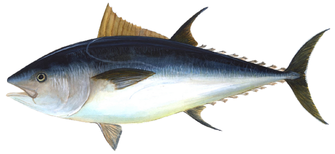
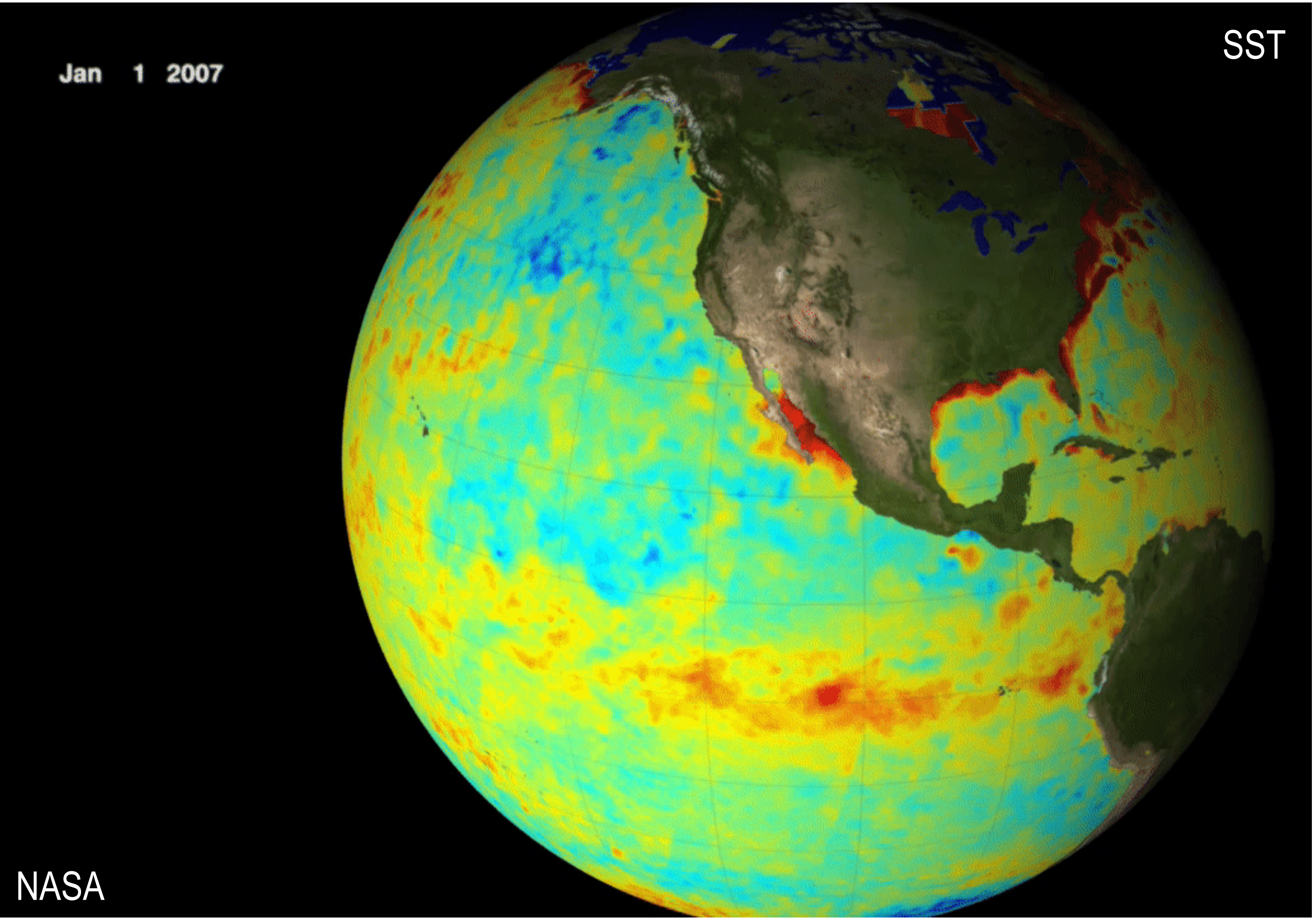
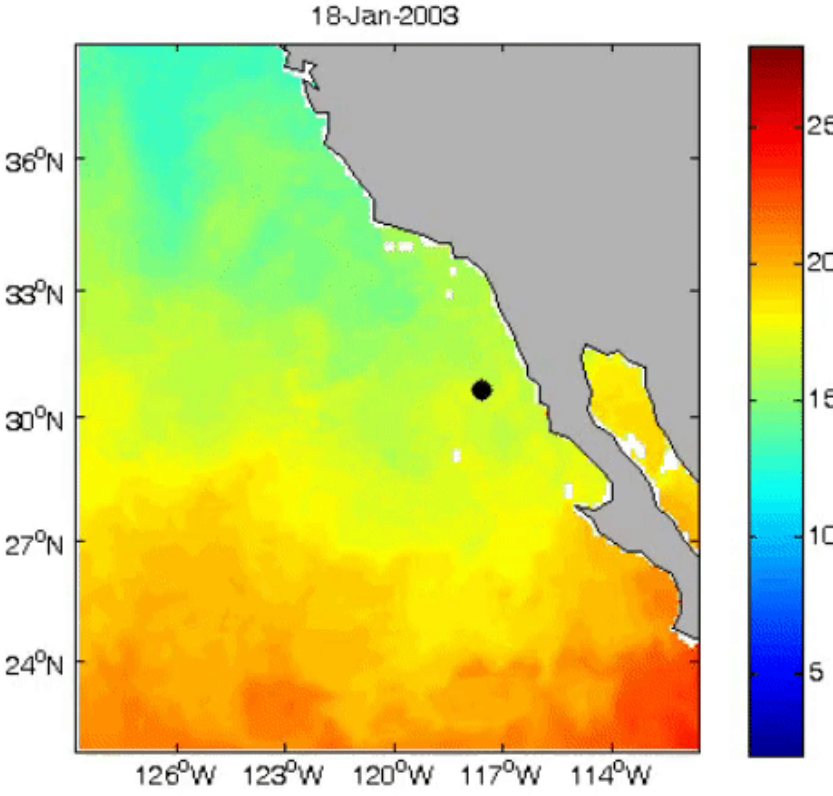
# Dynamic Oceans and Dynamic Ecosystems






Southwest Fisheries Science Center,
Environmental Research Division
UCSC – Cooperative Institute for Marine Ecosystems and Climate
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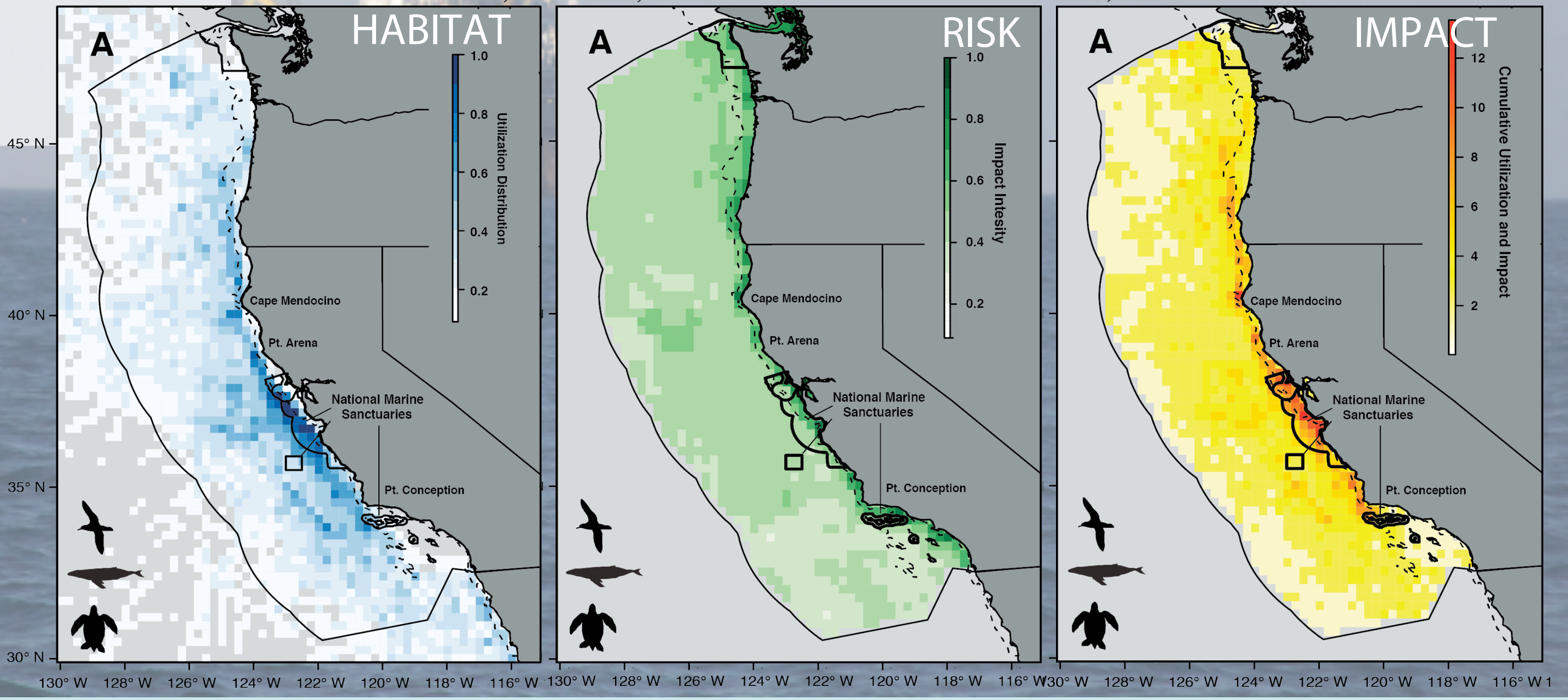
# Cumulative Risks in the California Current

## Multiple Risks

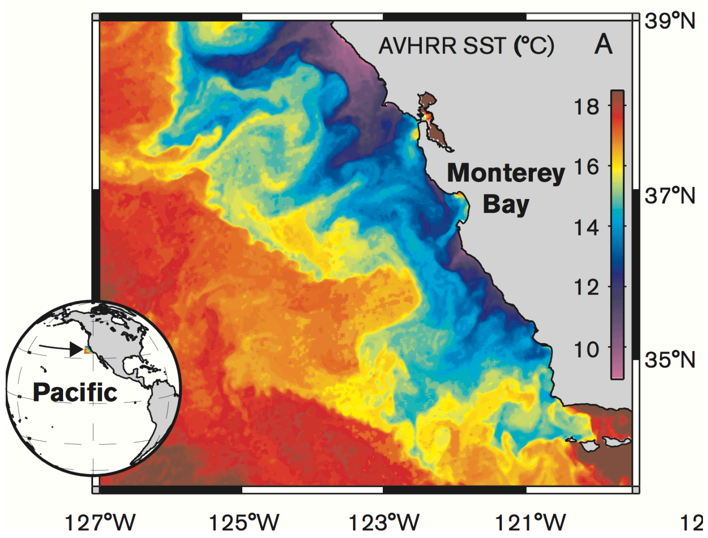
- Ship strikes
- Bycatch / entanglement
- Noise
- Climate change

- Use satellite data to model species and risk in near real time

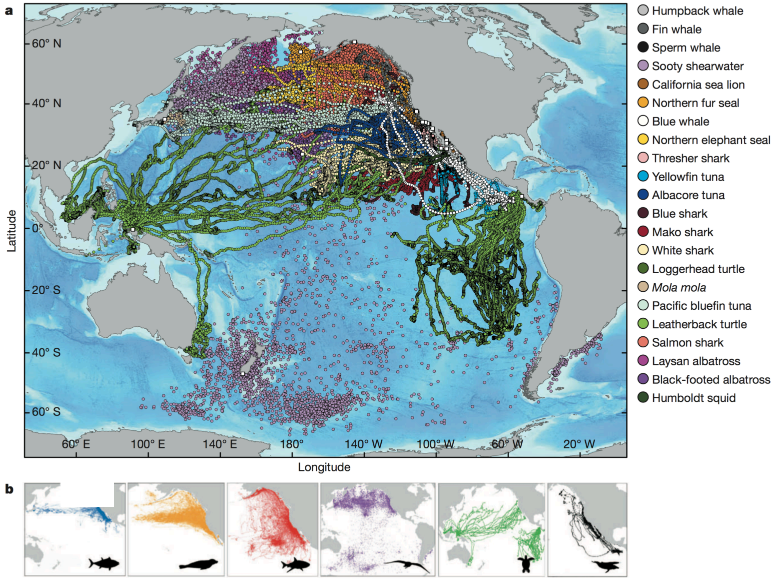
Maxwell, Hazen, et al. 2013 *Nature Comm.; 2013 CCIEA*



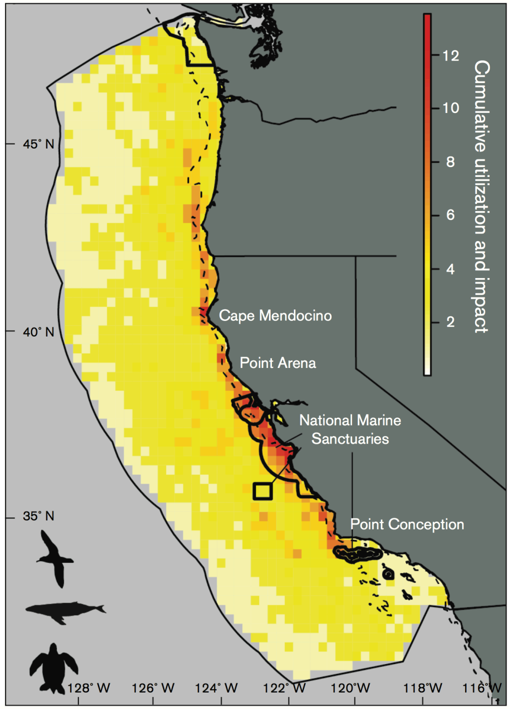
# Dynamic Ocean Management




Ryan et al. 2005




Block et al. 2011

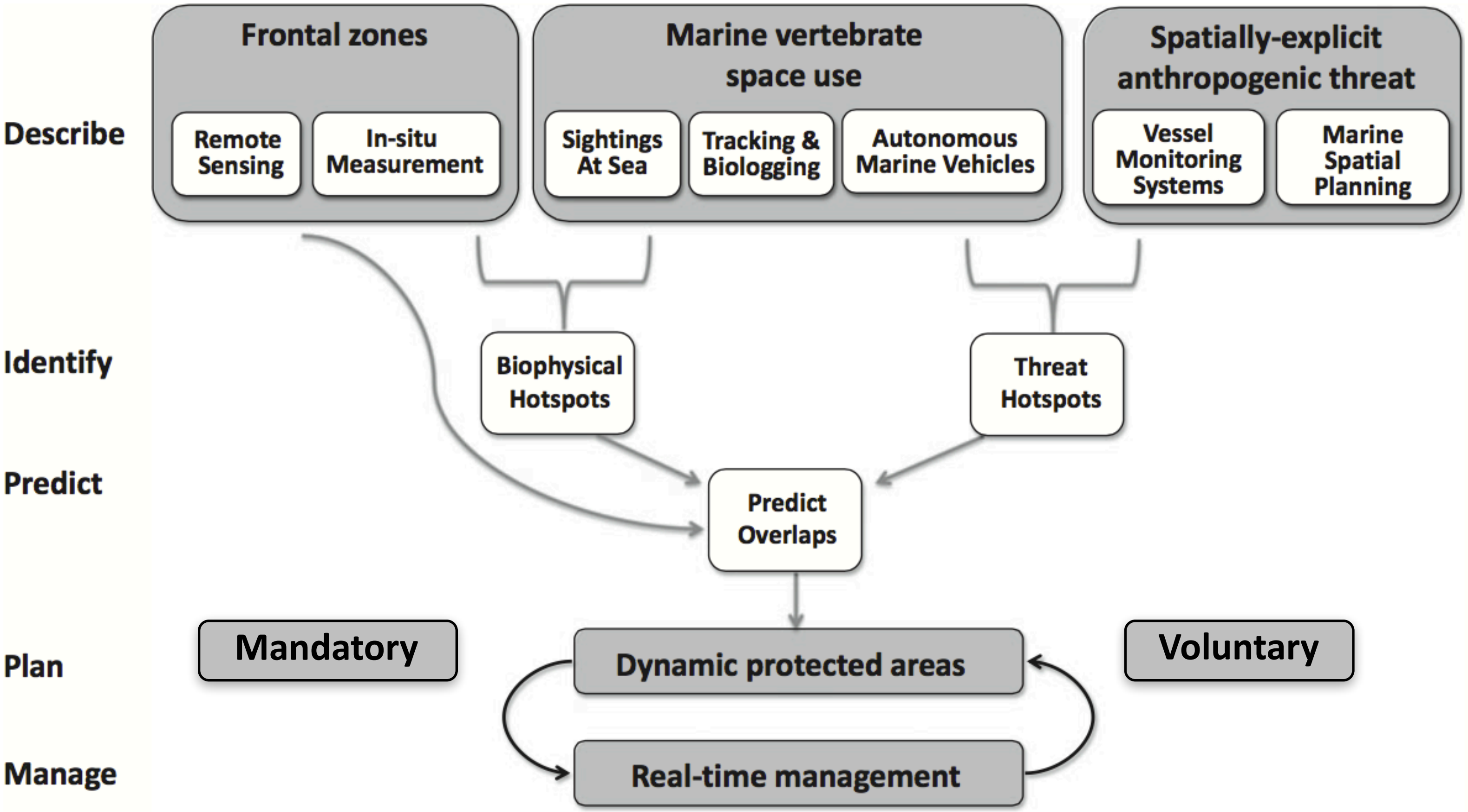


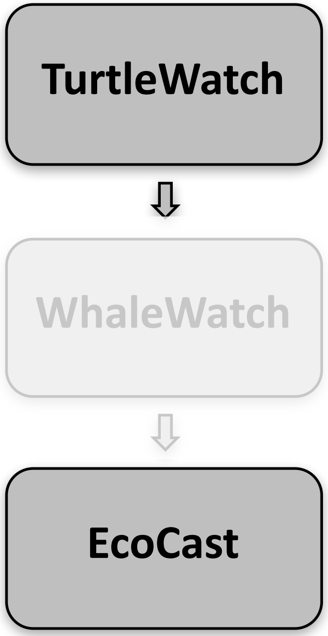

Maxwell et al. 2013

*Management that changes in space and time, at scales relevant for animal movement and human use.*

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

# Dynamic Ocean Management

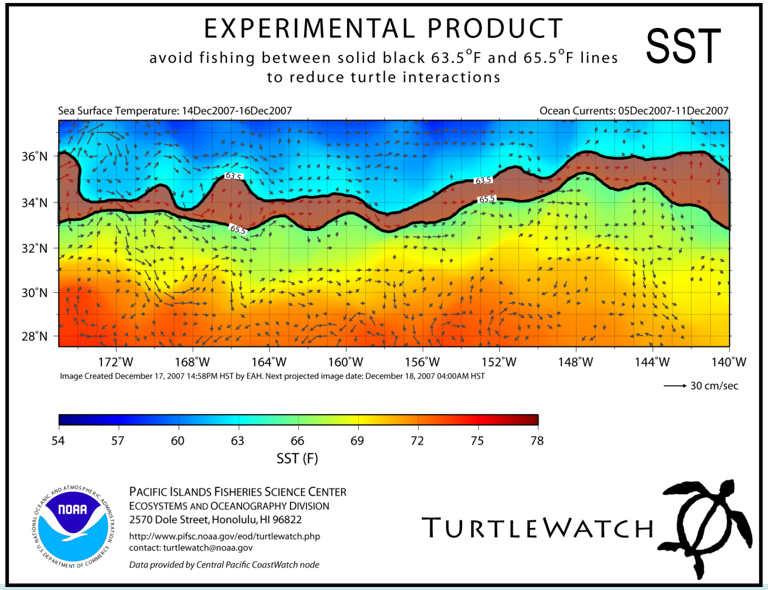



Scales et al. 2014 J Appl Ecol

# TurtleWatch

Voluntary,
yet effective





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*Contribution to the Theme Section 'Fisheries bycatch: problems and solutions'*

OPEN ACCESS


## TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery


**Evan A. Howell[1,*], Donald R. Kobayashi[1,2], Denise M. Parker[1,3], George H. Balazs[1], Jeffrey J. Polovina[1]**

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FISHERIES OCEANOGRAPHY

FISHERIES OCEANOGRAPHY *Fish. Oceanogr. 24:1, 57–68, 2015*


## Enhancing the TurtleWatch product for leatherback sea turtles, a dynamic habitat model for ecosystem-based management


EVAN A. HOWELL,[1,*] AIMEE HOOVER,[2,4] SCOTT R. BENSON,[3] HELEN BAILEY,[4] JEFFREY J. POLOVINA,[1] JEFFREY A. SEMINOFF[5] AND PETER H. DUTTON[5]

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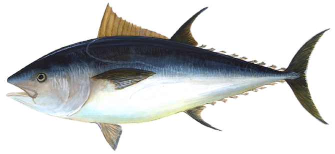
ABSTRACT

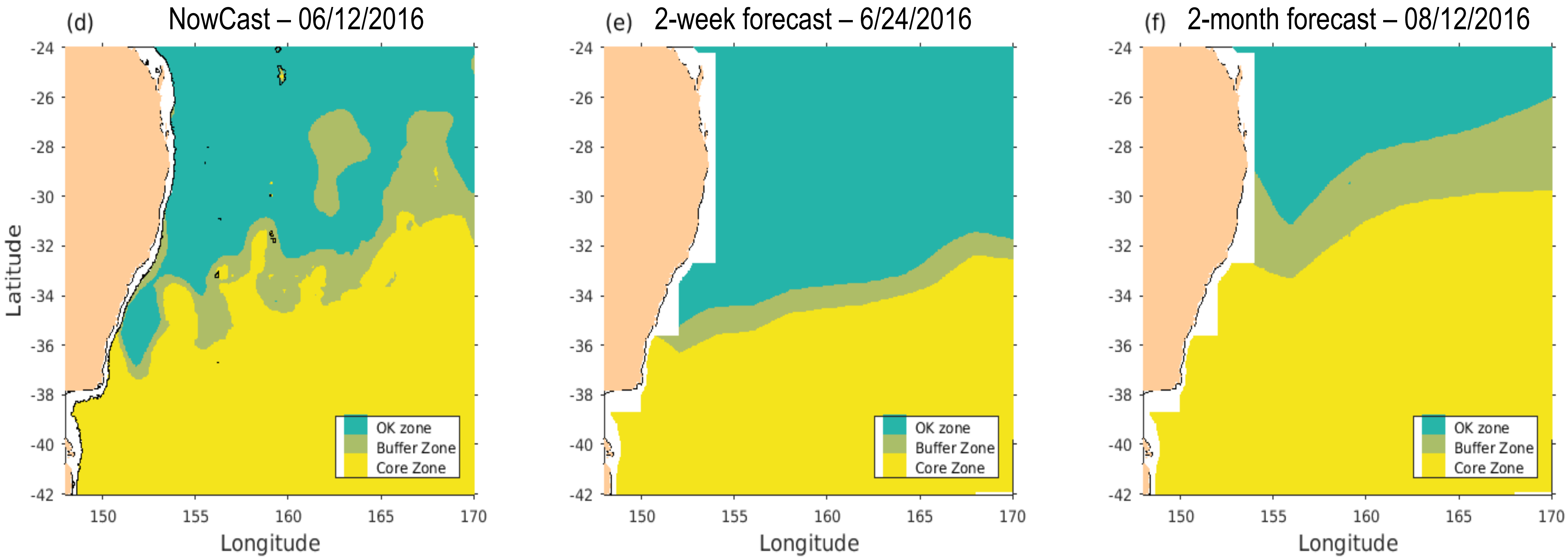
centered at 17.2° and 22.9°C, occupied by leatherbacks on fishing grounds of the Hawaii-based swordfish fishery. This new information was used to expand the TurtleWatch product to provide managers and industry near real-time habitat information for both loggerheads and leatherbacks. The updated TurtleWatch product provides a tool for dynamic management of the Hawaii-based shallow-set fishery to aid in the bycatch reduction of both species. Updating the management strategy to dynamically adapt to shifts in multi-species habitat use through time is a step towards an ecosystem-based approach to fisheries management in pelagic ecosystems.



**Key words:** Central North Pacific, dynamic management, fisheries, leatherback sea turtles, sea surface temperature, swordfish

# Southern Bluefin Tuna in Australia

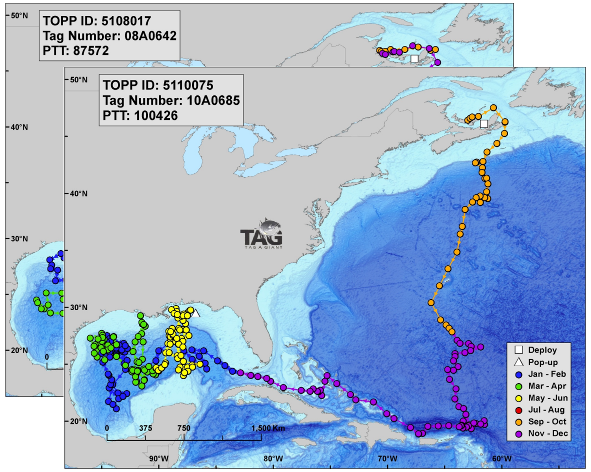




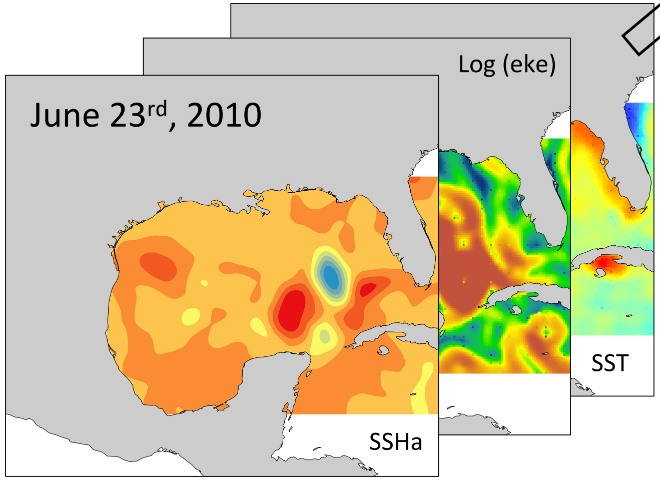

Hobday and Hartmann 2006, Hobday et al. 2011, Hobday et al. *in review*

# Species Distribution Modeling

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



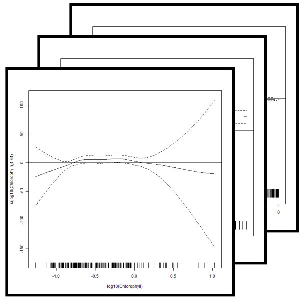

Sampled predictive data




Fit

Statistical models

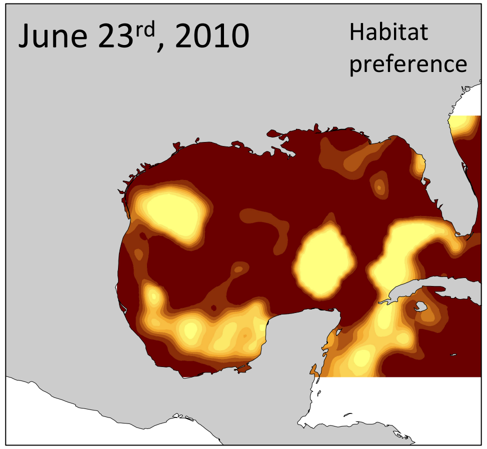
$$g(\mu) = \beta_0 + \beta_1 x_1 + \cdots + \beta_m x_m$$

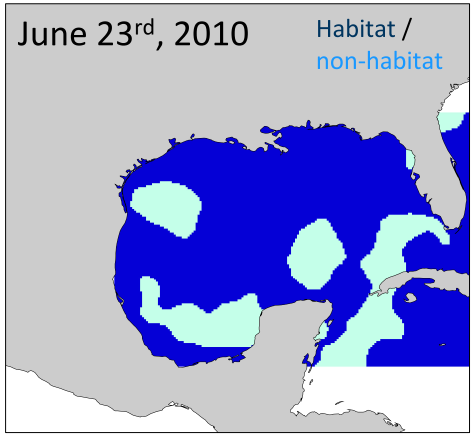


e.g. Generalized Additive Mixed Models,
Boosted Regression Trees

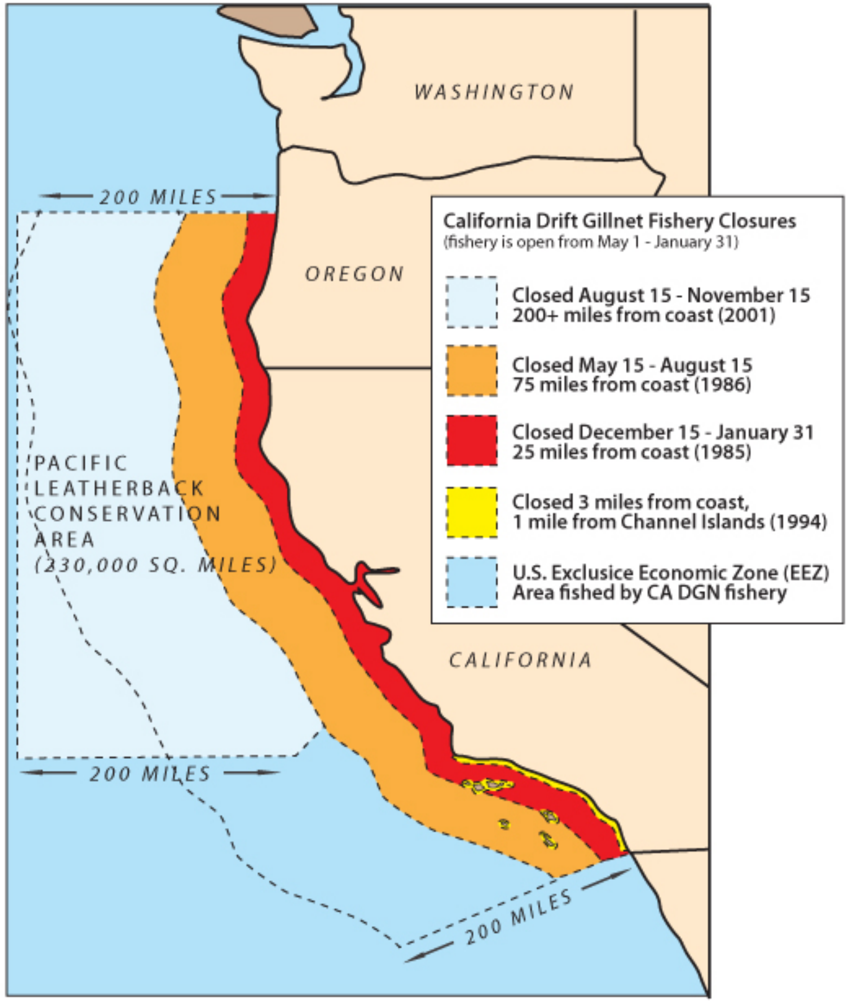
Predict

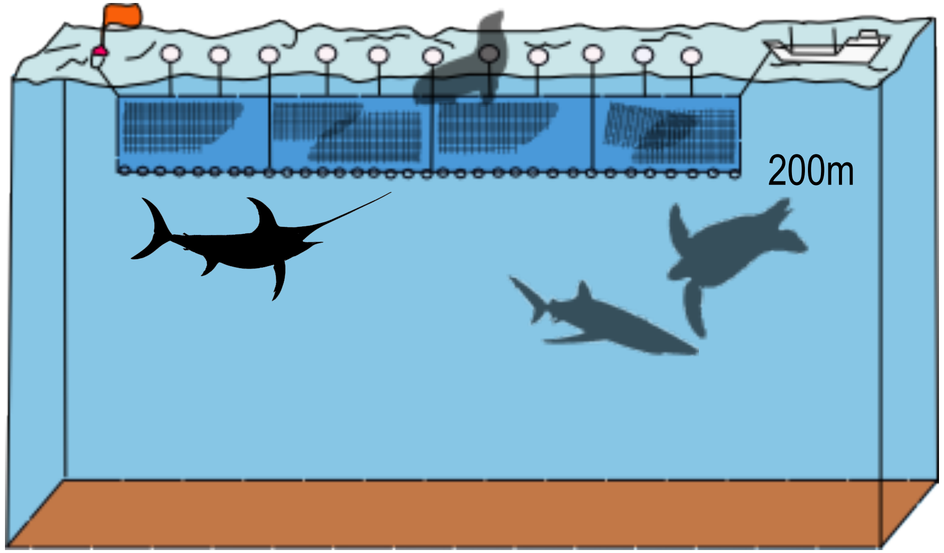
Probability of occurrence predicted from environmental covariates

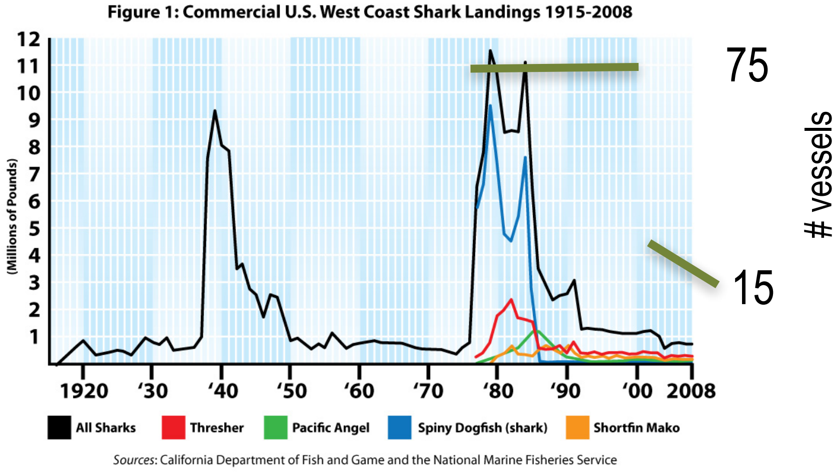


# California Drift Gillnet Fishery



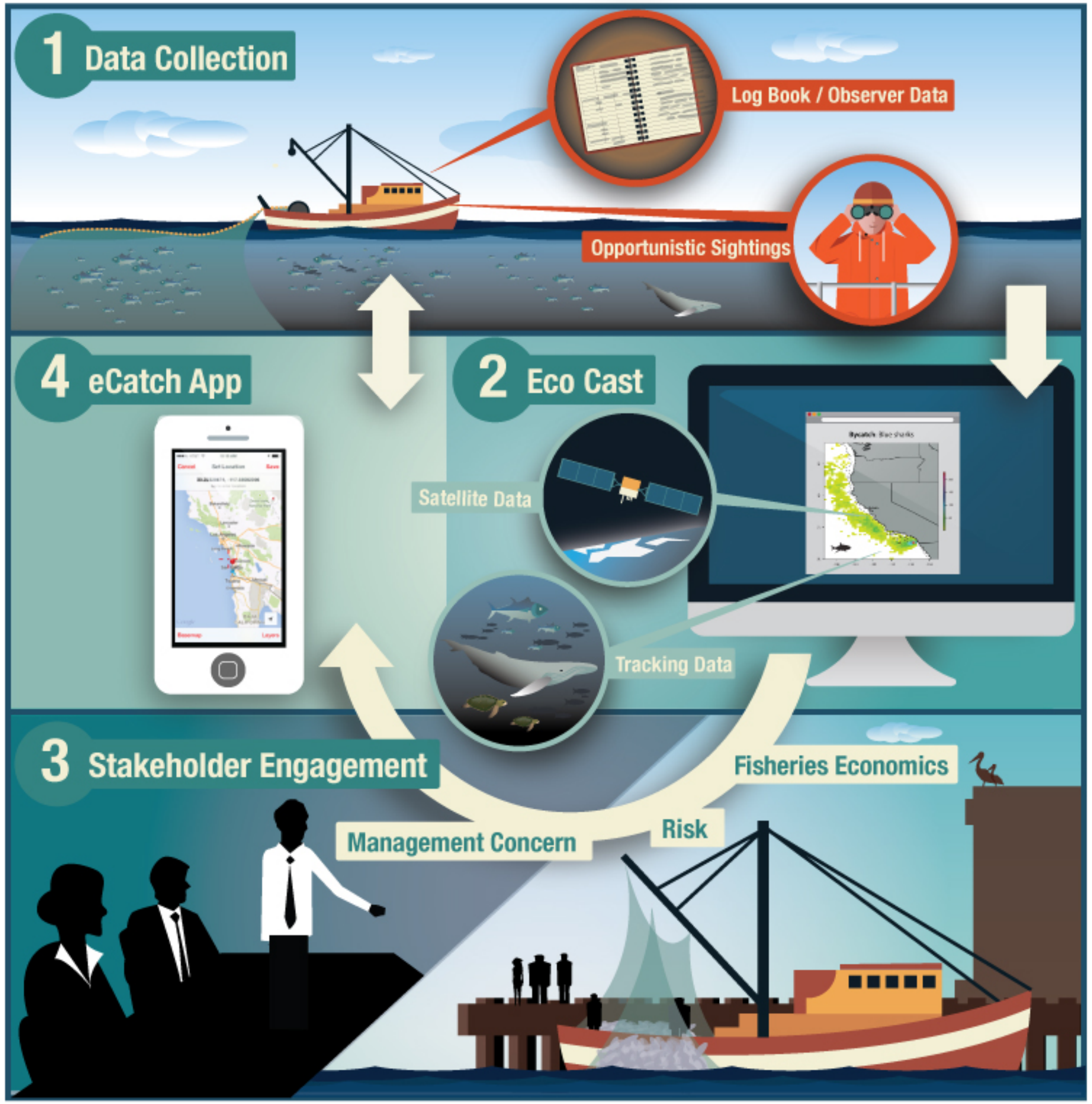



# EcoCast

Fishing zones predicted based on ocean features, catch potential, and weighted by bycatch risk

Good fishing zones served via web and mobile devices

Models to include: hard cap species, risk weightings, seasonal forecasting



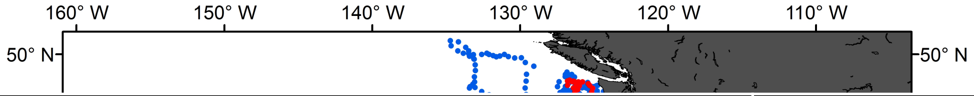
# California Drift Gillnet Fishery

Data Types:

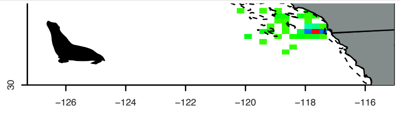
Satellite tracking data

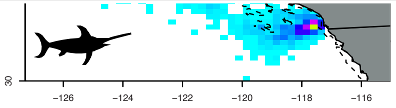
Fishery observer data

+ NOAA marine mammal survey data



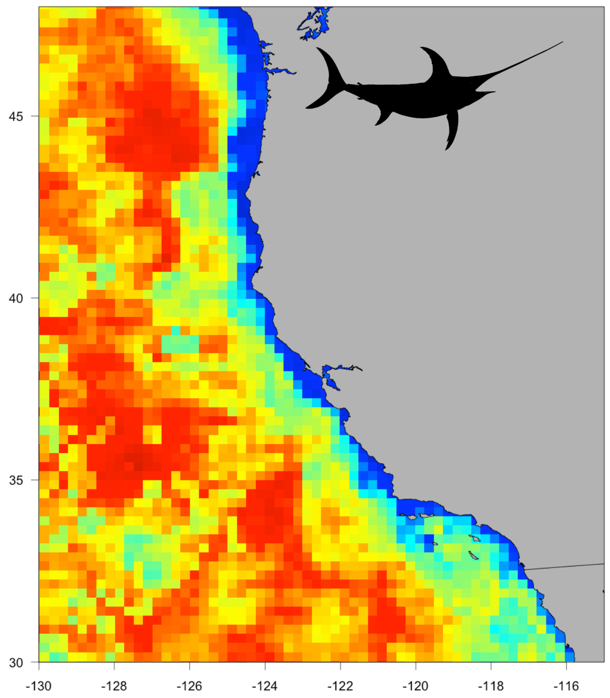

| Data Products | |
|---|---|
| SST and Standard Deviation | Daily – JPL GHRSST |
| Chl | 8-day – SeaWIFS, MODIS, VIRRS composite |
| EKE | Daily – AVISO at 25km |
| SSHa and SD | Daily – AVISO at 25km |
| Y winds | 8-day – QSCAT and ASCAT at 25km |
| Bathymetry and SD | ETOPO1 at 1’ |



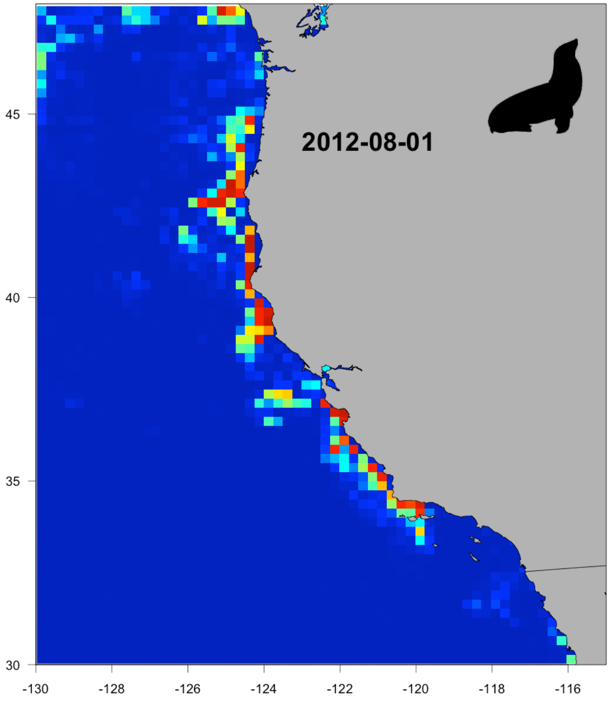



# California Drift Gillnet Fishery

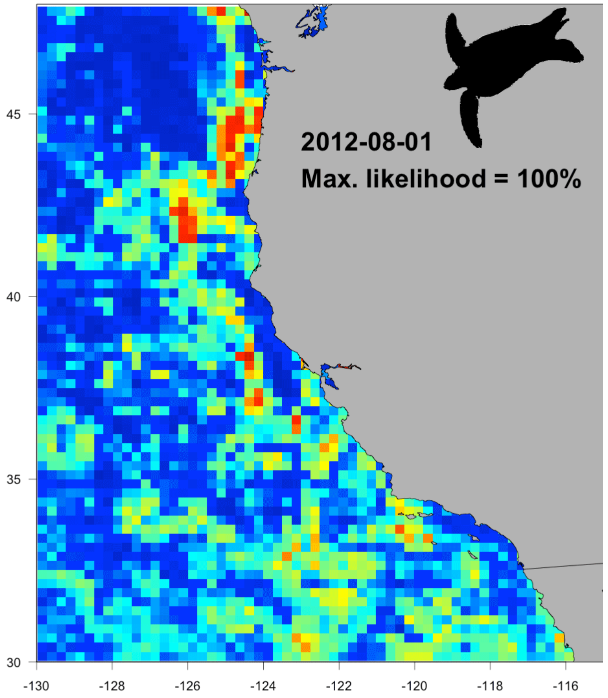
Swordfish Observer



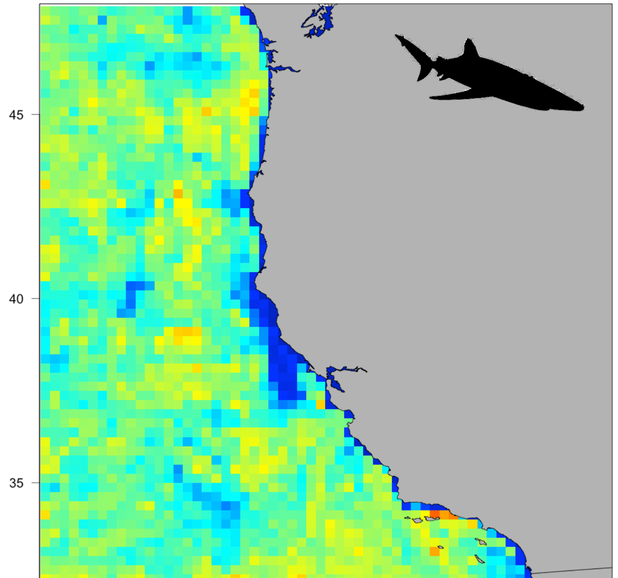

California Sea Lion



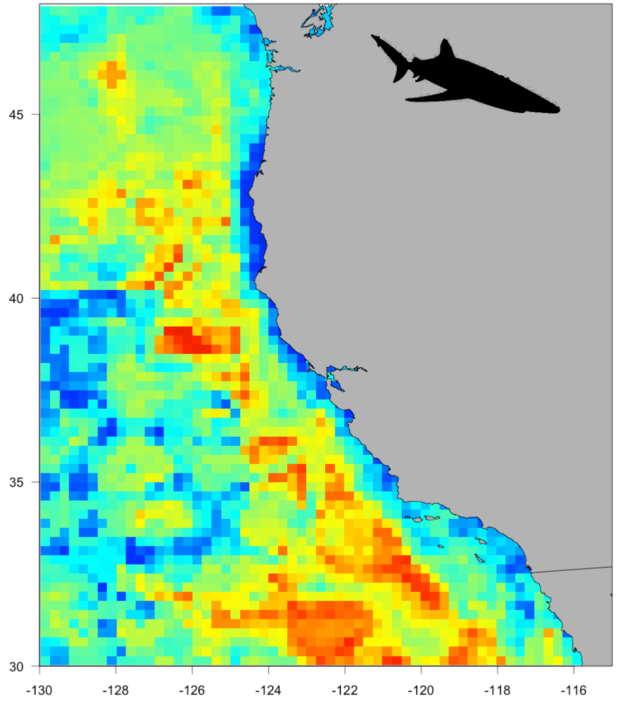

Leatherback Turtle



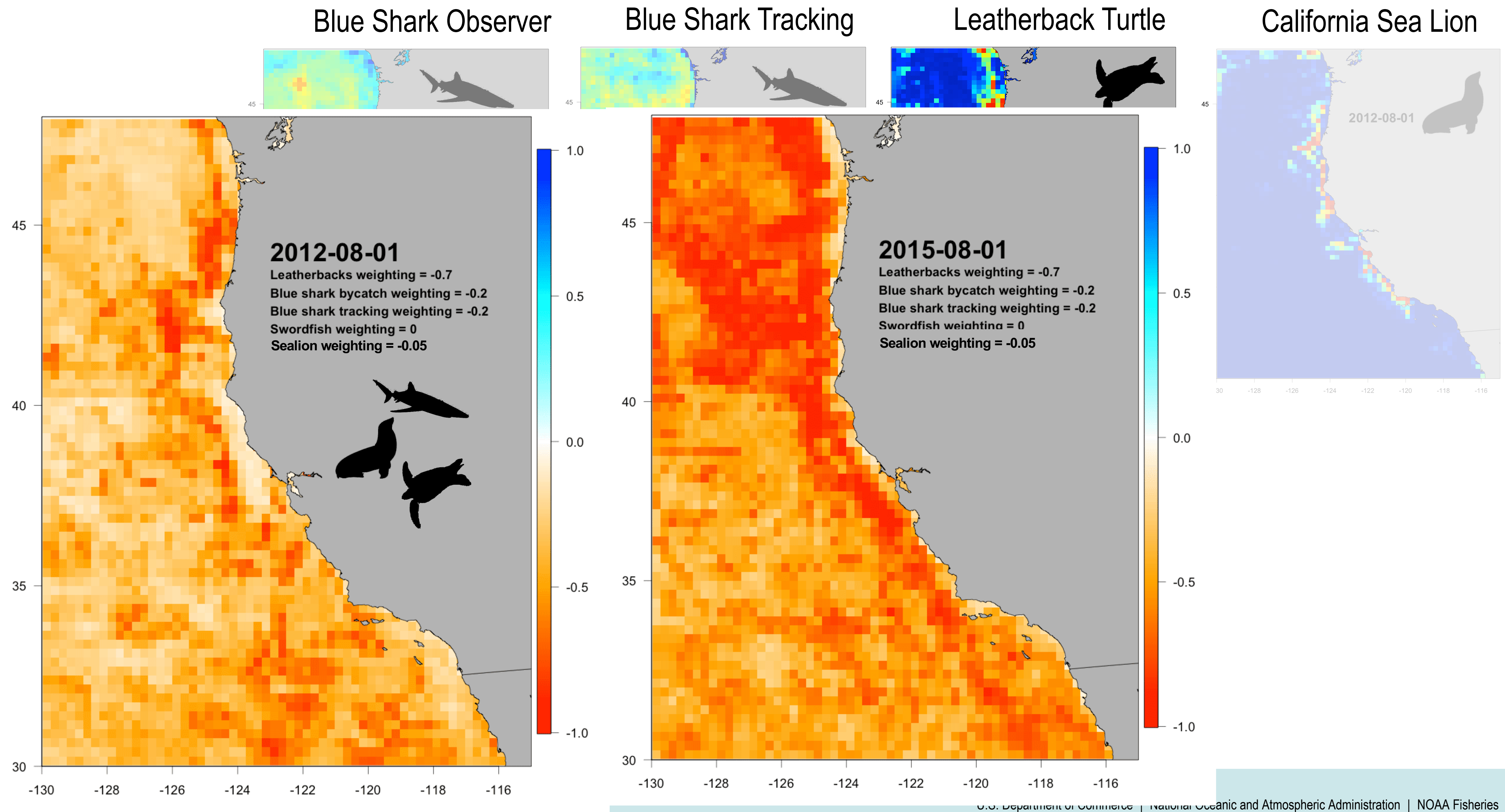

Blue Shark Tracking



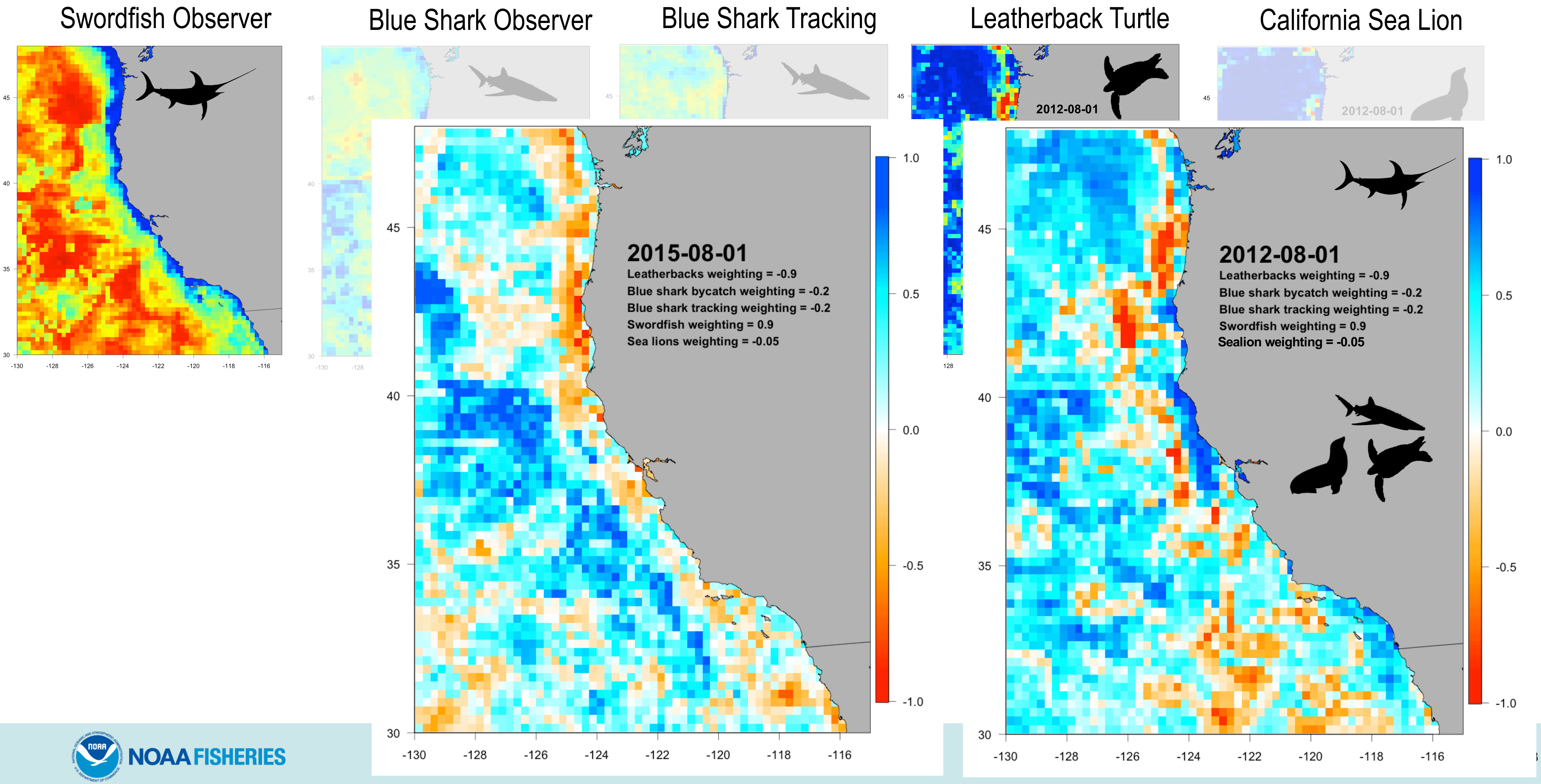

Blue Shark Observer



# California Drift Gillnet Fishery – 2012 bycatch predictions

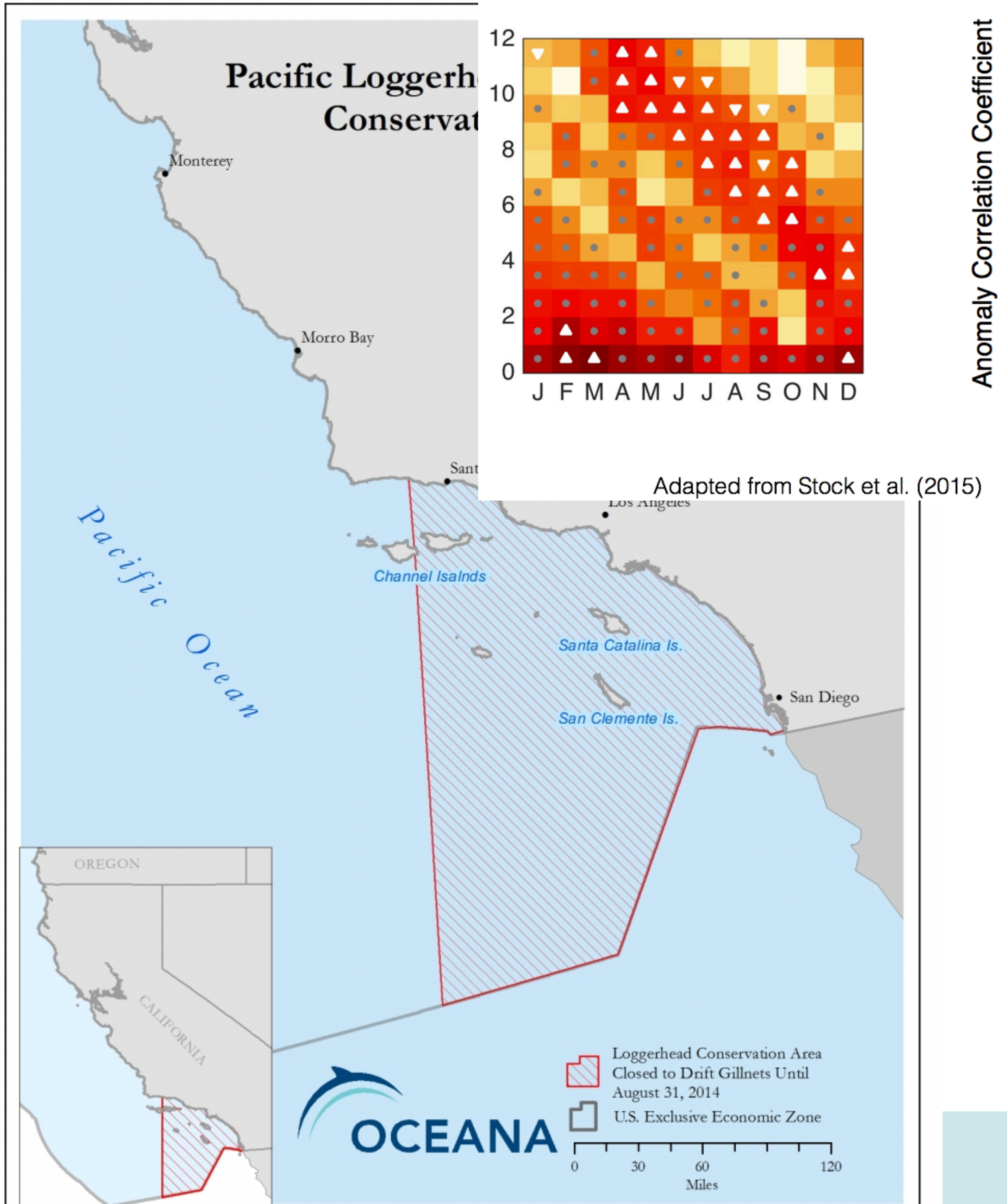


# California Drift Gillnet Fishery – 2012 EcoCast predictions



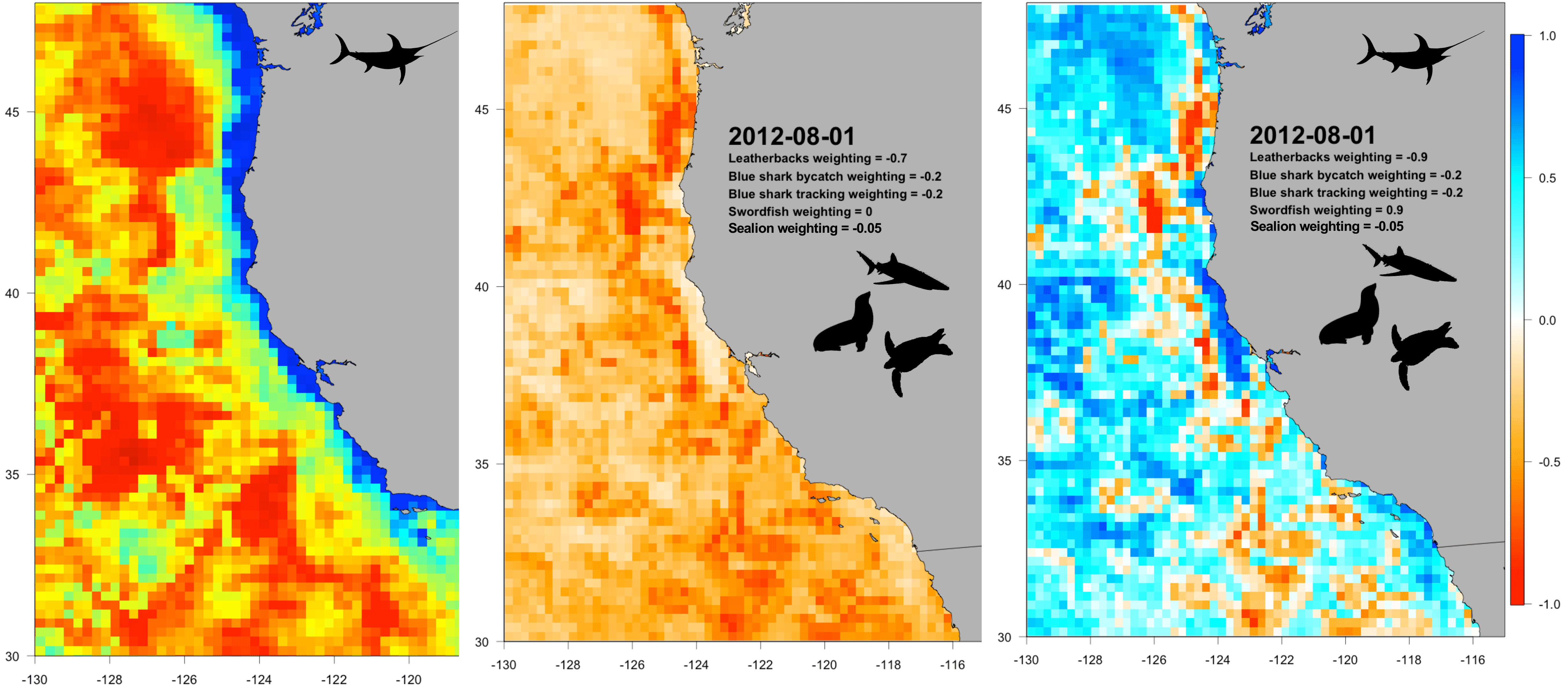
# Dynamic Ocean Management – N

1. Data-assimilative ROMS instead of Satellite fields
2. Derived frontal products (Scales et al. 2014) and Finite Size / Time Lyapunov Exponents from Aviso for mesoscale activity
3. Explore forecasting models (e.g. NMME) for use in pro-active planning, risk analyses, and management strategy evaluations.




Adapted from Stock et al. (2015)

# Questions?



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Blue shark bycatch weighting = -0.2
Blue shark tracking weighting = -0.2
Swordfish weighting = 0
Sealion weighting = -0.05
2012-08-01
Leatherbacks weighting = -0.9
Blue shark bycatch weighting = -0.2
Blue shark tracking weighting = -0.2
Swordfish weighting = 0.9
Sealion weighting = -0.05
45
40
35
30
-130
-128
-126
-124
-122
-120
-118
-116
1.0
0.5
0.0
-0.5
-1.0