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

Management in the Moving Ocean

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Static structures are being used to manage dynamic 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.

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

….loggerhead closure during El Niño events

Benson et al 2011
Context for EcoCast

SIGNIFICANT economic cost

2015 = 18 active permits

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

Economic viability
• 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
<table>
<thead>
<tr>
<th>Data Products</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST and Standard Deviation</td>
<td>Daily – JPL GHRSSST</td>
</tr>
<tr>
<td>Chl</td>
<td>8-day – SeaWIFS, MODIS, VIIRS composite</td>
</tr>
<tr>
<td>EKE</td>
<td>Daily – AVISO at 25km</td>
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<tr>
<td>SSHa and SD</td>
<td>Daily – AVISO/CMEMS at 25km</td>
</tr>
<tr>
<td>Y winds</td>
<td>8-day – QSCAT and ASCAT at 25km</td>
</tr>
<tr>
<td>Bathymetry and SD</td>
<td>ETOPO1 at 1’</td>
</tr>
</tbody>
</table>
Citizen science
Methodological approach

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

Oceanographic data

Statistical models

Fit

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

Predict

June 23rd, 2010

June 23rd, 2010

June 23rd, 2010

June 23rd, 2010

Probability of occurrence predicted from environmental covariates
Species Distribution Models

Swordfish Observer  California Sea Lion  Leatherback Turtle

Blue Shark (Tracking)

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

2012-08-01
Blue shark bycatch weighting = -0.2
Blue shark tracking weighting = -0.2
Sea lions weighting = -0.05
Leatherbacks weighting = -0.9
Swordfish weighting = 0.9

2015-08-01
Blue shark bycatch weighting = -0.2
Blue shark tracking weighting = -0.2
Sea lions weighting = -0.05
Leatherbacks weighting = -0.9
Swordfish weighting = 0.9

(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).
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
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.

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.

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.
Daily product

EcoCast

Most recent daily products

EcoCast
An Eco-informatic Tool for Fisheries Sustainability
Experimental Product

Apr 22 2018

Species weightings
Blue sharks weighting = -0.1
Sea lions weighting = -0.05
Leatherbacks weighting = -0.9
Swordfish weighting = 0.9

Environmental data
Sea surface temperature is from 2018-04-22
Chlorophyll a is from 2018-04-22
Eddy kinetic energy is from 2018-04-22
Sea surface height is from 2018-04-22
Surface wind is from 2018-04-22

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 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.

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Environmental Research Division, SWFSC, NMFS, NOAA
99 Pacific Street, Monterey CA 93948, USA
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

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. McHughon, Patrick W. Robinson, Carey Kuhn, Daniel P. Costa...See all authors

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. Jacon,1,2 Christopher A. Edwards,1 Dana K. Briscoe,6 Larry B. Crowder,6 Rebecca L. Lewison,7 and Steven J. Bograd5

Integrating dynamic subsurface habitat metrics into species distribution models

Hazen et al.

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

Journal of Applied Ecology

Forum
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
• EcoROMS – higher spatial res, integrating subsurface habitat metrics

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

• EcoCast applications in other US fisheries