Ocean Color & Fisheries

Cara Wilson

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What is Fisheries?

There are three principal aspects of fisheries:

1. Harvesting (catching “fish”)
2. Stock Assessment (counting “fish”)
3. Management & Conservation (saving “fish”)

Fisheries is more than just fish, it encompasses all living marine resources (LMRs), i.e. marine mammals, sea turtles and invertebrates.
1. Harvesting
Harvesting
Harvesting chlorophyll-a in phytoplankton (different sizes and types)
Oceanic Food Web

Modified from Pauly & Christensen [1993]
Linkages

From Ware & Thomson, Science, 2003
Linkages

From Ware & Thomson, Science, 2003

\[ r^2 = 0.87; \]
\[ p < 0.0001; \]
\[ n = 11 \]

Mean resident fish yield (metric tons · km⁻²)

Mean chl-a concentration (mg · m⁻³)
Albacore CPUE (catch per unit effort) overlain on SeaWiFS chlorophyll, showing that the longline fishery largely operates along the transitional zone chlorophyll front (TZCF).

Zainuddin et al., DSR-II, 2006
Upwelling Areas

Dots show the distribution of the tuna purse seine fishery in the Pacific. From Dale Kiefer’s poster (poster #70)
Indian National Centre for Ocean Information Services (INCOIS) generates and distributes Potential Fishing Zone (PFZ) advisories to the Indian Fishing Community.

The PFZs are generated using SST and chlorophyll data.

http://www.incois.gov.in/MarineFisheries/MarineFisheryAdvisory
INCOIS – Potential Fishing Zone (PFZ) Advisories

SATELLITE DATA SHOWS LIKELY AVAILABILITY OF FISH STOCK TILL 18 APR 2015

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http://www.incois.gov.in/MarineFisheries/MarineFisheryAdvisory
## INCOIS – Potential Fishing Zone (PFZ) Advisories

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Impact of PFZ on CPUE

Catch Per Unit Effort (kg/hr²)

Without PFZ

With PFZ

From Solanki et al., CSR, 2005
Time and fuel costs are always important considerations when fishing. ROFFS™ will show you where the fish are located before you leave the dock and while fishing by sending you the most current information possible.

ROFFS™ loves to talk to clients before, during and after their trips. ROFFS™ tries to update their “catch reports” on a weekly basis and will only report first hand information. No hear-say or dockside information.

ROFFS™ current office hours – September 29, 2014 through March 28, 2015 – Monday through Friday 9 AM – 5 PM, Saturday Closed. Please click below for more information on our products.
Since 2004, we have provided the highest quality online satellite fishing charts services on the market today – that is why the very best fishermen in the world rely on our product!
2. Stock Assessment
Stock Assessment is a fancy way of saying “counting fish”
NOAA Fisheries (National Marine Fisheries Service) is responsible for managing ~450 fish stocks. In addition, NMFS manages ~200 protected or endangered species (marine mammals and turtles).
In theory, counting fish seems relatively straightforward.
In practice, it’s much more complicated.
Stock Assessment

from http://www.st.nmfs.noaa.gov/stock-assessment/index

Assessments provide the technical basis for setting annual fishery harvest levels
Atlantic Herring Spawning Stock Biomass (SSB)

What drives the interannual variability in biomass?

Source: 54th Northeast Regional Stock Assessment Workshop, 2012
Stock Assessment

from http://www.st.nmfs.noaa.gov/stock-assessment/index

Abundance + Biological Data + Catch Data = Stock Assessment

Where’s the E (Environment)?
Timing of the spring bloom & Haddock survival

Annual anomaly in the timing of the spring bloom based on SeaWiFS chlorophyll data.

Earlier bloom means more time in the ‘green’ zone

From Platt et al., Nature, 2003
Habitat Modeling

Potential Sardine Habitat

Model predicts sardine occurrence based on satellite SST, chlorophyll and SSH.

Was developed to optimize the timing and location of ship surveys for sardine stock assessment (i.e., to improve the “A” part of the stock assessment).

From Zwolinski et al., ICES JMS, 2011
NRT Cruise support

- VIIRS chl image generated by NESDIS in support of a SEFSC survey cruise looking for bluefin tuna larvae.
- Images are used to position stations to cover frontal features, small and mesoscale oceanographic features, and to ensure as many different water masses as possible are sampled.
- They requested the images in gray scale.

John Lamkin, NOAA/NMFS/SEFSC
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John Lamkin, NOAA/NMFS/SEFSC
Developing ecological indicators for sablefish recruitment

**Objectives**
1. Support an ecosystem approach to management
2. $142 million fishery for sablefish in U.S.
3. Develop indicators for sablefish recruitment
4. **Use satellite color data to index chl-a, blooms**
5. Quantify blooms in rearing areas
6. Link to future sablefish recruitment

**Model Prediction**
High age-2 recruitment in 2002 was linked to high chlorophyll-a in the late summer in 2000.

Age-2 sablefish modeled as a function of Chl-a (t-2), sea temperature (ST) (t-2), and age-2 sablefish (t-1) with data collected in situ, 1999-2010 (Martinson et al. 2013).

Ellen Martinson, NMFS/AFSC/ABL
May 2008                   May 2009

Time series of average April-May chlorophyll concentrations in coastal Gulf of Alaska. The lowest value (2011) suggests that low productivity could have negatively influenced salmon survival that year.

Brian Burke
Fish Ecology Division
NWFSC, NOAA Fisheries
CA Current
Integrated Ecosystem Assessment (IEA)

From the 2013 California Current System IEA report
The NEFSC is using a (satellite derived) **bottom-up** approach to determine fisheries production potential and exploitation for various ecosystem components.

The proposed ecosystem limit reference point is that the exploitation rate should not exceed the fraction of microplankton production (~20-30%).

Fishery removals exceeded recommended levels (~935,000 t) in the past, but are now close to estimates of sustainable extraction rates.
3. Management & Conservation
Electronic tagging is a key methodology used by NOAA Fisheries to gather information on stock productivity and recruitment, fish behavior, feeding ecology and habitat selection—information needed for accurate and responsible fisheries management.¹

Satellite data, such as ocean color, SST, SSH and SVW, are necessary to place the telemetric data from tags in an environmental context as part of the transition to an ecosystem approach to management.


http://spo.nmfs.noaa.gov/tm
Top Predator Exploration of the Pacific Ocean

- 23 species; 4,000 tags; >1 Million profiles
- Tracking, conservation, ocean observation

From Block et al, 2011, Nature 475, 86–90
TOPP Synthesis: Marine Predator Migrations

From Block et al, 2011, Nature 475, 86–90
TZCF

Transitional Zone Chlorophyll Front

- It’s interannual variability affects the population of the endangered monk seal in the Hawaiian islands (Baker et al., 2007, 2012)
EXPERIMENTAL PRODUCT

avoid fishing between solid black 63.5°F and 65.5°F lines
to help reduce loggerhead sea turtle interactions

Sea Surface Temperature: 21Apr2015-23Apr2015
Ocean Currents: 17Apr2015-23Apr2015

Image Created April 24, 2015 04:00AM HST by EAH. Next projected image date: April 25, 2015 04:00AM HST

SST (F)

51 54 57 60 63 66 69 72 75

→ 30 cm/sec

PACIFIC ISLANDS FISHERIES SCIENCE CENTER
ECOSYSTEMS AND OCEANOGRAPHY DIVISION
2570 Dole Street, Honolulu, HI 96822
http://www.pifsc.noaa.gov/eod/turtlewatch.php
contact: Evan.Howell@noaa.gov
Data provided by Central Pacific CoastWatch node

http://www.pifsc.noaa.gov/eod/turtlewatch.php
Whale Watch

- Use satellite data to model blue whales & ship strike risk in near real time
- 104 OSU Blue Whale tracks
- NASA funded

Elliott Hazen et al., NMFS/SWFSC
Predicting fishery bycatch for management

Using remotely sensed products, these surfaces can be predicted in near-real time for use by managers and fishers. A NASA funded project.

Elliott Hazen et al., NMFS/SWFSC
High resolution (750m) ocean color and SST data from VIIRS will be extremely useful.

Need data in a format that is easy to pull into ArcGIS.

Biogeographical assessment of new MPA (marine protected area) in Puerto Rico.

Gustav Kågesten & Will Sautter, NOS/NCCOS

MERIS Turbidity 1km 2003-2012
Log transformed red band reflectance values
Harmful Algal Blooms (HABs)

NOAA National Ocean Service

Operational Monitoring and Forecasting of HABs in the Gulf of Mexico

Wind Speed (ms⁻¹)

Wind conditions from Venice Pier

Orbimage - SeaWiFS

Courtesy of Rick Stumpf, NOS
Are southern right whale calf deaths at Península Valdés caused by HABs?

In the past 10 years there has been a dramatic increase in the number of SRW deaths at their calving ground in Argentina. Most of the deaths (~90%) are calves less than 3 months old.

The chlorophyll maximum of the spring phytoplankton bloom at PV has increased by an order of magnitude in the past 10 years.

See Wilson et al. poster under review for *Marine Mammal Science*
• Used Google Earth imagery to identify intertidal weirs in the Persian Gulf.
• Estimated the 19,000 visible weirs catch > 30,000 tons of fish per year, six times greater than the official reported catch of 5,000 ton/year.
• Observed weirs in areas where they have been banned (Qatar).
Whales from Space

- A selection of 20 comparable false color image chips from the WorldView2 satellite of probable whales found by automated analysis.

- This study was done in Península Valdés, Argentina, which is a calving ground for Southern Right Whales (see Wilson et al. poster).

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0088655
Take Home Points

• “Fisheries” is more than just catching fish; stock assessment, management and conservation are important aspects to fisheries, which encompasses all living marine resources.

• NRT ocean color data are needed for optimizing harvesting and assessment surveys, detecting and monitoring HABs and making forecasts.

• Long-term Climate Quality ocean color data are needed for use in stock assessments, ecosystem assessments, and management and conservation applications.
Thank you!