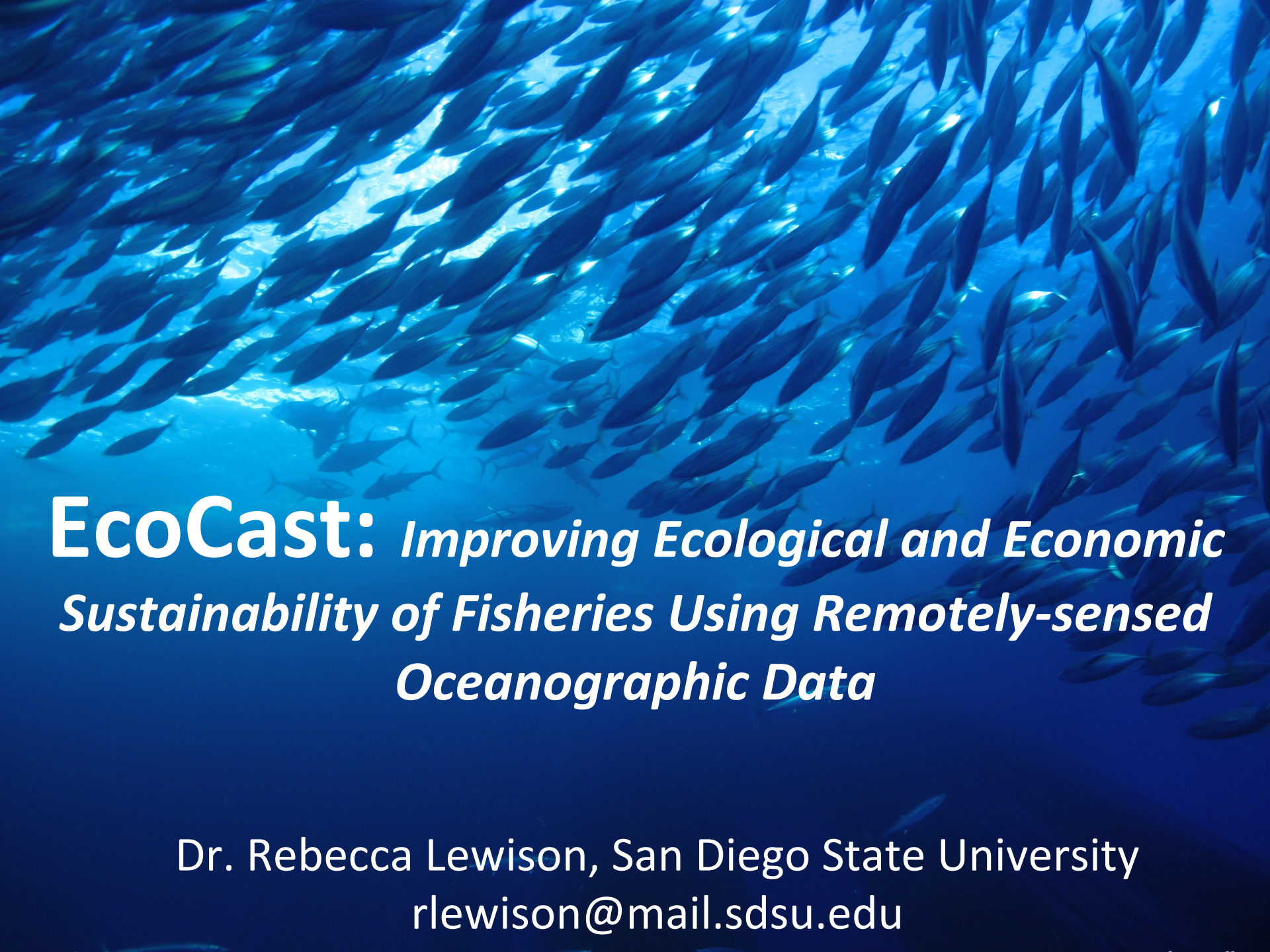


EcoCast: *Improving Ecological and Economic Sustainability of Fisheries Using Remotely-sensed Oceanographic Data*

Dr. Rebecca Lewison, San Diego State University
rlewison@mail.sdsu.edu

Project team

Project team is collaboration between multiple academic institutions, agencies and NGOs.

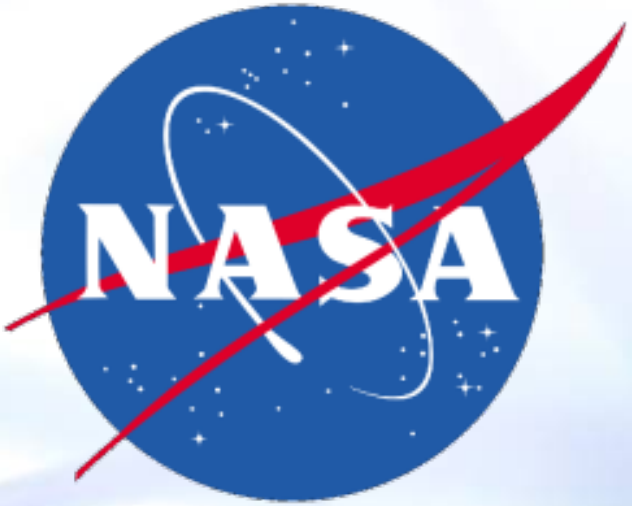
Sara Maxwell (**Old Dominion**), Elliott Hazen (**NOAA**)
Melissa Stevens, Matt Merrifield (**TNC**)

Steven Bograd, Scott Benson, Tomo Eguchi,
Heidi Dewar, Suzy Kohin, Tim Sippel
(**NOAA Southwest Fisheries Science Center)**

Larry Crowder, Dana Briscoe (**Stanford Univ**)
Helen Bailey (**U of Maryland**)
Dan Costa (**UC Santa Cruz**)

Supporting agencies/organizations

CENTER FOR
OCEAN
SOLUTIONS



Partners, endusers & stakeholders

We have two primary endusers: fisheries management & industry

Fisheries management agencies:

NOAA

Pacific Fisheries Management Council

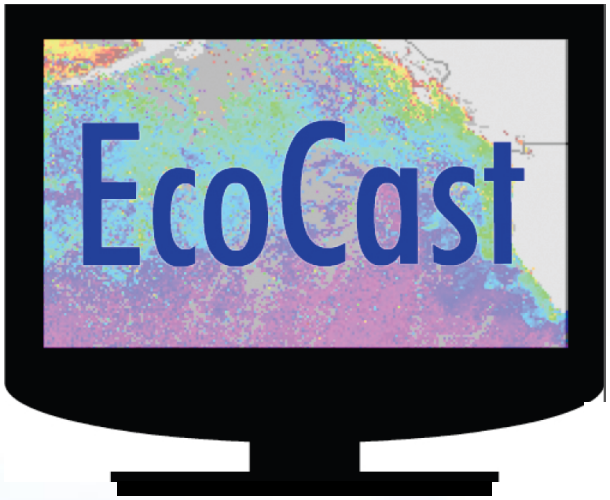
Industry:

DGN fishermen

Industry groups

ACSF
Alliance of Communities for Sustainable Fisheries

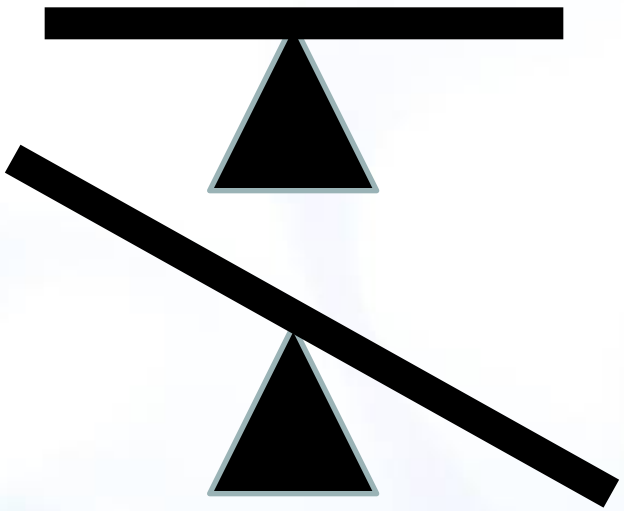
Project: EcoCast



A **flexible**, **user-driven,** and **responsive decision support application** that uses **NASA satellite data** to support sustainable fisheries.

Motivation and context

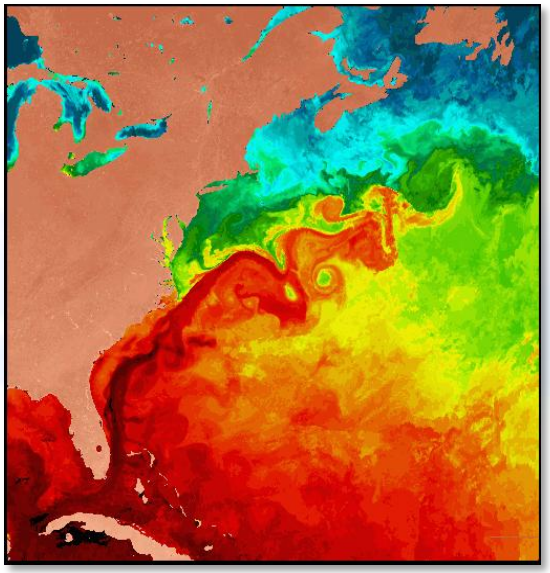
Ecologically sustainable fisheries



Economically viable fisheries

Current practices: fixed & seasonal TACs, quotas, hard caps

Motivation and context



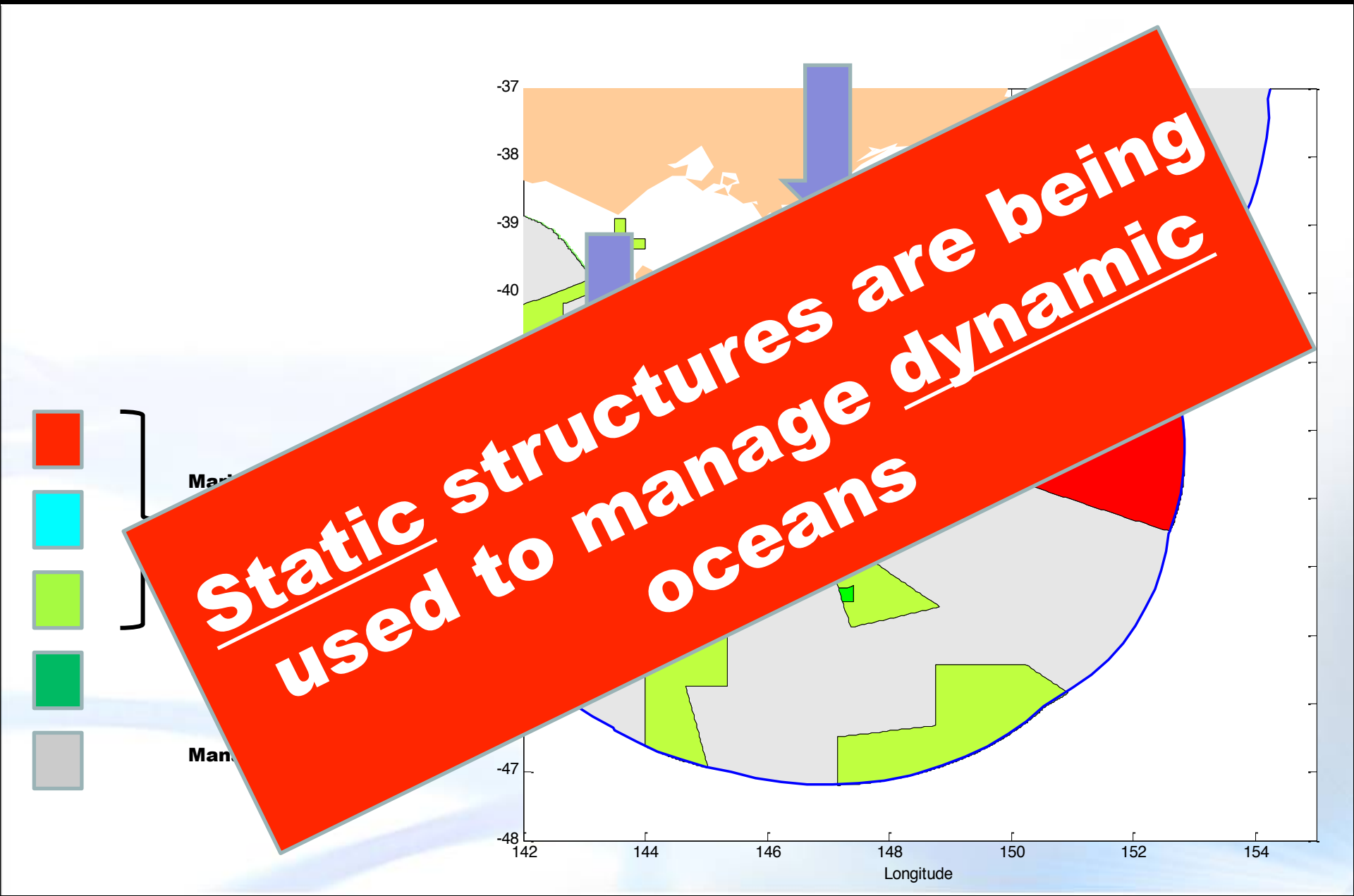
seascapes

marine life

human uses

are all dynamic

Motivation and context

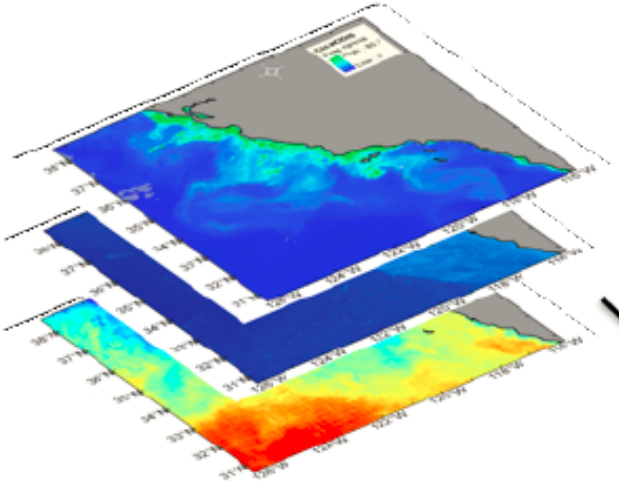


Static structures are being used to manage dynamic oceans

Satellite data/products

Variable/ Model significance	Product/Sensor	Grid Res.	Temp. Res	Source
Sea surface height	Merged (Topex/Poseidon, ERS-1/-2, Geosat, GFO, Envisat, Jason-1/-2)	0.3333 deg	1 day	AVISO
Geostrophic currents	Merged (Topex/Poseidon, ERS-1/-2, Geosat, GFO, Envisat, Jason-1/-2)	0.25 deg	1 day	AVISO
Seawinds	QuikSCAT	0.25 deg	1, 3 day	NASA
	METOP ASCAT	0.25 deg	1, 3 day	NOAA/NESDIS
Eddy kinetic energy	Merged (Topex/Poseidon, ERS- 1/-2, Geosat, GFO, Envisat, Jason-1/-2)	0.3333 deg	7 day	AVISO
Ekman upwelling	Seawinds/QuikSCAT	12.5 km	8 day	NASA/JPL
Sea surface temperature	Global High Resolution AVHRR Pathfinder v. 5 (day and night)	4.4 - 25 km	1 day	NOAA/NESDIS/NCDC
	Blended (AVHRR/POES, Imager/GOES, MODIS/Aqua, AMSR-E/Aqua)	0.1 deg	5 day	NOAA/NESDIS
SST gradient	AVHRR Pathfinder v.5 (day and night)	4.4 km	5 day	NOAA/NESDIS
Chlorophyll-a concentration	SeaWiFS/Orbview-2	8.8 km	1, 3, 8 day	NASA/GSFC
	MODIS/Aqua	4.4 km	1, 3, 8 day	NASA/GSFC
	VIIRSN	4 km	1, 3, 8 day	NASA/GSFC

Analytical approach



Environmental data

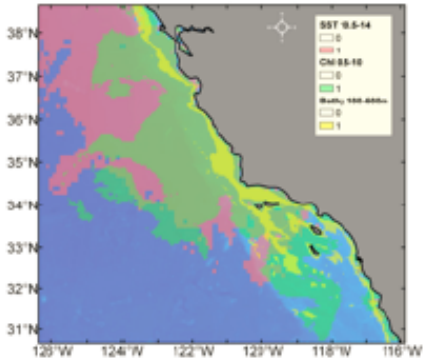
Data Types:

Satellite tracking data

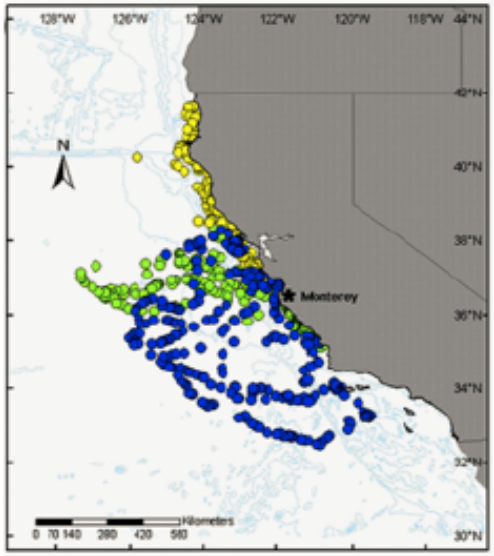
Fishery observer data

Environmental data

Presence/absence ~
dist2coast * *a* + chla * *b* + sst * *c*



Habitat suitability



Animal observations

Models tested:

- **GAMMS**
- **Boosted regression trees**

Model validations:

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

Analytical approach

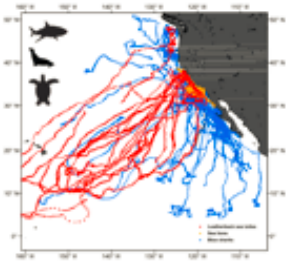
Habitat Models + Fishery Interaction Models

Catch/Bycatch Probability Model
(Zydelis et al 2012 *Proceedings of the Royal Society B*)

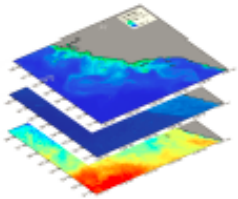
$\sum P_i \sim H_i + B_i + \text{error}$

- **Swordfish**
- **Leatherback sea turtles**
- **Blue shark**
- **California sea lion**
- ***Cetaceans***

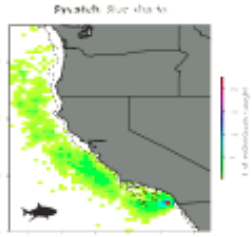
Satellite tracking data



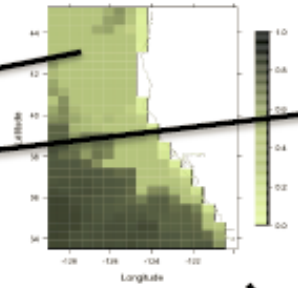
Remotely-sensed oceanographic data



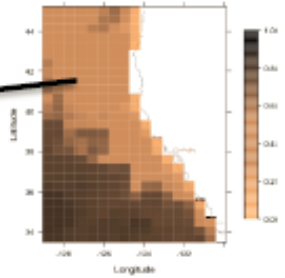
Fishery Observer Data



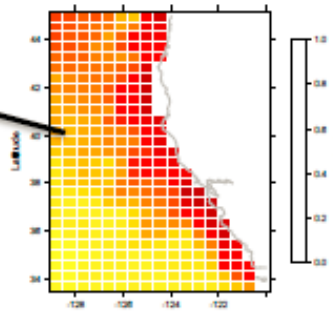
Suitable habitat models



Fishery interaction models



Probable bycatch models

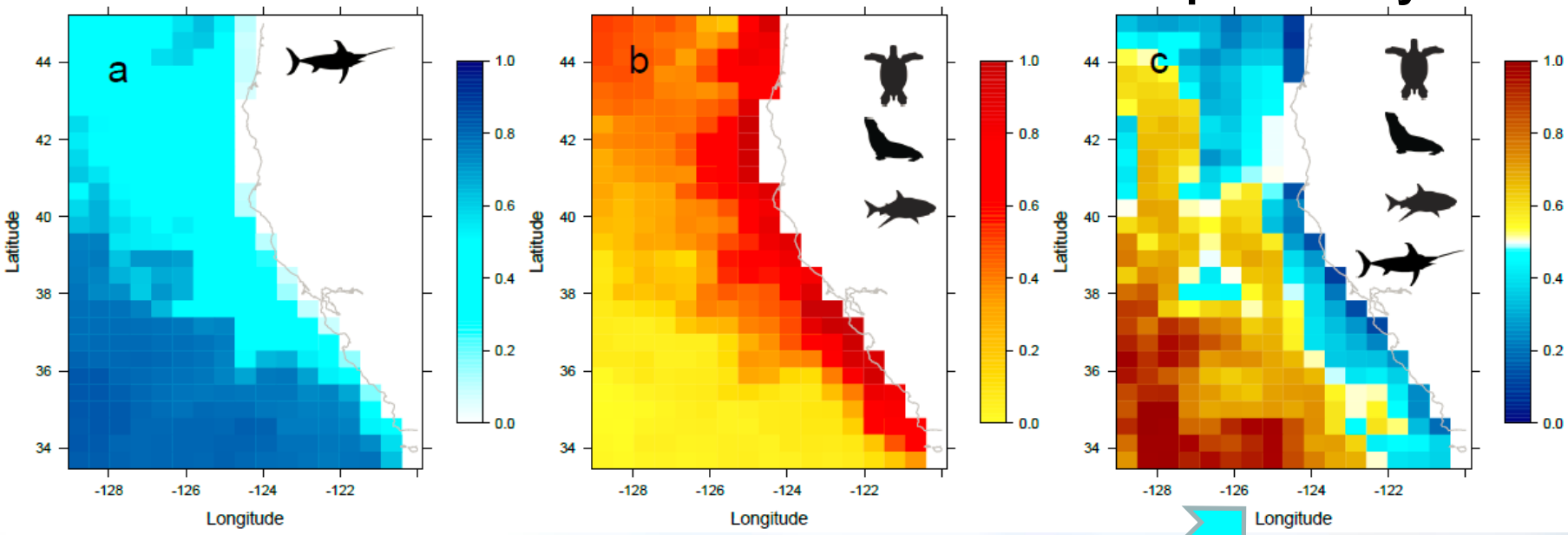


Where catch/bycatch is most likely to occur

Target

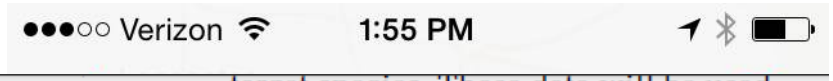
Non-target

Integrated catch probability



Economics layer

Crowdsourcing and uptake



measures to protect sea turtles and marine mammals. The applicants requested issuance of an EFP for two fishing seasons or two calendar years. The Council discussed the merits of the application at its March 2015 meeting and concluded that obtaining additional information was warranted.[2]

At the June 2015 Council meeting, ACSF submitted a revised application addressing the Council's concerns. Based on the revised application, the Council recommended [3] that NMFS consider issuing an EFP to ACSF as long as the EFP were restricted in accordance with the Council's supplementary conservation recommendations. These recommendations were to ensure

[1] *http://www.pcouncil.org/wp-content/uploads/HMS_EFP_Notice_Letter_July2014.pdf.*

[2] *http://www.pcouncil.org/wp-content/uploads/2015/03/0315decisions.pdf.*

[3] *http://www.pcouncil.org/wp-content/uploads/2015/06/0615decisions.pdf.*

respectively, are successfully used to obtain high target species catch and low incidence of bycatch in full-fleet fisheries (Pacific Fishery Management Council, personal communication).

Academic researchers, in collaboration with NMFS scientists, have been developing EcoCast, a tool to predict favorable habitat for swordfish and bycatch species to assist fishers in targeting catch and in bycatch avoidance. This tool may be used to support the EFP objective of testing the use of environmental triggers to direct fishing to times and areas of increased swordfish catch and decreased bycatch.

The Council has indicated that if the innovations tested in this EFP are able to demonstrate higher target catch and lower bycatch than the current DGN fleet, the Council would consider

[4] *http://www.pcouncil.org/wp-content/uploads/0614decisions.pdf.*

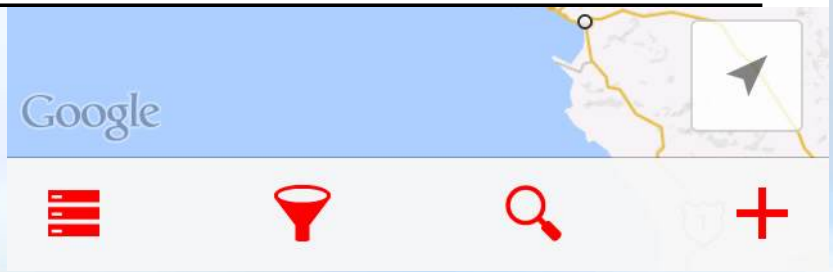
target species. These data will be used to test and improve the oceanographic models to ensure they are accurately predicting times and areas with a high target catch to bycatch ratio.

(4) The EFP vessels must collect detailed data on catch and bycatch, gear deployment, and ocean conditions, including: Catch-per-unit-effort, sea surface temperature, water clarity, profiles of temperature with depth, species and abundance of marine mammals and turtles in the area, and other information available from sonar, echo-sounder, or other onboard electronic technology devices.

(5) 100% on-board observer coverage would be required while fishing under the EFP.

(6) The following gear modifications must be instituted relative to the rest of the DGN fishery:

—Installation of 50 percent more acoustic pingers,



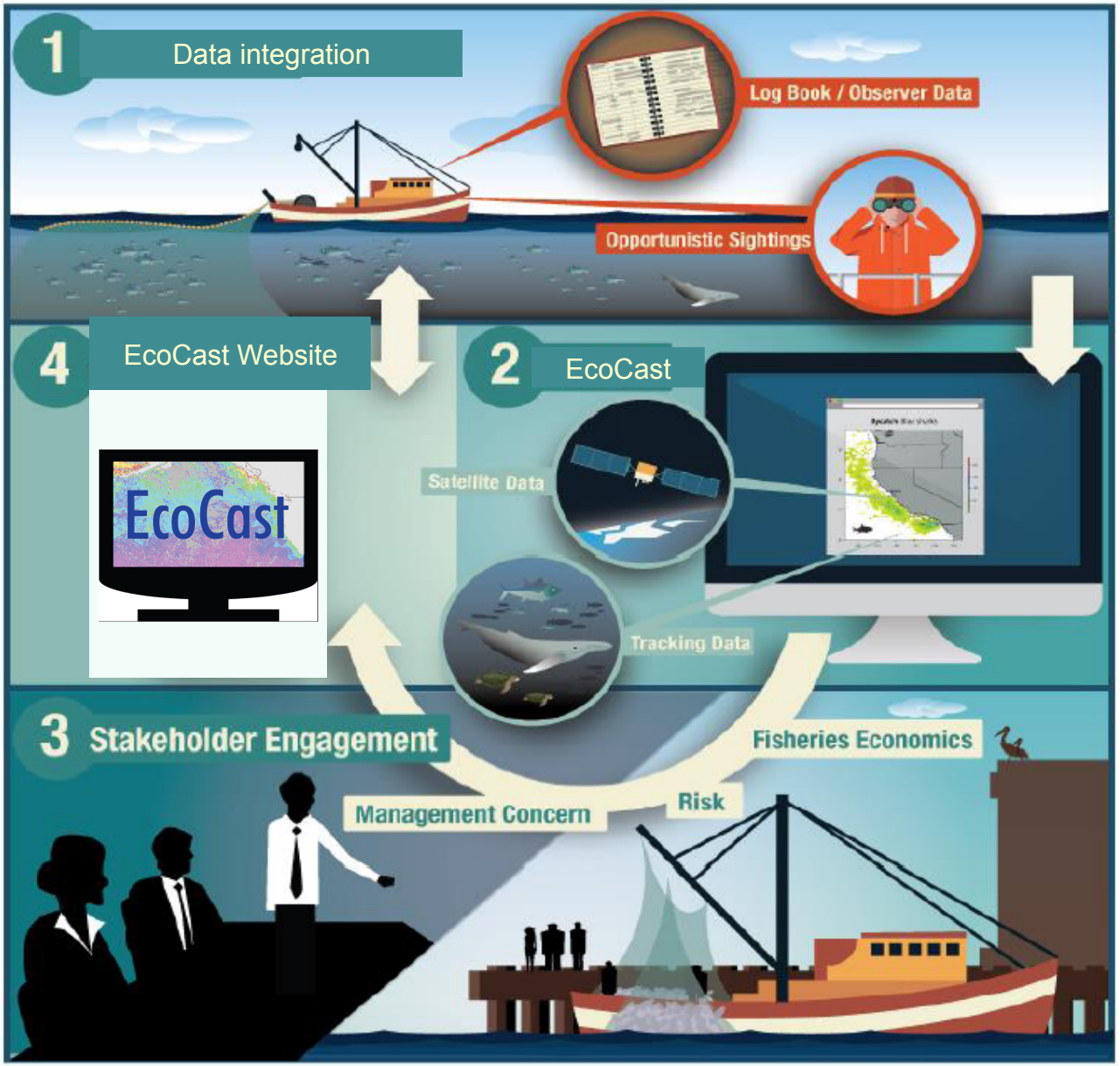
Publications

2017-2027 NRC Decadal Survey in Earth Science and Applications from Space

- Kacev, D, Lewison, RL. 2016. Satellite Remote Sensing in Support of Fisheries Management in Global Oceans in *Earth Science Satellite Applications: Current and Future Prospects*. Springer.
- Hossain, F, Serat-Capdevilla, A., Granger, S. et al 2016. A global capacity building vision for societal applications of earth observing systems and data. American Meteorological Society

- McGowan, J., Beger, M. Lewison, RL et al, in review. Fulfilling the promise of animal telemetry research for conservation Journal of Applied Ecology
- Maxwell SM, Hazen EL, Lewison RL, Dunn, DC, Bailey H, Bograd SJ, Hobday, AJ, Bennett M, Benson S, Briscoe DK, Caldwell M, Costa, D, Dewar H, Eguchi, T, Fossette, S, Hazen L, Kohin S, Sippel T, Crowder LB. 2015 Dynamic Oceans need dynamic management. Marine Policy
- Lewison, R.L., Hobday, A., Maxwell, S., Hazen, E., Hartog, J.R., Dunn, D. C., Briscoe, D., Fossette, S., O'Keefe, C.E., Barnes-Mauthe, M., Abecassis, M., Bograd, S., Bethoney, N.D., Bailey, H., Wiley, D., Andrews, S., Hazen, L., Crowder, L.B. 2015. Dynamic ocean management: Identifying the critical ingredients of dynamic approaches to ocean resource management. Bioscience.

Phase II


1
Data integration
Log Book / Observer Data
Opportunistic Sightings
4
EcoCast Website
EcoCast
2
EcoCast
Satellite Data
Tracking Data
3
Stakeholder Engagement
Fisheries Economics
Management Concern
Risk