EcoCast: Improving Ecological and Economic Sustainability of Fisheries Using Remotely-sensed Oceanographic Data

Management in the Moving Ocean

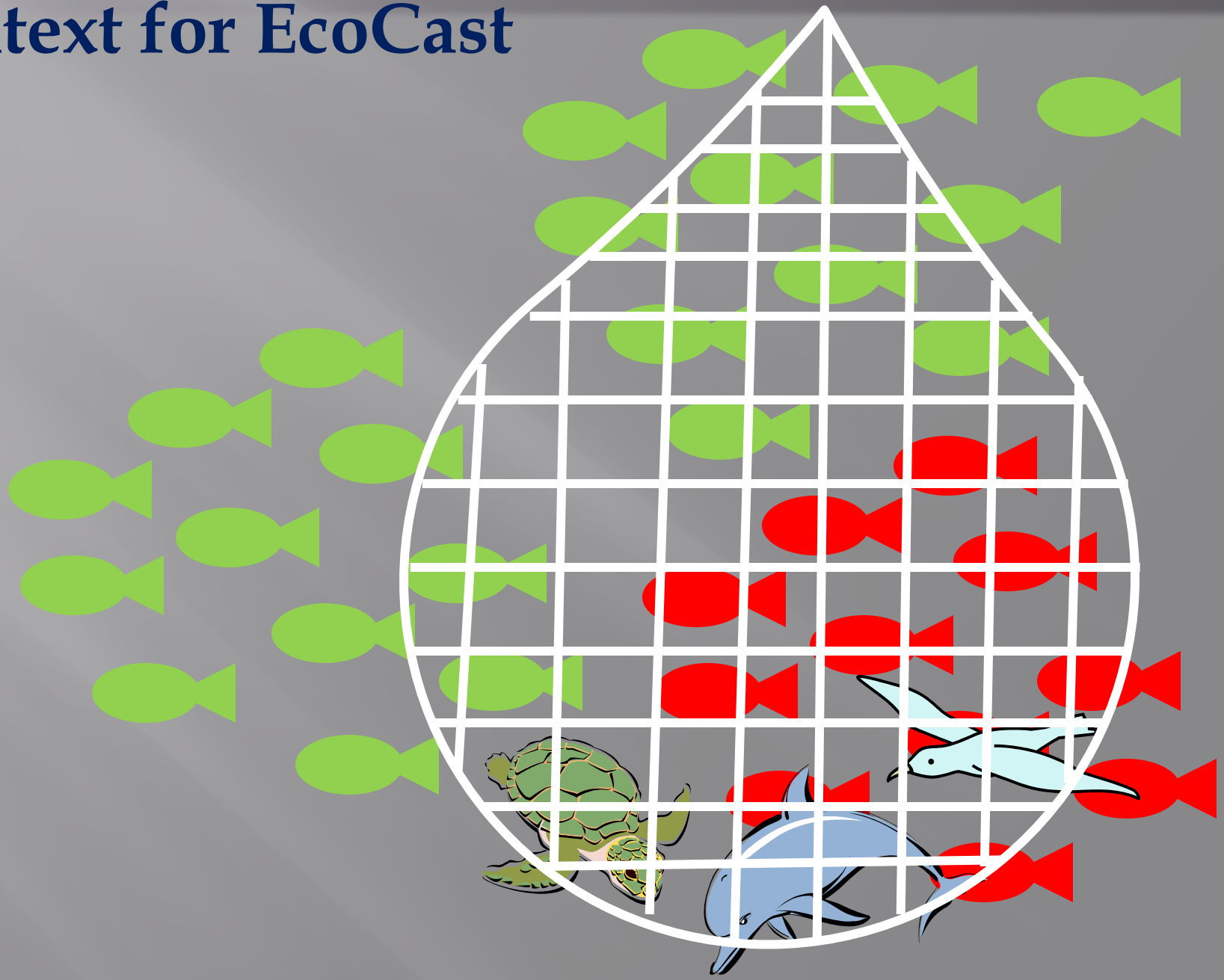
Rebecca Lewison
San Diego State University
Biodiversity and EcoForecasting, April 2018

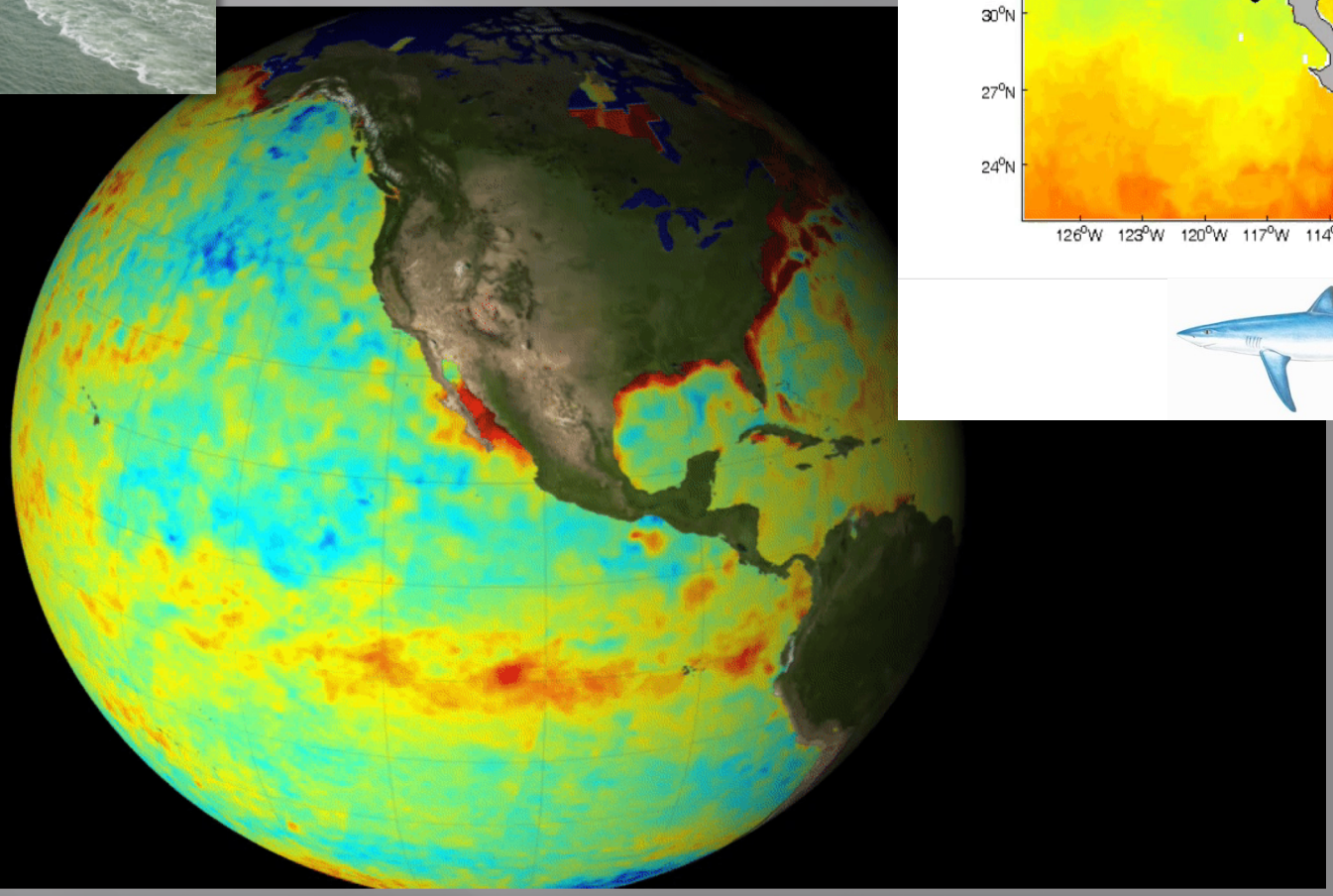
EcoCast

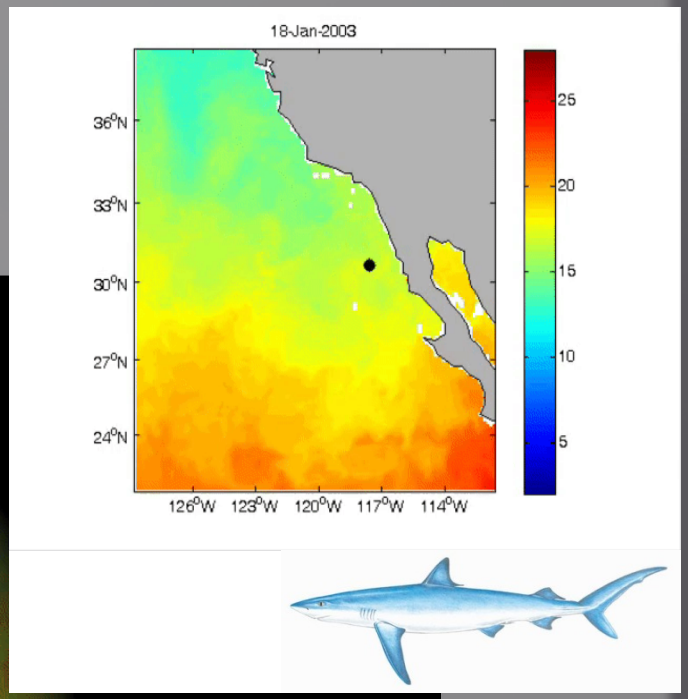
An Eco-informatic Tool for Fisheries Sustainability

- **Elliott Hazen**, Heather Welch, Stephanie Brodie, Stephen Bograd *NOAA*
- Kylie Scales, *Univ of Sunshine Coast*
- Dana Briscoe, *USC*
- Sara Maxwell, Nick Sisson *Old Dominion*
- Helen Bailey, *Univ of Maryland*
- Larry Crowder, *Stanford*

Context for EcoCast






18-Jan-2003
36°N
33°N
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27°N
24°N
126°W
123°W
120°W
117°W
114°W
25
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15
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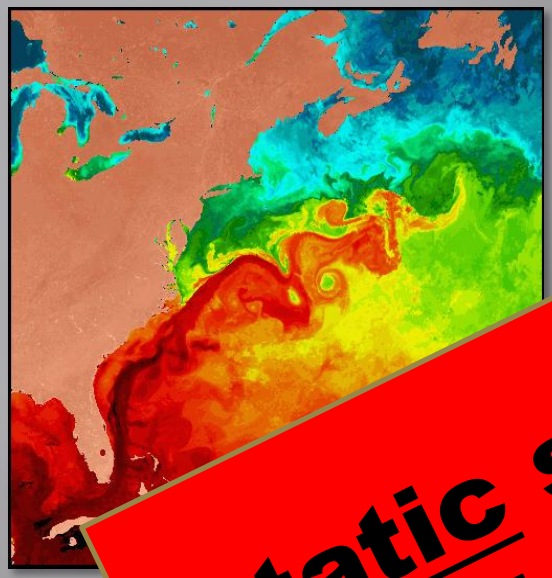
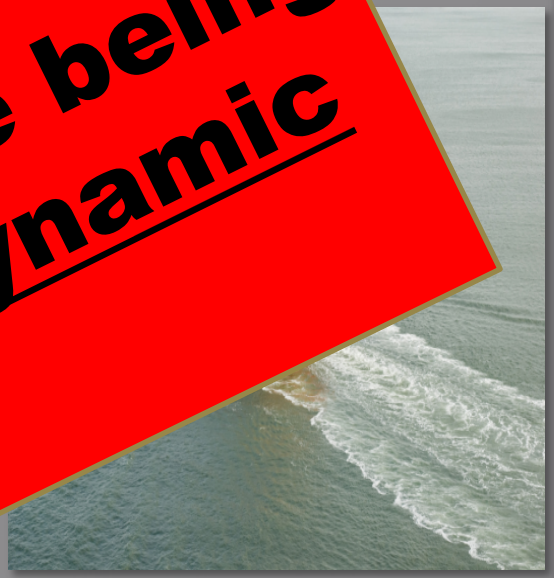




s ure human uses

are all dynamic

<u>Static</u> structures are being used to manage <u>dynamic</u> oceans

Dynamic ocean management

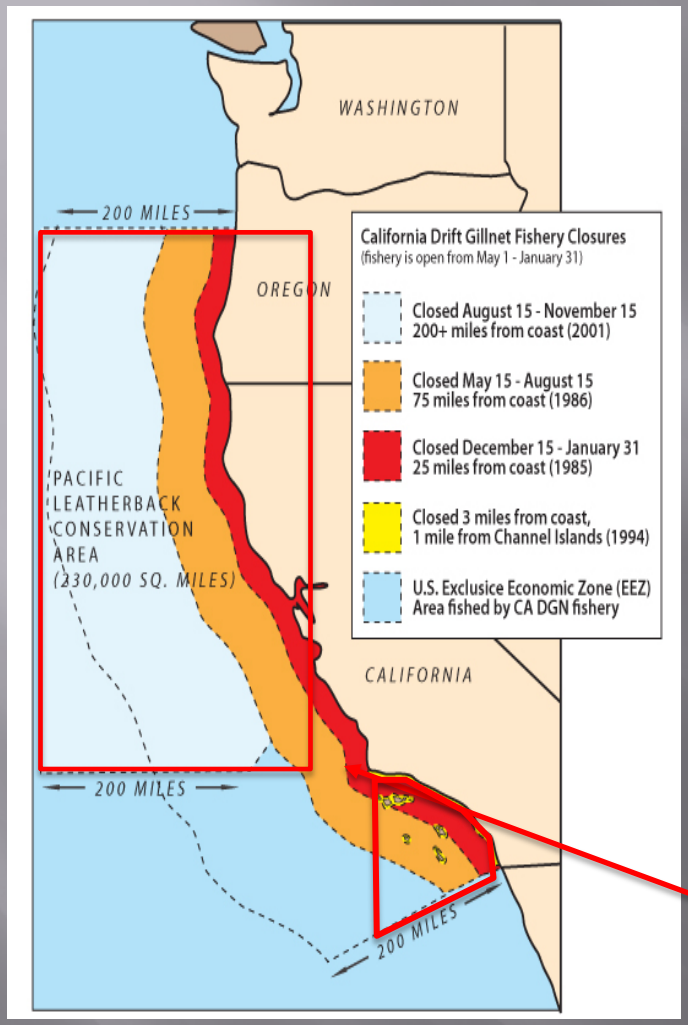
uses real-time and near real-time data to support management responses that can change in space and time, at scales relevant for animal movement and human use.

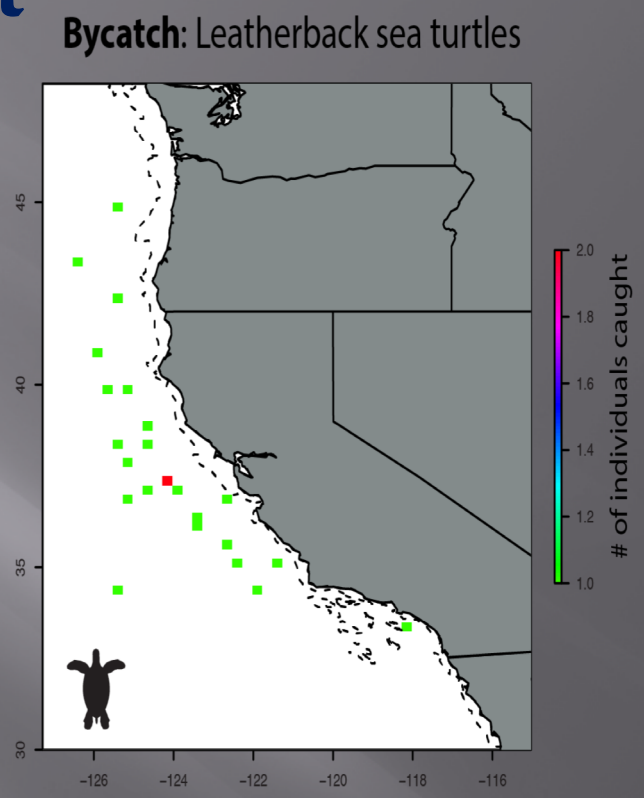
diverse data to support responsive management that can change in space/time

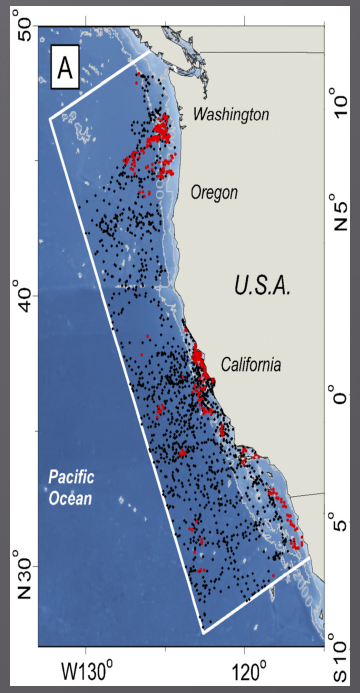
(Hobday et al. 2014, Lewison et al. 2015, Maxwell et al. 2015)

EcoCast is a dynamic ocean mgmt application that uses RS and in-situ biological data to support fisheries sustainability

Context for EcoCast







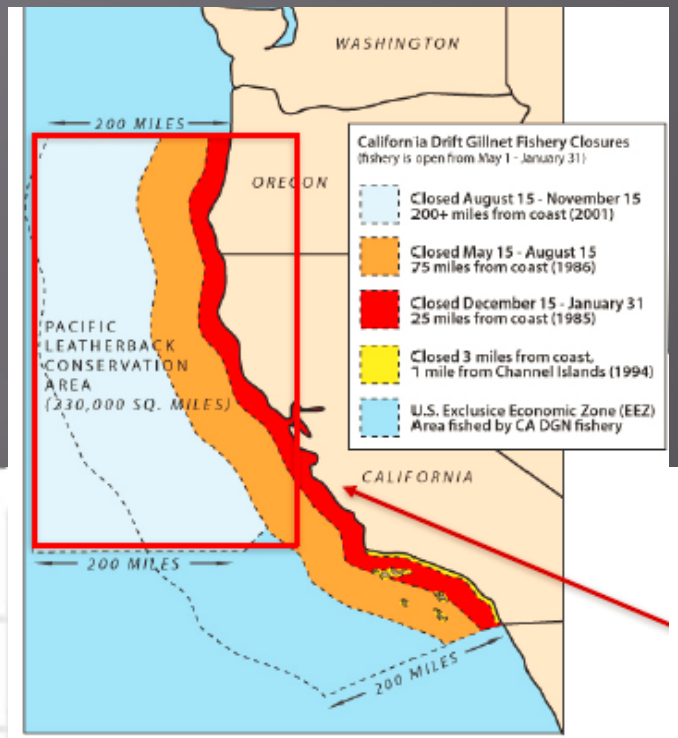
Benson et al 2011

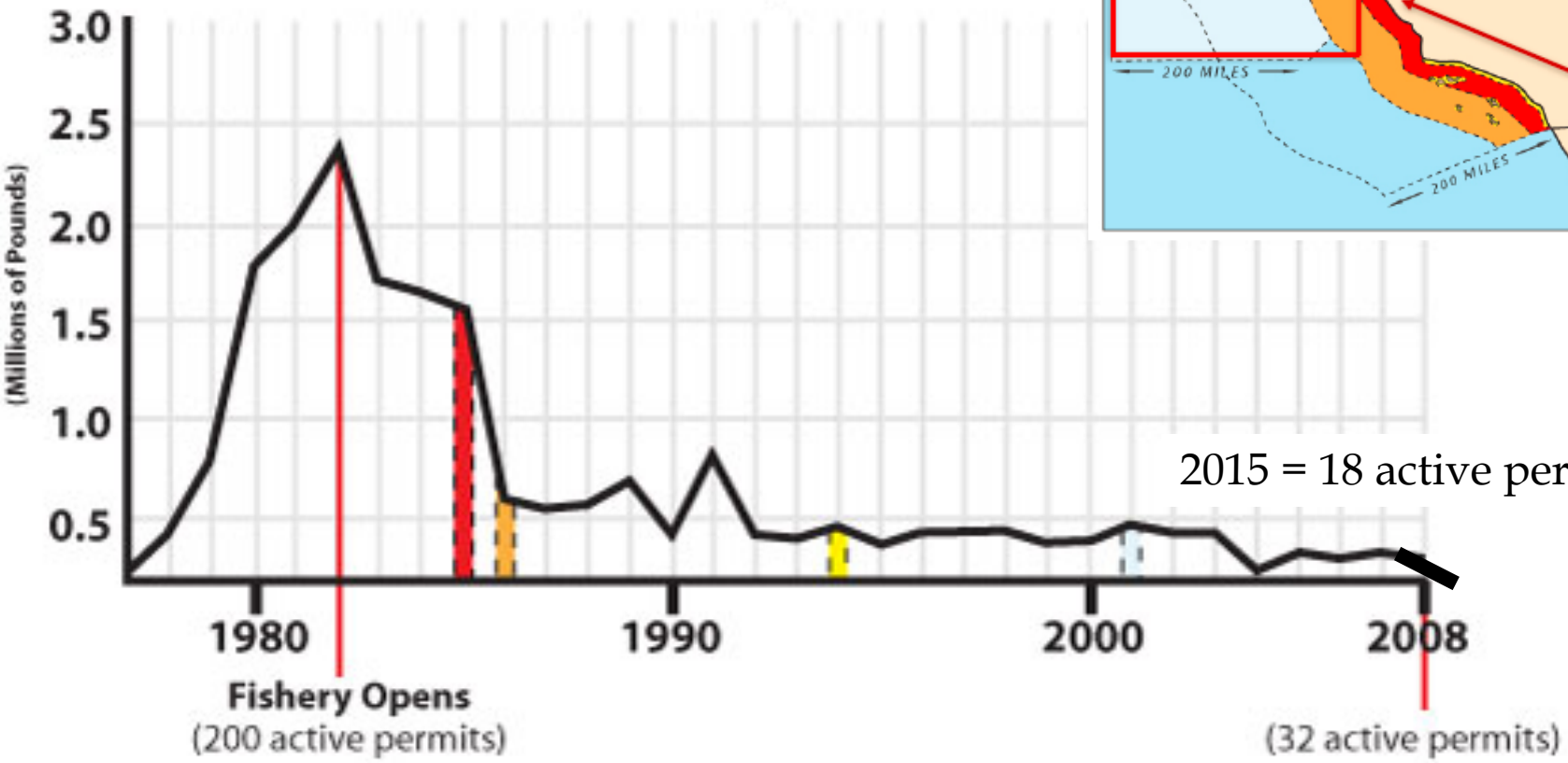
Large seasonal closure put into place in 2001 to protect critically endangered leatherbacks

….loggerhead closure during El Niño events

Context for EcoCast

SIGNIFICANT economic cost





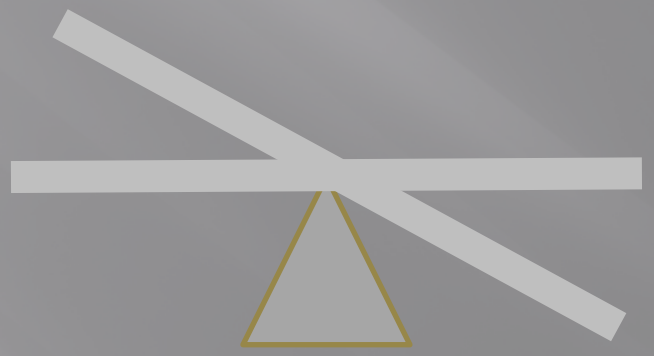
2015 = 18 active permits

Sources: California Department of Fish and Game and the National Marine Fisheries Service

EcoCast

An Eco-informatic Tool for Fisheries Sustainability

Ecological sustainability



Economic viability

EcoCast

An Eco-informatic Tool for Fisheries Sustainability

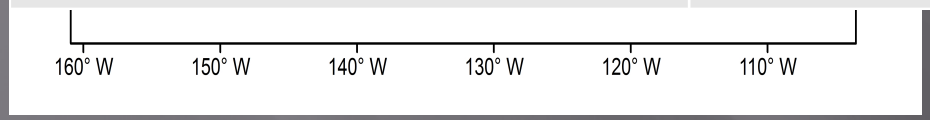
- Identifies areas where target catch probability is high and non-target catch probability is low

- DST to help managers and fishermen track distribution of target and non-target species as they shift in response to changing oceanographic conditions

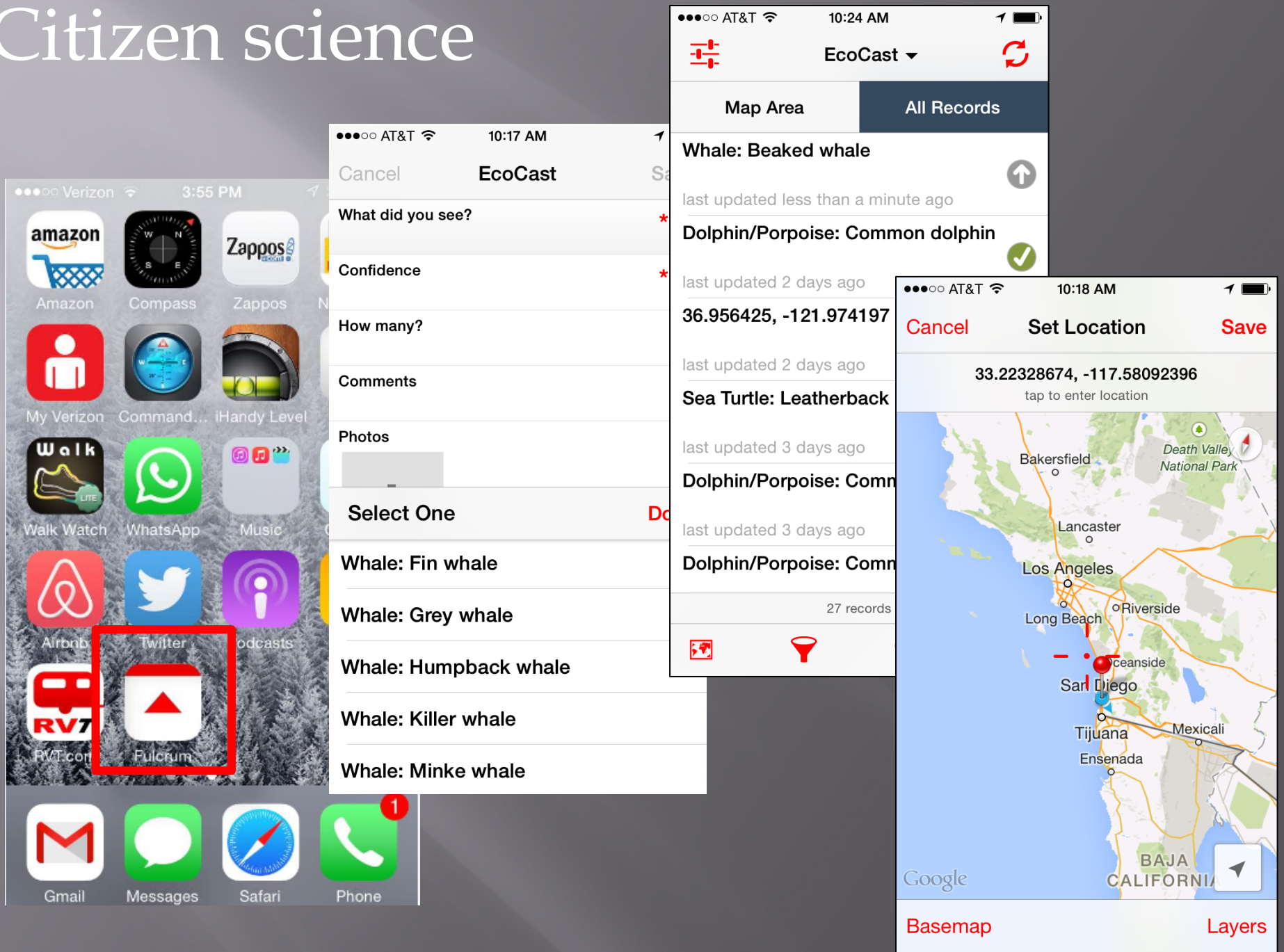
Data Types:

Satellite tracking data

Data Products	
SST and Standard Deviation	Daily – JPL GHRSST
Chl	8-day – SeaWIFS, MODIS, VIIRS composite
EKE	Daily – AVISO at 25km
SSHa and SD	Daily – AVISO/CMEMS at 25km
Y winds	8-day – QSCAT and ASCAT at 25km
Bathymetry and SD	ETOPO1 at 1’

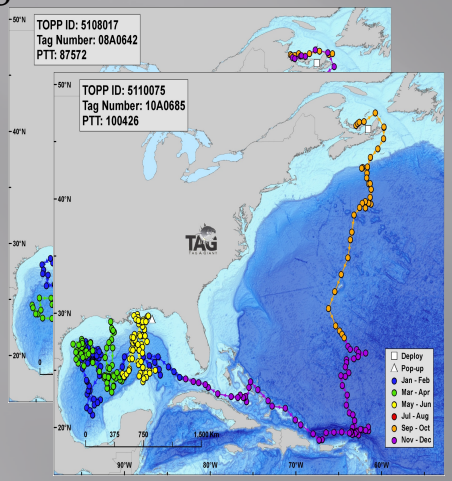


Citizen science

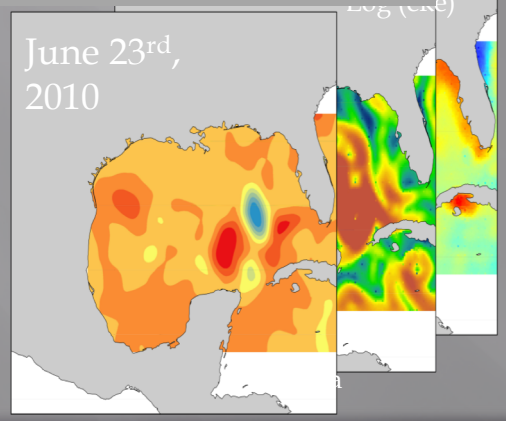


Methodological approach

Distribution / behavioral data
e.g. sightings data, tag data, foraging events



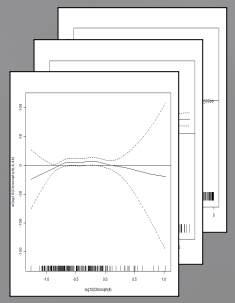
Oceanographic data



Fit

Statistical models

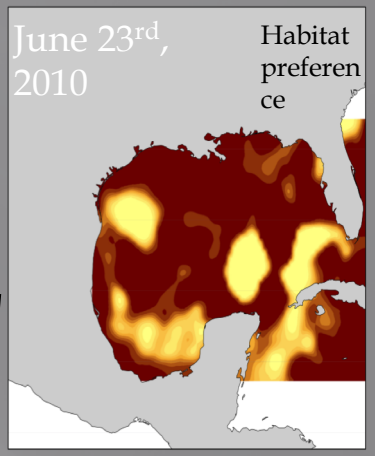
$$g(\mu) = \beta_0 + \beta_1 x_1 + \cdots + \beta_m x_m$$

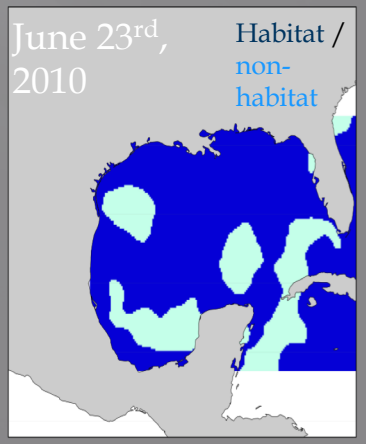


e.g. Generalized Additive Mixed Models (GAMMS), Boosted Regression Trees

Predict

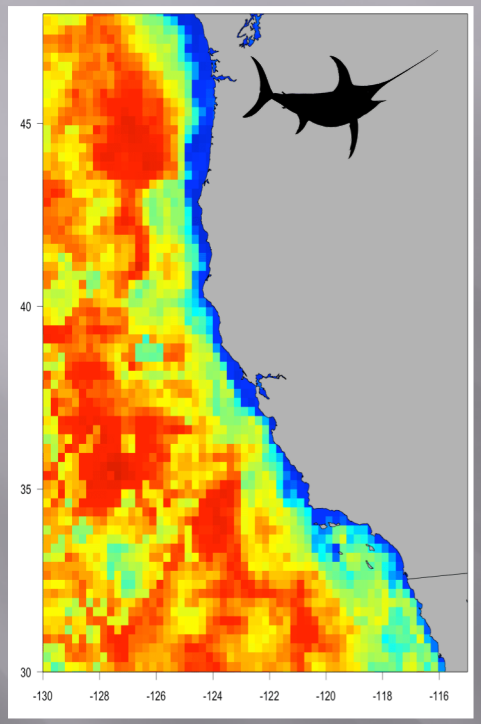
Probability of occurrence predicted from environmental covariates



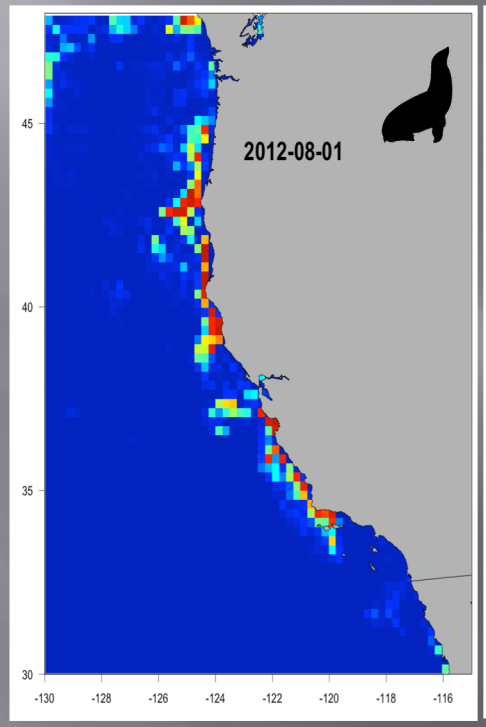


Species Distribution Models

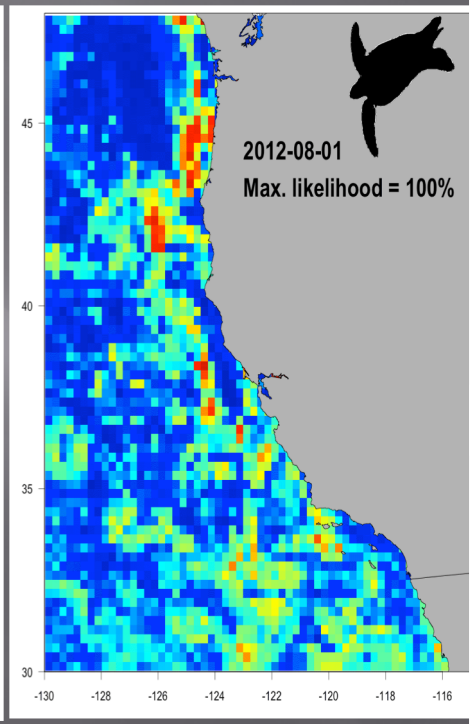
Swordfish Observer



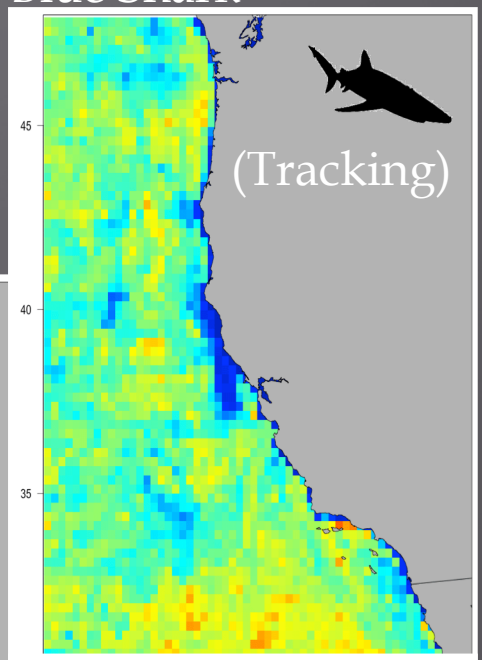
California Sea Lion

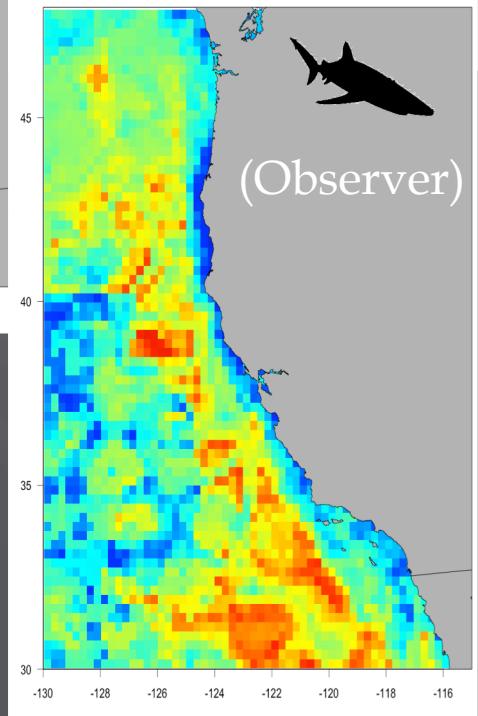


Leatherback Turtle



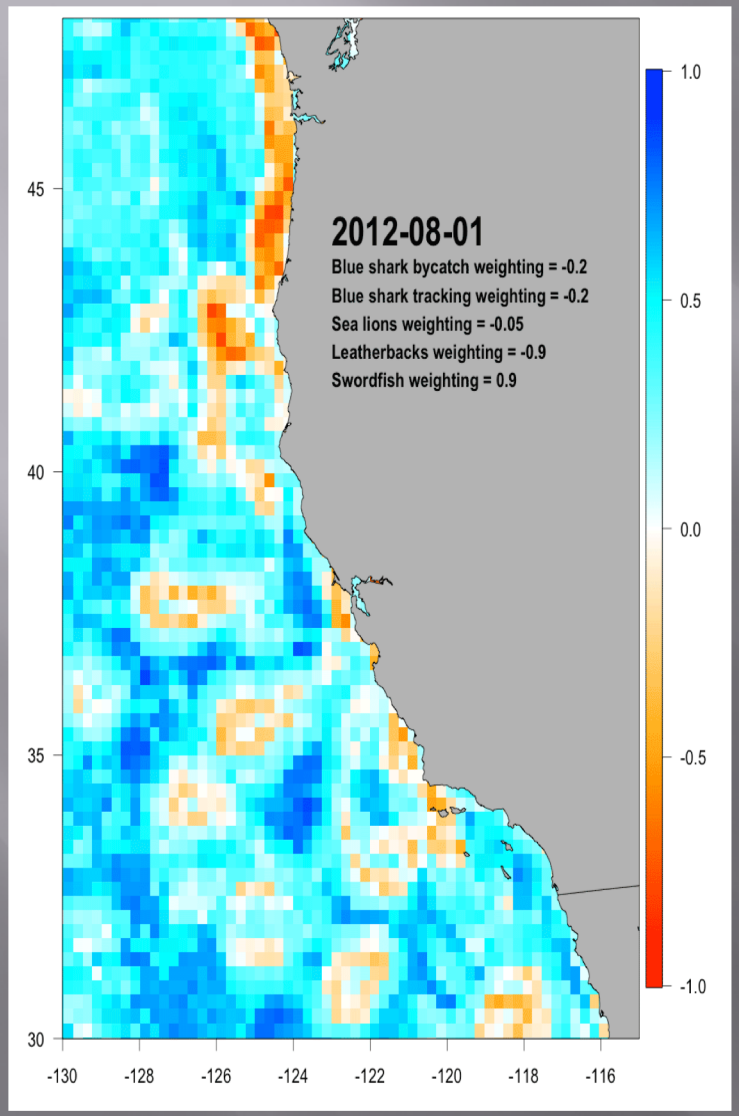
Blue Shark

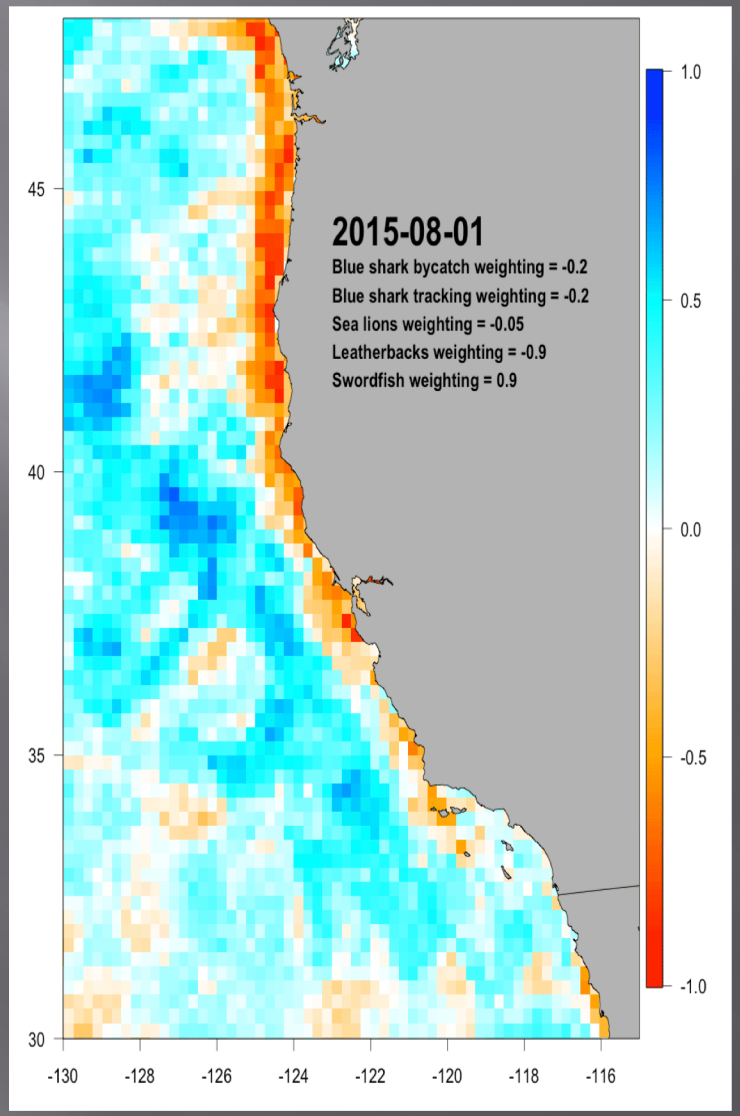




(Scales et al, 2018, Briscoe et al 2018, Maxwell et al. , in review)

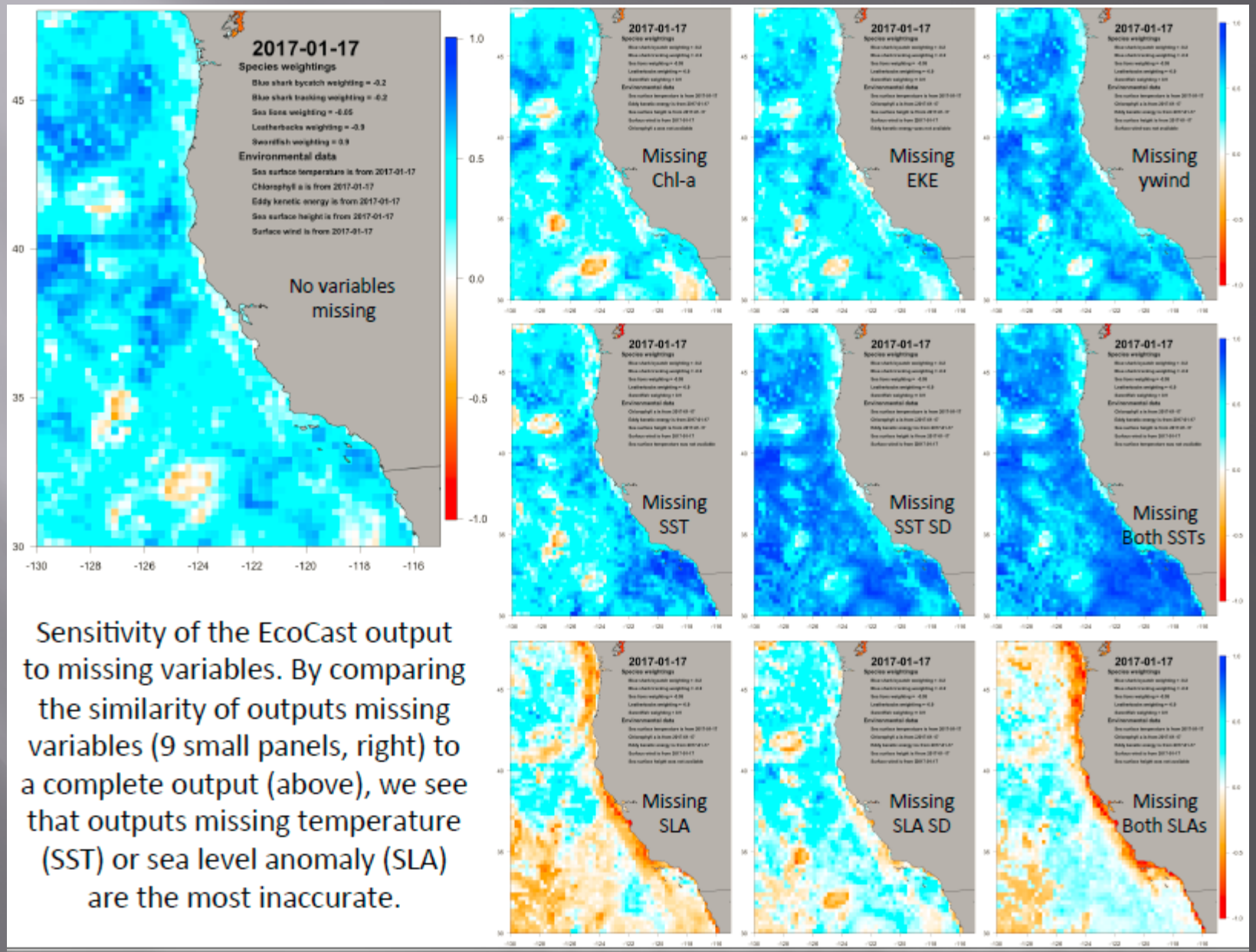
Integrated predictive surface





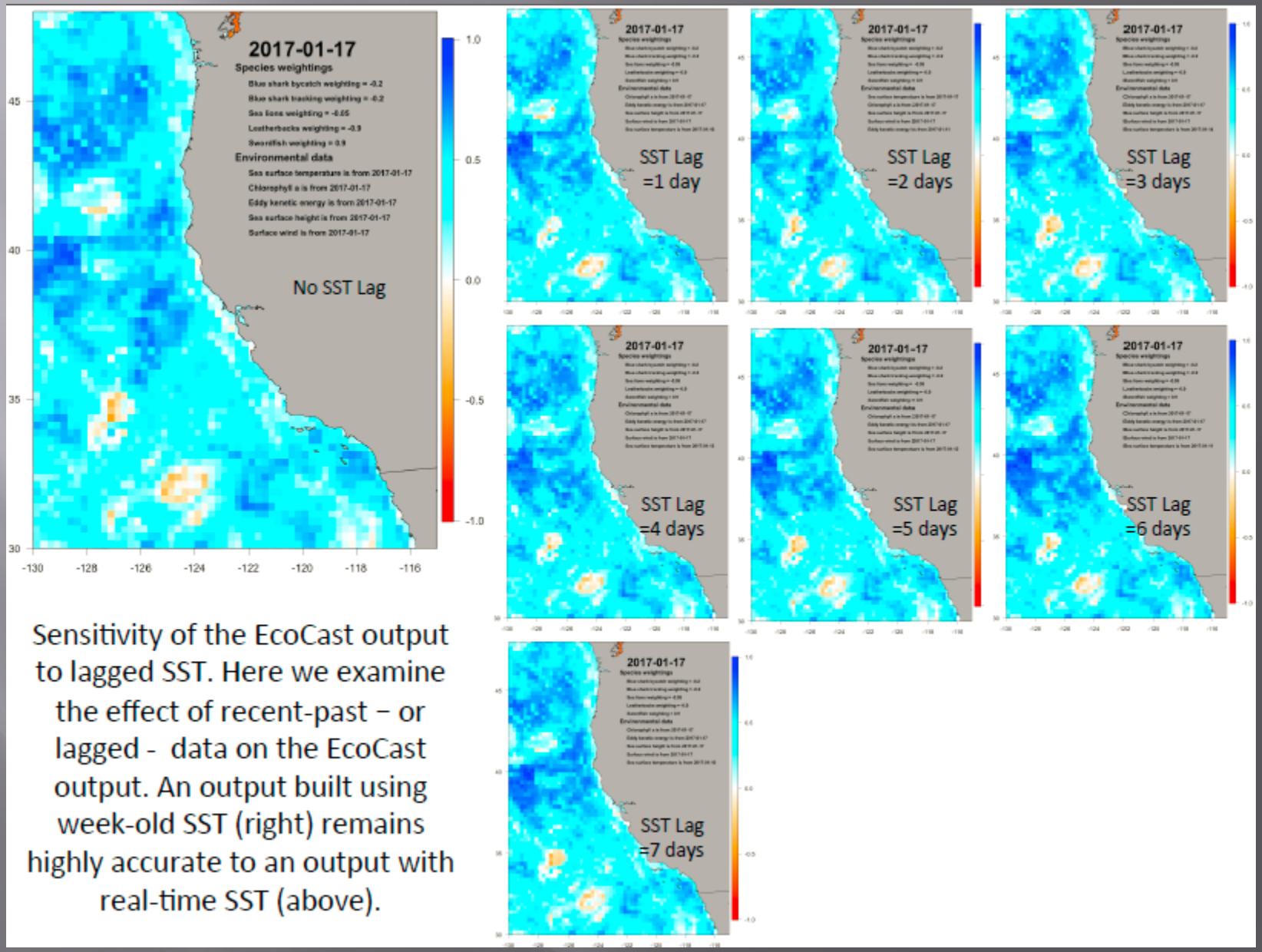
(Hazen et al., in press)

Sensitivity analyses: data gaps



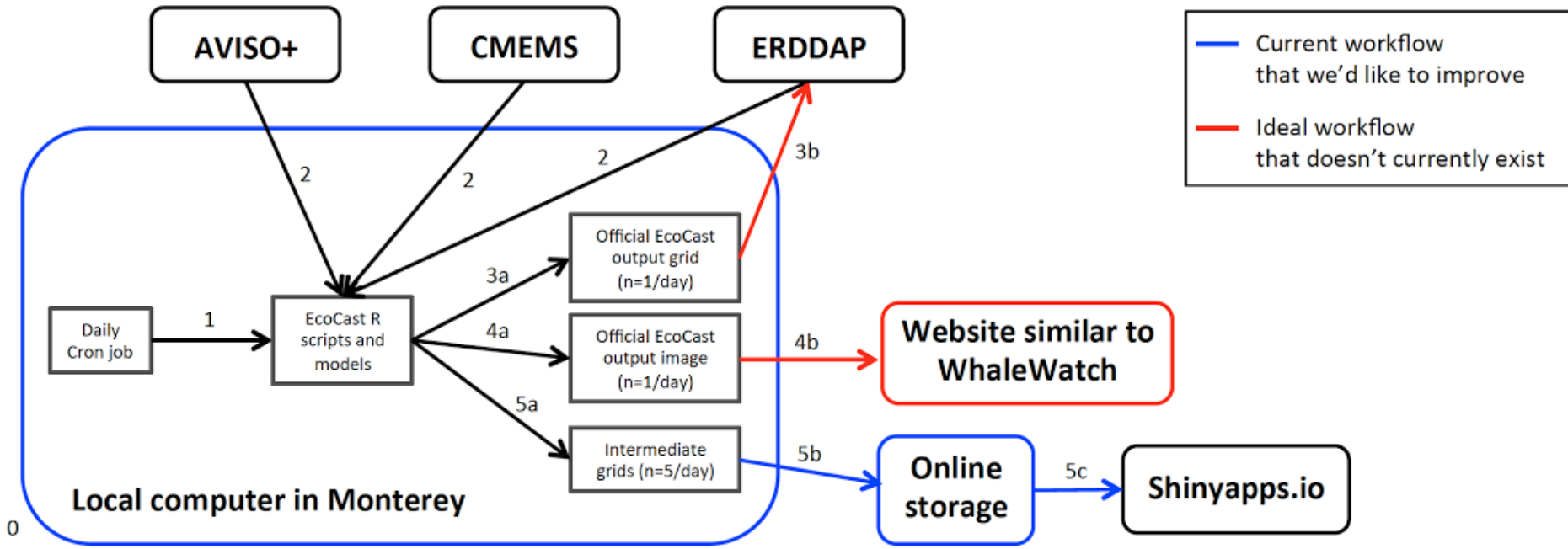
Sensitivity of the EcoCast output to missing variables. By comparing the similarity of outputs missing variables (9 small panels, right) to a complete output (above), we see that outputs missing temperature (SST) or sea level anomaly (SLA) are the most inaccurate.

Sensitivity analyses: time lags



Sensitivity of the EcoCast output to lagged SST. Here we examine the effect of recent-past – or lagged - data on the EcoCast output. An output built using week-old SST (right) remains highly accurate to an output with real-time SST (above).

Delivery to end-users



0. Entire EcoCast process is hosted on a computer in Monterey
1. A daily cron job initiates a series of R scripts
2. Real-time environmental data are acquired from online sources
3a. Official EcoCast output grid is created
3b. Grid is uploaded to ERDDAP where users can access official real-time and historical geospatial outputs
4a. Official EcoCast output image is created
4b. Image is uploaded to a site similar to WhaleWatch
5a. Intermediate data are created. These won't be disseminated to the public.
5b. Intermediate data are uploaded to online storage
5c. Rshiny app accesses intermediate data stored online as required by users

NOAA COASTWATCH WEST COAST REGIONAL NODE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

EcoCast

EcoCast Product | EcoCast Explorer | About EcoCast

Photo copyright: Mark Conlin

A Eco-Informatic Tool for Fisheries Sustainability

What is EcoCast?

EcoCast is a fisheries sustainability tool that helps fishers and managers evaluate how to allocate fishing effort to optimize the sustainable harvest of target fish while minimizing bycatch of protected or threatened animals.

View details »

Finding a good place to fish

The EcoCast Product combines the predicted distributions of target catch species and bycatch species into a single map that suggests better and poorer locations to fish off the US West Coast.

View the map »

Scenario analysis

EcoCast Explorer gives users an opportunity to run scenario analyses to explore how the EcoCast product works. Users are able to generate predictive maps for specific dates, for single species, and can change the species weightings. This tool gives users the ability to explore how species are responding to changing ocean conditions, and how that can influence the EcoCast Product.

Run Analyses »

Daily product

NOAA COASTWATCH WEST COAST REGIONAL NODE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

EcoCast

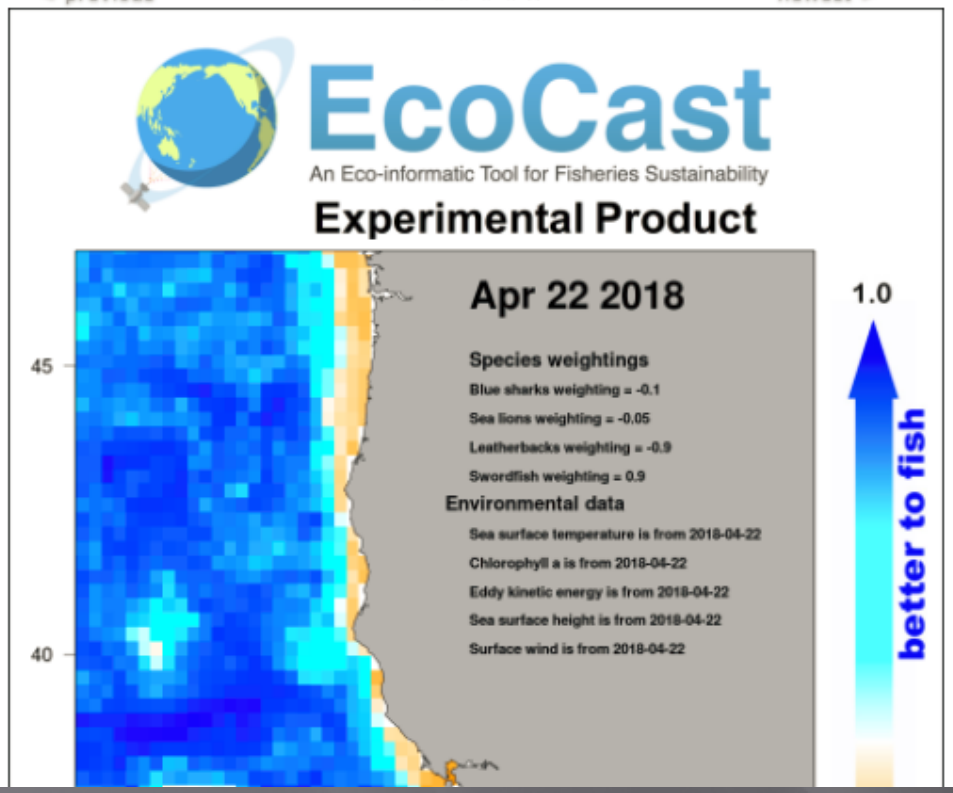
EcoCast Product | EcoCast Explorer | About EcoCast

EcoCast Product

Product only page

Most recent daily products

< previous newest >



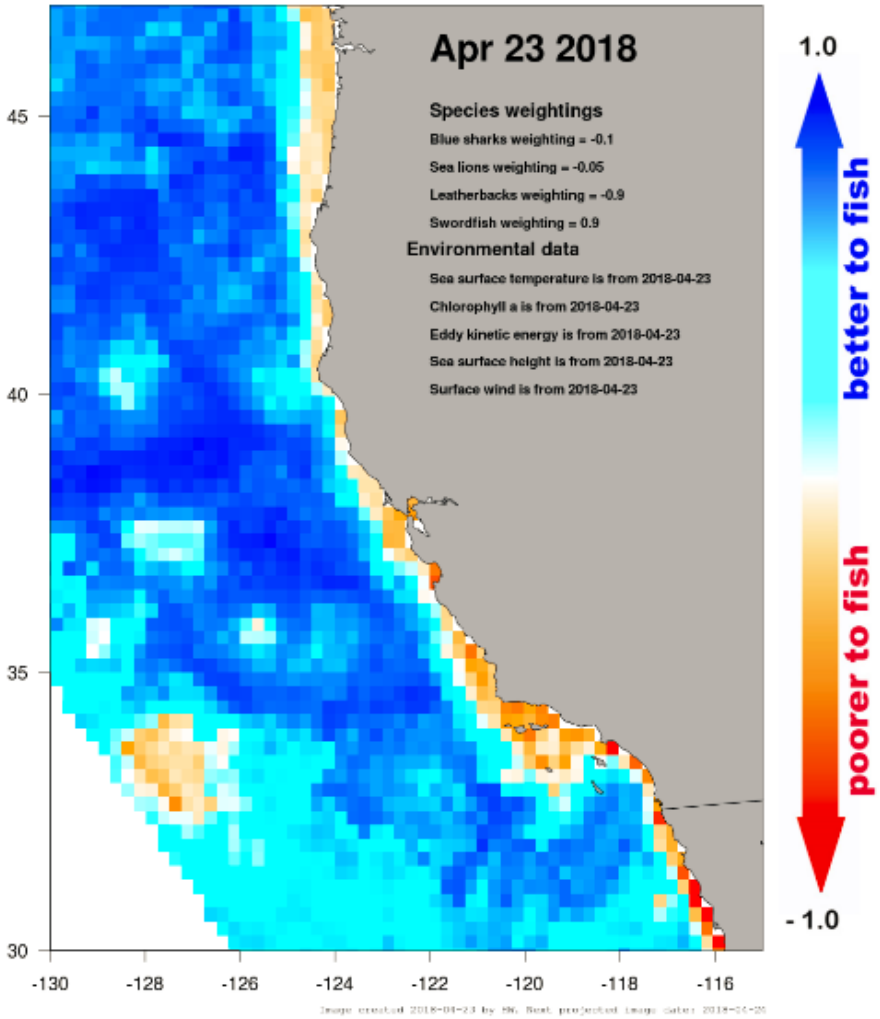
Product FAQs

- What is the EcoCast product?
- How do I use the product?
- How is the product made?
- How are the species weightings determined?
- What environmental data are used?
- Can I download the product as a data file?
- Can I access the environmental data?

EcoCast

An Eco-informatic Tool for Fisheries Sustainability

Experimental Product



EcoCast is a dynamic ocean management tool that aims to minimize fisheries bycatch and maximize fisheries target catch in real-time. Map shows daily relative bycatch:target catch probabilities. Species weightings reflect management priorities and recent catch events. Environmental data are used to predict where species are likely to be each day.

Contacts: elliott.hazen@noaa.gov and heather.welch@noaa.gov
Environmental Research Division, SWFSC, NMFS, NOAA
99 Pacific Street, Monterey CA 93940, USA

EcoCast

EcoCast Product | EcoCast Explorer | About EcoCast

EcoCast Explorer

Information and Instructions

EcoCast Explorer

EcoCast

Date to show

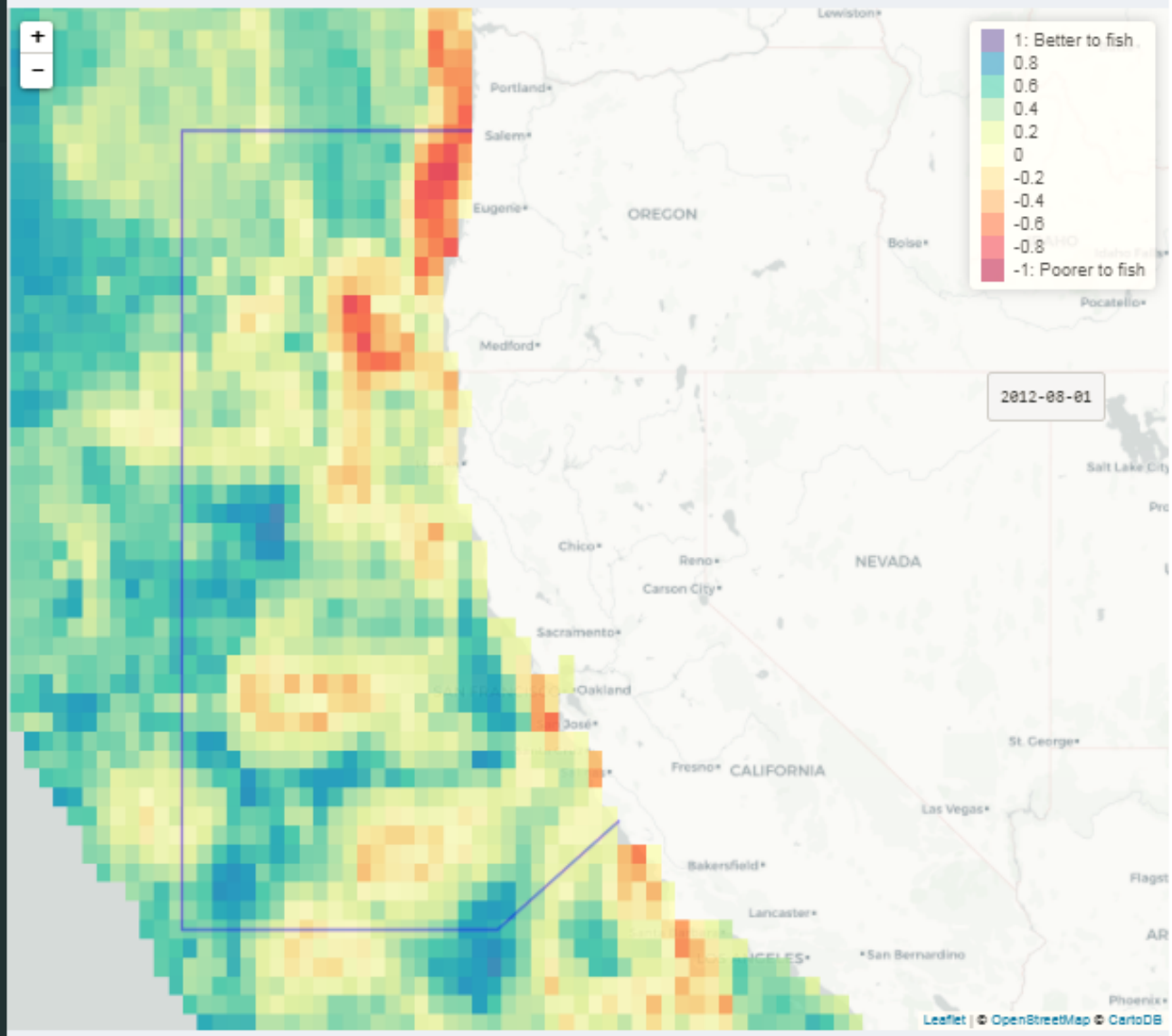
2012-08-01

Adjust species weightings

Filter map

Add map elements

Change extent



Ecology and Evolution
Open Access

ORIGINAL RESEARCH | Open Access

Characterizing habitat suitability for a central-place forager in a dynamic marine environment

Dana K. Briscoe, Sabrina Fossette, Kylie L. Scales, Elliott L. Hazen, Steven J. Bograd, Elizabeth A. McHuron, Patrick W. Robinson, Carey Kuhn, Daniel P. Costa, ... See all au

Fit to predict? Eco-informatics for predicting the catchability of a pelagic fish in near real time

Kylie L. Scales,[1,2,3,8] Elliott L. Hazen,[1,2] Sara M. Maxwell,[4] Heidi Dewar,[5] Suzanne Kohin,[5] Michael G. Jacox,[1,2] Christopher A. Edwards,[1] Dana K. Briscoe,[6] Larry B. Crowder,[6] Rebecca L. Lewison,[7] and Steven J. Bograd[2]

A Rubric to Evaluate Citizen-Science Programs for Long-Term Ecological Monitoring

CATHERINE A. TREDICK, REBECCA L. LEWISON, DOUGLAS H. DEUTSCHMAN, TIMOTHY ANN HUNT, KAREN L. GORDON, AND PHOENIX VON HENDY

Journal of Applied Ecology
British Ecological Society
Journal of Applied Ecology 2016 doi: 10.1111/1365-2664.12755

FORUM

Integrating research using animal-borne telemetry with the needs of conservation management

frontiers

Integrating dynamic subsurface habitat metrics into species distribution models

Science Advances
AAAS

Hazen et al.

A dynamic ocean management tool to reduce bycatch and support sustainable fisheries

2018 OCEAN SCIENCES MEETING

Dynamic ocean management:

Supporting sustainable use of the ocean

Opportunities, challenges and solutions

Monday, February 12, 2018: 12:45 PM - 1:45 PM

Oregon Convention Center, E141-E142

Food, drinks, networking, community engagement! Space is limited. RSVP at https://www.eventbrite.com/ (search for dynamic ocean).

Distribution and Implementation

- Industry

- NOAA
- Outreach/training/testing - fishers
- Council

EcoCast

An Eco-informatic Tool for Fisheries Sustainability

- EcoROMS – higher spatial res, integrating subsurface habitat metrics

- EcoFronts- Lagrangian Coherent Structures (LCS) associated with sub-mesoscale features

- EcoCast applications in other US fisheries

EcoCast

An Eco-informatic Tool for Fisheries Sustainability

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