Predictive Mapping Tools and Technology: Existing and emerging applications

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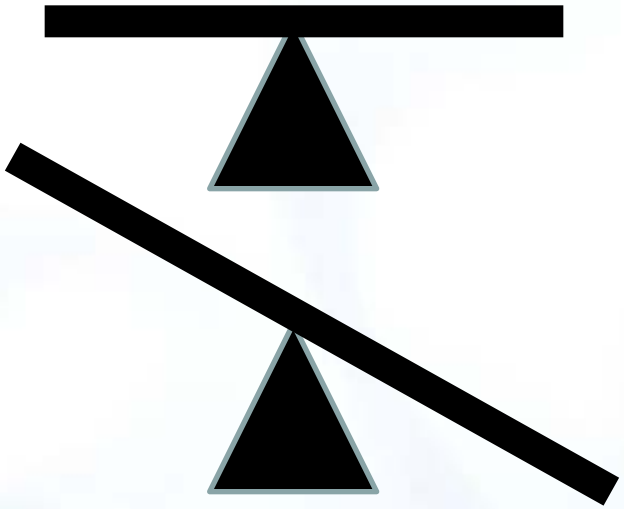
Next steps in bycatch reduction for SWO (all) fisheries

- Continued compliance/enforcement for existing measures
- Support stakeholder engagement and involvement
- Develop new methods for bycatch reduction that continue to support managed target catches and economic viability

Motivation and context

Ecologically sustainable fisheries



Economically viable fisheries

What is dynamic ocean management?

" management that changes in space and time in response to the shifting nature of the ocean and its users based on the integration of real-time or near real-time biological, oceanographic, social, economic and other data."

(Maxwell et al 2012, Hobday et al 2014, Lewison et al. 2015)

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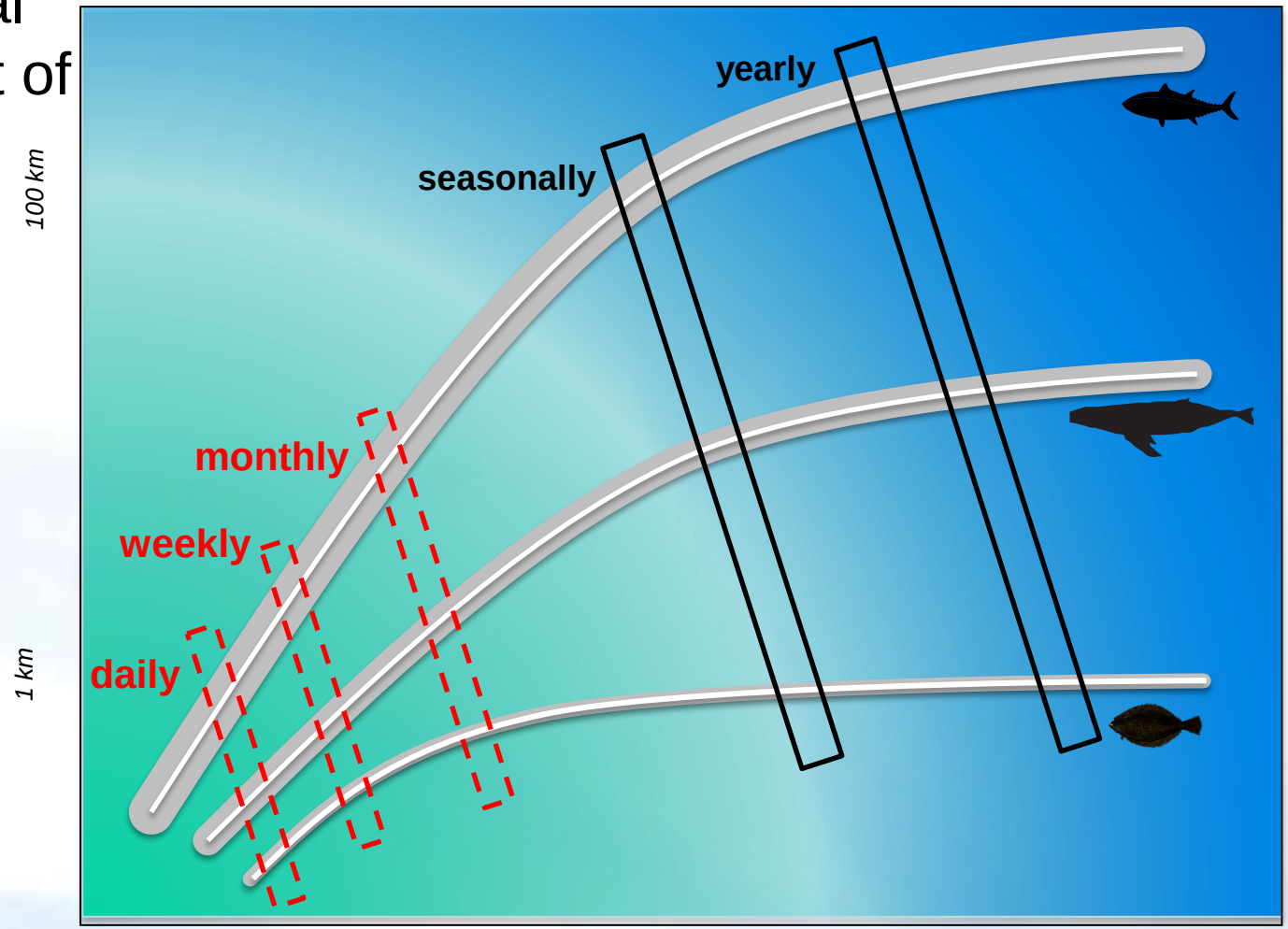
What is dynamic ocean management?

Spatial extent of mgmt



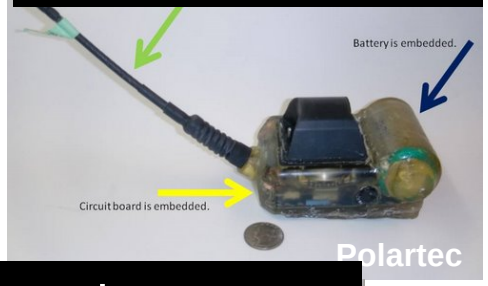
Temporal scale of data used

(Lewison et al. 2015)

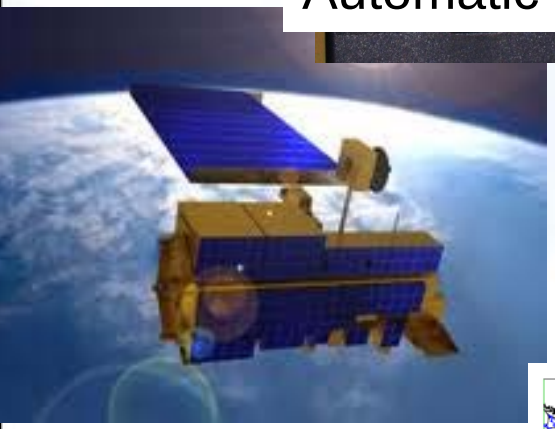
Data sources

Automatic Identification System (AIS)

Telemetry devices

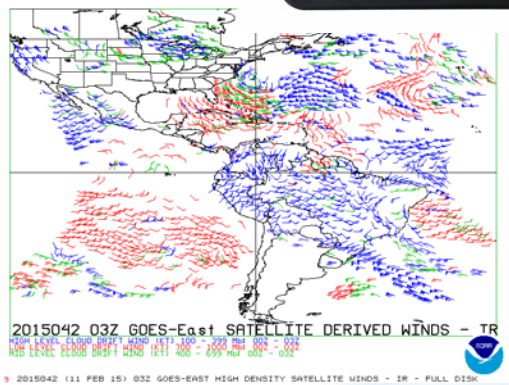


Acoustic arrays



Remote-sensing

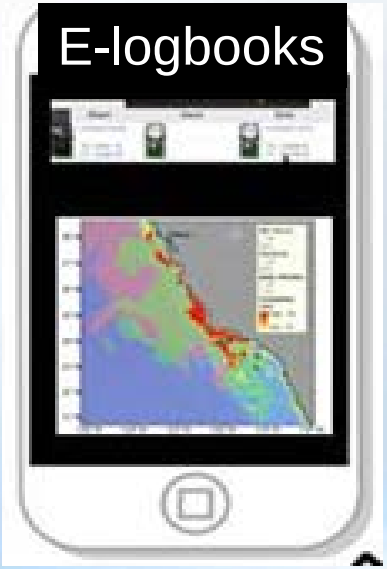
VHF



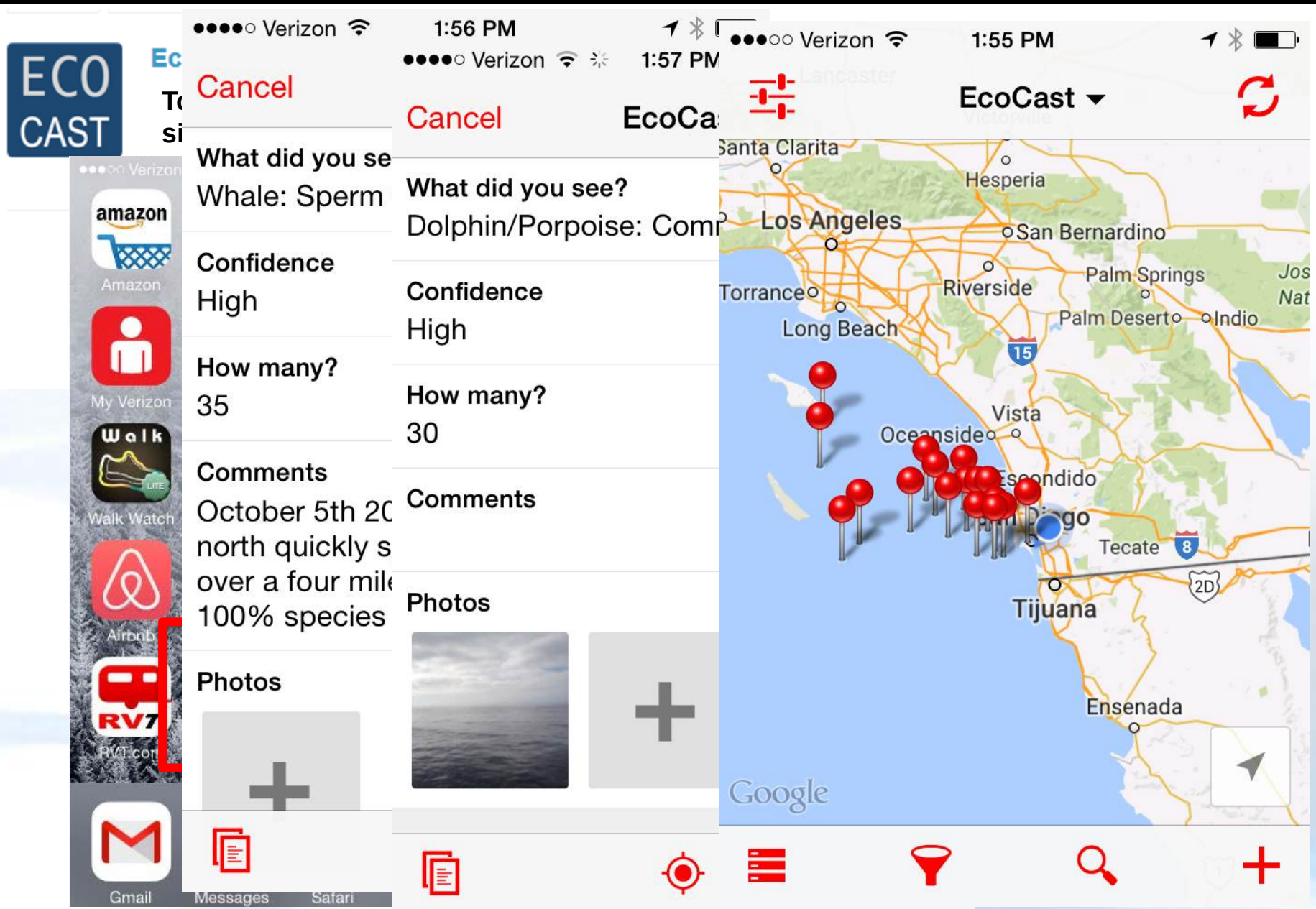
Derived products

SMS

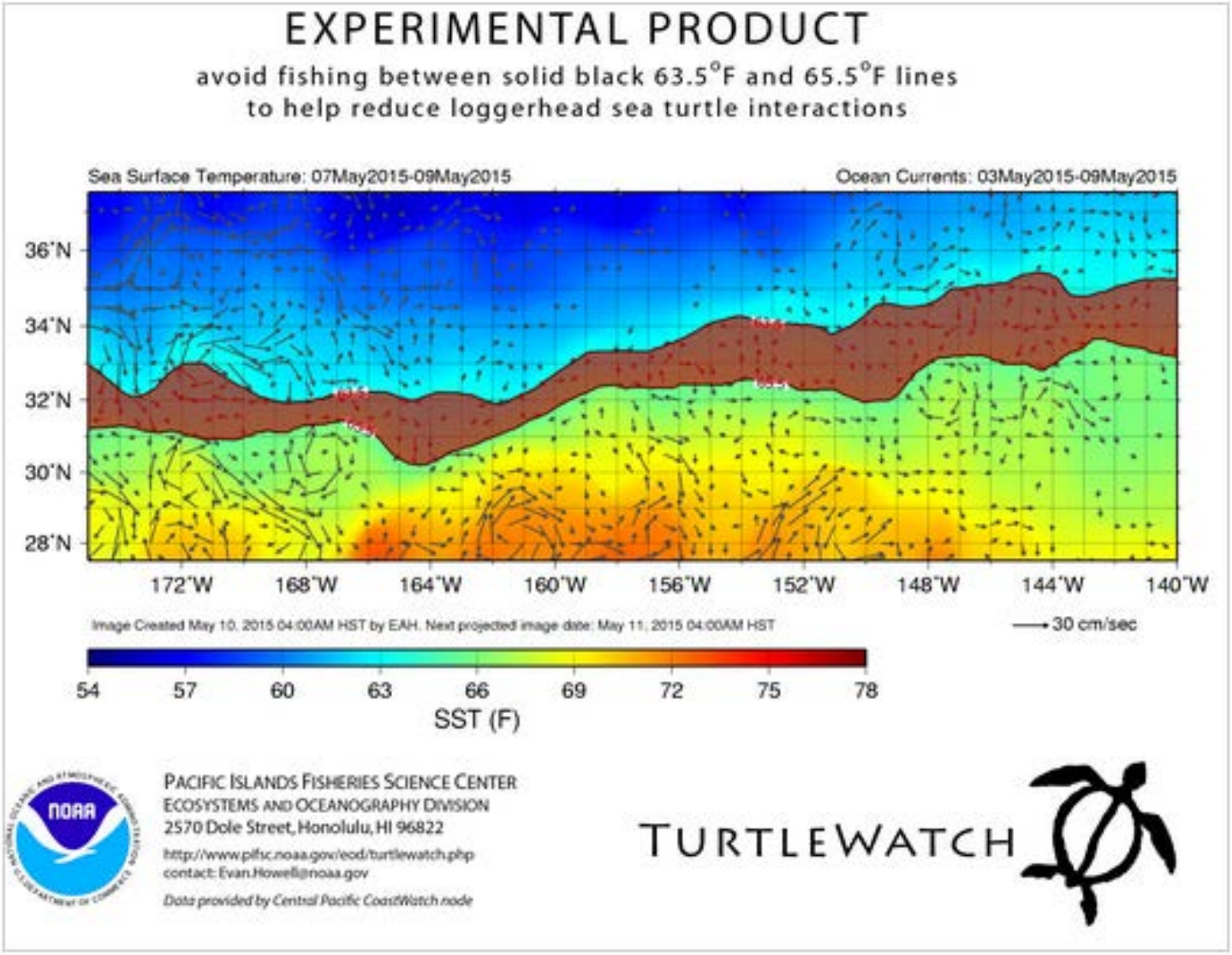
E-logbooks



Data sources



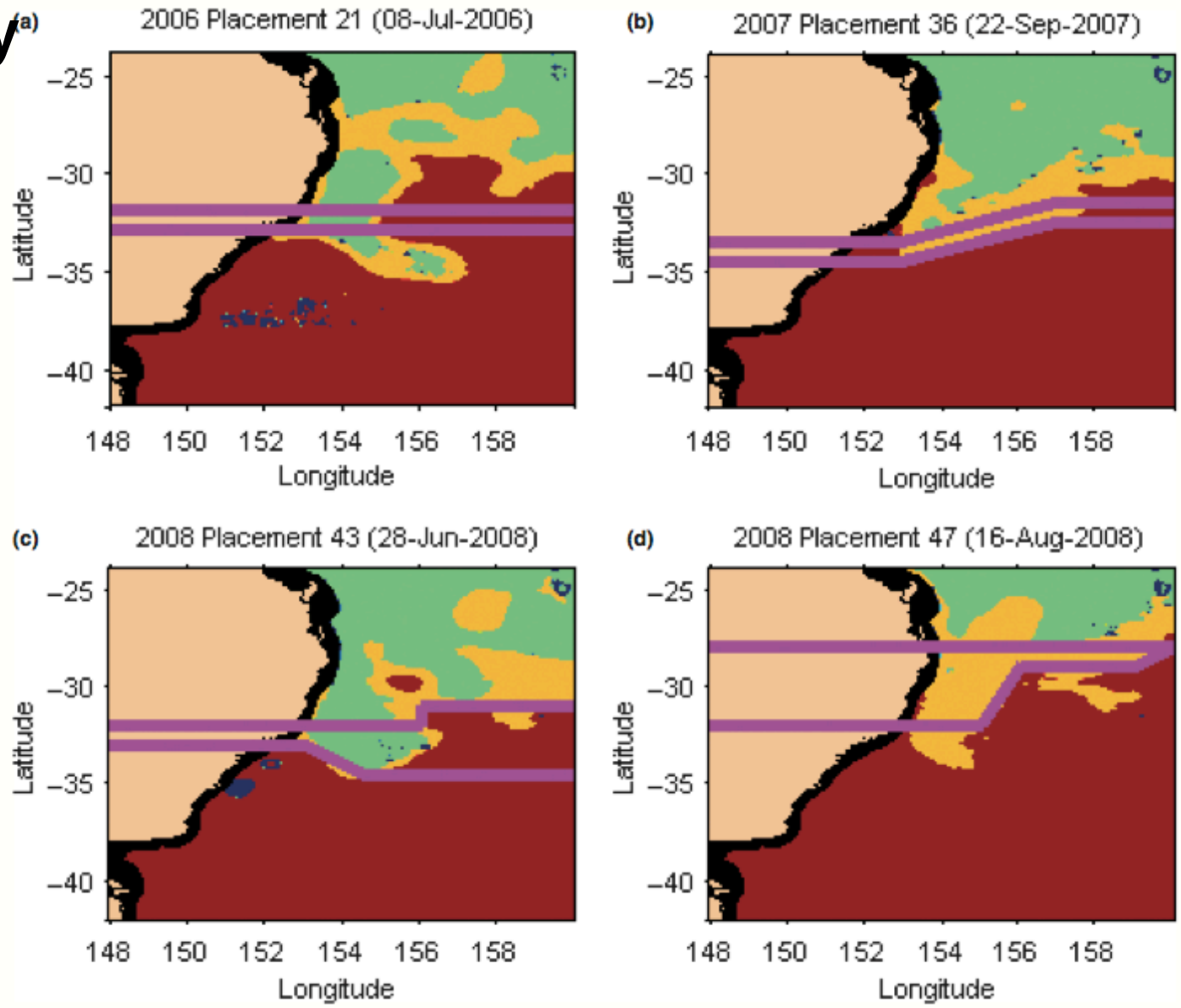
Existing and emerging applications



Turtlewatch
PI: E. Howell

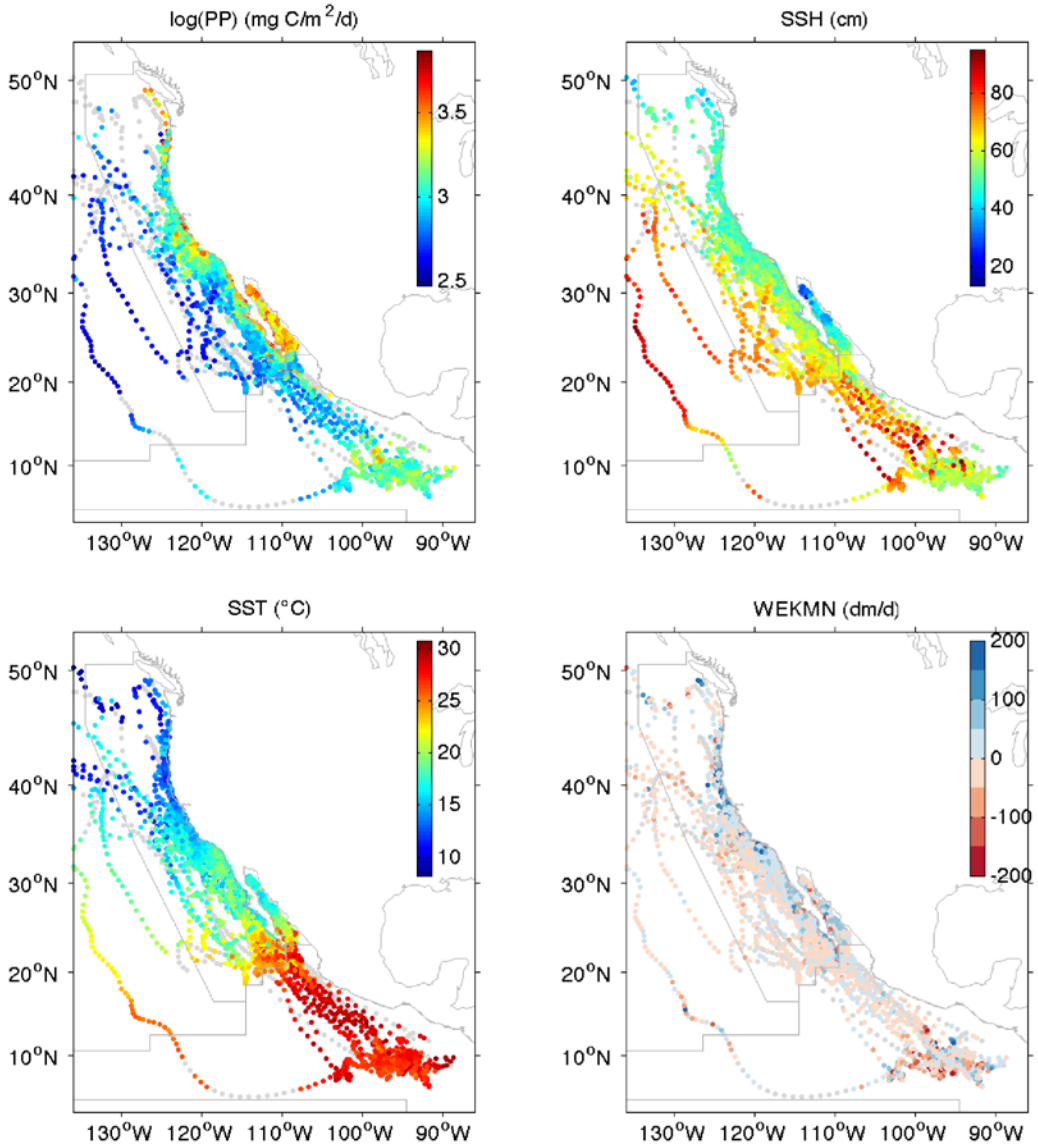
Existing and emerging applications

PI: A. Hobday



Existing and emerging applications

Whalewatch
PI: H. Bailey



Existing and emerging applications

Whale Alert

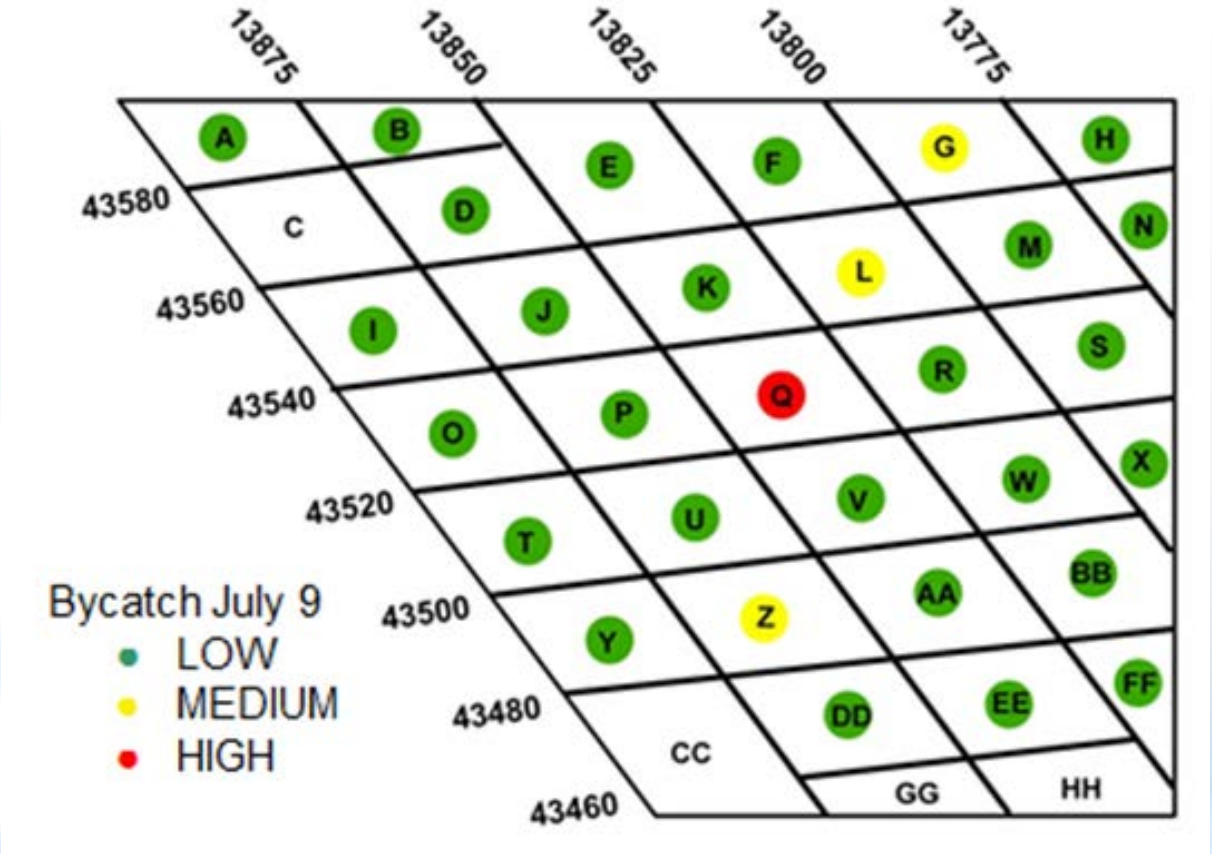
PI: D. Wiley

Whale Alert

Existing and emerging applications

PI: C. O'Keefe

SMAST – SCALLOP INDUSTRY



Project title: EcoCast

A **predictive mapping tool** that aims to balance sustainable catch and bycatch mitigation

Project team

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

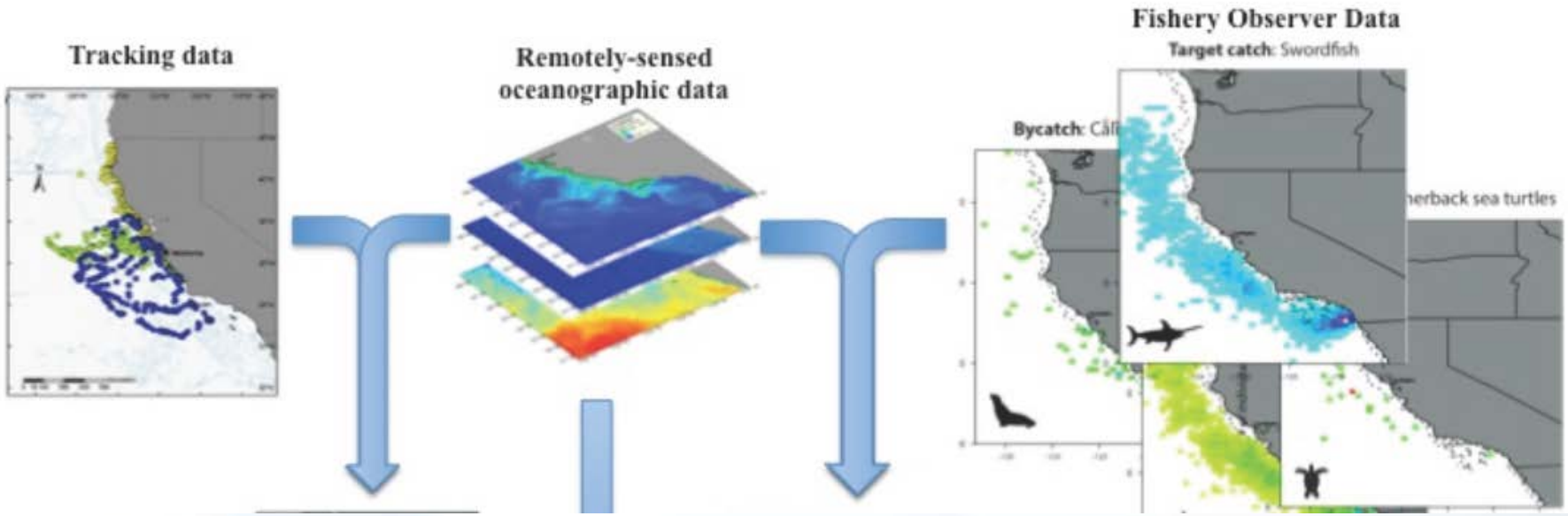
Sara Maxwell (**Old Dominion**), Elliott Hazen (**NOAA**)
Melissa Stevens, Matt Merrifield (**TNC**)

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**)

Analytical approach

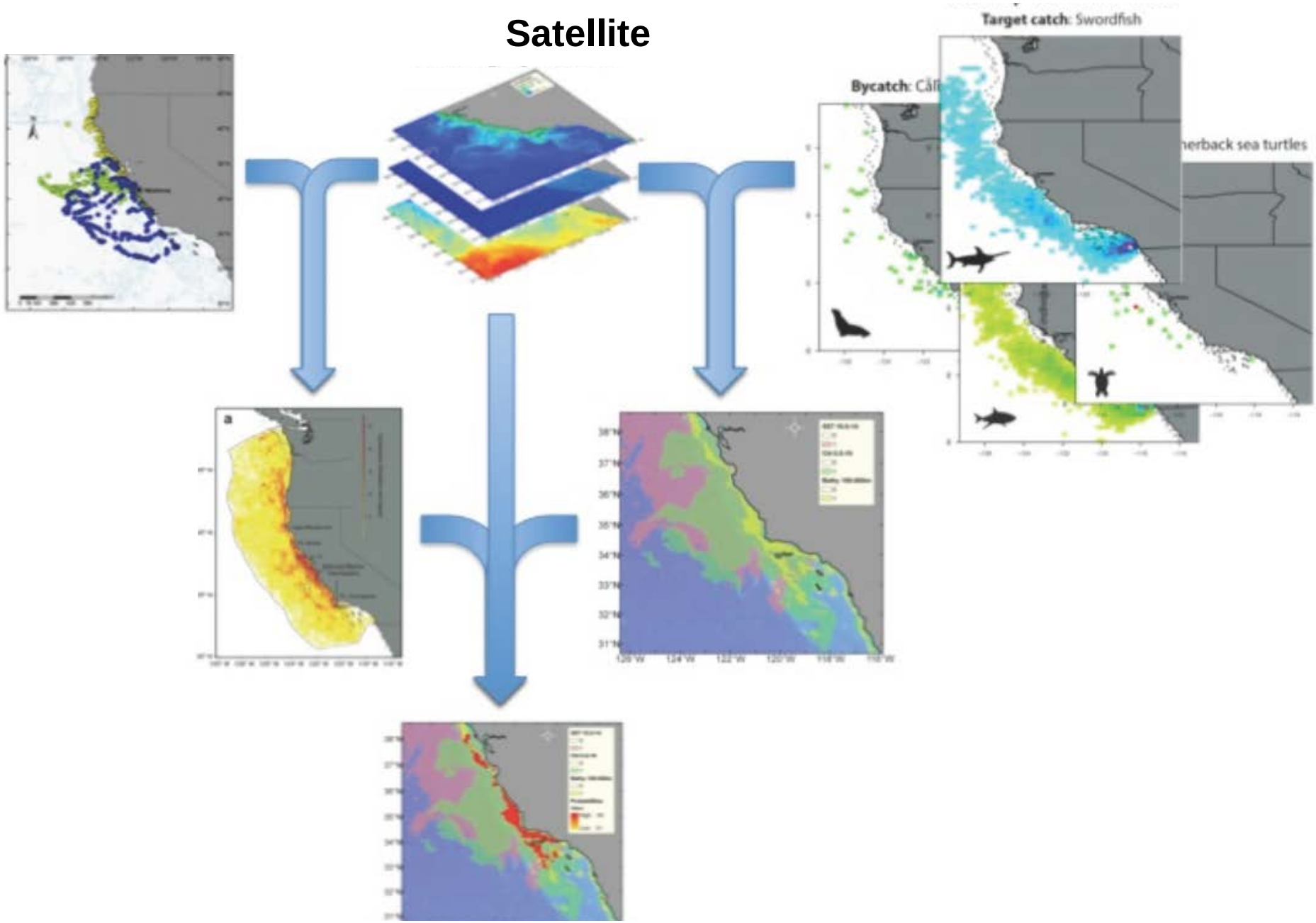
Leveraging science & technology



EcoCast leverages

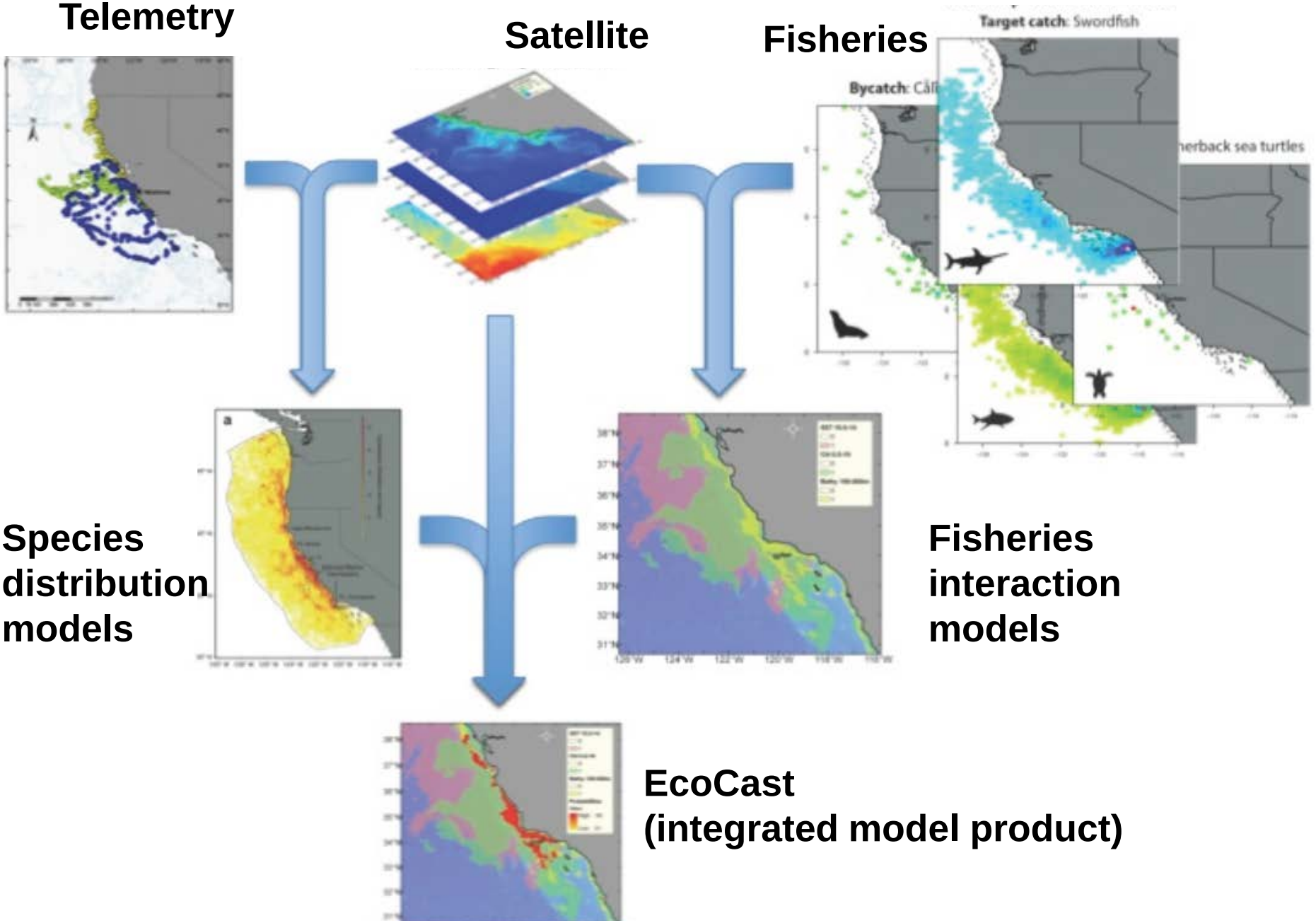
- Next-gen telemetry (Bailey et al. 2009, Block et al. 2011)
- Innovative spp. distribution modelling (Hobday et al. 2011))
- Robust spatial data integration (Pikesley et al 2013)

Satellite



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


Telemetry
Satellite
Fisheries
Target catch: Swordfish
Bycatch: Cal
erback sea turtles
Species distribution models
Fisheries interaction models
EcoCast
(integrated model product)

Phase I products

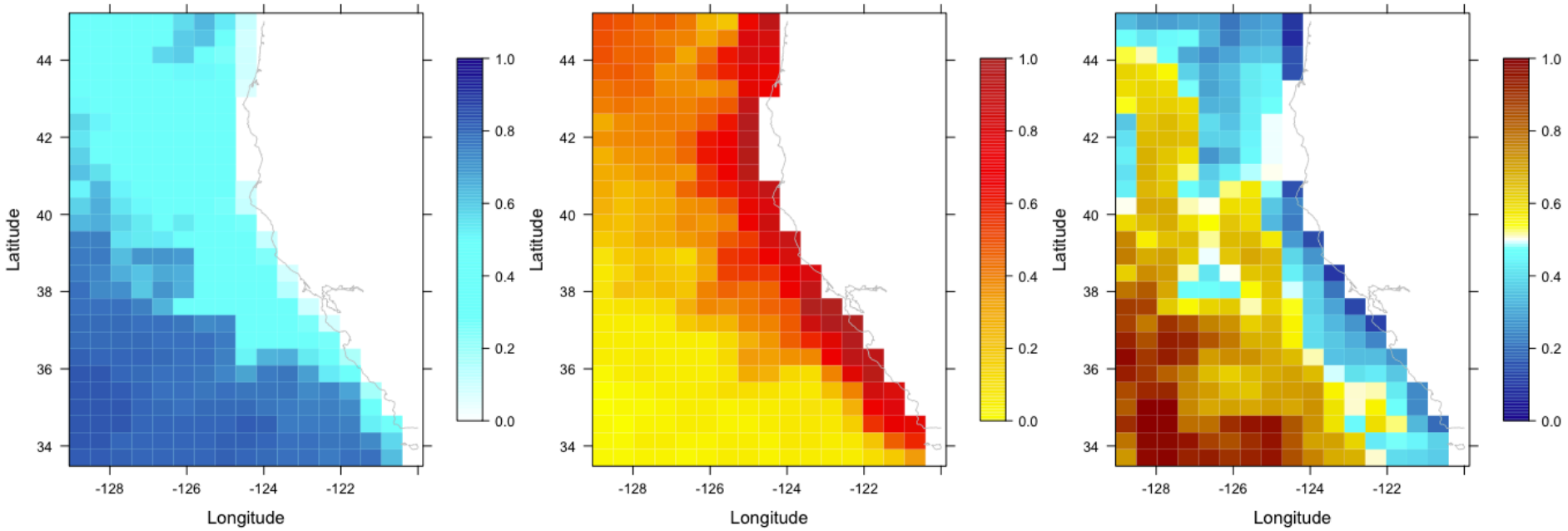
Variable/ Model significance	Product/Sensor	Grid res. (degree)	Temporal res. (day)	Temporal coverage	Source
Sea surface height	Merged (Topex/Poseidon, ERS-1/-2, Geosat, GFO, Envisat, Jason-1/-2)	0.25	1 day	[14-Sep-94 present]	AVISO
Geostrophic currents	Merged (Topex/Poseidon, ERS-1/-2, Geosat, GFO, Envisat, Jason-1/-2)	0.25	1 day	[14-Oct-92 present]	AVISO
Seawinds	QuikSCAT	0.25	1, 3 day	[22-Jul-99 19-Nov-09]	NASA
	METOP ASCAT	0.25	1, 3 day	[4-Oct-09 present]	NOAA/NESDIS
Eddy kinetic energy	Merged (Topex/Poseidon, ERS-1/-2, Geosat, GFO, Envisat, Jason-1/-2)	0.25	7	[14-Sep-94 present]	AVISO
Ekman upwelling	Seawinds/QuikSCAT	12.5 km	8	[1-Aug-99 10-Apr-08]	NASA/JPL
Sea surface temperature	Global High Resolution AVHRR Pathfinder v . 5 (day and night)	4.4 - 25 km	1	[01-Sep-81 2-Apr-14]	NOAA/NESDIS/NCDC
	Blended (AVHRR/POES, Imager/GOES, MODIS/Aqua, AMSR-E/Aqua)	0.1 deg	5	[4-Jul-02 present]	NOAA/NESDIS
SST gradient	AVHRR Pathfinder v.5 (day and night)	4.4 km	5	[15-Sep-94 13-Apr-08]	NOAA/NESDIS
Chlorophyll-a concentration	SeaWiFS/Orbview-2	8.8 km	1, 3, 8	[9-Aug-98 10-Apr-08]	NASA/GSFC
	MODIS/Aqua	4.4 km	1, 3, 8	[1-Jul-02 present]	NASA/GSFC
	VIIRSN	4 km	1, 3, 8	[2-Jan-12 Present]	NASA/GSFC

Preliminary predictive habitat models have been constructed for each focal species

- generalized additive mixed models (GAMMs)
- generalized additive models (GAMs)

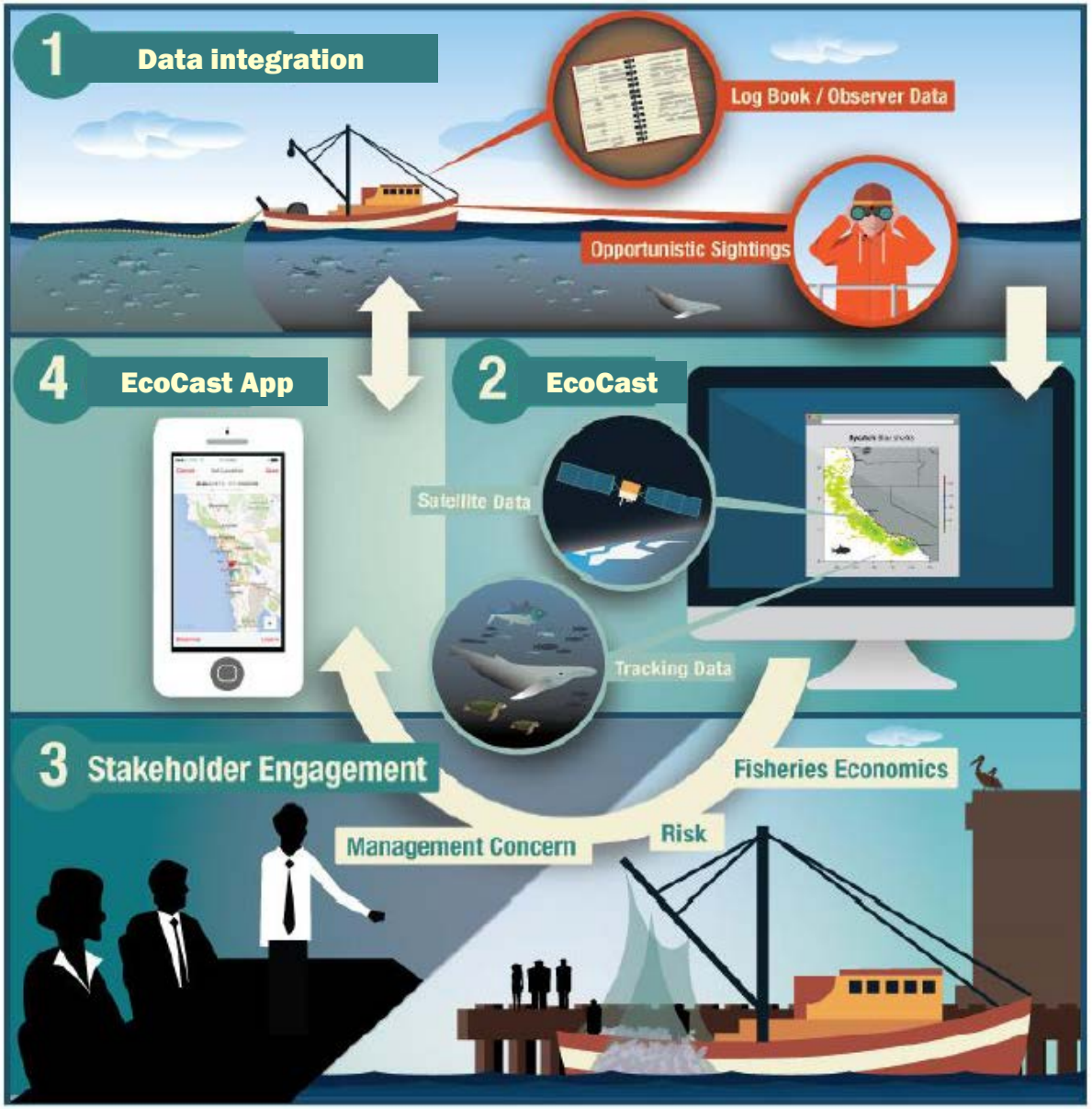
Model development to continue in Phase II

Phase I products



Phase I progress demonstrates feasibility, tractability and utility

Phase II



Ensemble model approach

California Current Regional Ocean Modeling System (ROMS)

- ⇧ temp & spatial resolution
- Improve ocean characterization

Crowdsource data

- EcoCast application aims to support the SWO fishery, irrespective of the gear used

- Phase II of the project has just begun

- Working to integrate satellite, telemetry, observer, logbook, and fisher (opportunistic) data

- Will be providing EcoCast users with dynamic ocean conditions maps (e.g. SST)

- **Dynamic ocean management/predictive mapping is an emerging approach that can support fisheries management (not specific to a particular gear type)**

- **These approaches can use multiple data sources (high and low tech)**

- **Powerful complement to traditional fisheries management**