



**EcoCast: Improving Ecological and Economic
Sustainability of Fisheries Using Remotely-sensed
Oceanographic Data**
Management in the Moving Ocean

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San Diego State University
Biodiversity and EcoForecasting, May 2017



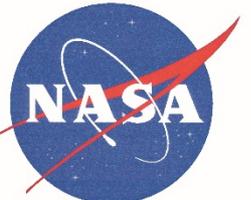
Project team



Primary Investigators: Dr. Rebecca Lewison, Dr. Elliott Hazen

Co-PIs: Dr. Steven Bograd, Dr. Sara Maxwell, Dr. Larry Crowder, Dr. Helen Bailey

Research Team: Dr. Kylie Scales, Dr. Dana Briscoe, Ms. Sabrina Foss



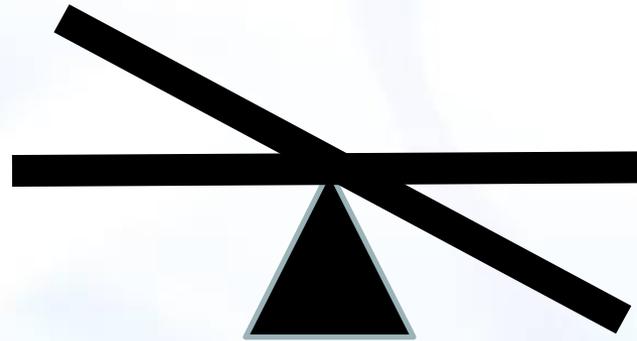


What is EcoCast?

- A DS tool to help managers and fishermen track distribution of target and non-target species
- Built on the assertion that distributions shift in response to changing oceanographic conditions
- EcoCast designed to identify areas where target catch probability is high and non-target catch probability is low (**multiple species**).

Why EcoCast?

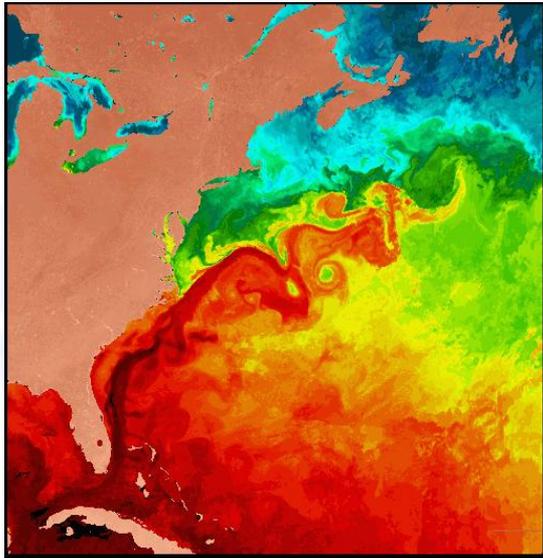
**Ecological
sustainability**



**Economic
viability**

- Opportunity to use cutting edge SDM and RS science to support fisheries sustainability

Why EcoCast?



seascapes



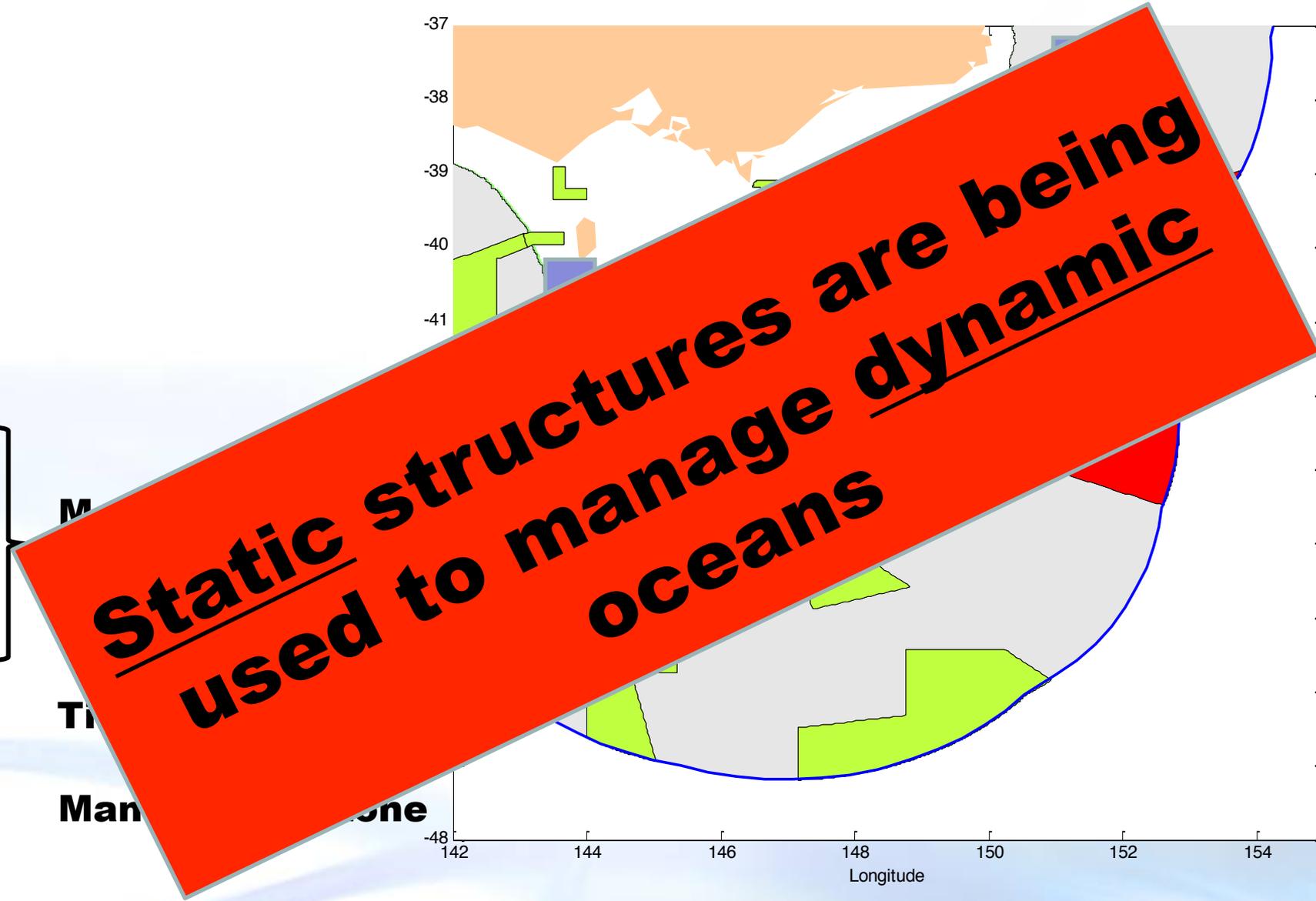
marine life



human uses

are all dynamic

Why EcoCast?



M

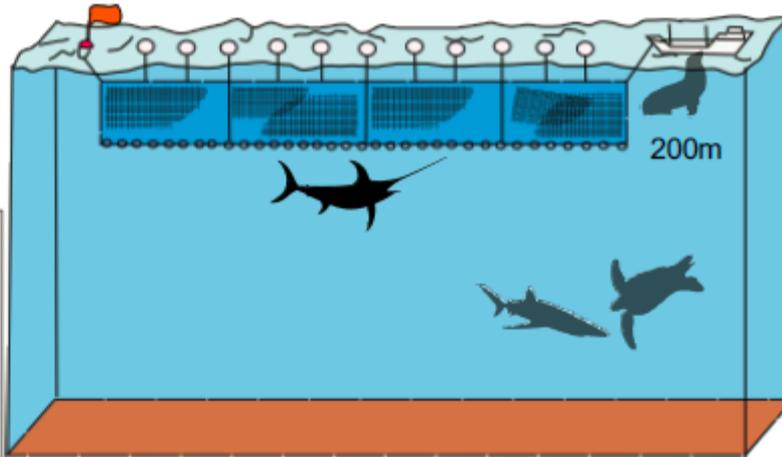
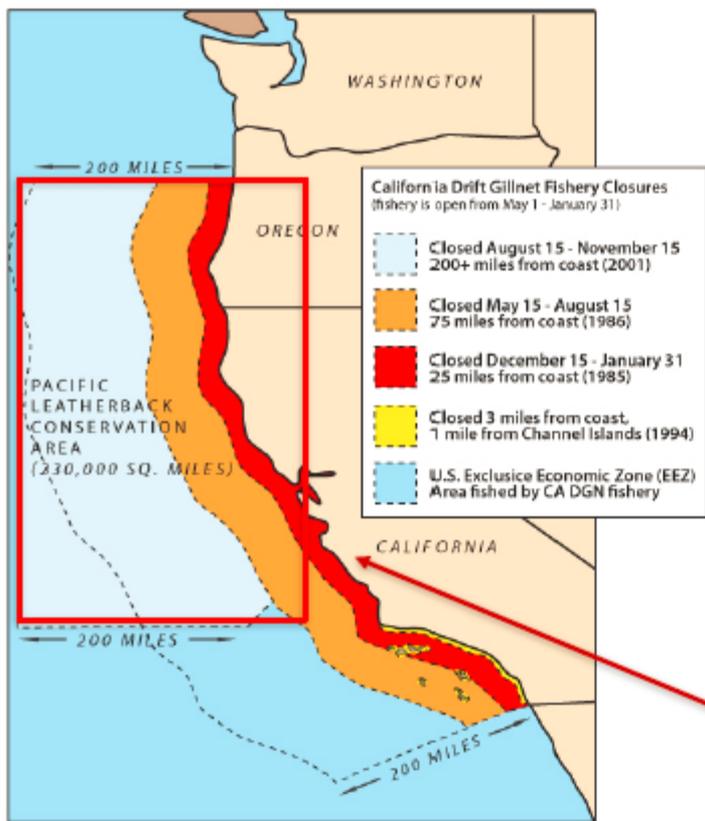
T

Man Management Zone

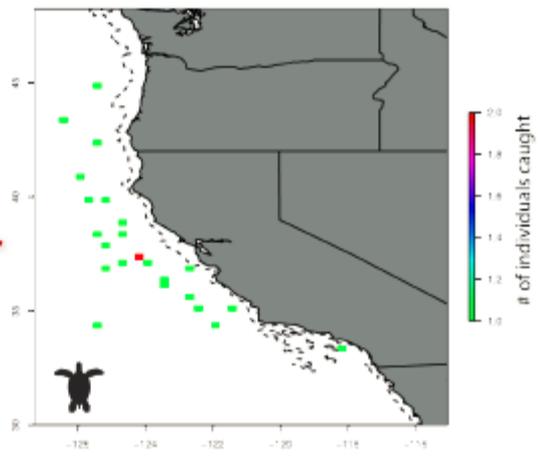
Longitude

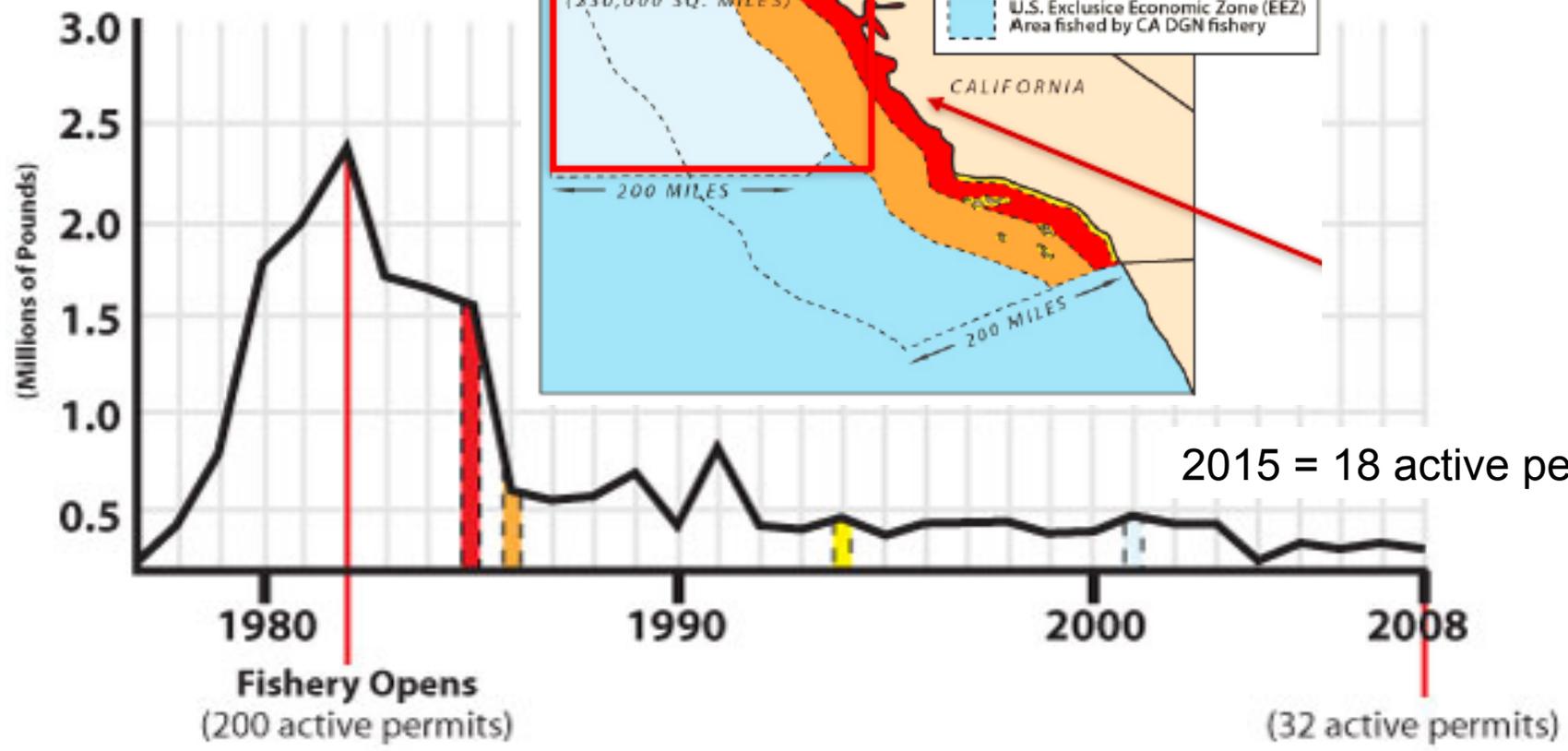
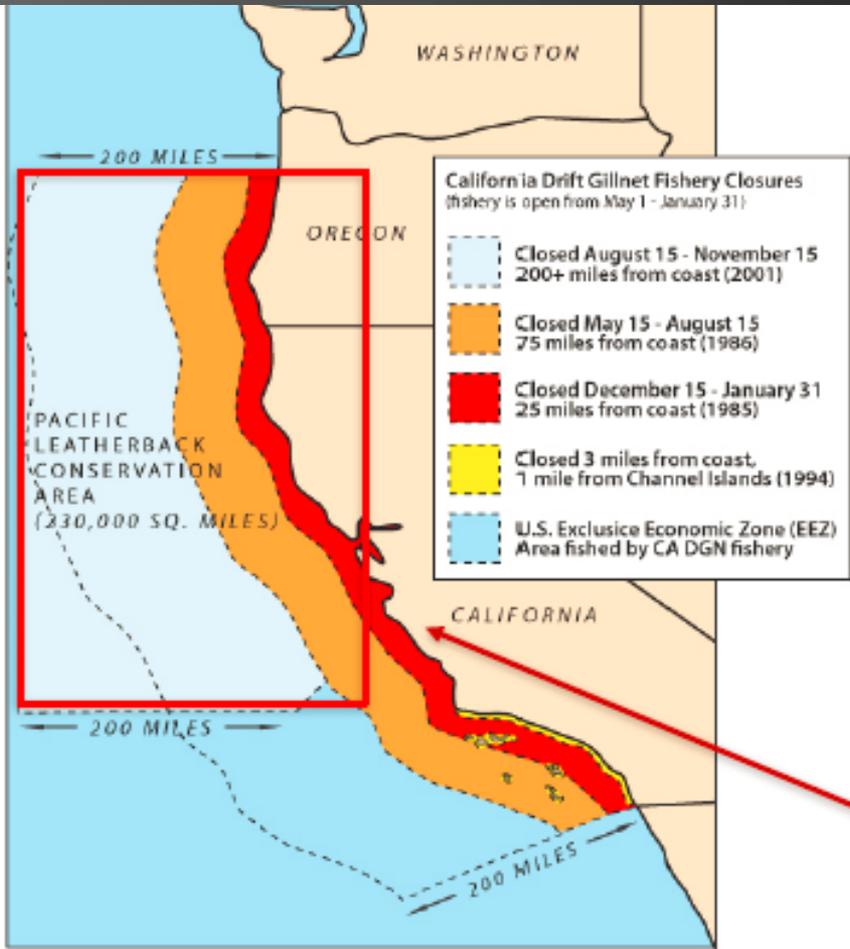
What is EcoCast?

California Drift Gillnet Fishery



Bycatch: Leatherback sea turtles

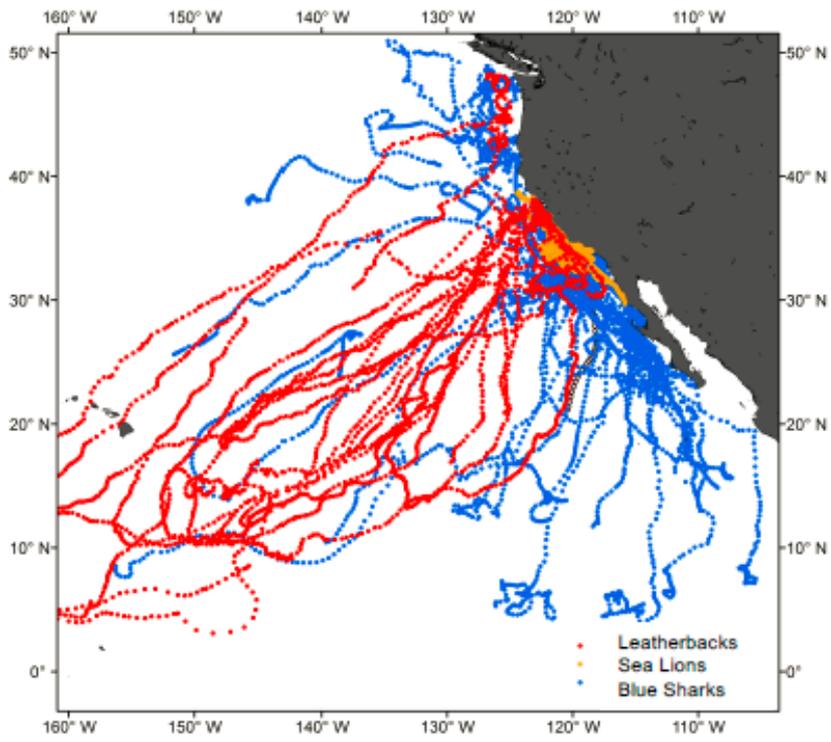




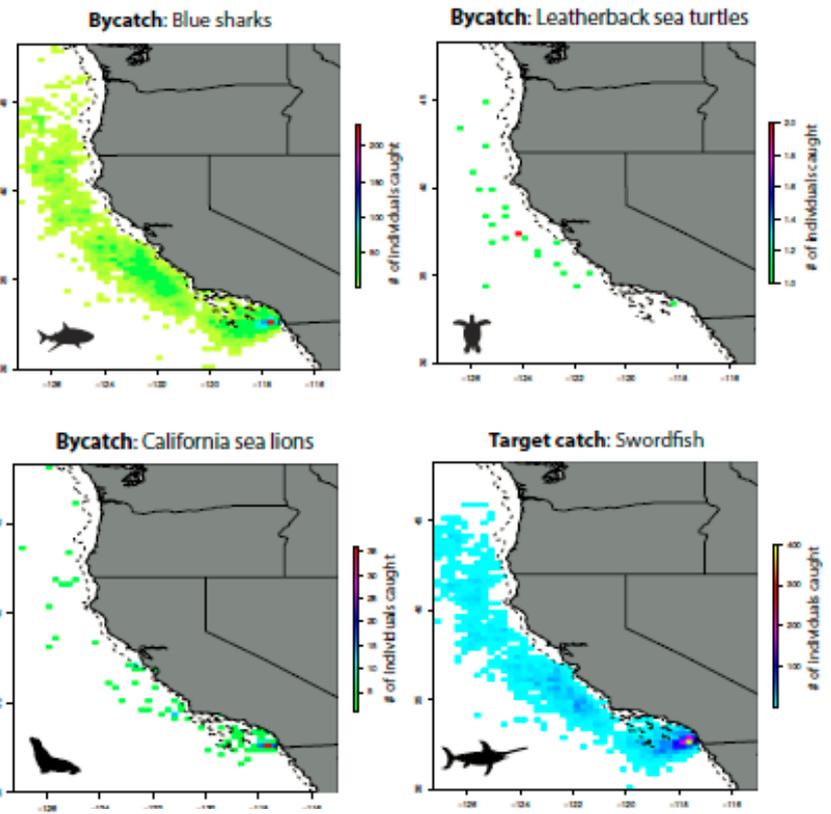
Sources: California Department of Fish and Game and the National Marine Fisheries Service

EcoCast inputs

In situ biological data



Telemetry data



Observer data

EcoCast inputs

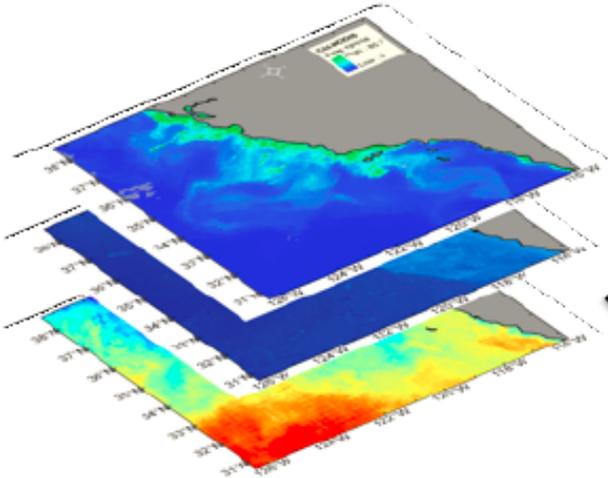
Data Products	
SST and Standard Deviation	Daily – JPL GHRSSST, OI Pathfinder
Chl	8-day – SeaWIFS, MODIS, VIIRS composite
EKE	Daily – AVISO at 25km
SSHa and SD	Daily – AVISO at 25km
Y winds	8-day – QSCAT and ASCAT at 25km
Bathymetry and SD	ETOPO1 at 1'

- *California Current configuration Regional Ocean Modeling System (ROMS)*
- *Frontal products from UC Santa Cruz Ocean Modelling Group and National Center for Atmospheric Research, Colorado*

Analytical approach

Data Types:

- Satellite tracking data
- Fishery observer data
- Environmental data



Environmental data

Species distribution modeling

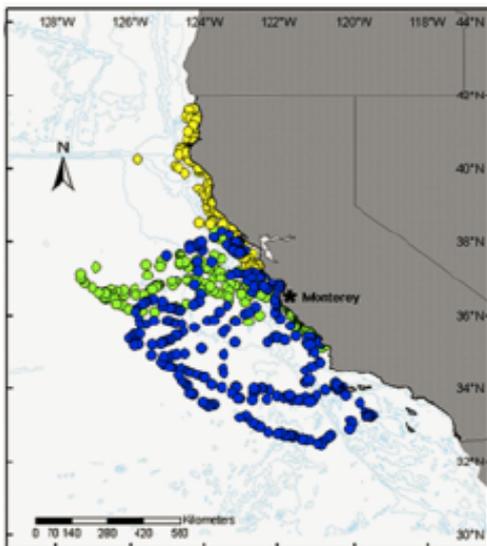
$$\text{Presence/absence} \sim \text{dist2coast} * a + \text{chl}a * b + \text{sst} * c$$

Models tested:

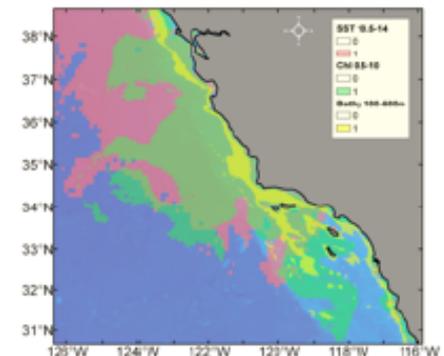
- GAMMS
- BRTs

Model validations:

- Random selection/CRWs
- Cross validation (training/testing data)
- AUC
- Jackknifing



Animal observations



Habitat suitability

Model output

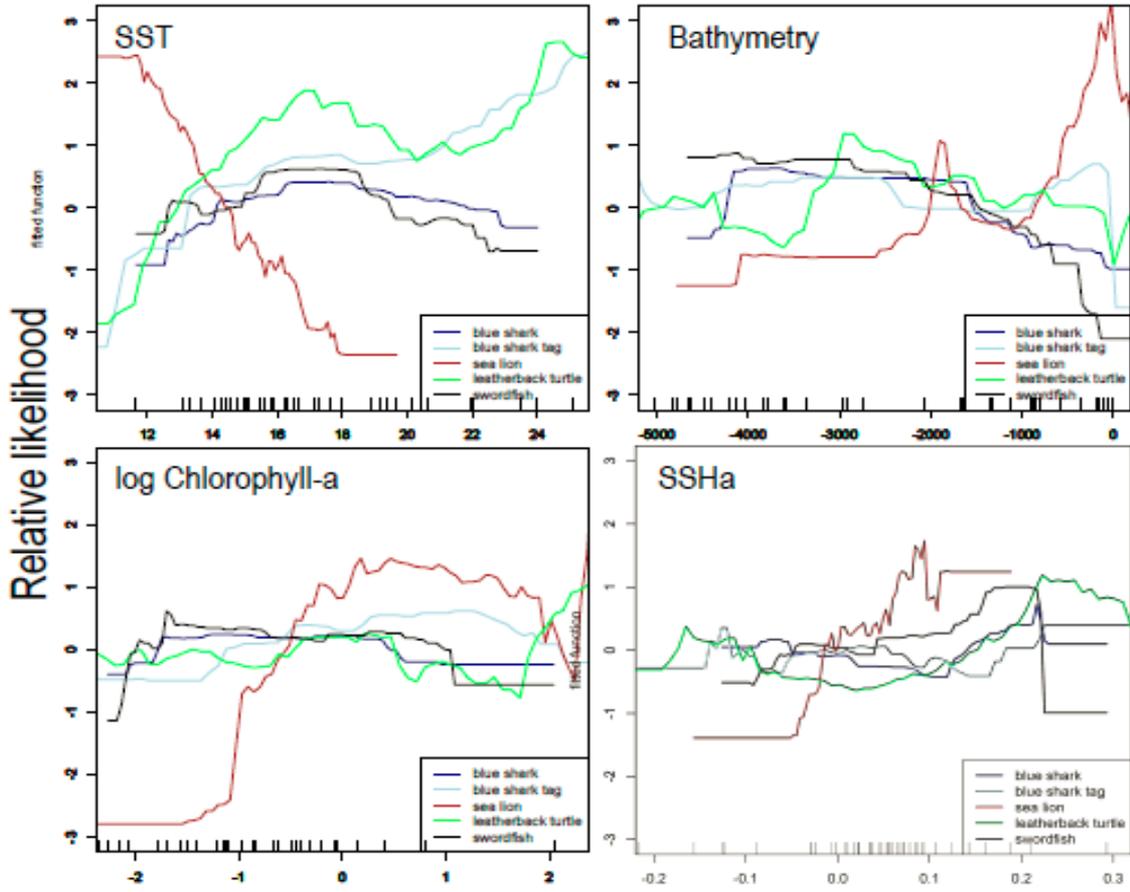
EcoCast Model Results – Boosted Regression Trees

Variable influence in each model by species

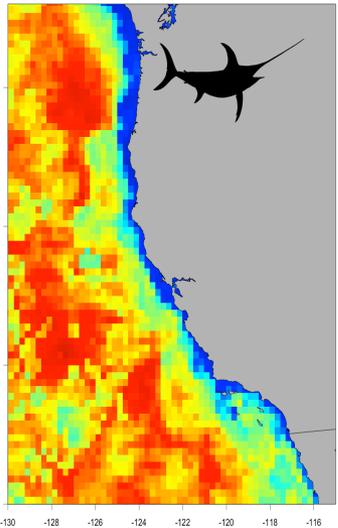
	SST	Bathymetry	Chl-a	SSHa
swordfish	18.0	32.9	7.9	10.3
blue shark	8.0	47.2	2.7	8.2
blue shark tracking	49.3	15.6	11.0	4.7
leatherback	34.7	14.6	8.9	11.2
sea lion	14.3	49.1	12.2	5.4

75% / 25% validation / Hold one-out

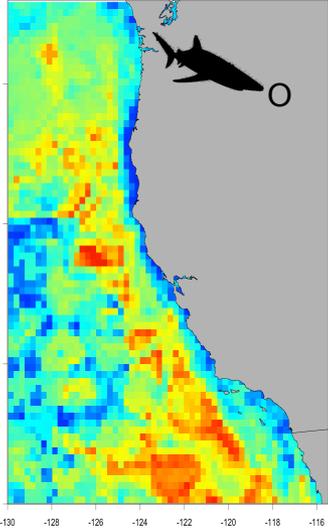
	AUC	CV
swordfish	0.72	0.66
blue shark	0.73	0.67
blue shark tracking	0.76	0.73
leatherback	0.93	0.85
sea lion	0.86	0.81



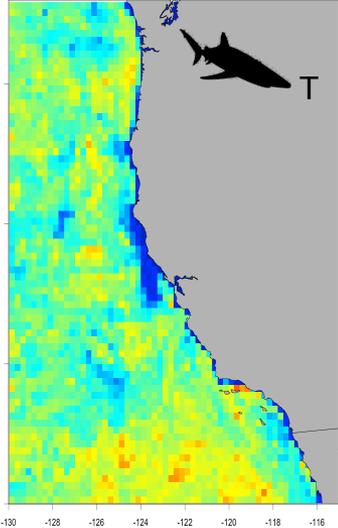
Model output



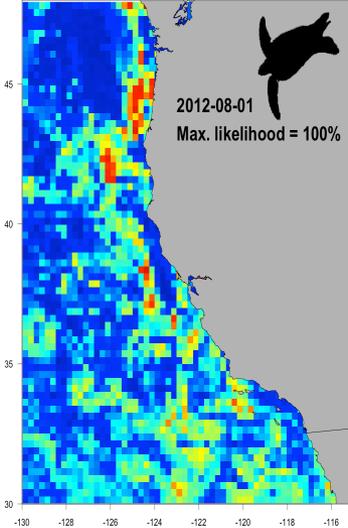
Swordfish



Blue Shark



Leatherback



CA sea Lion



Scales et al, *Ecological Applications*, in revision



Briscoe et al, *Diversity and Distributions*, in review

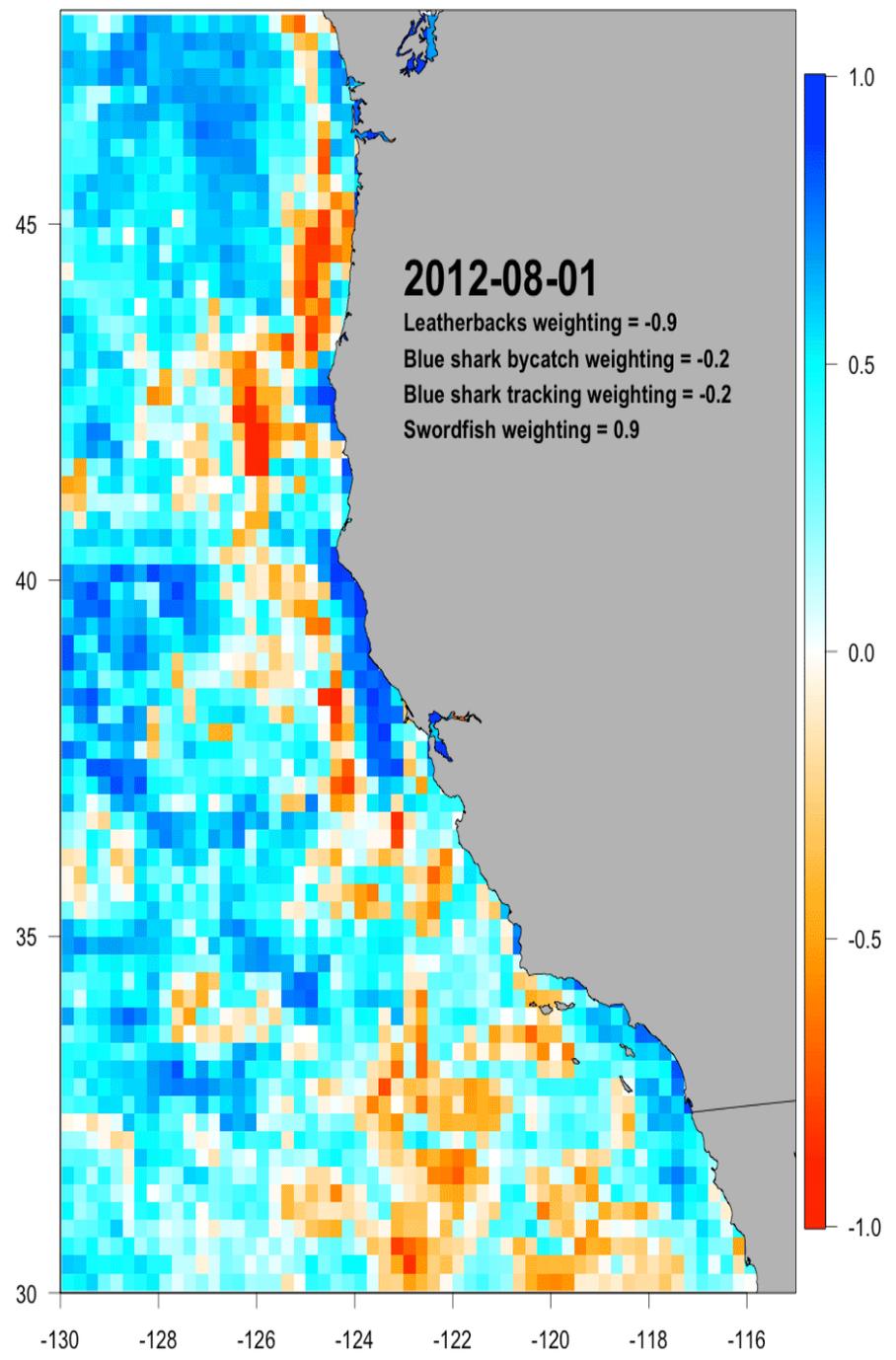


Maxwell et al, in prep

Deliverables

- **EcoCast product:** daily dynamic spatial predictions on encounter likelihoods with target and non-target species
- **EcoCast tool:** Online scenario analysis app where users can evaluate effect of species risk, time periods, oceanographic conditions, area of interest

EcoCast product

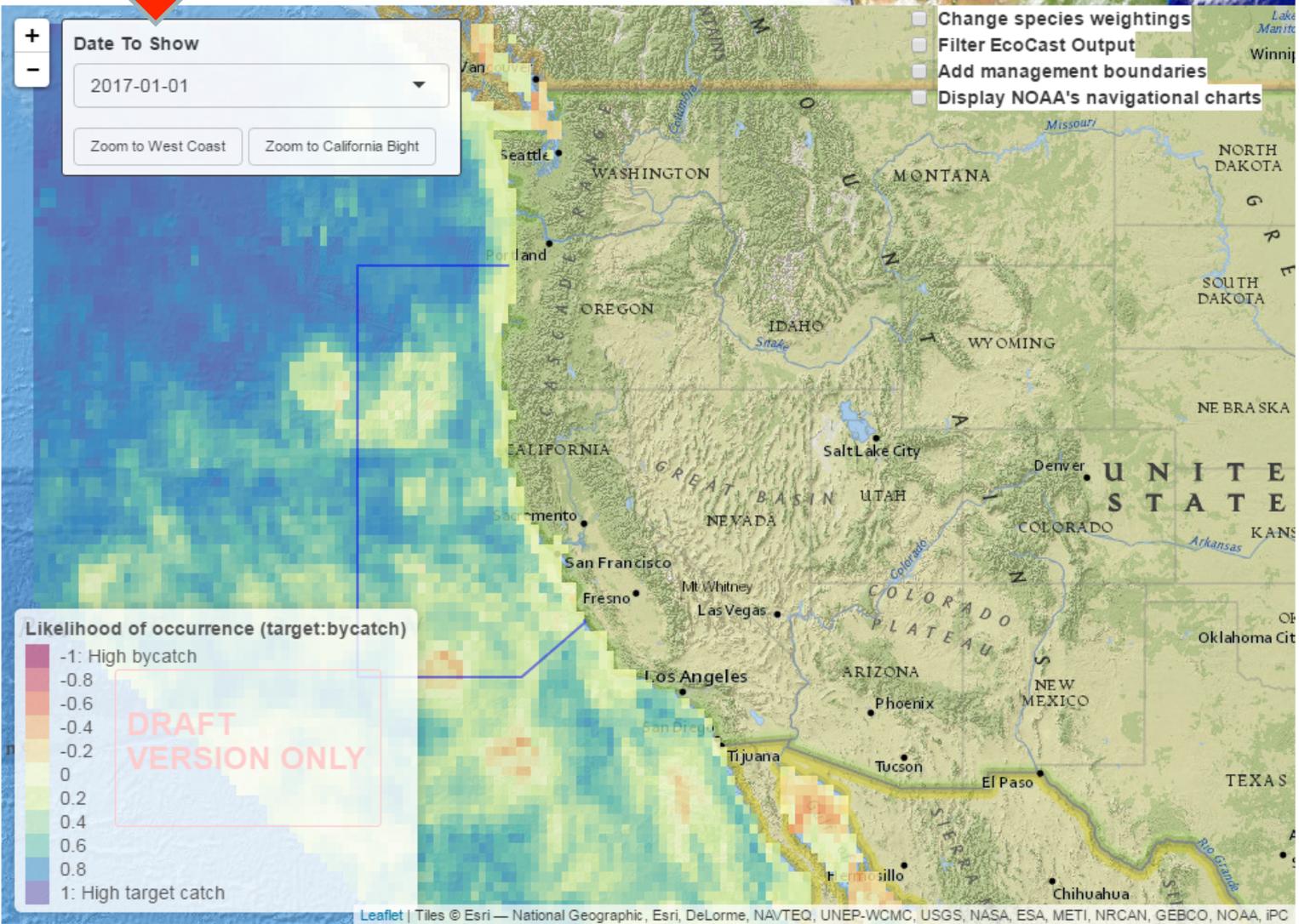


EcoCast tool



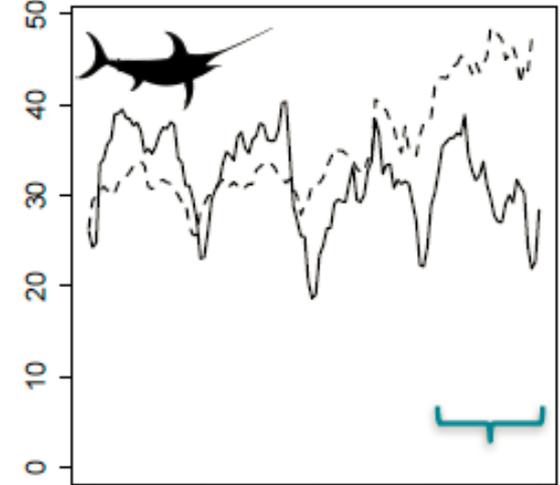
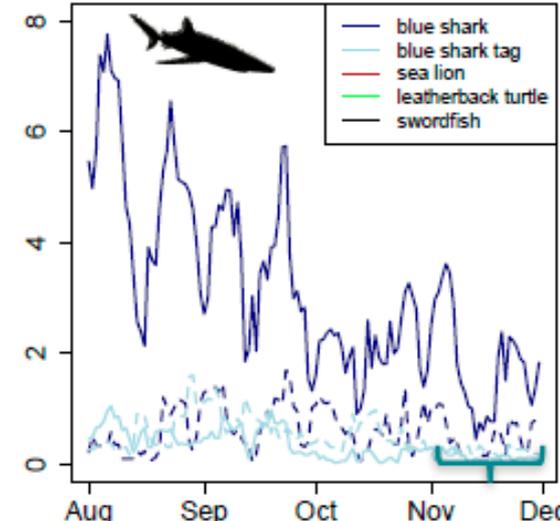
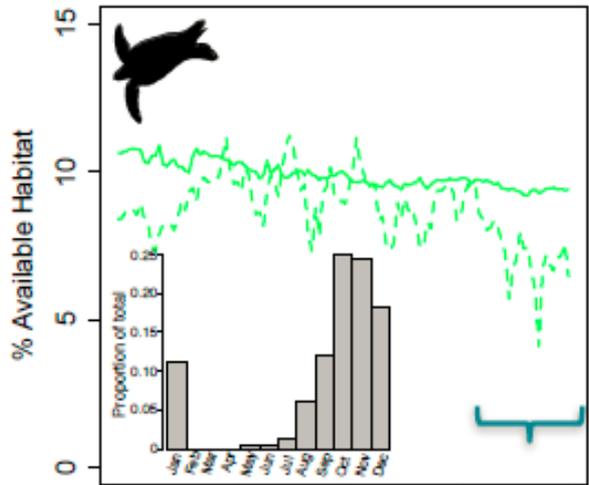
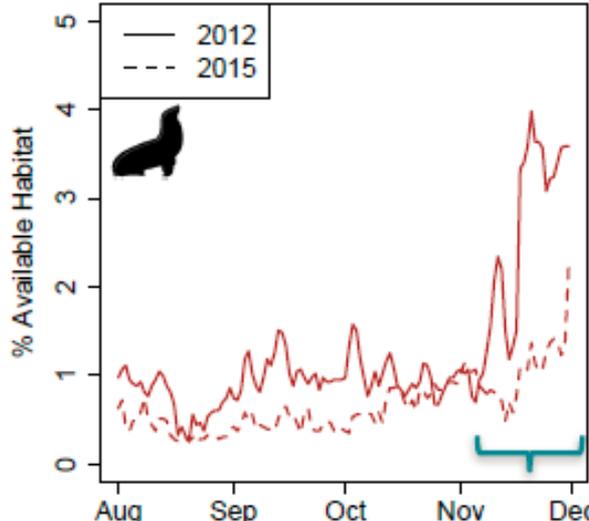
ECOCAST

Monitoring, Modeling, and Forecasting Ecosystem Change

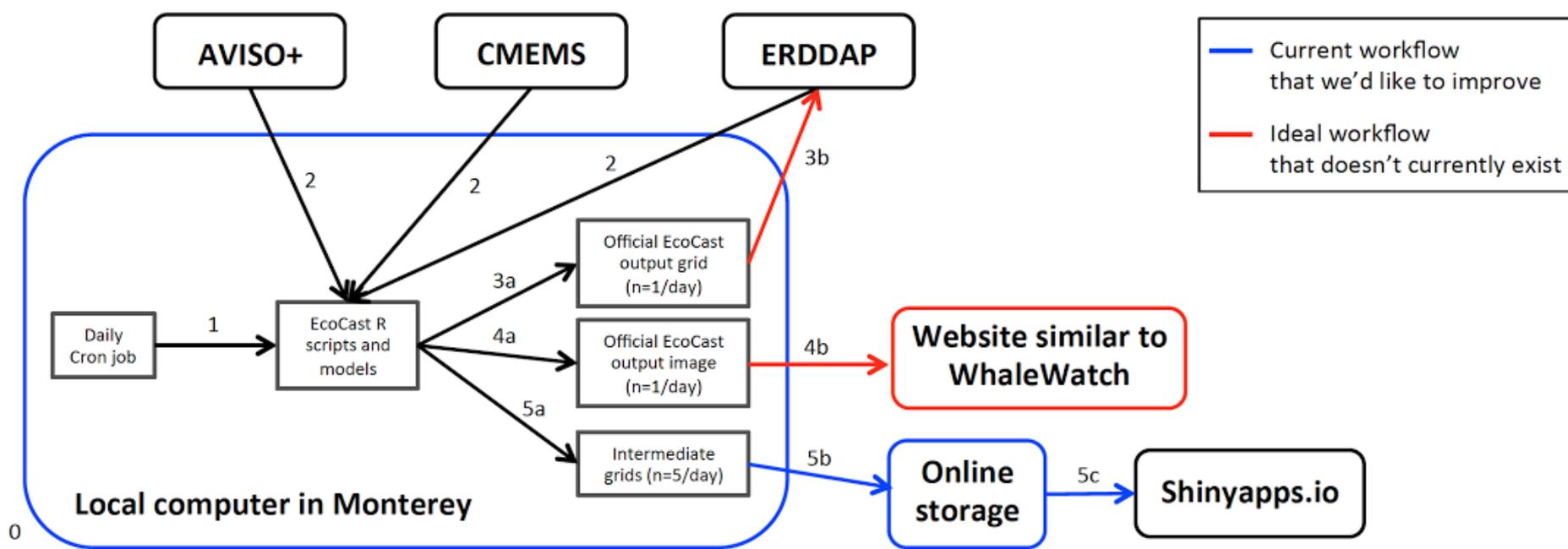


Effects of climate change

1. CCS core habitat (top quartile) is predicted to contract in an El Niño year (2015) for all but swordfish.
2. Fishing late in the season (Nov-Dec) in 2015 may have been optimal (except for sea lions).
3. In process of validating with 2015 observer data.

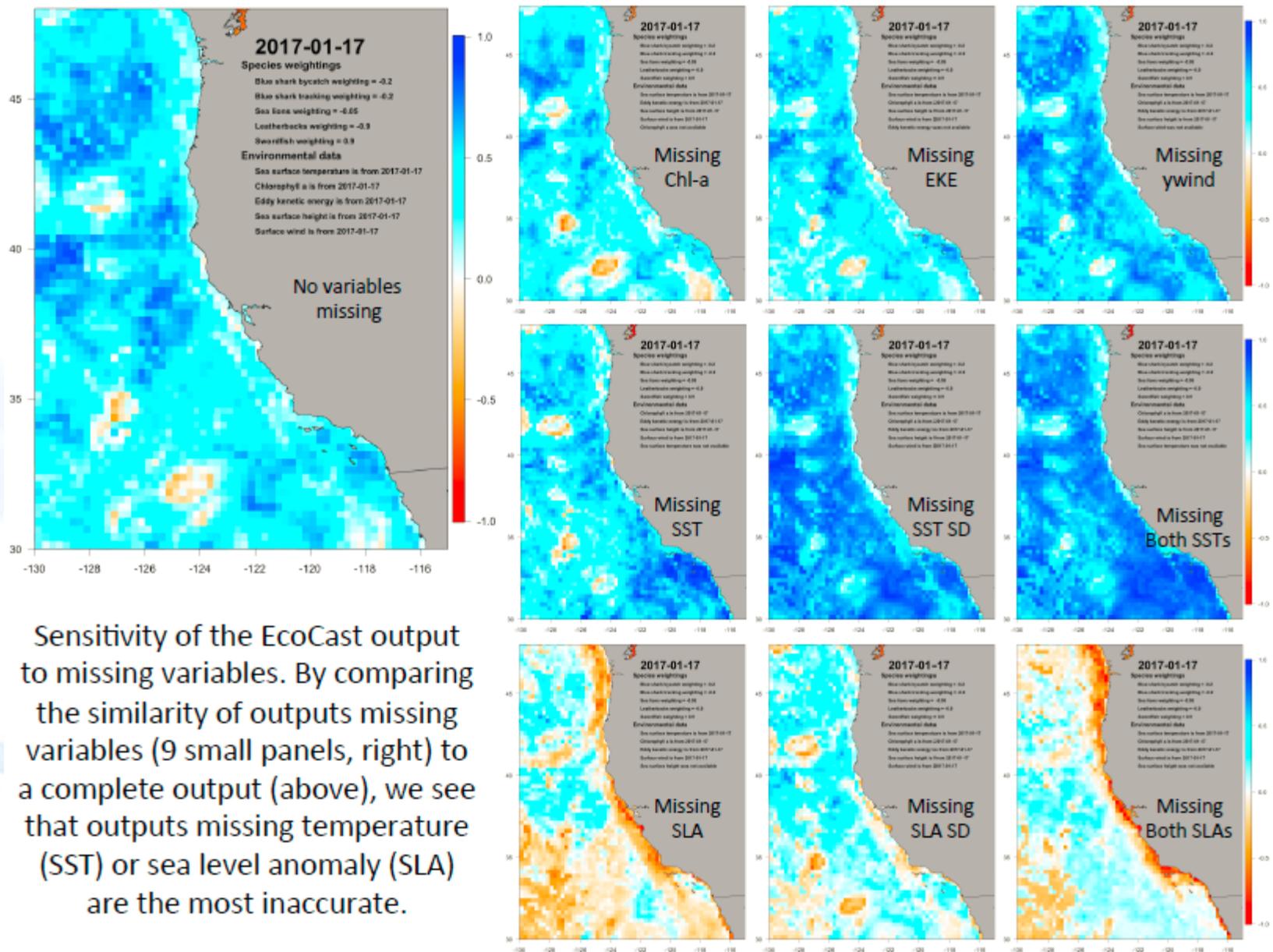


Delivery to end-users



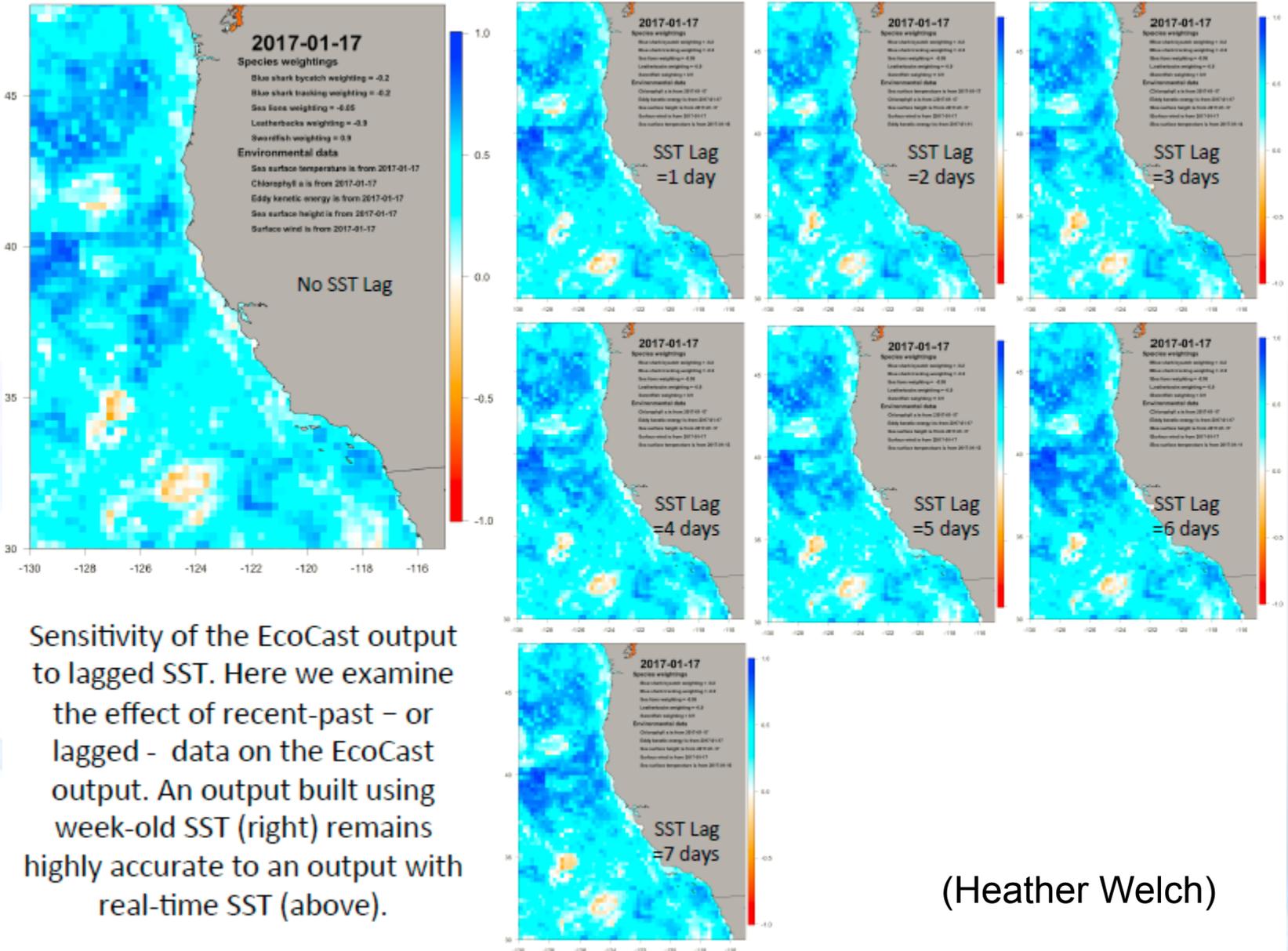
- 0. Entire EcoCast process is hosted on a computer in Monterey
- 1. A daily cron job initiates a series of R scripts
- 2. Real-time environmental data are acquired from online sources
- 3a. Official EcoCast output grid is created
- 3b. Grid is uploaded to ERDDAP where users can access official real-time 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

Sensitivity analyses



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



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).

(Heather Welch)



NOAA FISHERIES Webinar Series

Sponsored by the

Quantitative Ecology and Socioeconomics Training (QUEST) Program

Webinar Details:

Date: Thursday, April 6, 2017

Time: 2:00-3:00 pm Eastern Time

Space is limited. Reserve your seat at:

goo.gl/hcf007

Topic: Dynamic ocean management: A tool for optimizing ecological and economic sustainability

Presenter: Elliott Hazen
*Research Ecologist
NOAA Fisheries, Southwest Fisheries Science Center*



Abstract: Highly migratory species are inherently difficult to manage as they cross human-designed jurisdictional boundaries in the open seas. Top predators face multiple threats such as ship-strike risk and incidental catch (bycatch) in fisheries. Given many top predators migrate seasonally across ocean basins, targeted management approaches require an understanding of how distribution and abundance varies with the oceanic environment. Here I discuss two recently developed tools, [WhaleWatch](#) and EcoCast. WhaleWatch is designed to assess blue whale density on a monthly basis to help reduce the risk of ship strikes. EcoCast is designed for maximizing target catch while minimizing bycatch. In regard to EcoCast, we focused our analysis on the California Drift Gillnet fishery which



- **EcoCast implementation training starts June 12th**
- **Working to support EcoCast product implementation with WCRO**
- **Clear need to continue ROMS and frontal products integration**

EcoCast is Dynamic Ocean Mgmt

