



# How EO can be used for Fisheries and Aquaculture

Plenary session #1 - Fisheries



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5<sup>th</sup> Symposium | Accra, Ghana | 24 – 28 October 2022



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# NOAA Earth Observation Tools for Fisheries And Aquaculture

**Katie Geddes<sup>1</sup> and Cara Wilson<sup>2</sup>**

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# Outline

1. Principles of fisheries management
2. U.S. fisheries legislation
3. Overview of available data
4. Earth obs for catching, counting, and managing fish
5. NOAA applications
6. GEO Blue Planet Fisheries Working Group and my work



Image Credit: NOAA



# Fisheries Management

Three principal aspects of fisheries:

1. Harvest (catching fish)
2. Stock Assessments (counting fish)
3. Management (conserving fish)

Fisheries is more than just fish. It encompasses all living marine resources (LMRs), i.e. marine mammals, sea turtles and invertebrates.



Image Credit: NOAA



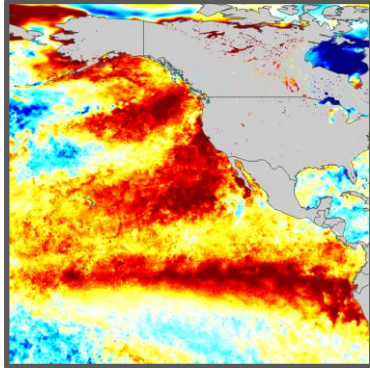
# U.S. Fisheries Legislation

- The **Magnuson–Stevens Fishery Conservation and Management Act** is the primary law that governs marine fisheries management in U.S. federal waters.
- Under the **Endangered Species Act**, NMFS is responsible for endangered and threatened marine and anadromous species—from whales and sea turtles to sharks, tunas and salmon (163 species)
- Under the **Marine Mammal Protection Act**, NMFS is responsible for the protection of whales, dolphins, porpoises, seals, and sea lions (119 species)

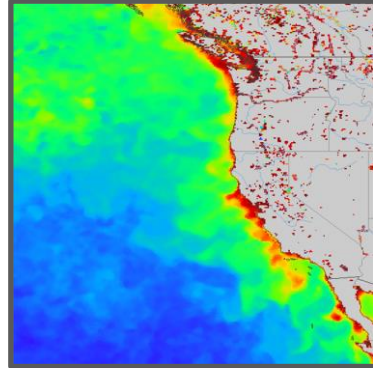


# Available Oceanographic Satellite Products

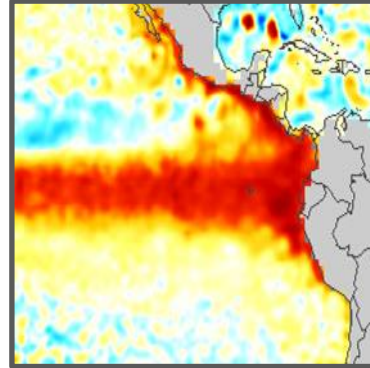
## Sea Surface Temperature



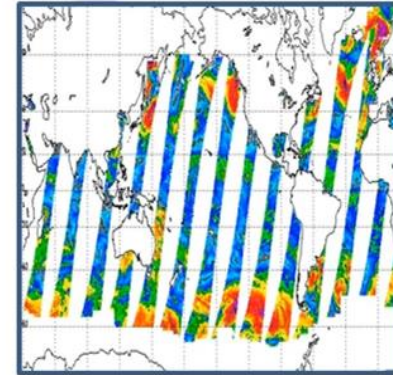
# Chlorophyll a



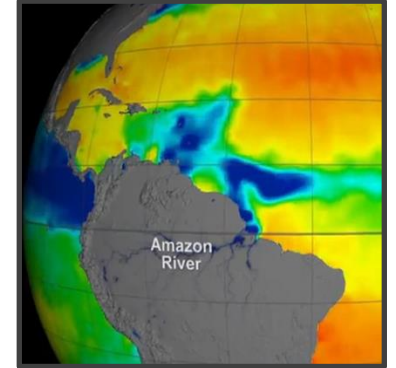
## Sea Level



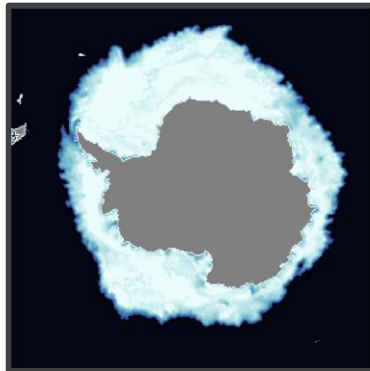
# Ocean Winds



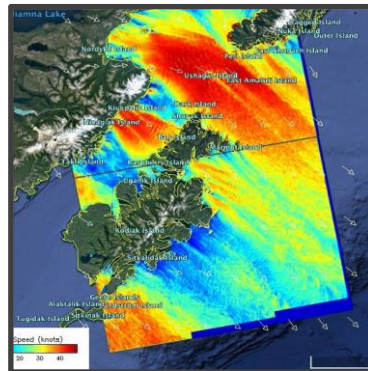
## Salinity



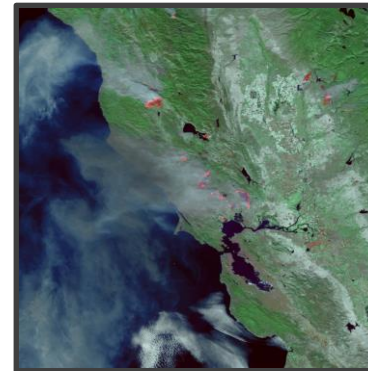
## Sea Ice



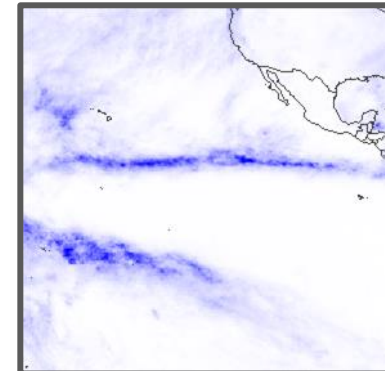
# Synthetic Aperture Radar



## Imagery



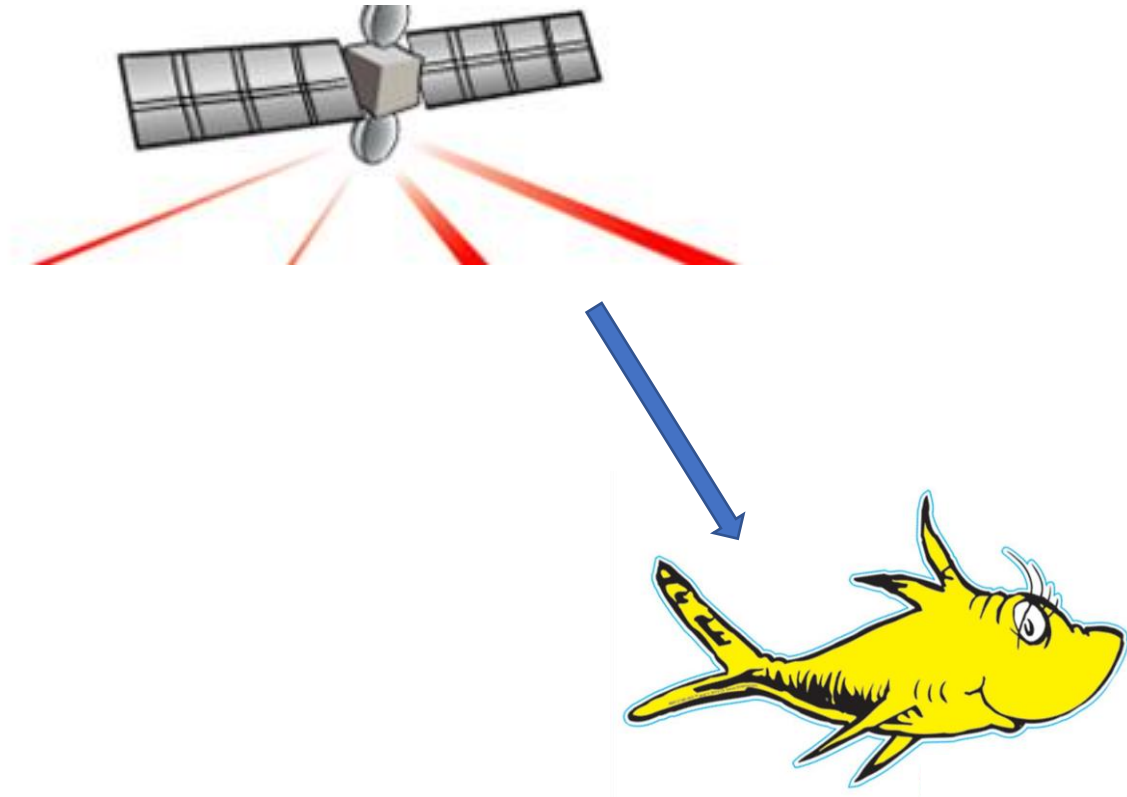
## Rainfall

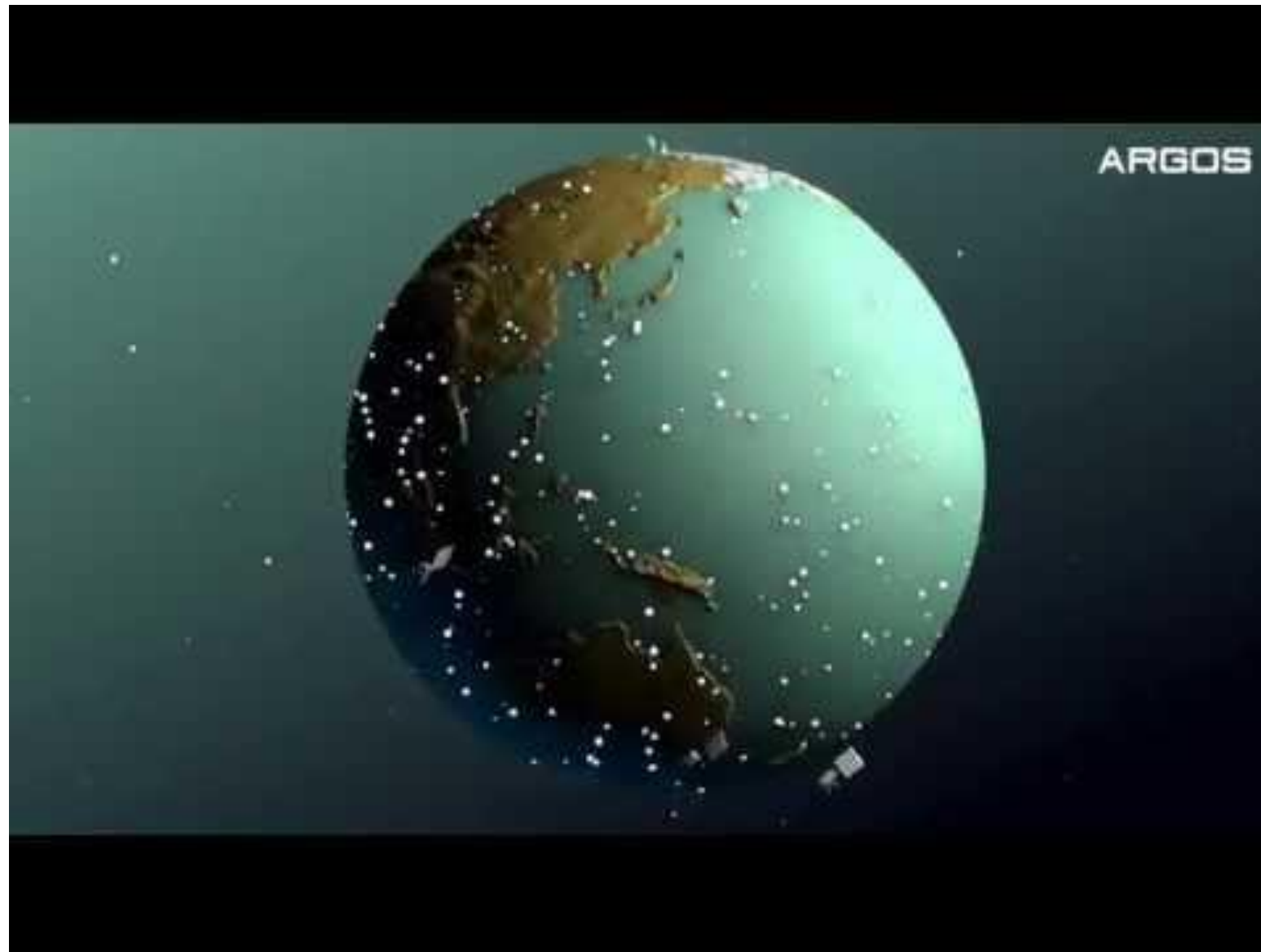


# Harvest – Catching Fish

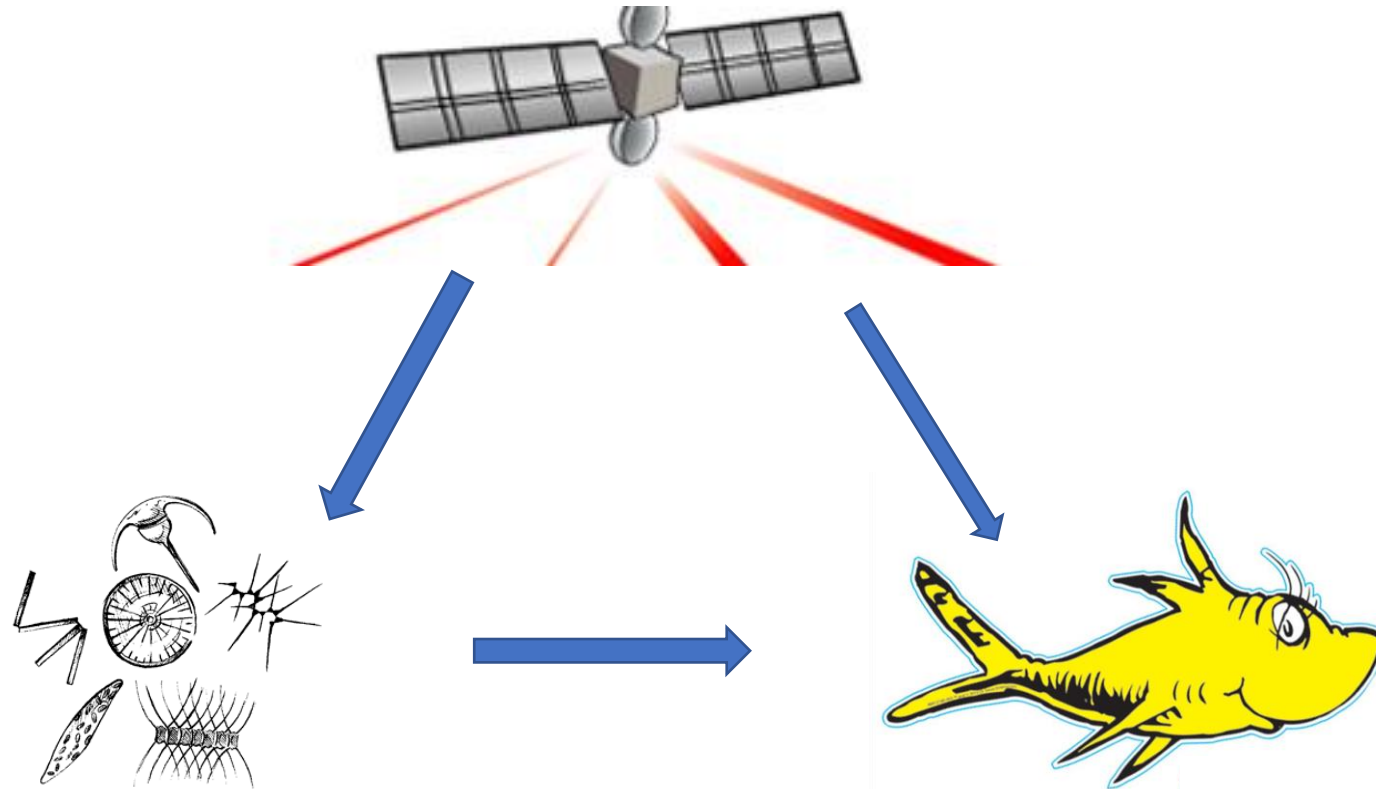


# Harvest – Catching Fish

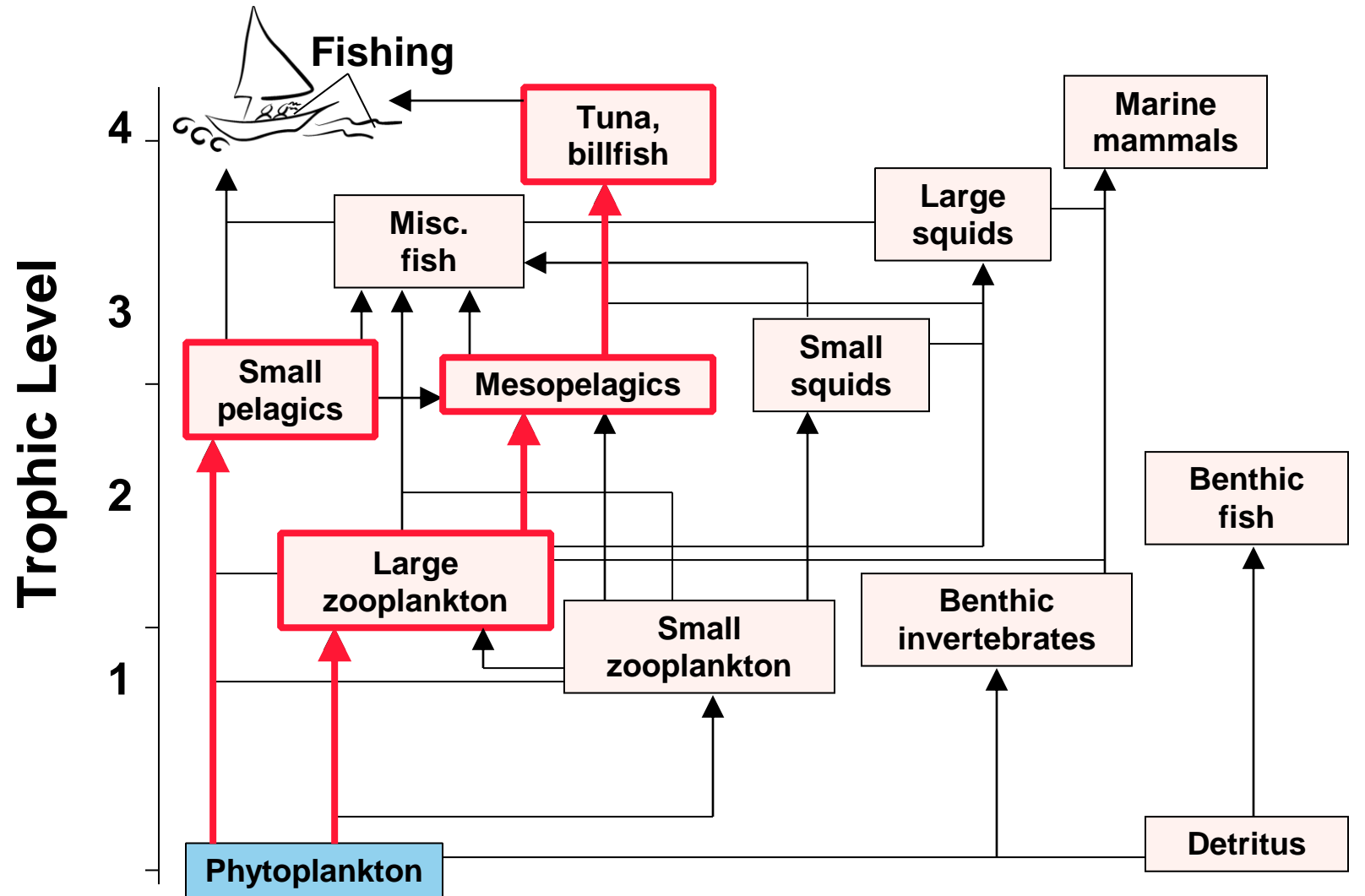




# Harvest – Catching Fish



# Oceanic Food Web



Modified from Pauly & Christensen [1993]

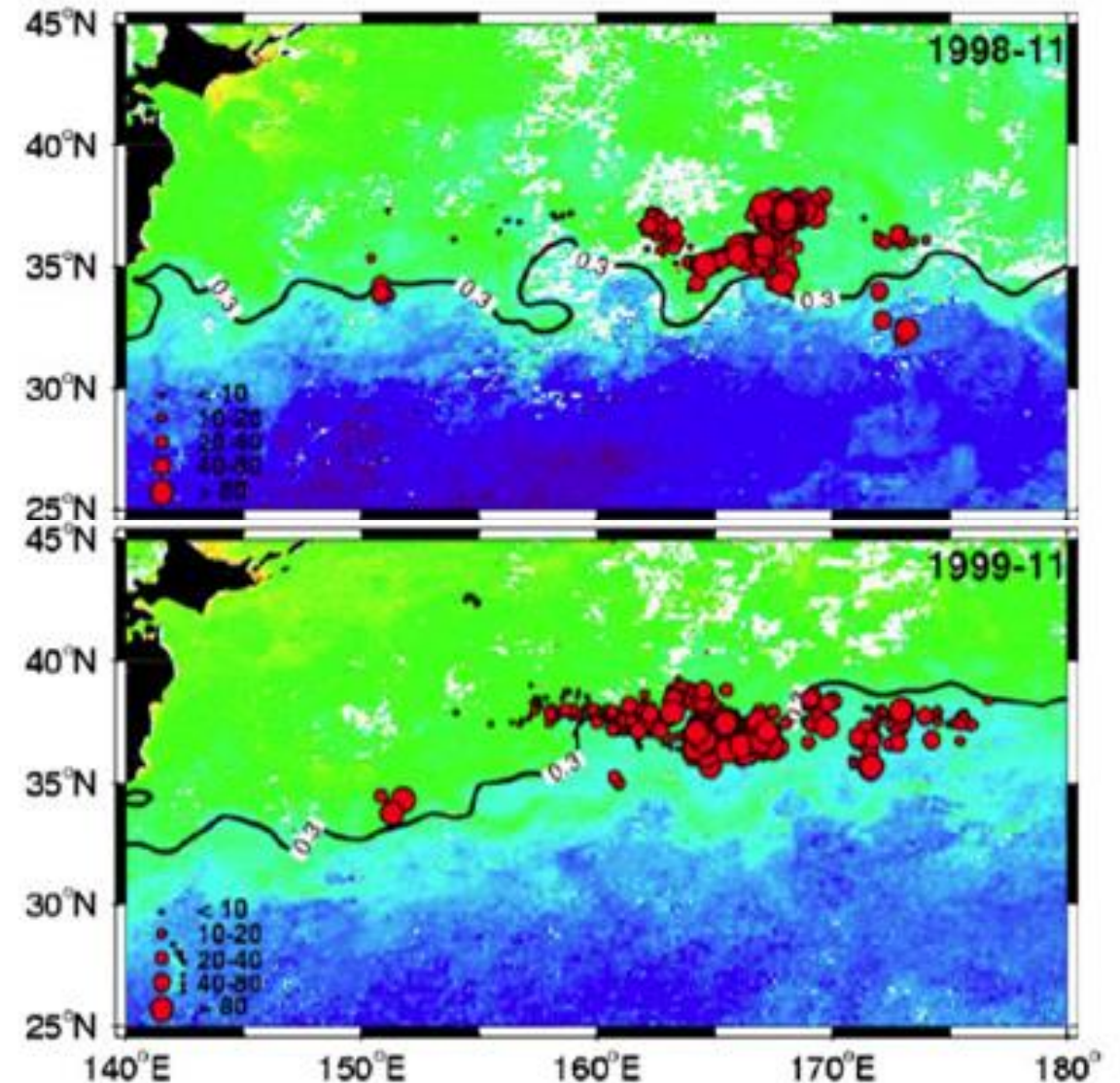
# Harvest – Catching Fish

## Example: Frontal Zones

Albacore CPUE (catch per unit effort) overlain on SeaWiFS chlorophyll, showing that the longline fishery largely operates along the transitional zone chlorophyll front (TZCF)



Source: Zainuddin et al., DSR-II, 2006

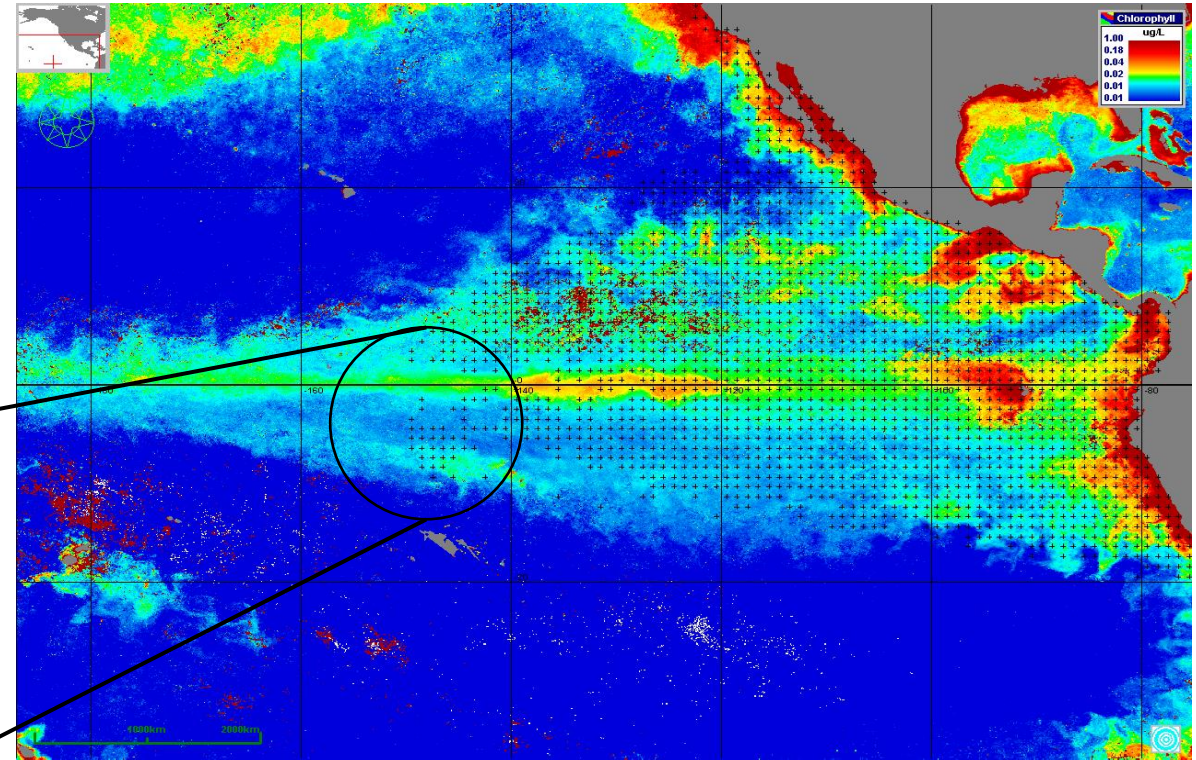
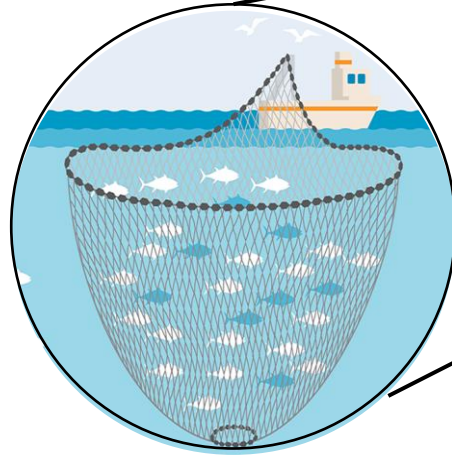


# Harvest – Catching Fish

## Example: Upwelling Areas

Black dots show the distribution of the tuna purse seine fishery in the Pacific.

Source: Dale Kiefer



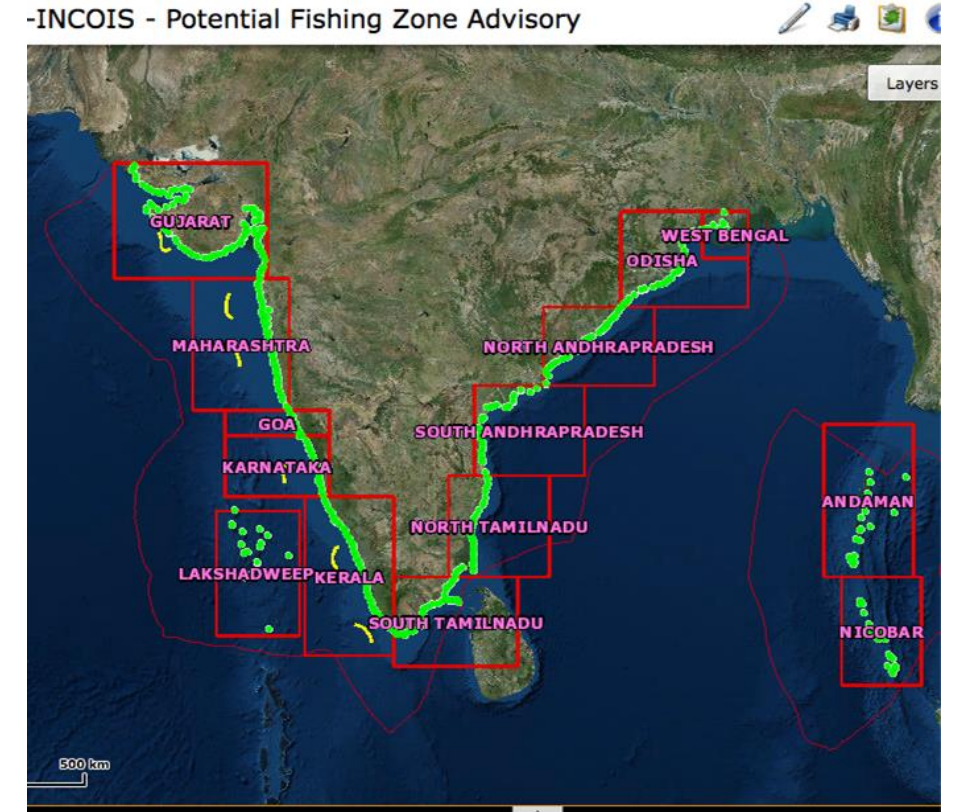
# Harvest – Catching Fish

## Example: Potential Fishing Zone Advisories

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.

Source: <https://incois.gov.in/MarineFisheries/PfzAdvisory>



# Harvest – Catching Fish

## Example: Potential Fishing Zone Advisories

From the coast of	Direction	Bearing (deg)	Distance (km) From-To	Depth (mtr) From-To	Latitude (dms)	Longitude (dms)
Mul Dwarka	SW	246	88-93	68-73	20 26 3 N	69 53 47 E
Dwarka	SW	262	86-91	87-92	22 8 12 N	68 8 54 E
Nargol	NW	273	111-116	20-25	20 24 32 N	71 46 48 E
Madhavpur	SW	256	118-123	1057-1062	20 59 22 N	68 52 41 E
Veraval	SW	259	155-160	1633-1638	20 39 3 N	68 55 27 E
Raatadi	SW	238	77-82	82-87	21 21 39 N	68 51 31 E
Chorwad	SW	262	142-147	1756-1761	20 48 49 N	68 54 22 E
Okha	SW	250	82-87	56-61	22 13 43 N	68 20 9 E
Mangrol	SW	260	125-130	1206-1211	20 55 1 N	68 56 44 E
Kadwar	SW	242	84-89	78-83	20 29 35 N	69 44 9 E
Porbandar	SW	240	69-74	64-69	21 18 40 N	69 2 5 E
Gorsar	SW	253	126-131	1524-1529	21 0 19 N	68 45 27 E
Vadodra	SW	242	84-89	58-63	20 27 34 N	69 48 54 E
Kuranga	NW	273	115-120	103-108	22 5 25 N	68 4 57 E
Kachchigadh	SW	258	76-81	66-71	22 11 32 N	68 14 25 E
Umargam	NW	277	98-103	20-25	20 23 49 N	71 51 29 E
Kuchhadi	SW	238	72-77	90-95	21 19 28 N	68 57 15 E
odadar	SW	239	69-74	78-83	21 14 45 N	69 5 31 E



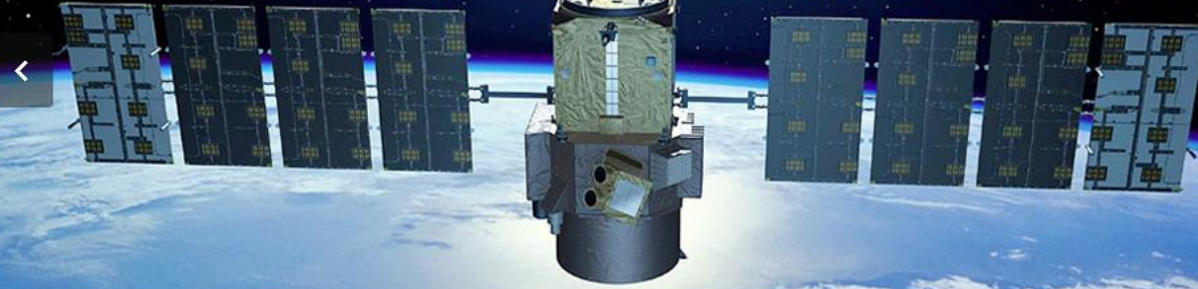
# Harvest – Catching Fish

## Example: Potential Fishing Zone Advisories

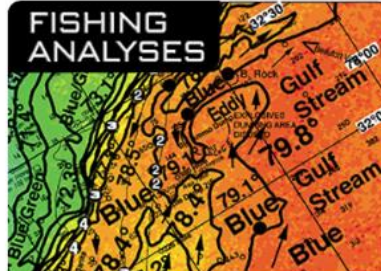
From the coast of	Direction	Bea	Potential Fishing Zone			ntnr)	Go	Latitude (dms)	Longitude (dms)
Mul Dwarka	SW		<div>Languages</div> <div>» English</div> <div>» हिन्दी</div> <div>» తెలుగు</div> <div>» தமிழ்</div> <div>» ಕನ್ನಡ</div> <div>» ଓଡ଼ିଆ</div> <div>» বাংলা</div> <div>» മലയാളം</div> <div>» ગુજરાતી</div> <div>» मराठी</div> <div>Sectors</div> <div>WebGIS</div>			3		20 26 3 N	69 53 47 E
Dwarka	SW					2		22 8 12 N	68 8 54 E
Nargol	NW					5		20 24 32 N	71 46 48 E
Madhavpur	SW					062		20 59 22 N	68 52 41 E
Veraval	SW					538		20 39 3 N	68 55 27 E
Raatadi	SW					7		21 21 39 N	68 51 31 E
Chorwad	SW					761		20 48 49 N	68 54 22 E
Okha	SW					L		22 13 43 N	68 20 9 E
Mangrol	SW					211		20 55 1 N	68 56 44 E
Kadwar	SW					3		20 29 35 N	69 44 9 E
Porbandar	SW					9		21 18 40 N	69 2 5 E
Gorsar	SW					529		21 0 19 N	68 45 27 E
Vadodra	SW					3		20 27 34 N	69 48 54 E
Kuranga	NW					08		22 5 25 N	68 4 57 E
Kachchigadh	SW					L		22 11 32 N	68 14 25 E
Umargam	NW					5		20 23 49 N	71 51 29 E
Kuchhadi	SW					5		21 19 28 N	68 57 15 E
odadar	SW					3		21 14 45 N	69 5 31 E



# FISH THE HOT SPOTS WITH ROFFS™



## FISHING ANALYSES



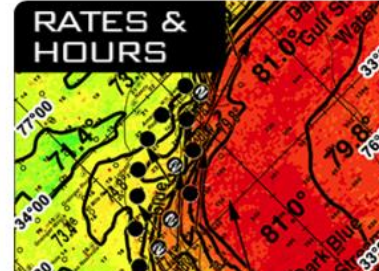
Time and fuel costs are always important considerations when fishing. ROFFS™ will show you where the fish are located before you leave the dock and while fishing by sending you the most comprehensive interpretive oceanographic analysis for fishing. We will put you on the fish!

## CATCH REPORTS



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 dock rumors here! Please click below to view the most recent catch reports on our website now!

## RATES & HOURS



ROFFS™ current office hours – September 29, 2014 through March 28, 2015 – Monday through Friday 9 AM – 5PM, Saturday Closed. Please click below for more information on our current rates & office hours.



# Stock Assessments – Counting Fish

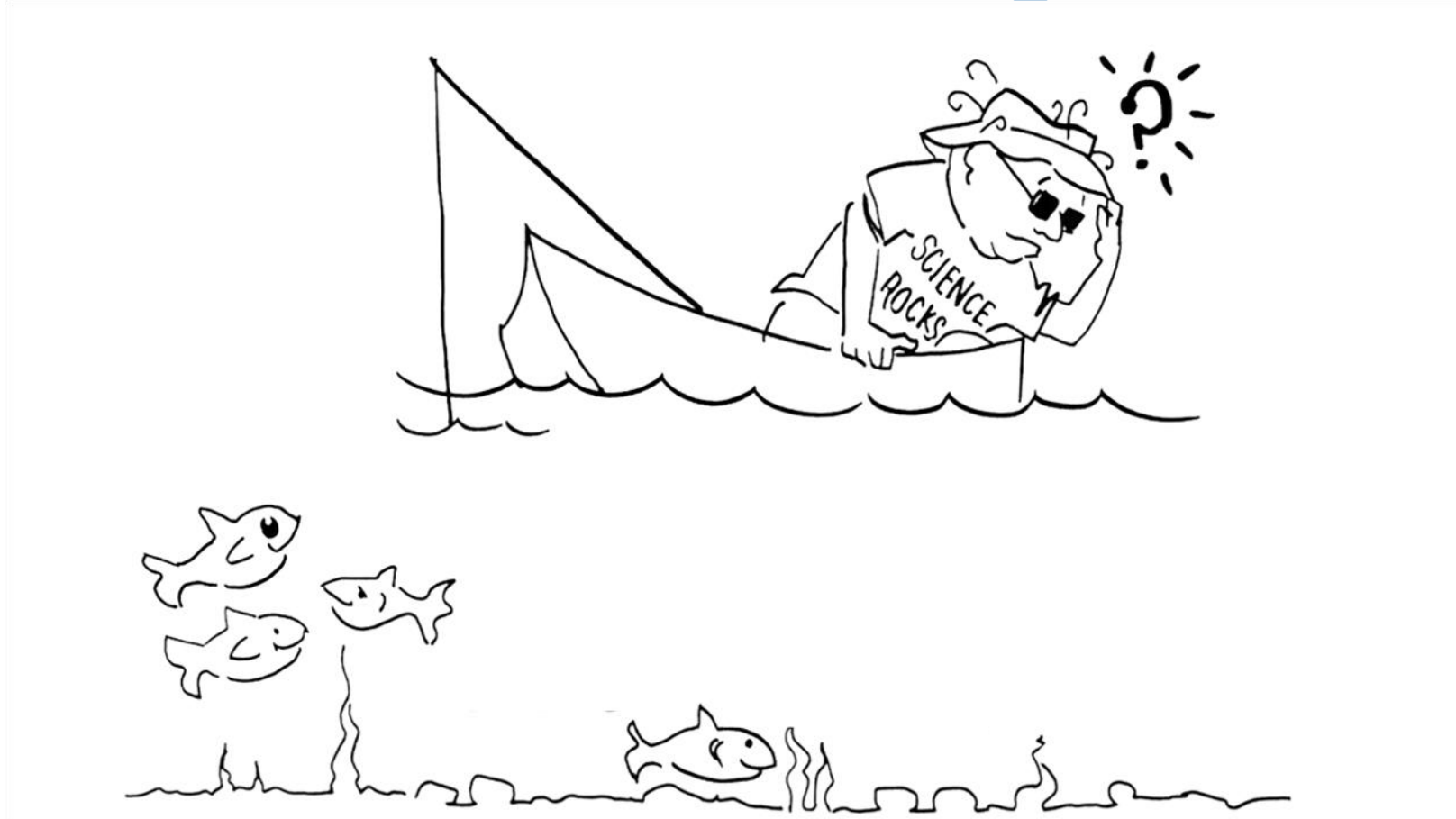
## The ABCs of Stock Assessments



From: <https://www.fisheries.noaa.gov/topic/population-assessments/fish-stocks>

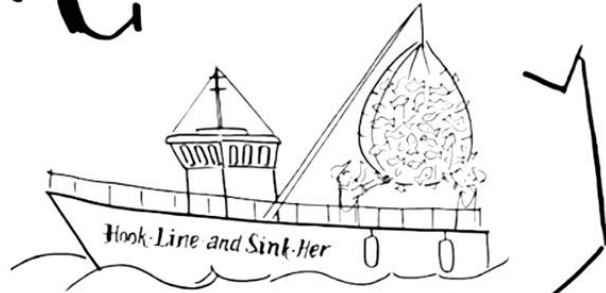


# Stock Assessments – Counting Fish



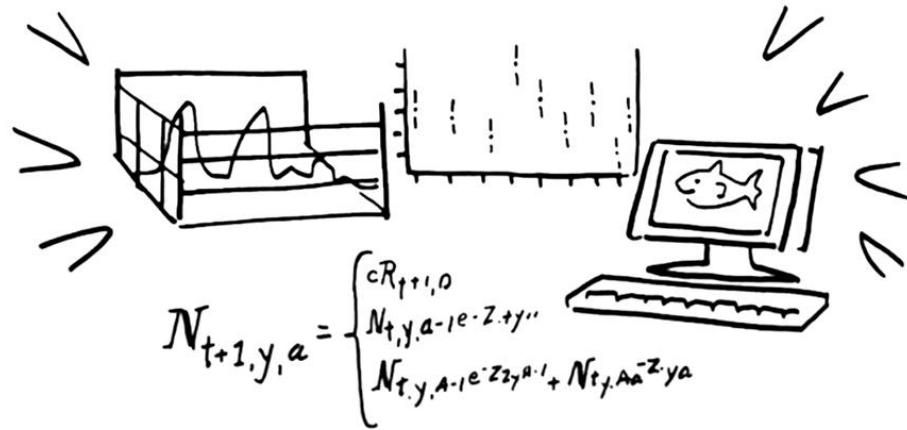
# Stock Assessments – Counting Fish

+ Catch Data



Abundance  
+  
Biological Data

$A+B+C=$   
Stock Assessment

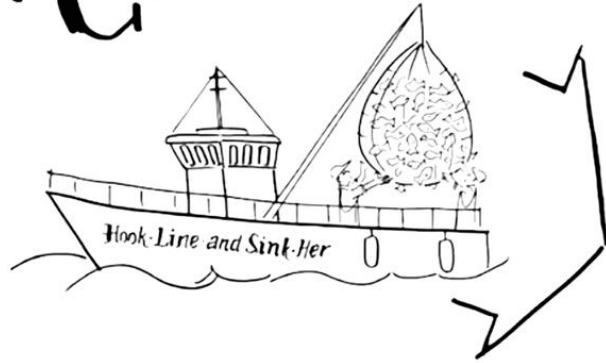


$$N_{t+1,y,a} = \begin{cases} cR_{t+1,0} \\ N_{t,y,a-1}e^{-Z+Y_{t,a}} \\ N_{t,y,a-1}e^{-Z_{t,a-1}} + N_{t,y,a-2}e^{-Z_{t,a-2}} \end{cases}$$



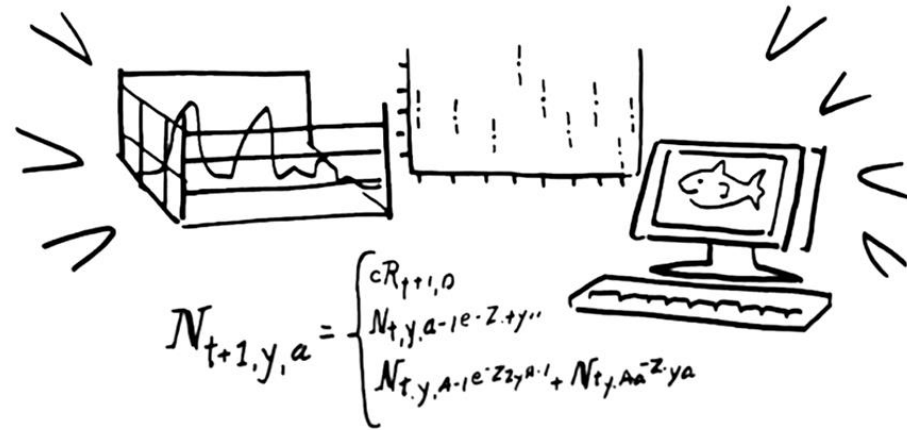
# Stock Assessments – Counting Fish

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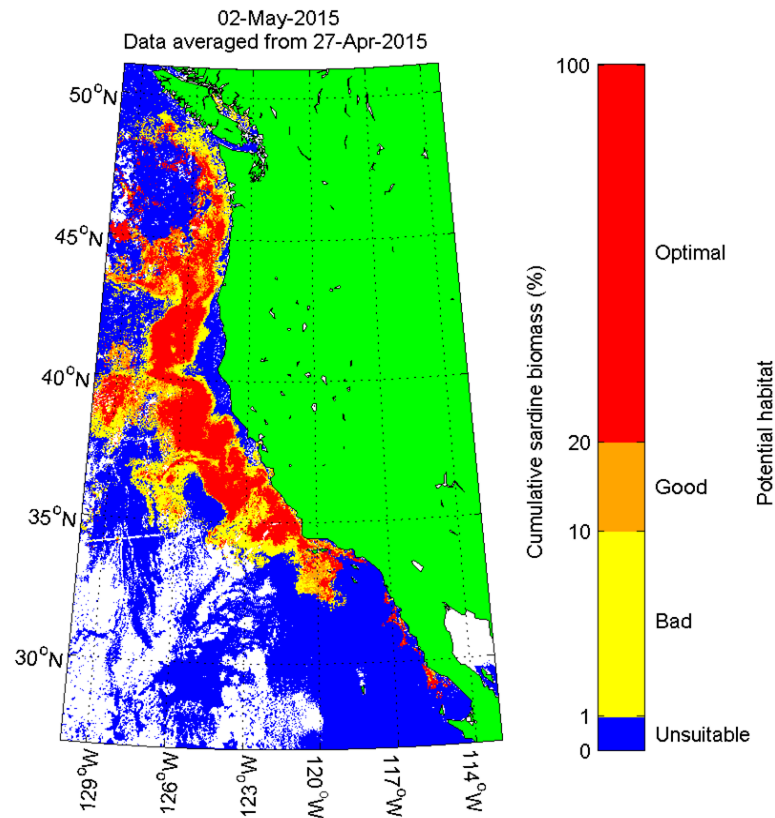
$$N_{t+1,y,a} = \begin{cases} cR_{t+1,0} \\ N_{t,y,a-1}e^{-Z+Y_{t,y,a}} \\ N_{t,y,a-1}e^{-Z_{t,y,a-1}} + N_{t,y,a-1}e^{-Z_{t,y,a}} \end{cases}$$

Where's the E (Environment)?



# Stock Assessments – Counting Fish

## 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



# Management – Conserving Fish

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.

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

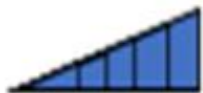


Report of the NMFS Workshop on advancing electronic tag technologies and their use in stock assessment. NOAA Tech. Memo. NMFS-F/SPO-82, 82 pp, 2007.

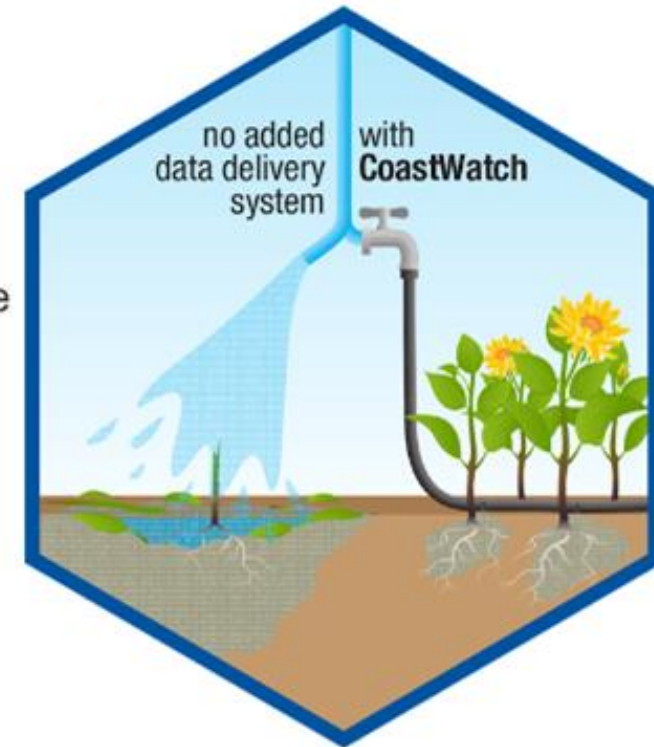


# NOAA Applications: NOAA CoastWatch

INCREASING  
ENGAGEMENT  
WITH USER



- Provide access to global and regional **curated, monitored, datasets**
- Develop **tools** and tutorials to help users access and use data; Viewing tools are either an end solution or give a “shop-before-you-buy” experience
- Provide **training** and hands-on assistance; One-on-one consultations, helpdesk and user forum, multi-day satellite courses, conference tutorial sessions, etc.
- Create tailored **products** in response to NOAA mission needs
- **Collaborate directly with users** on applications and developmental projects



<https://coastwatch.noaa.gov/>





NOAA  
COASTWATCH

<https://coastwatch.noaa.gov>

● Map redrawn (code:0)

Lat: 15.19, Long: 39.03 Zoom: 3

Reference Date: 2022-10-17 (289)



# CoastWatch Data Portal

Interactive search

Loading status:



Toggle Menus



Help & Tutorials

## Date / Calendar

Date Oct 17, 2022

Select an Hour 00 minutes 00 UTC

## Active Layers

## CoastWatch Data Layers

Layers L1/L2 Spatial Search

Imagery (True Color, etc.)

L1/L2 Overlays & Data

L3/L4 Global Data

## Sea Surface Temperature

- ☐ Blended 5km Night (2016-present)
- ☐ Blended 5km Night (2002-2016)
- ☐ Blended 5km Day+Night (7/2019-present)
- ☐ Blended 5km Diurnal (7/2019-present)
- ☐ Coral Reef Watch SST (1985-present)
- ☐ Coral Reef Watch SST Anomaly (1985-present)
- ☐ ACSPO 2km Daily LEO L3S (NRT)
- ☐ ACSPO 2km Daily LEO L3S Fronts (NRT)
- ☐ ACSPO 2km AM LEO L3S (NRT,night)

## User Data

## Search Results

## Info

## Legend

Displaying file:

Blended 5km Night (2016-present)

2022/20221017000000-OSPO-L4\_GHRSST-SSTfnd-Geo\_Polar\_Blended\_Night-GLOB-v02.0-fv01.0.nc?



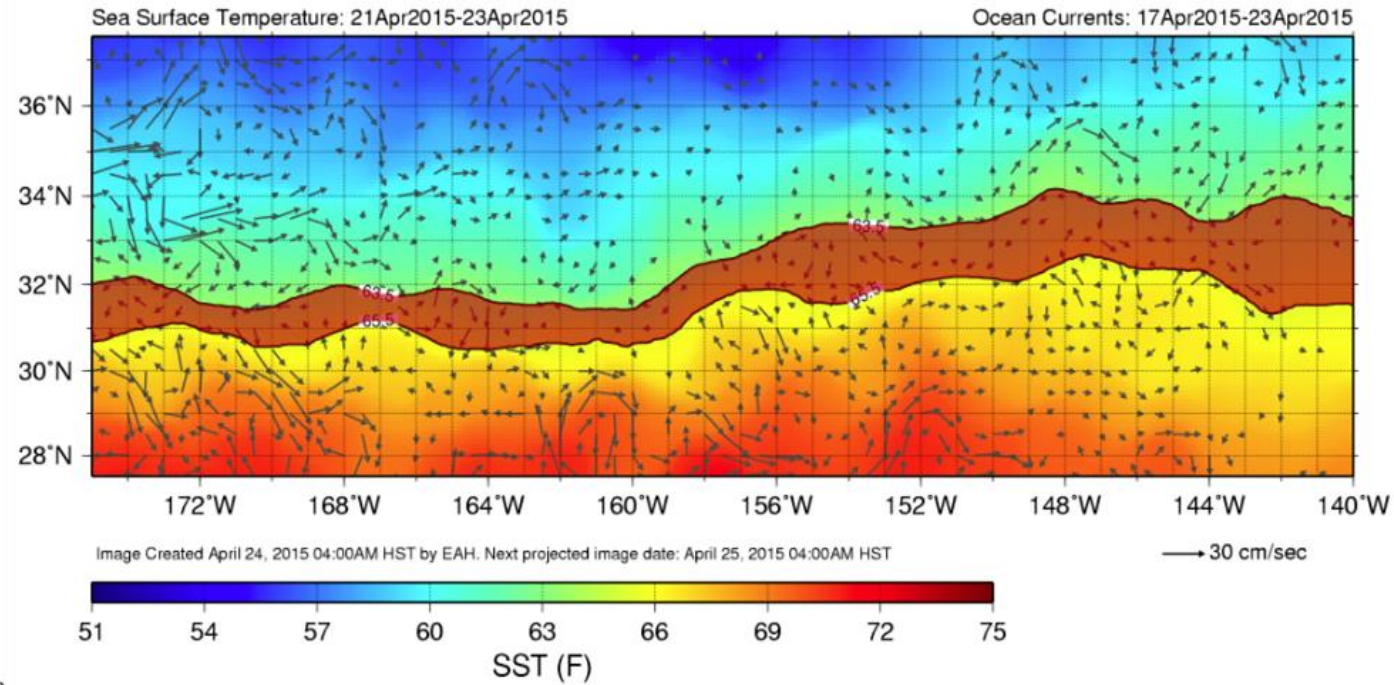
Copernicus  
Europe's eyes on Earth

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, A...

# NOAA Applications: TurtleWatch

## EXPERIMENTAL PRODUCT

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



TURTLEWATCH



<http://www.pifsc.noaa.gov/eod/turtlewatch.php>



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

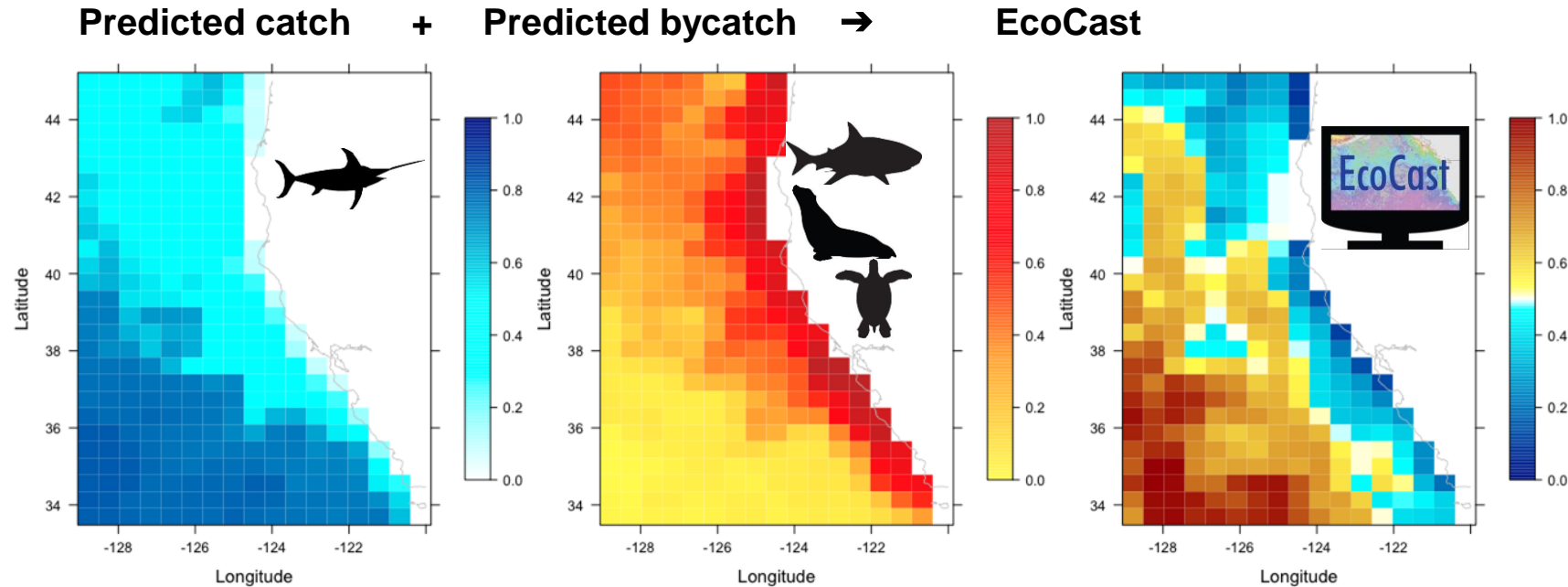


5th Symposium | 24 - 28 Oct 2022 | Accra, Ghana



# NOAA Applications: EcoCast

## Predicting fishery bycatch for management



Using satellite data, these surfaces can be predicted in near-real time for use by managers and fishers. A NASA funded project. Contributed by Elliot Hazen.

<https://coastwatch.pfeg.noaa.gov/ecocast/>



🕒 Date to show

2017-08-01

☰ Adjust species weightings

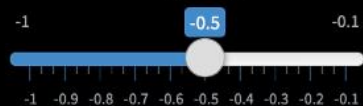
**Swordfish weighting**



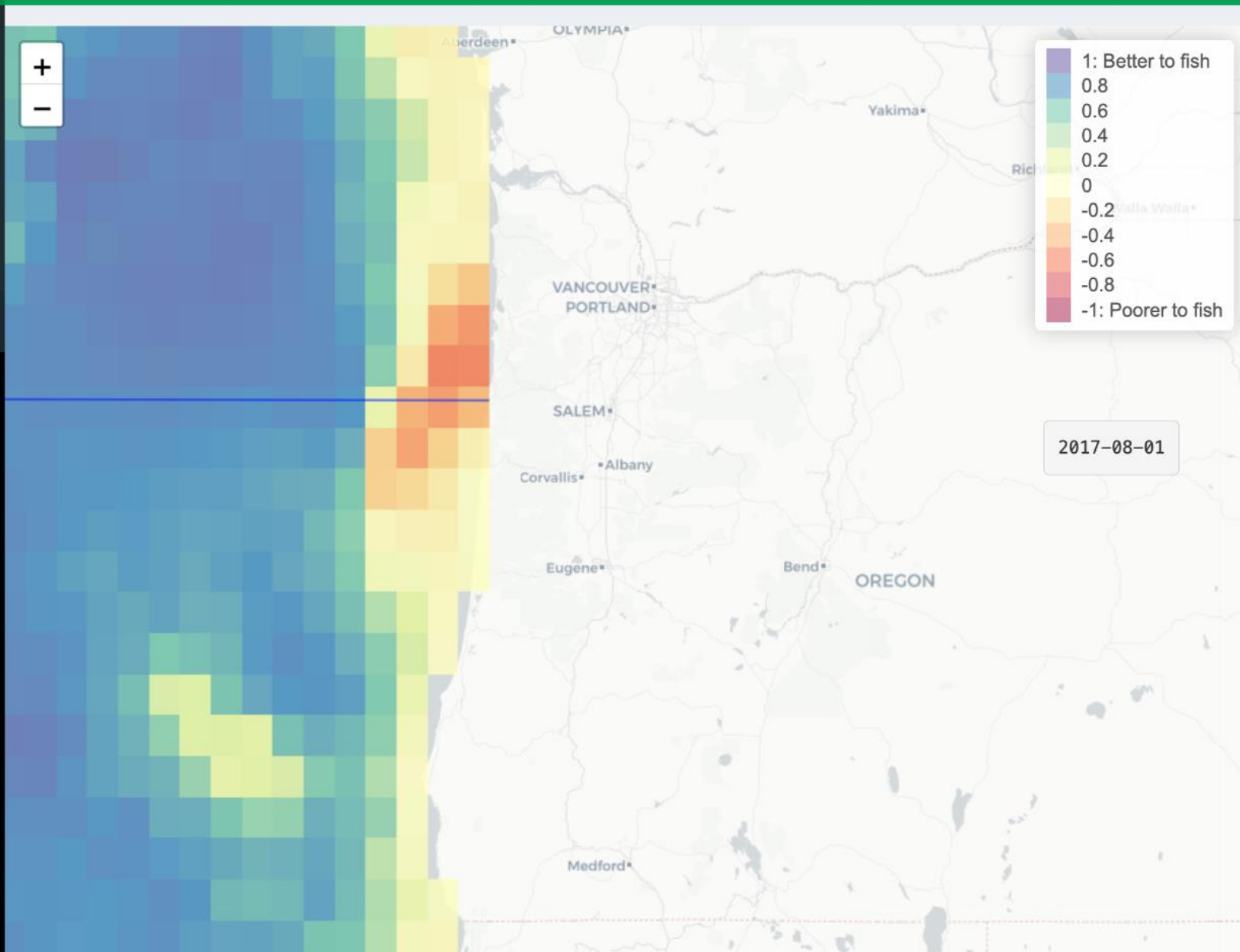
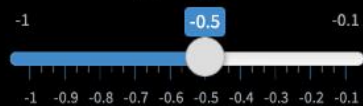
**Leatherback weighting**



**Blue shark weighting**



**Sea lion weighting**



# NOAA/GEO Blue Planet Synergy

## Earth Observations for Tuna Fisheries Management



Image Credit: [www.bluebridge-vres.eu](http://www.bluebridge-vres.eu)

- **Session 1** - Current knowledge and understanding of climate change impacts on tuna fisheries
- **Session 2** - Sustainable fisheries management of tuna: challenges and solutions
- **Session 3** - Improving sustainable tuna management and biodiversity conservation through Earth observation data
- **Session 4** - Earth observation data for detection and monitoring of vessel activities to reduce Illegal, Unreported and Unregulated (IUU) fishing
- **Session 5** - Earth observation data for habitat mapping and operational forecasting system for tuna





Thank You.  
Medaase.  
Oyiwaladon.

Contact:  
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coastwatch.info@noaa.gov

