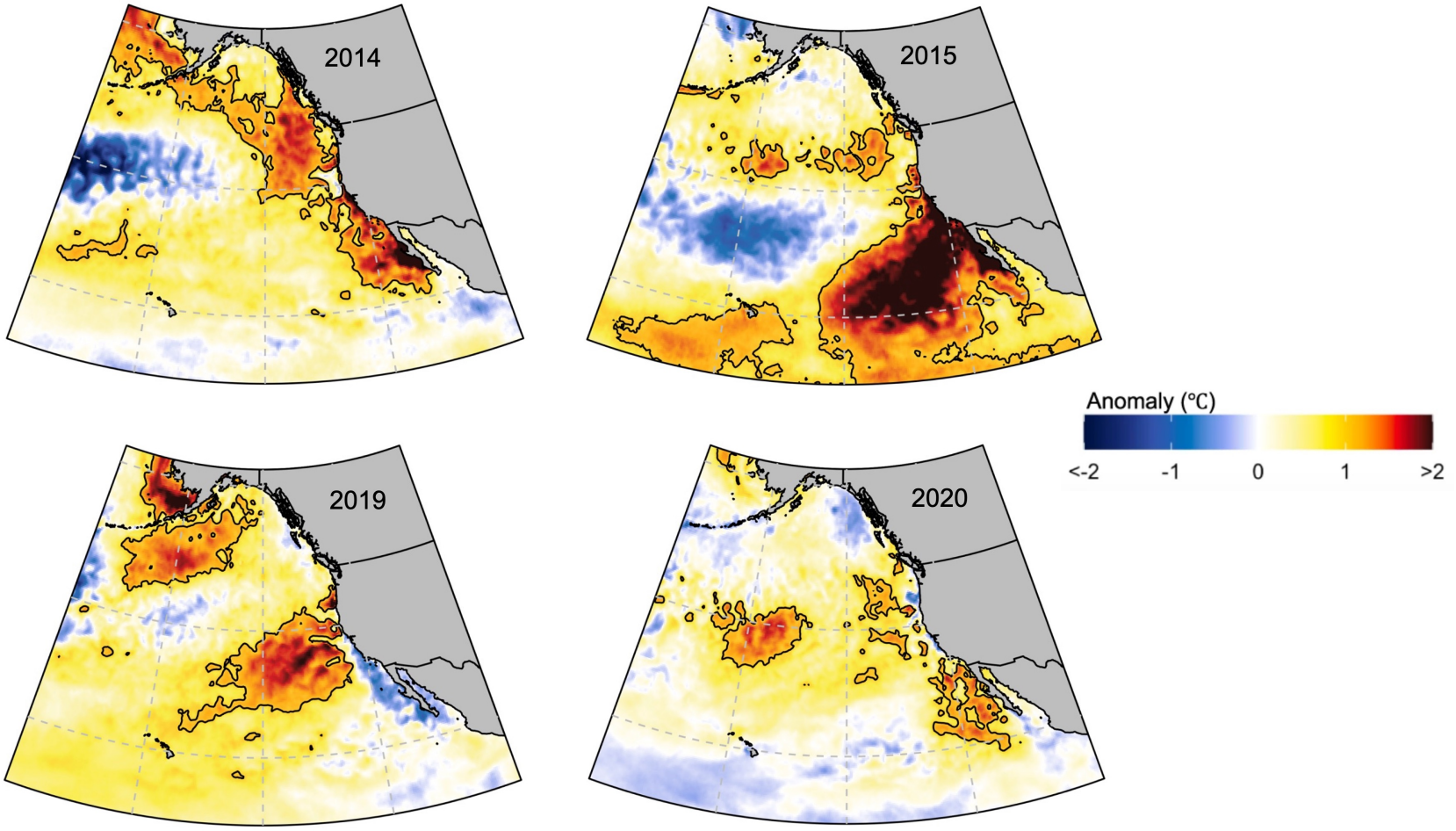


Marine heatwave impacts are surprisingly diverse

Can't assume future marine heatwaves will have the same impact as past events

However, marine heatwave impacts are highly predictable in modeling space

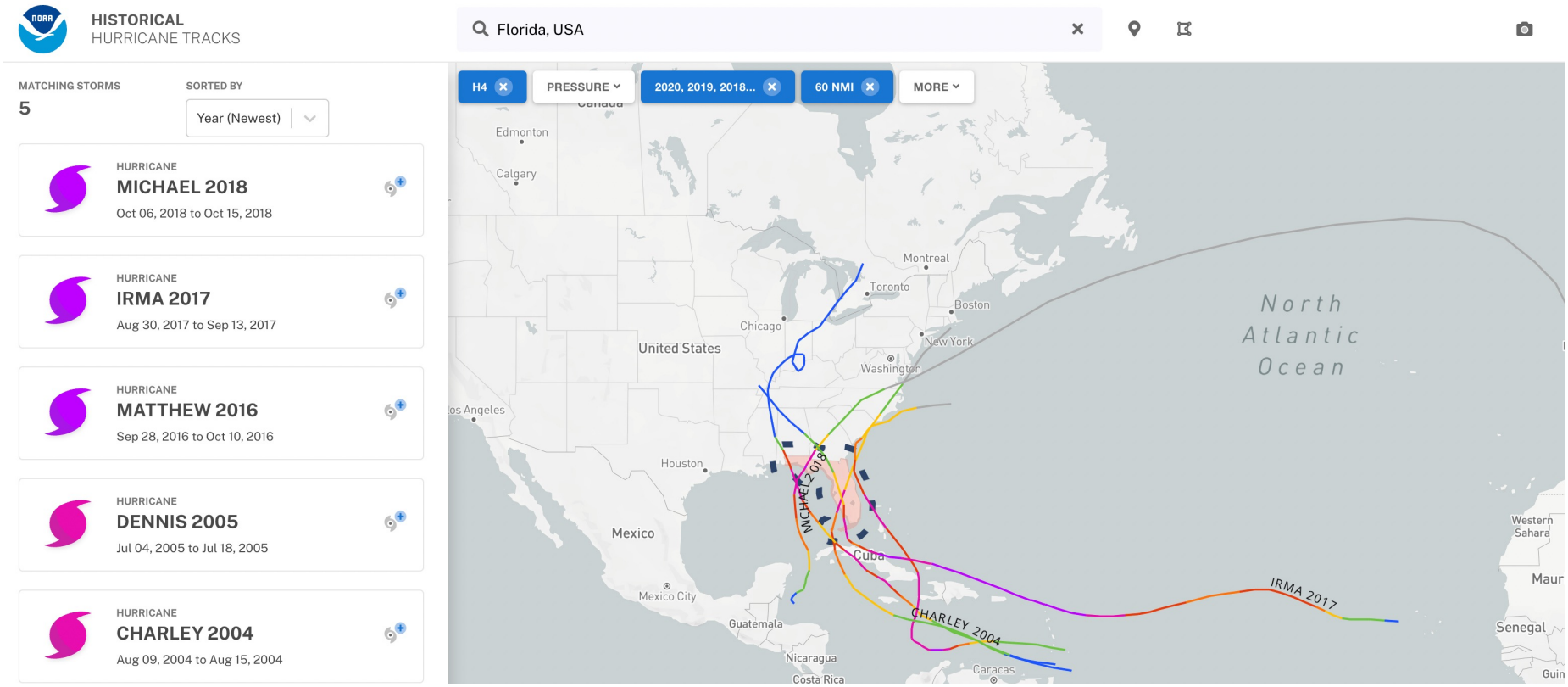
And we can predict impacts in real-time as marine heatwaves unfold

Hurricanes are surprisingly diverse

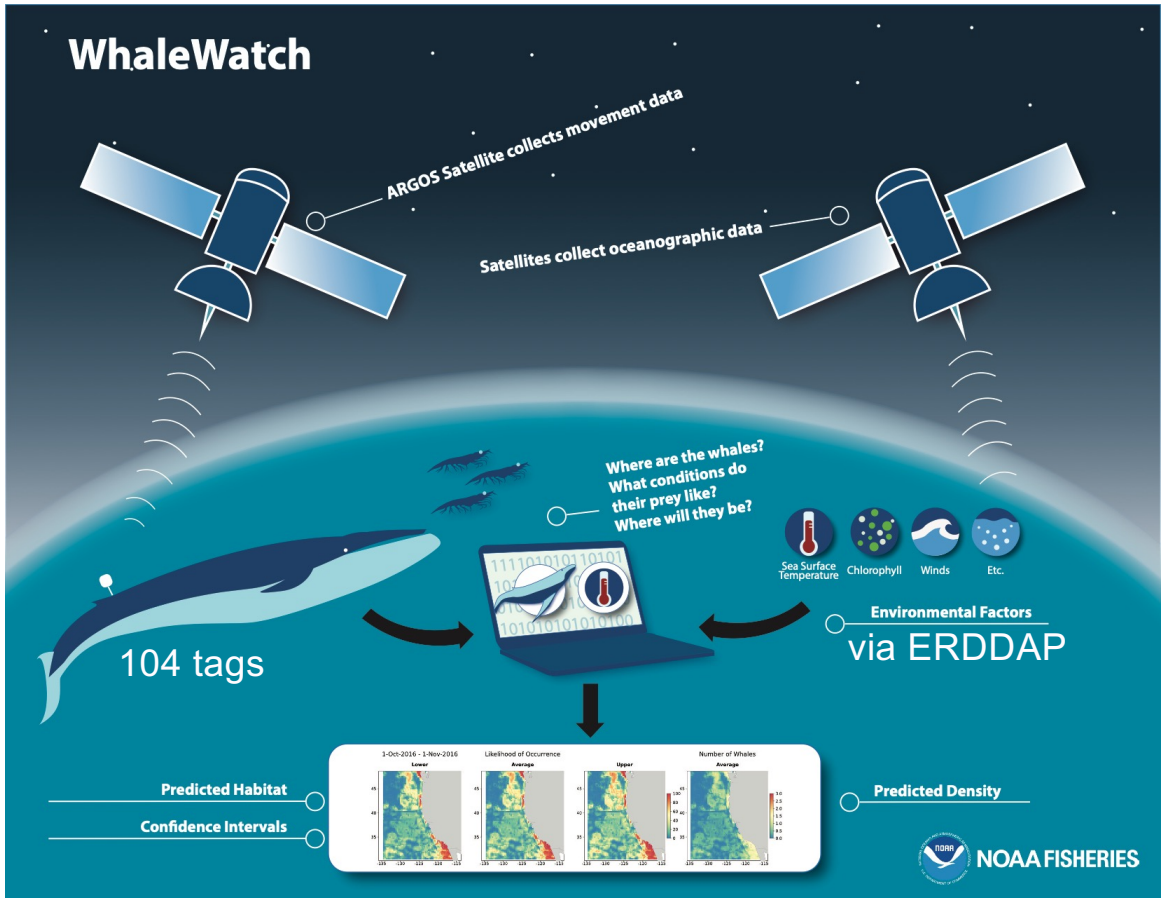
Can't assume future hurricanes will have the same track as past events

However, hurricane tracks are highly predictable in modeling space

And we can predict tracks in real-time as hurricanes unfold

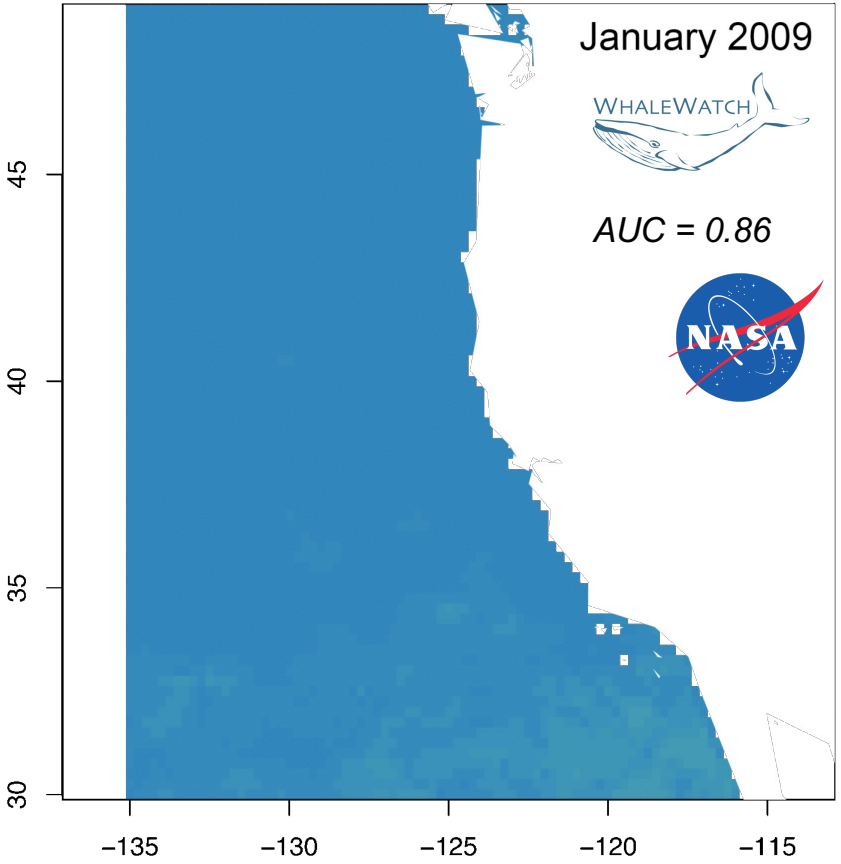


WhaleWatch: Near real-time models for dynamic management of blue whales in the North Pacific

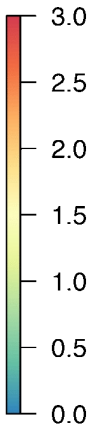


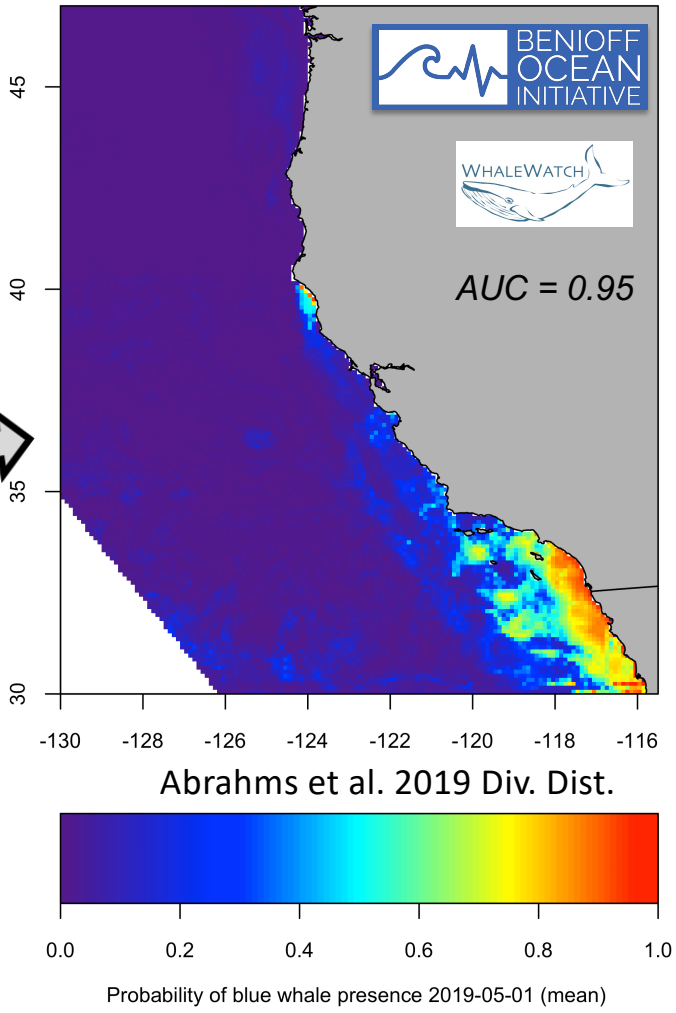
WhaleWatch 1.0 to 2.0

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



Hazen et al. 2017 J. Appl. Ecol





Abrahms et al. 2019 Div. Dist.

WhaleWatch 2.0 to end-users

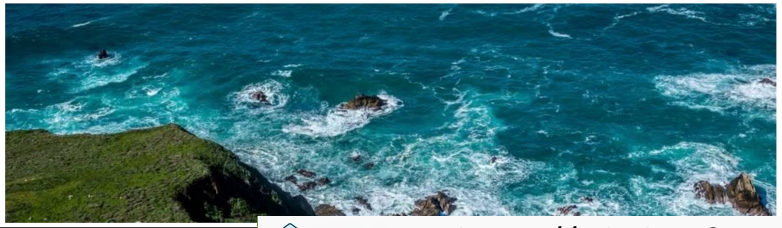
https://coastwatch.pfeg.noaa.gov/projects/whalewatch2/

Risk Assessment and Mitigation Program (RAMP)

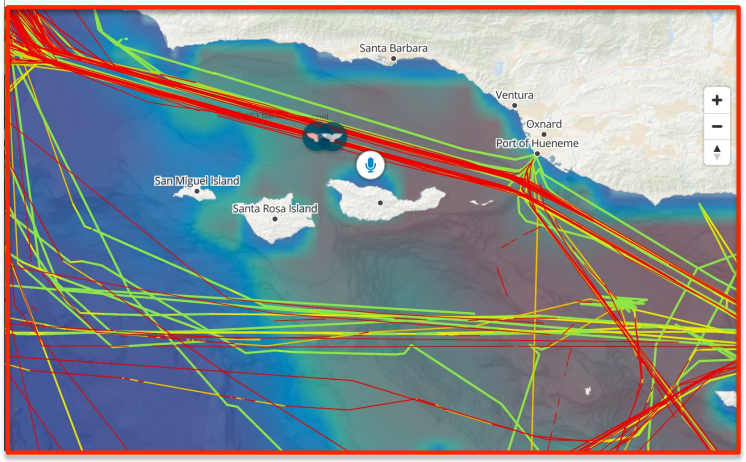
Since September 2015, the California Dungeness Crab Fishing Gear Working Group (Working Group) has been taking steps to actively identify and be responsive to elevated risks of whale entanglements in California Dungeness crab fishing gear. This unique coalition of diverse stakeholders—which includes 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.

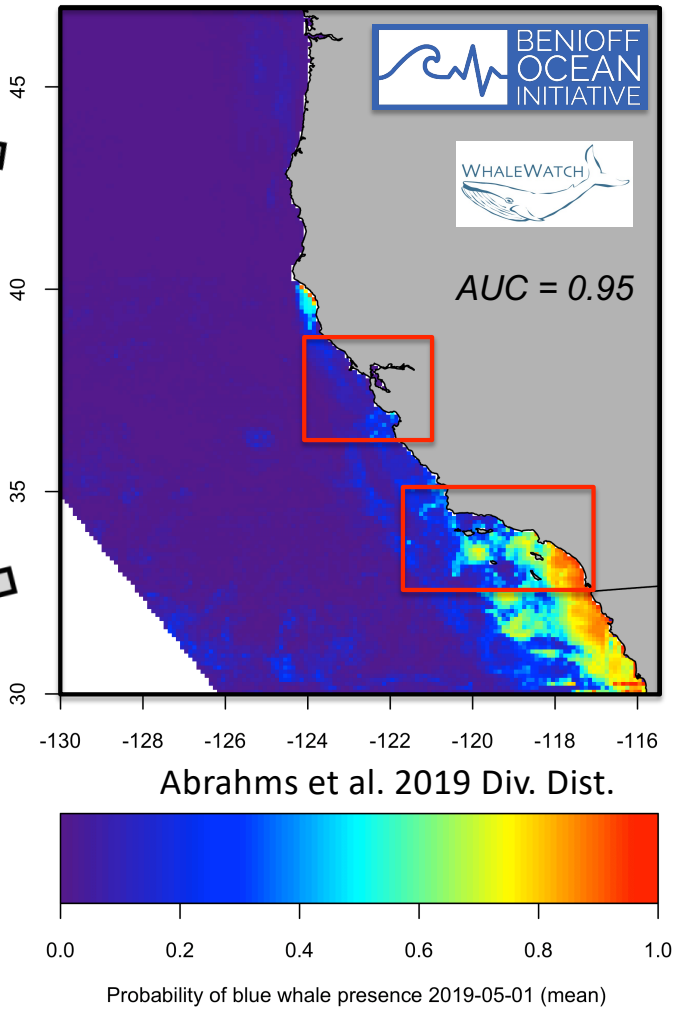
Risk Assessment and Mitigation Program (RAMP)

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.

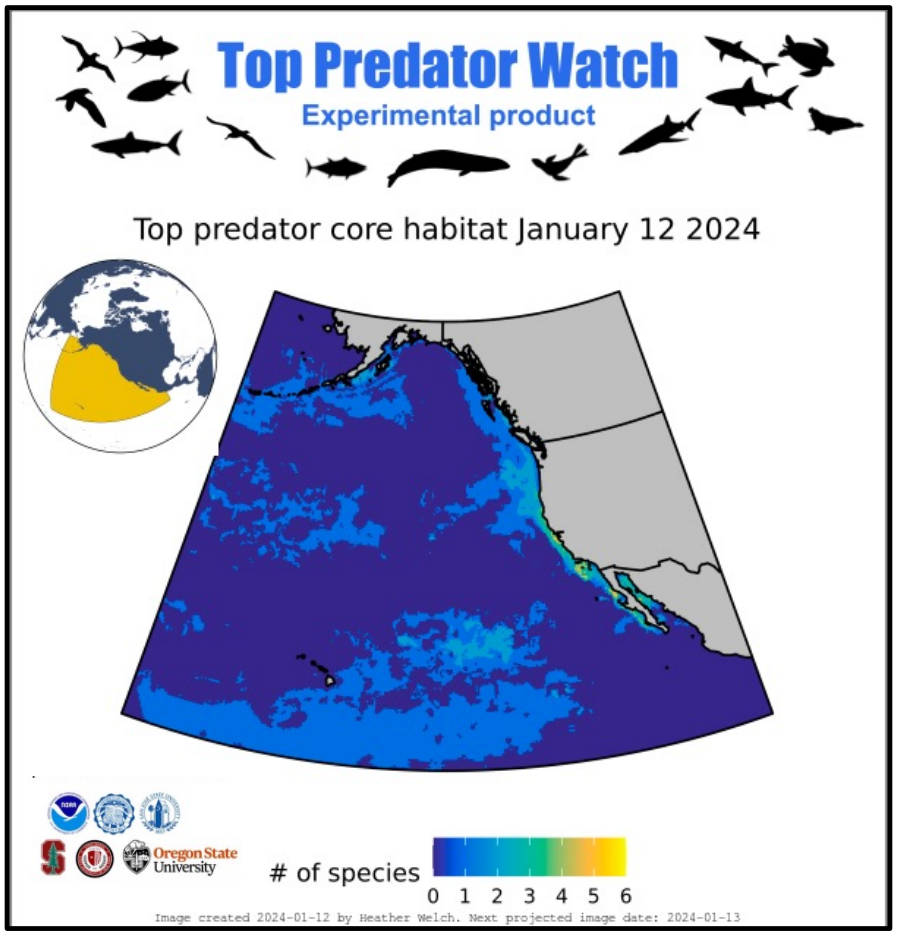


WHALE SAFE https://whalesafe.com/ MAP MENU



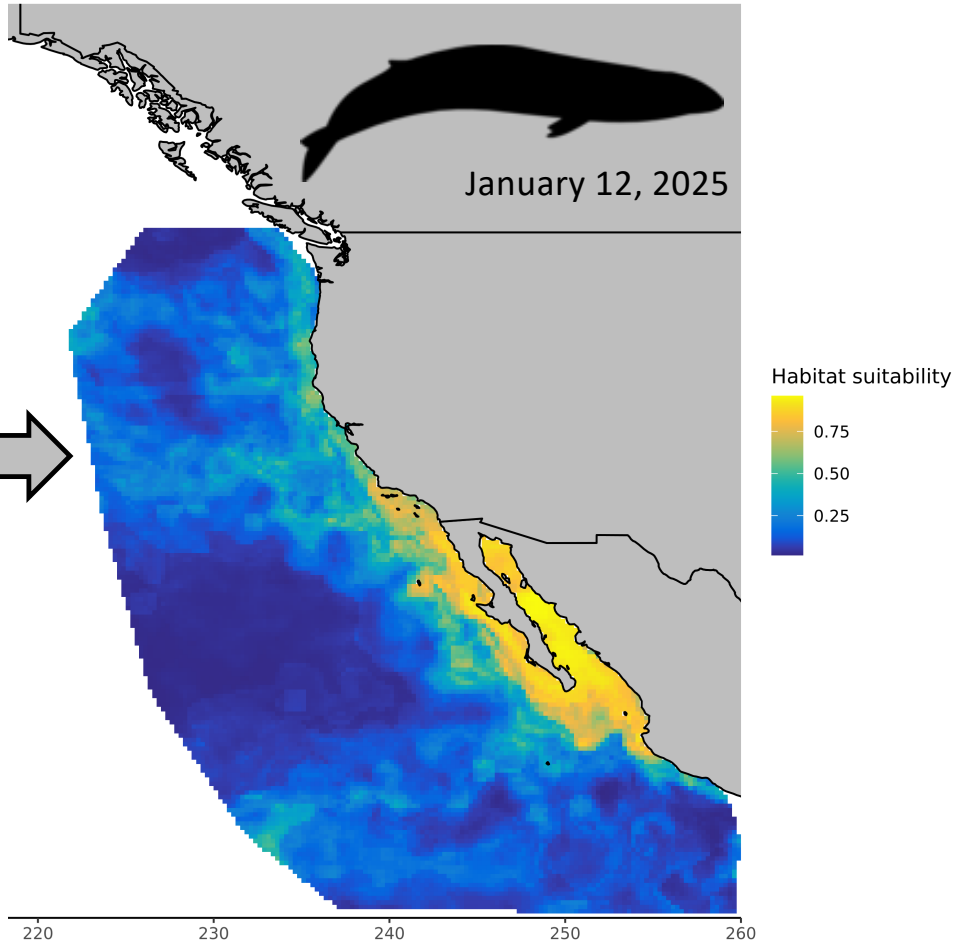


Nowcasts:
Real-time information

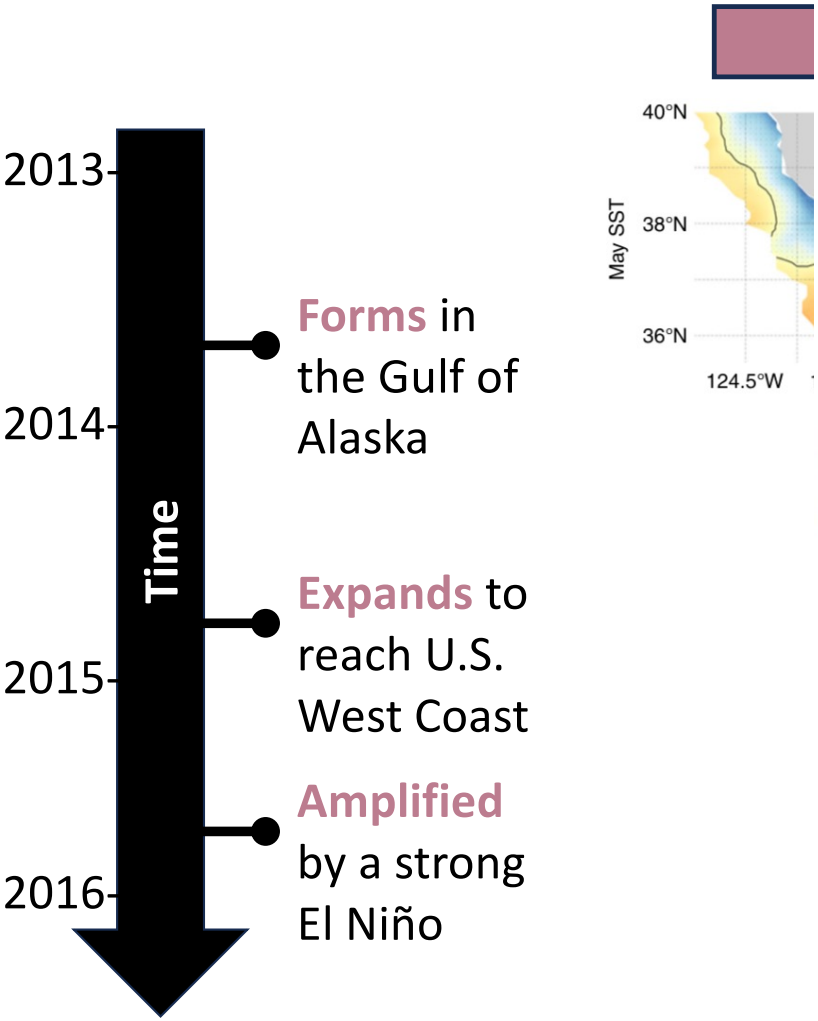


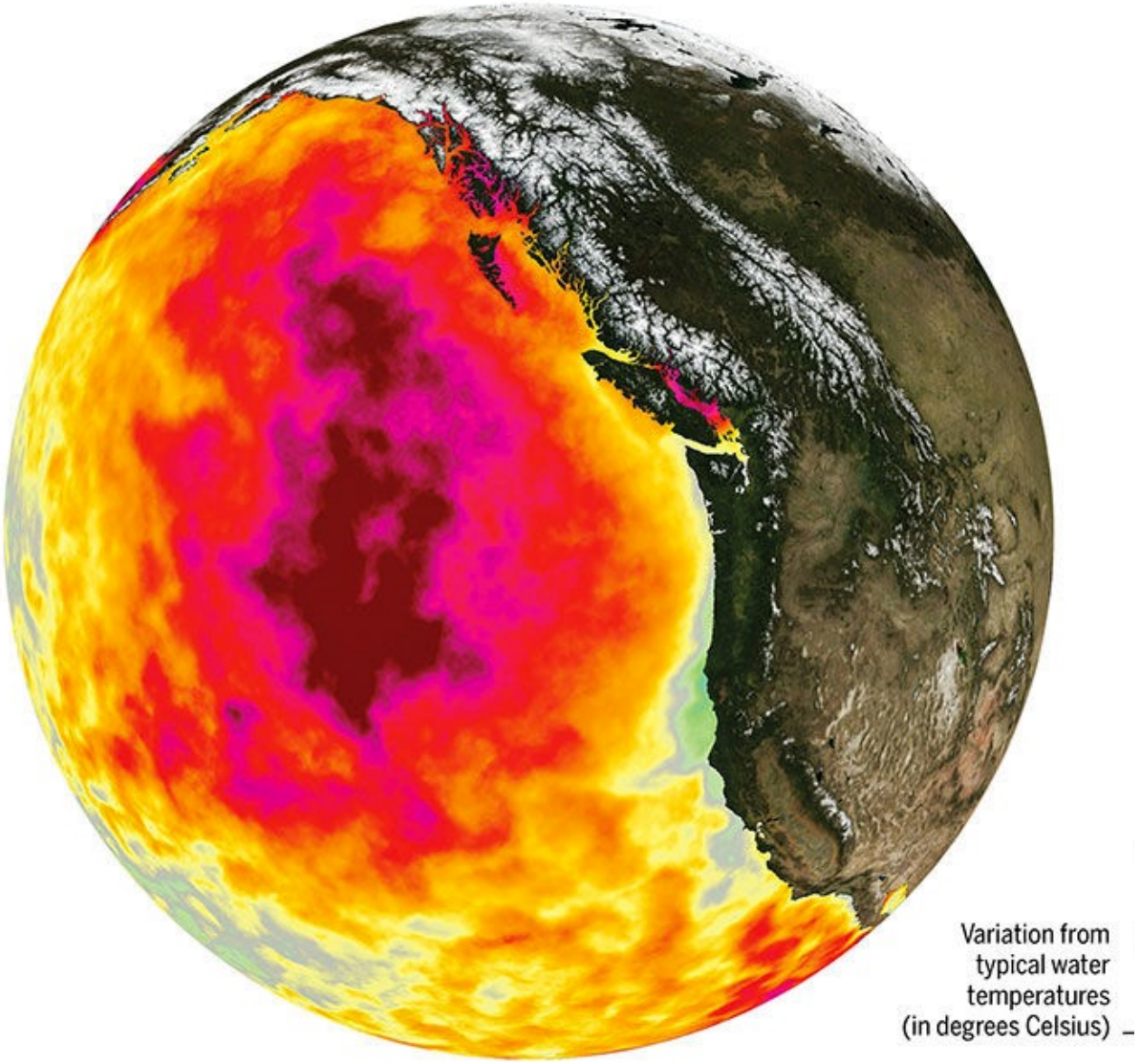
https://oceanview.pfeg.noaa.gov/top-predator-watch/

Forecasts:
Forward-looking information



The Habitat Compression Index (HCI)





The Habitat Compression Index (HCI)

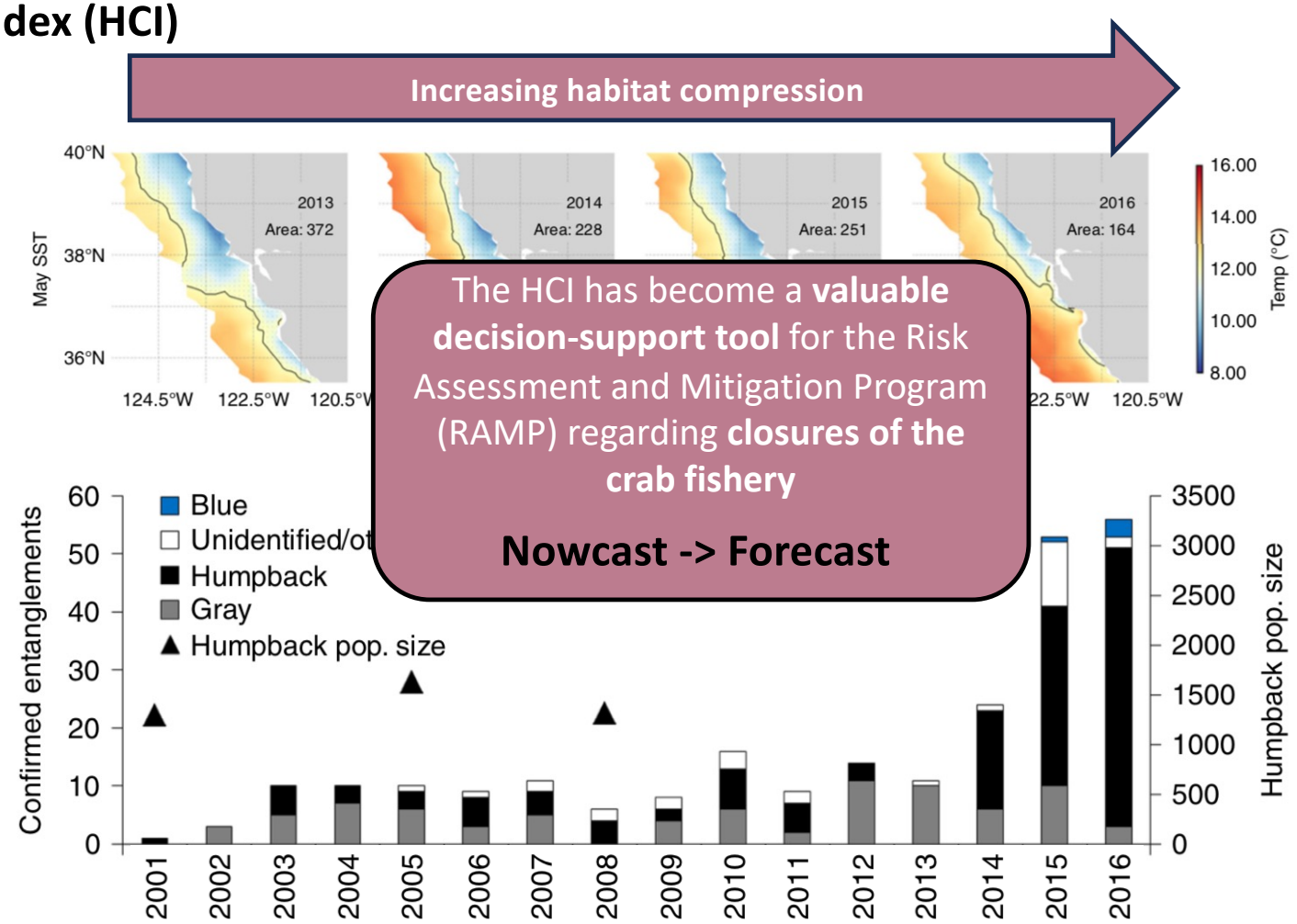
2013 – **Forms** in the Gulf of Alaska

2014 – **Expands** to reach U.S. West Coast

2015 – **Amplified** by a strong El Niño

2016

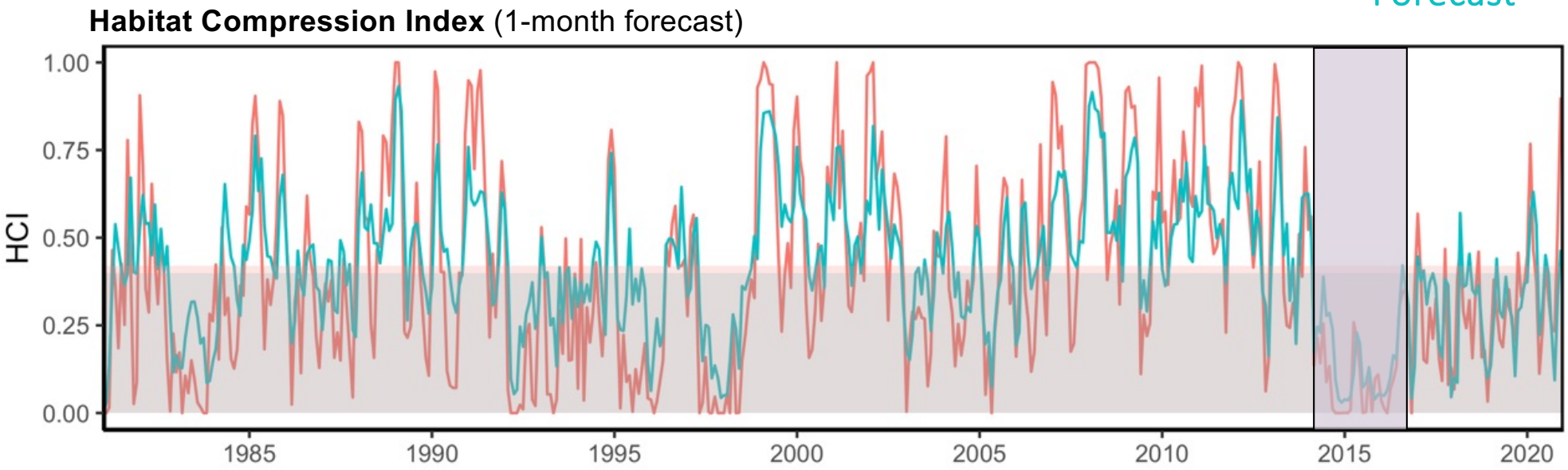
Time



Santora et al 2020. Nat Comms

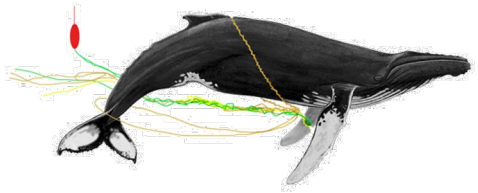
Seasonal forecasts of the HCI

Observed
Forecast



- **94%** of forecasts **correctly** identified high habitat compression Mar 2014–Dec 2016

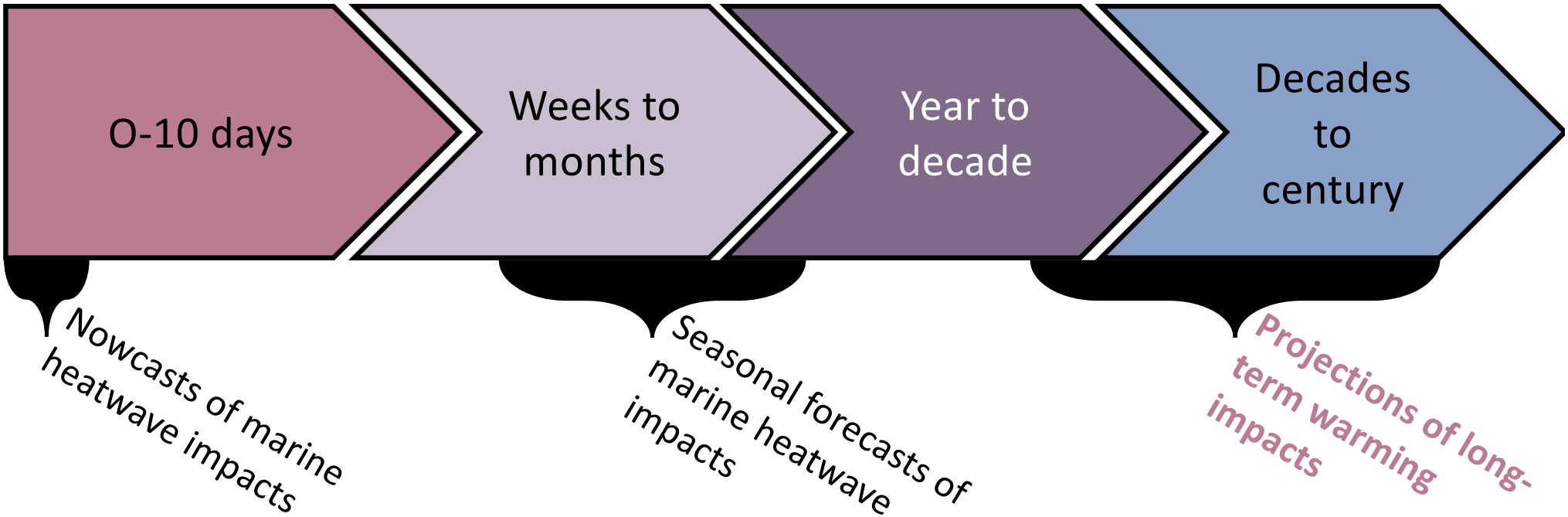
- HCI forecasts **correctly predicted** high compression during Mar 2014–Dec 2016 up to **11.5 months in advance**



Brodie et al 2023. Nat Comms

Accurate predictions across multiple time-scales are needed to support climate-ready decision-making

Three California Current case-studies:



Background Projections

Species Distribution Model outputs

↓

Three high-resolution (~10 km) downscaled ocean models under the high emissions scenario (RCP8.5)

Daily Habitat Suitability (HS) (1980-2100)

↙ ↘

Changes in suitability

↙ ↘

Distance Direction

↘

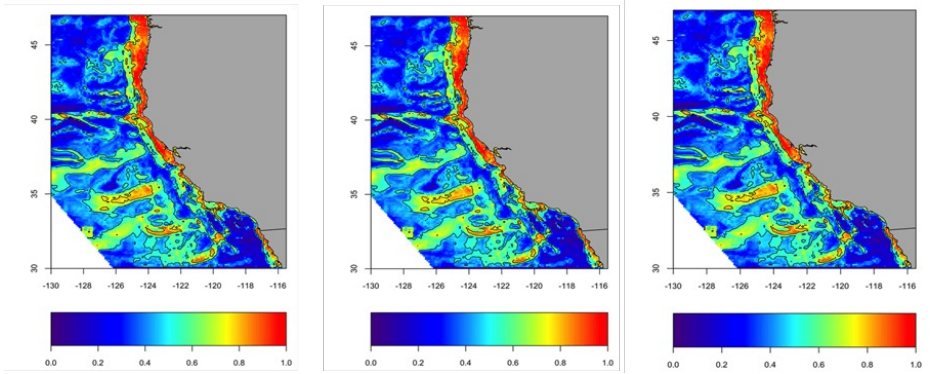
National Marine Sanctuary Refugia/Bright Spots

A Dynamically Downscaled Ensemble of Future Projections for the California Current System

Mercedes Pozo Buil[1,2], Michael G. Jacox[1,2,3], Jerome Fiechter[4], Michael A. Alexander[3], Steven J. Bograd[1,2], Enrique N. Curchitser[5], Christopher A. Edwards[4], Ryan R. Rykaczewski[6] and Charles A. Stock[7]*

[1] Institute of Marine Science, University of California, Santa Cruz, Santa Cruz, CA, United States, [2] NOAA Southwest Fisheries Science Center, Monterey, CA, United States, [3] NOAA Earth System Research Laboratory, Boulder, CO, United States, [4] Ocean Sciences Department, University of California, Santa Cruz, Santa Cruz, CA, United States, [5] Department of Environmental Sciences, Rutgers University, New Brunswick, NJ, United States, [6] NOAA Pacific Islands Fisheries Science Center, Honolulu, HI, United States, [7] NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ, United States

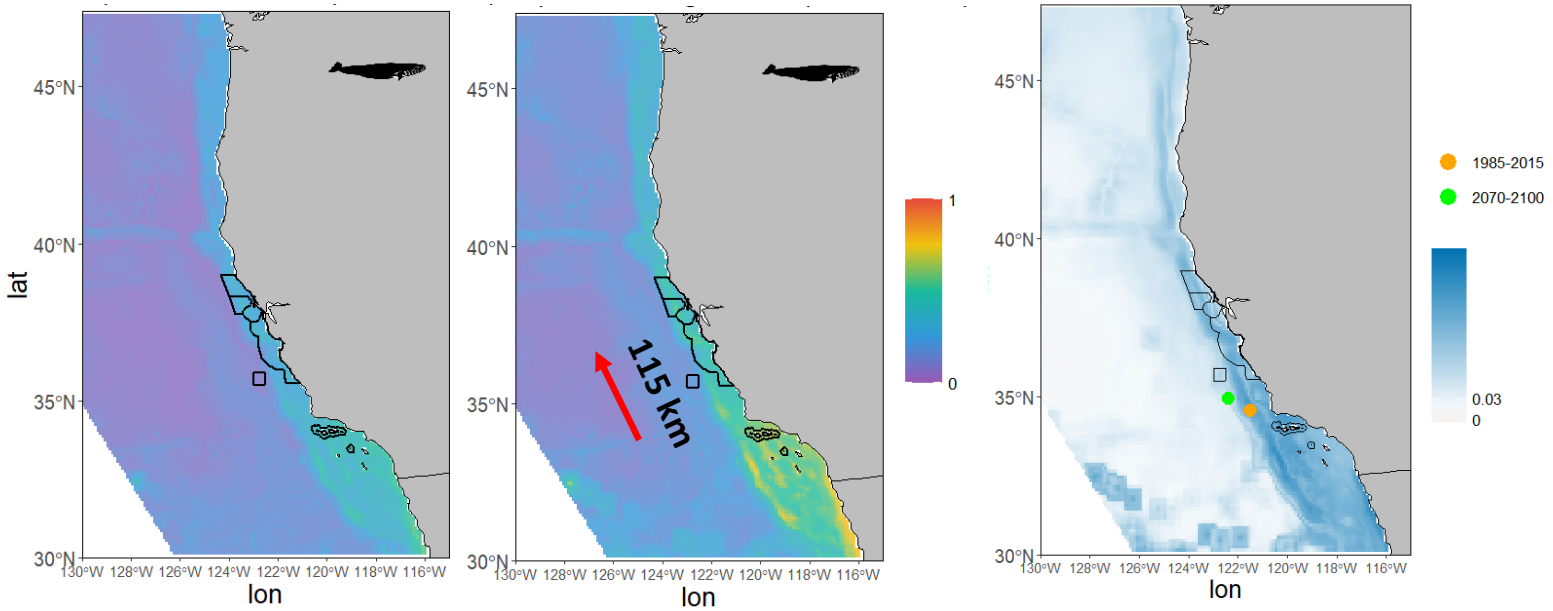
GFDL HAD IPSL



Results 1. Project blue whale distribution

Habitat suitability CCE

Historical (1985-2015) Future (2070-2100) Future minus historical



Lezama-Ochoa et al., 2024 (in prep.)

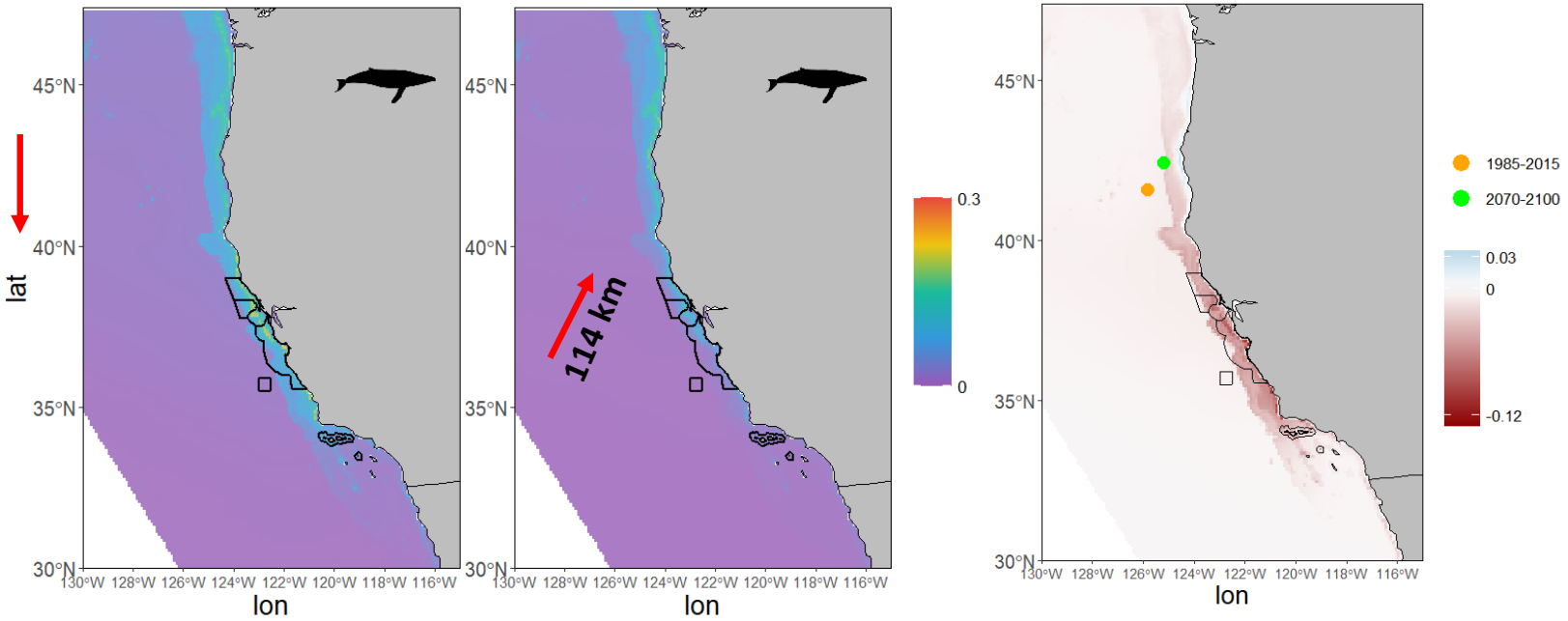
Results 1. Project humpback whale distribution

Habitat suitability CCE

Historical (1985-2015))

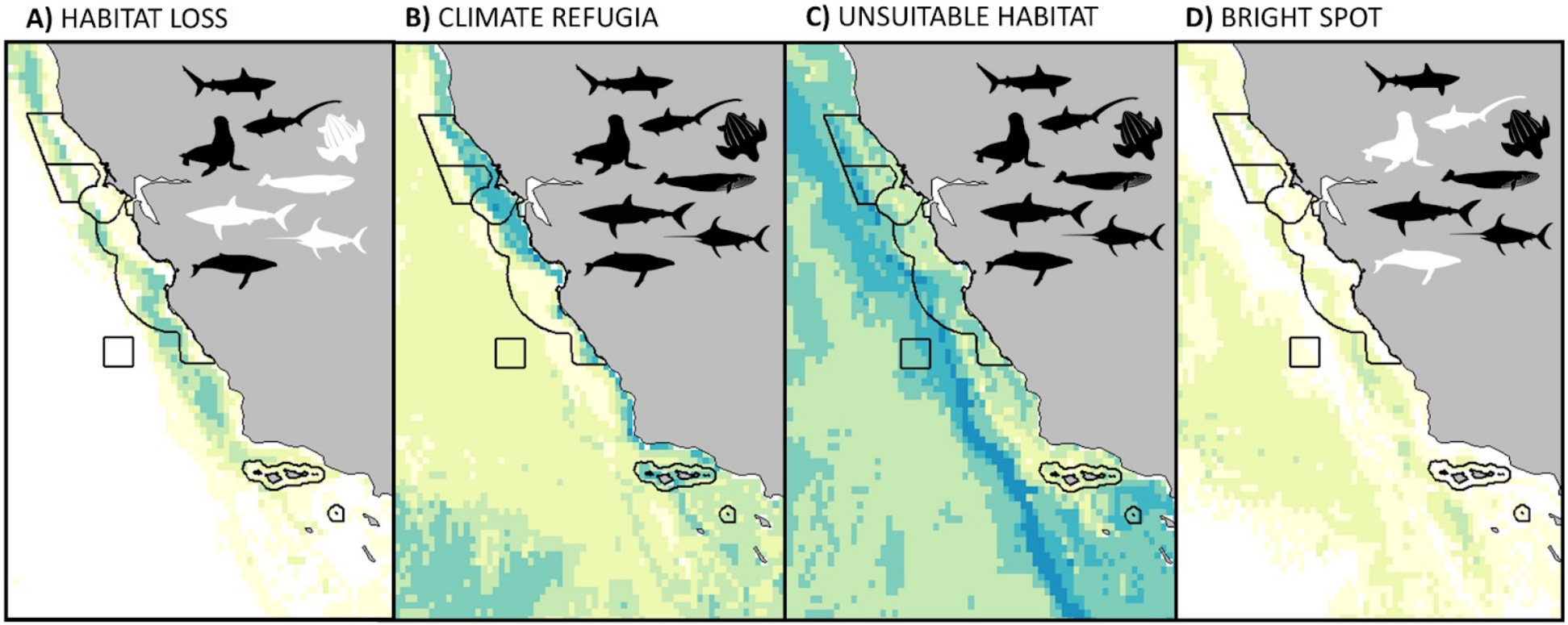
Future (2070-2100)

Future - historical



Lezama-Ochoa et al., 2024 (in prep.)

Results 2. Identify climate refugia & bright spots

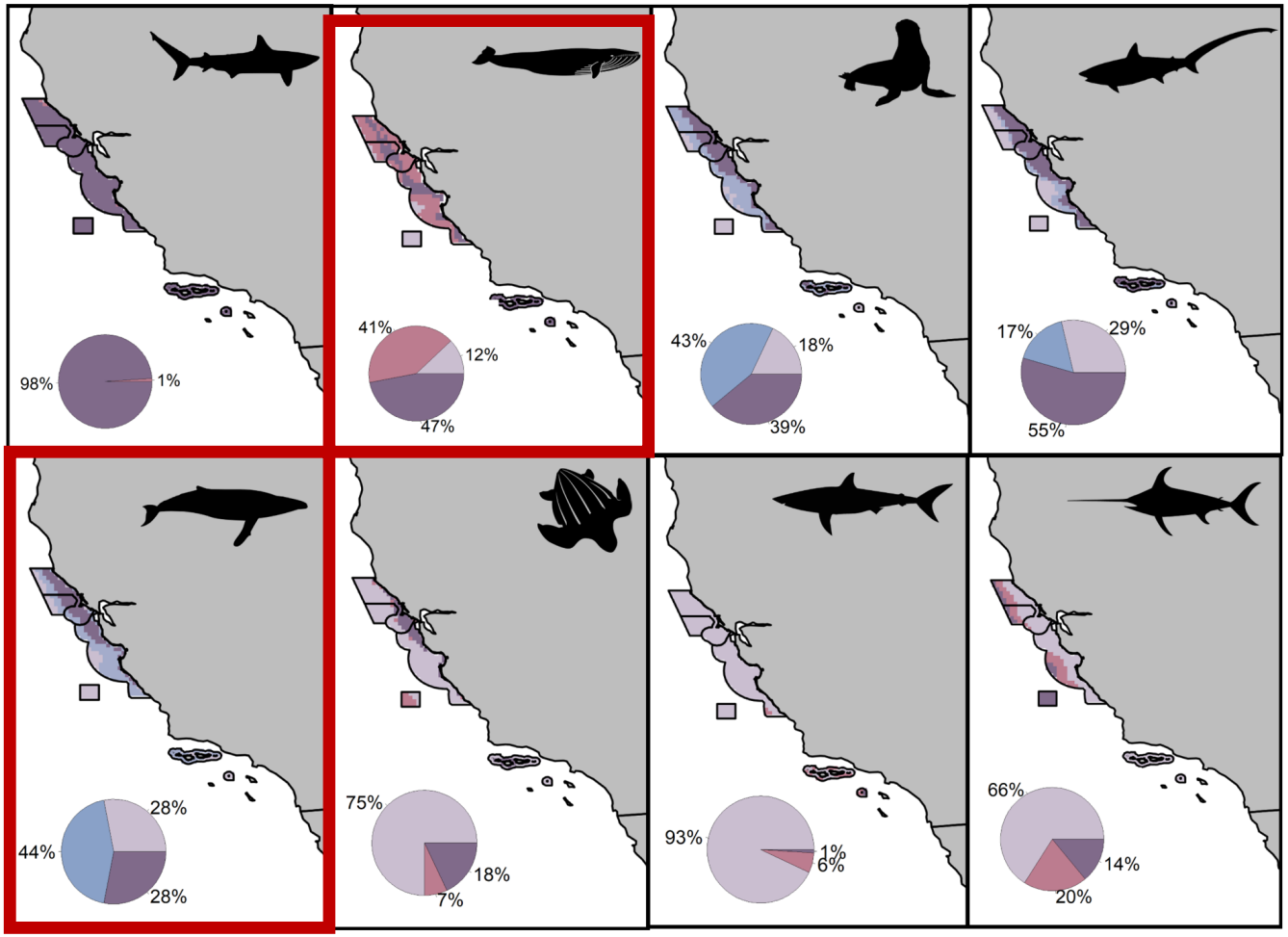


Results 2. Identify climate refugia & bright spots

Assessing historic and future habitat in NMS for fished and protected species

Developed for use in strategic planning by West Coast Sanctuaries

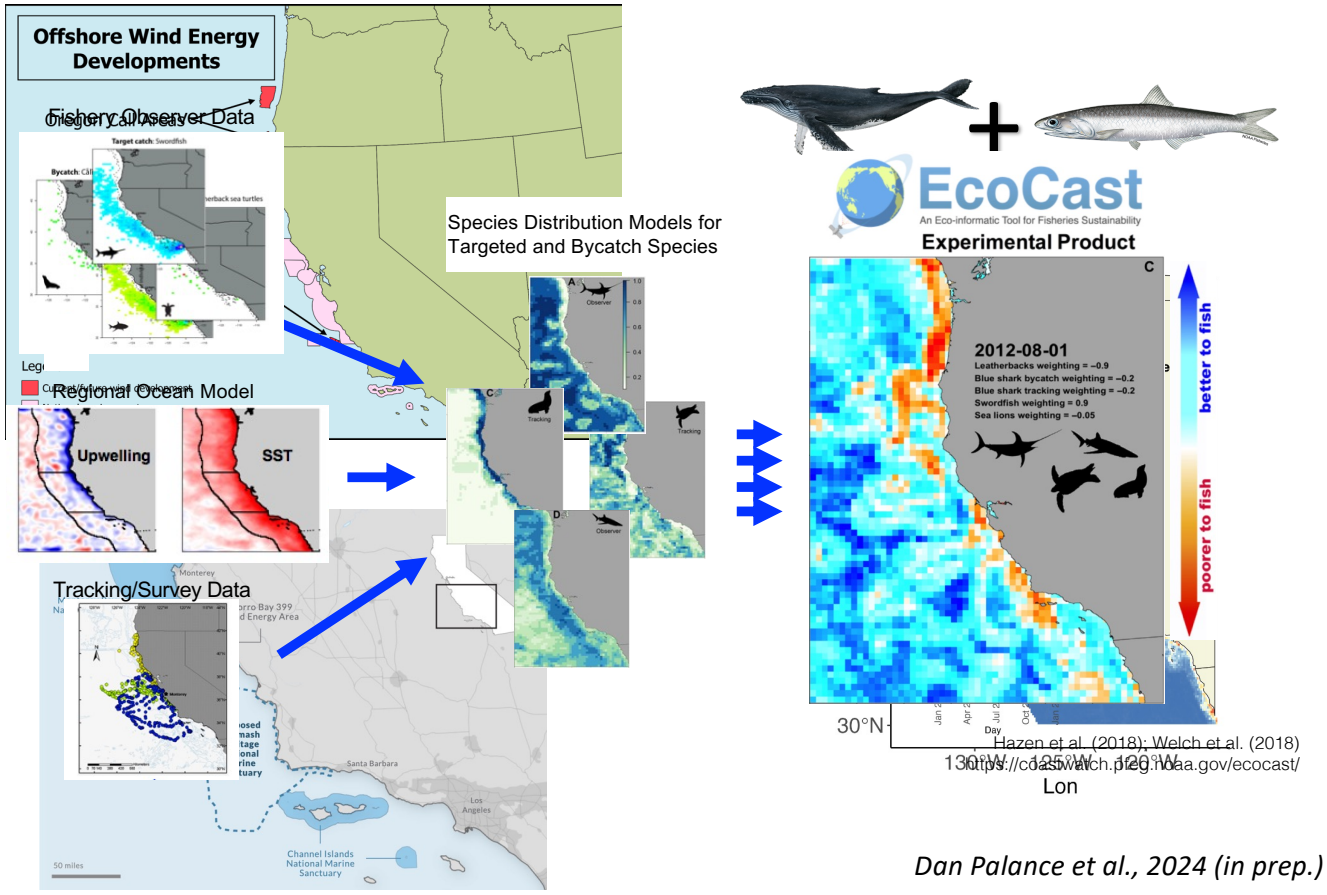
- Bright Spot (suitable habitat emerges)
- Climate Refugia (suitable habitat remains)
- Unsuitable (unsuitable now and future)
- Risk of loss (suitable habitat is lost)



Applications

Marine Spatial Planning

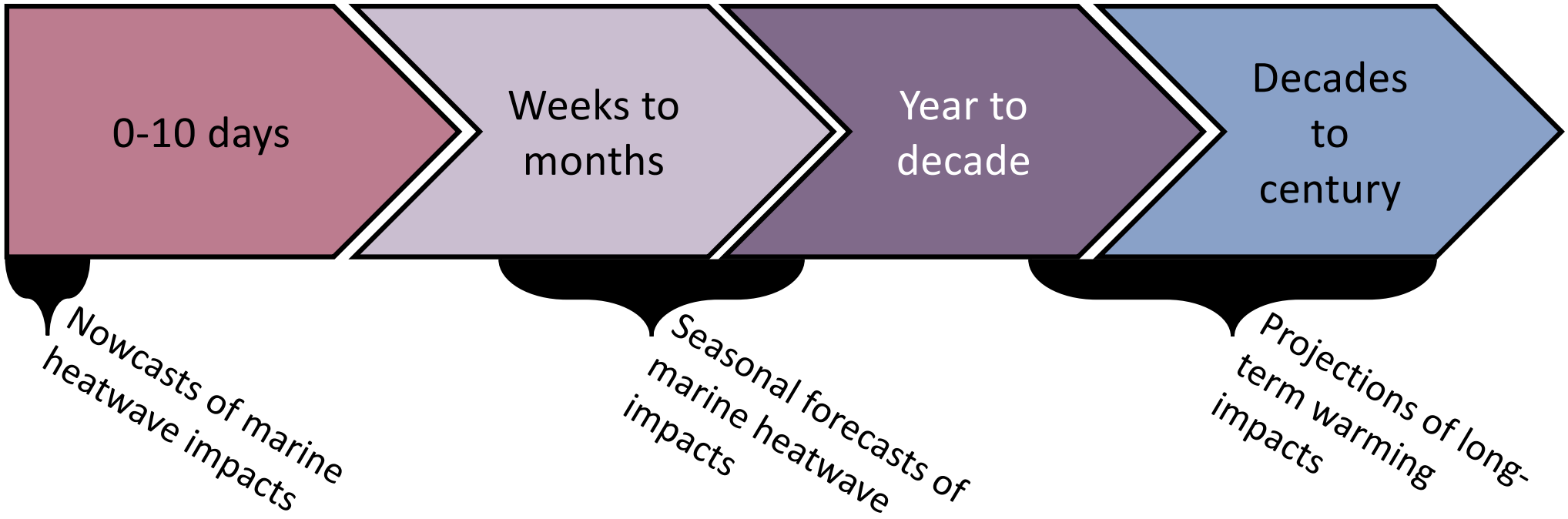
- Spatial closures (fisheries)
- National Marine Sanctuaries
- Chumash designation planning
- Long term planning & development (WEIAs)
- Overlap between predators-prey
- Informing ecosystem models



Dan Palance et al., 2024 (in prep.)

Conclusions

We **can** build an integrated portfolio across scales to improve our ability to assess climate variability & change.



Summary and synthesis

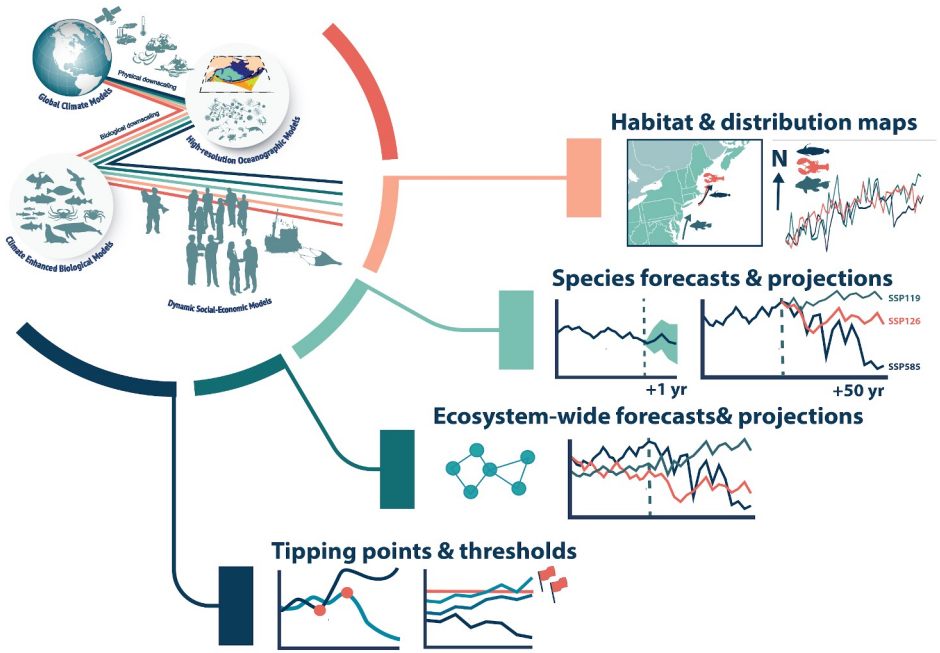
Climate variability and change are increasing the need for climate-ready tools and management approaches

- Nowcasts can provide information on species distribution at finer temporal scales (e.g. via ecosystem status reports) to help make targeted and responsive decisions.
- Forecasts can be used as an early warning indicator for management decisions similarly to how we prepare for El Niño / La Niña conditions.
- A suite of nowcasts, forecasts, and projections can inform multiple management decision targets **and** can serve as climate-ready management approaches as species and the humans that depend on them shift

Climate, Ecosystems, and Fisheries Initiative (CEFI): forecasts in support of fisheries management and adaptation strategies

- Provide a national capacity for sustained provision of regional ocean and climate information **across LMR management time scales**.

Ocean Predictions **Decision Support Teams**



Slide from Cisco Werner