



Biology and Fisheries applications: Requirements, synergies, and gaps

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Outline

- What do we mean with Biology and Fisheries?
- Relevance of the Tropical Atlantic for Fisheries
- What data do we need to collect? And what is currently done?
- What needs to be done more and how does that link to other observations?



Biology and fisheries - what do we mean?

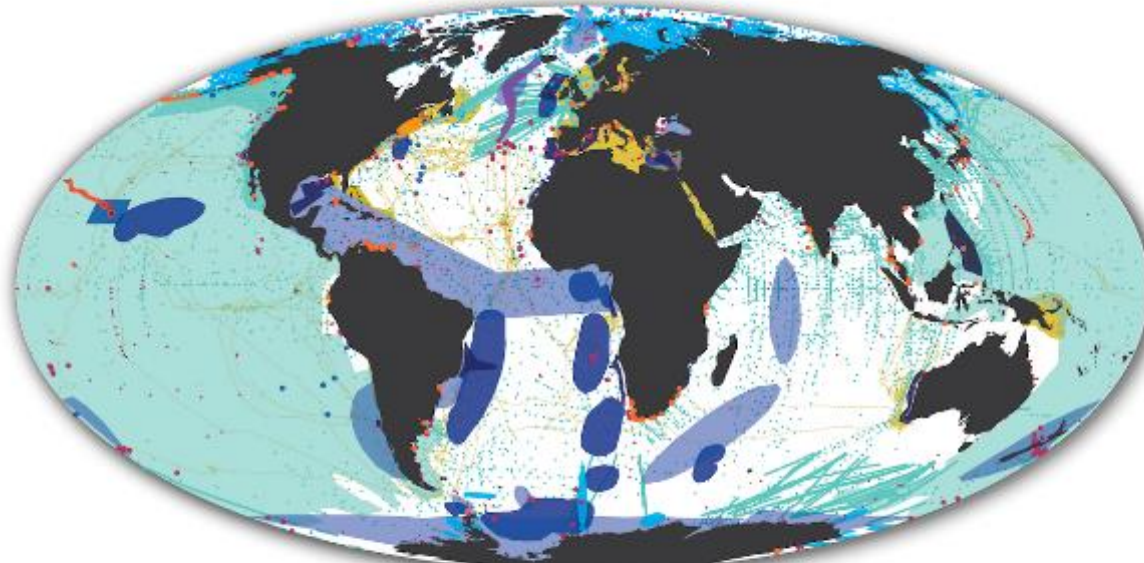
- Phytoplankton
- Zooplankton – from nano to makro
- Ichthyoplankton – fish eggs and larvae
- Fish – juvenile and adult
- Shellfish – Squid, mussels, etc.
- Benthic organisms – corals, sponges, etc.
- Megafauna – birds and marine mammals



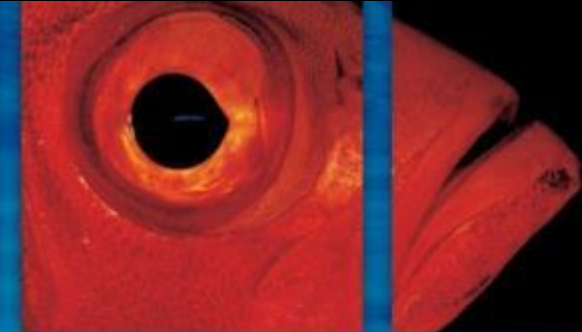
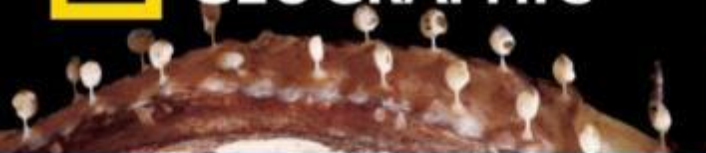
Sampling on biodiversity



2000-2010
2700 Scientists
80+ Nations
540 Expeditions
Costs: > 650 mill US Dollars (2010)



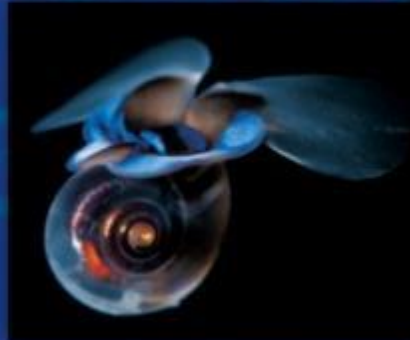
- | | | | | |
|----------------------------|------------------------|----------------------------|-------------------------------|--|
| Coastal | Polar | Pelagic | Deep Sea | Global Information and Analysis |
| Regional Ecosystems (GoMA) | Arctic Ocean (ArcOD) | Top Predators (TOPP) | Vents and Seeps (CNES) | Oceans Future (FMAP) |
| Near Shore (NeGISA) | Antarctic Ocean (CAML) | Continental Shelves (POST) | Abyssal Plains (CeDAMar) | Information Systems (IBIS) |
| Coral Reefs (CReefs) | | Zooplankton (CMarZ) | Seamounts (CenSeam) | Microbes (ICoMM) |
| | | | Continental Margins (COMARGE) | Oceans Past (HMAP) |
| | | | Mid-Ocean Ridges (IMAR-ECO) | |



CITIZENS of the SEA

Wondrous Creatures from
the Census of Marine Life

NANCY KNOWLTON



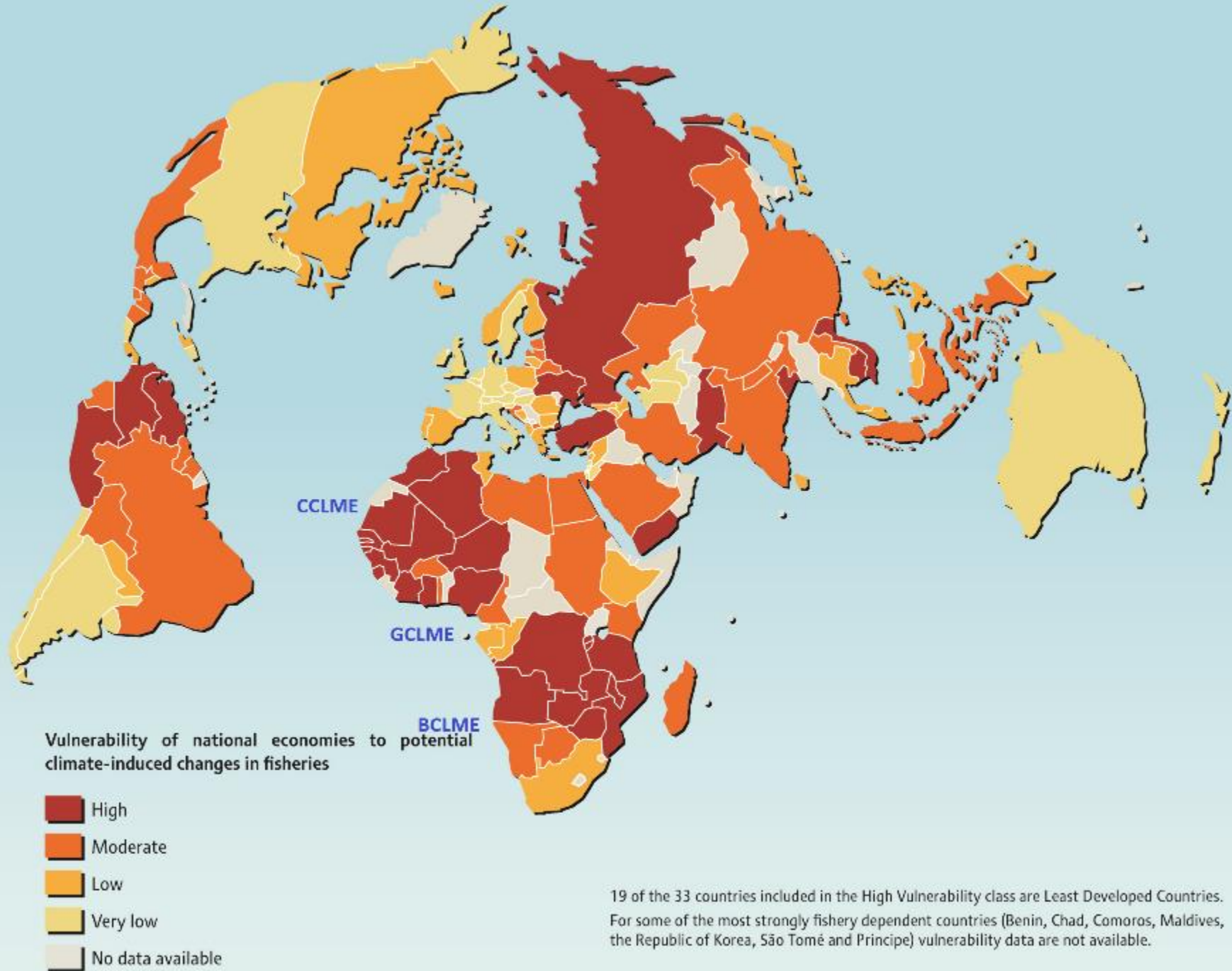
Biodiversity

Ecologically or Biologically
Significant Marine Areas
(EBSAS)



Fish Catches

FISHING AREA CODE	FISHING AREA NAME	AVERAGE 2003-2012	2013	2014	AVERAGE (2003-2012)-2014	2013-2014	2013-2014	
			<i>(Tonnes)</i>		<i>(Percentage)</i>		<i>(Tonnes)</i>	
21	Atlantic, Northwest	2 136 378	1 853 747	1 842 254	-13.8	-0.6	-11 493	
27	Atlantic, Northeast	8 969 599	8 454 196	8 654 722	-3.5	2.4	200 526	
31	Atlantic, Western Central	1 450 734	about 9 mill. tonnes of catch					
34	Atlantic, Eastern Central	3 929 634						
37	Mediterranean and Black Sea	1 484 499						
41	Atlantic, Southwest	2 021 094						
47	Atlantic, Southeast	1 479 746						
51	Indian Ocean, Western	4 313 756						4 579 366
57	Indian Ocean, Eastern	6 274 406	7 617 838	8 052 256	28.3	5.7	434 418	
61	Pacific, Northwest	20 256 795	21 374 002	21 967 669	8.4	2.8	593 667	
67	Pacific, Northeast	2 831 978	3 205 426	3 148 703	11.2	-1.8	-56 723	
71	Pacific, Western Central	11 298 748	12 398 778	12 822 230	13.5	3.4	423 452	
77	Pacific, Eastern Central	1 825 231	2 024 994	1 907 785	4.5	-5.8	-117 209	
81	Pacific, Southwest	642 355	581 852	543 030	-15.5	-6.7	-38 822	
87	Pacific, Southeast	11 716 946	8 518 117	6 890 058	-41.2	-19.1	-1 628 059	
18, 48, 58, 88	Arctic and Antarctic areas	161 608	236 617	311 896	93.0	31.8	75 279	
WORLD TOTAL		80 793 507	80 963 120	81 549 353	0.9	0.7	586 233	



Source: E. H. Allison et al, Vulnerability of national economies to the impacts of climate changes on fisheries, *Fish and Fisheries*, 2009, 10, pp. 173-196.

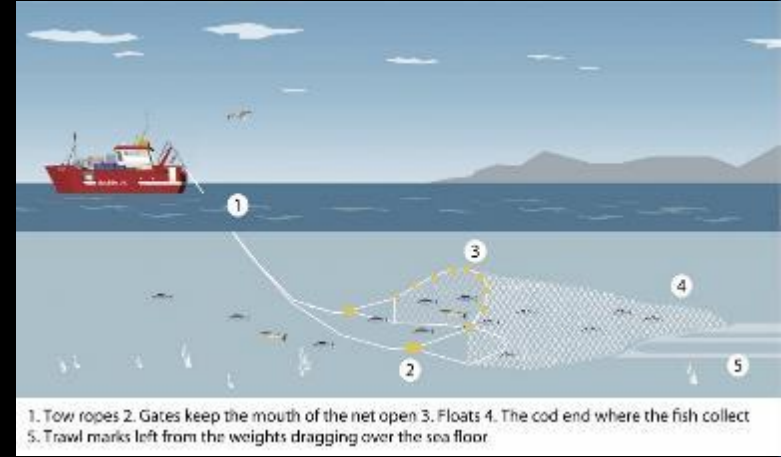


What data do we need to collect to assess fish stocks?

- Fishery-dependent data
 - Target species
 - Catch
 - Bycatch
 - Discards
 - Effort
- Fishery-independent data
 - Egg surveys
 - Larval surveys
 - Juvenile and adult surveys

Fishery independent surveys

Net surveys

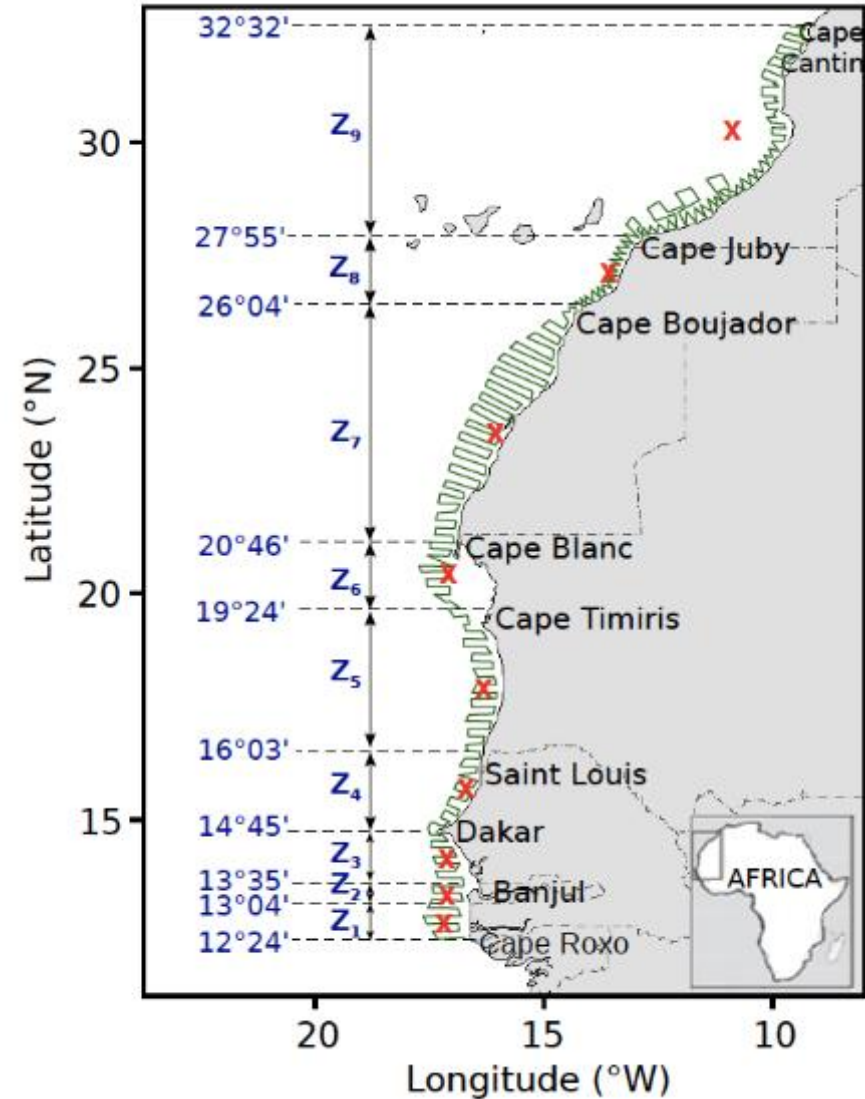


There are more types, of course
Many of those are also used in the tropical Atlantic

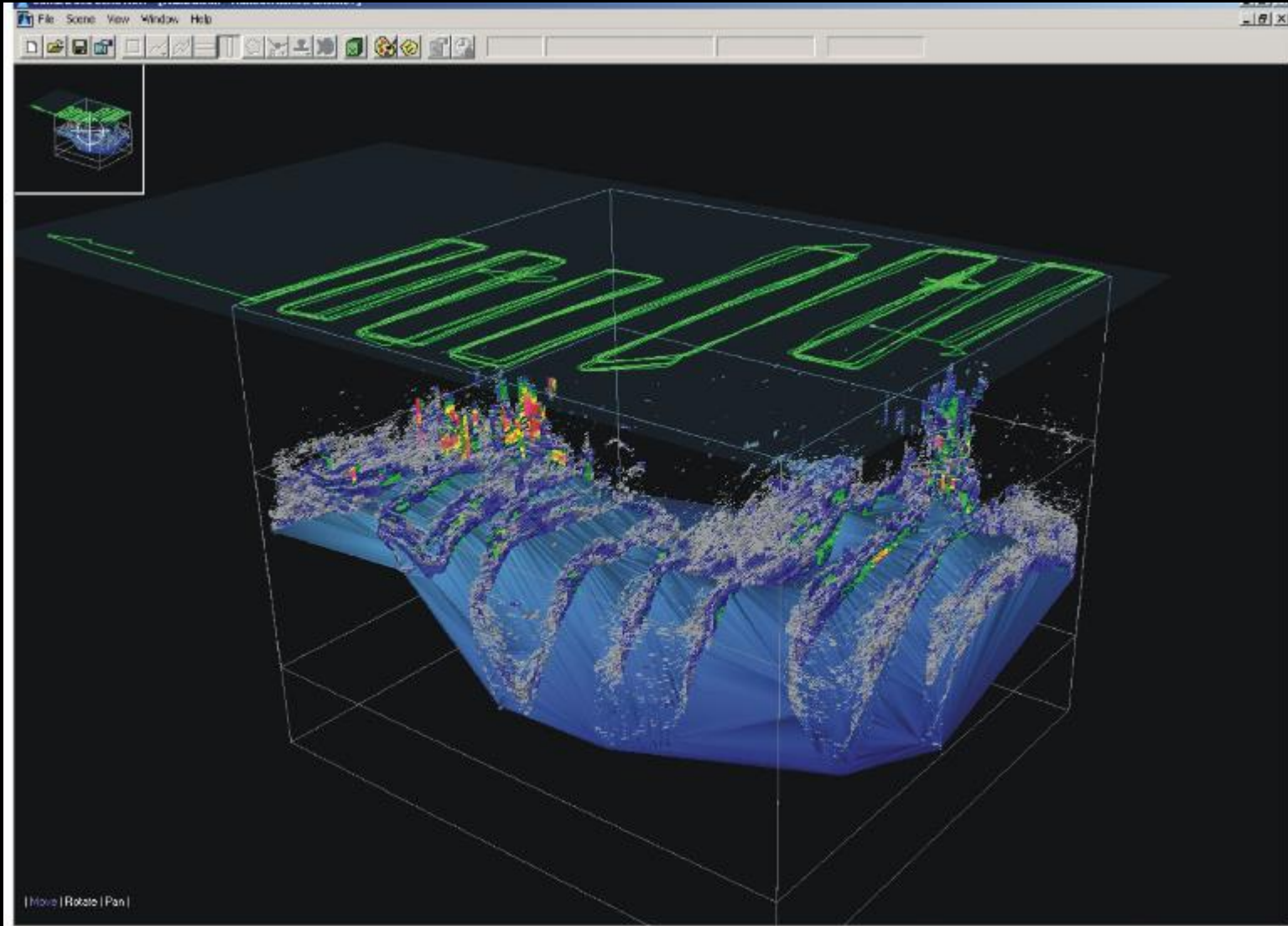
Small pelagics



Exemplary cruise track
along the West-African
coast



Hydroacoustics



The EAF Nansen Programme

- Since 1975 a joint initiative of Norway and the Food and Agriculture Organization of the United Nations (FAO)
- The research vessel, *Dr Fridtjof Nansen* was built for the programme



EAF Nansen Programme

Fisheries and ecosystems	Pollution	Climate variability and change
<ul style="list-style-type: none">> Abundance, distribution and dynamics of transboundary stocks> Biological parameters and life cycle of main species> Identification of vulnerable marine habitats> Mapping biodiversity, particularly on the sea-floor> Characterization of ecosystems	<ul style="list-style-type: none">> Environmental assessment of the impact of oil/gas extraction and other mining activities> Measuring levels of hazardous substances in bottom habitats and in fish, and identifying pollutant pathways> Mapping distribution and density of marine debris, including microplastics	<ul style="list-style-type: none">> Examining trends in climate-change related indicators> Assessing how climate variability and change affects marine ecosystems, including food-web dynamics, recruitment, distribution, migration and growth of fish species> Understanding how climate change affects ocean biochemistry processes

Large Pelagics

BLUEFIN TUNA STOCK ASSESSMENTS

1 DATA COLLECTION

The data that can be used in stock assessments fall into two categories: fishery independent data that are collected by scientists and fishery dependent data that are collected by commercial and recreational fishermen as they catch their fish. Currently, the majority of information that is used in the Atlantic bluefin stock assessments comes from fishery dependent catch and market records.

Fishery Independent Data

Aerial Surveys

Using airplanes, scientists identify and count fish that are parts of schools near the ocean surface. Aerial surveys can collect data on the numbers of reproductive mature adults and younger juvenile fish.

Tagging—Fishery Independent

By releasing tunas with tags that are retrieved by fishermen when the fish is caught, or using tags that communicate and send data back to satellites, scientists can gather information on fish movement, spawning behavior, seasonal distribution, and natural and fishing mortality.

Growth Studies

Combining the results of tagging studies with biological sampling and looking at the sizes of wild fish can help scientists chart growth rates and the ratio between length and weight for different ages of tuna.

Biological Sampling

Analysis of the chemical composition of the inner ear bone, or otolith, of individual tunas can tell scientists where a tuna was born. Scientists can also count the rings of the otolith or other bony parts, which, much like the rings of a tree trunk, indicate the age of the animal.

Fishery Dependent Data

Catch Records

Logbooks, observer data, and catch records from fishermen around the Atlantic provide scientists a wealth of information on the size, spatial distribution, and abundance of the bluefin tuna population. They also provide data on the effort fishermen are expending to catch each fish. However, recorded information from fishermen is often incomplete and can negatively impact the accuracy of the stock assessment.

Market Records

Trade documents and records of the fish bought and sold at fish markets often include the weight of individual fish and can be used to calculate the size distribution of a population.

Tagging—Fishery Dependent

Scientists have worked with recreational fishermen to tag tunas and collect data on the movement habits and migration patterns of the population.

2 THE MODEL

ICCAT scientists use a virtual population analysis (VPA) model that breaks the Atlantic bluefin tuna population into age classes, assigns each class its own growth and mortality rates, and works backwards using both fishery independent and dependent data to calculate past population levels. The model is often run multiple times, incorporating a range of assumptions and scenarios.

Stock assessment models use mathematical formulas, statistical techniques, educated assumptions about the biology of the species, and the provided data to simulate a fish population as individual fish are born, grow up, reproduce, and die.

3 MODEL RESULTS

Stock assessment models provide scientists and managers with estimates of stock size, mortality over time, and projections of future conditions. These are then compared with concrete numbers, called biological reference points, to judge the health of the population.

Biological Reference Points

Stock Size

Stock size can be measured in two main ways: Abundance is the number of fish in the population; biomass is the total weight of all the fish in the population. Most models report stock size in terms of biomass.

Fishing Mortality

Fishing mortality is the rate that fish are removed from the population by harvesting. A population is undergoing overfishing when more fish are being caught than can naturally be replaced.

Targets

Targets are numbers that managers aim to achieve and maintain. One of the most important is maximum sustainable yield (MSY), which is the maximum number of fish that can be sustainably caught and removed from the population, year after year.

Thresholds

Thresholds are values that indicate a population is in trouble and that managers aim to avoid. For example, the threshold for an overfished stock occurs at the point when the population falls below the level that can support MSY.

MANAGEMENT OPTIONS

While stock assessments provide information on the status of the population and predict the likely outcomes of a variety of management options, it is ultimately up to the fishery managers to choose which management plan to implement. These decisions are often influenced by other factors besides the scientific information provided by the stock assessment.

QUOTAS

CLOSURES

SIZE RESTRICTIONS

Quotas Managers often set a Total Allowable Catch (TAC), which limits the total weight of fish that can be harvested in a specified time period.

Area and Time Closures Both area and time closures are an effective way to reduce harvest or protect important habitat or spawning grounds.

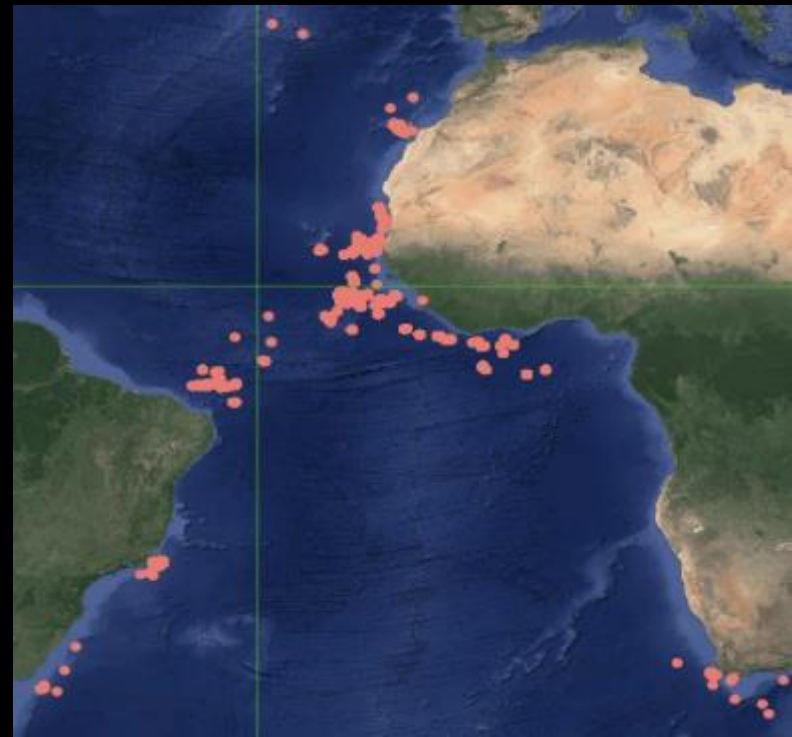
Size Restrictions By restricting the minimum or maximum size of fish that can be kept by fishermen, managers can protect juvenile fish or mature reproductive adults.

ICCAT Atlantic – Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP)

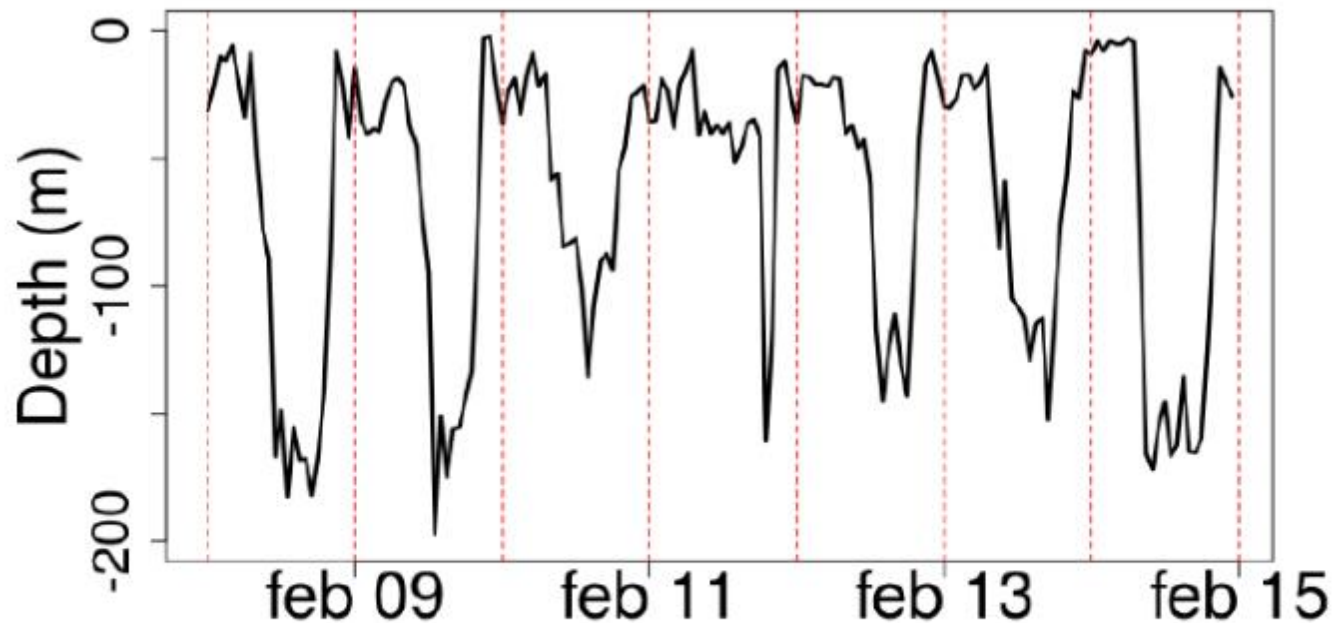
The AOTTP Programme (<http://www.iccat.int/AOTTP/en/>) is collecting tag-recapture data from Atlantic Ocean tropical tuna fisheries.

AOTTP will tag 120,000 fish using conventional and electronic tags.

Location of yellowfin tuna tagged between June 2016 and Sept 2017

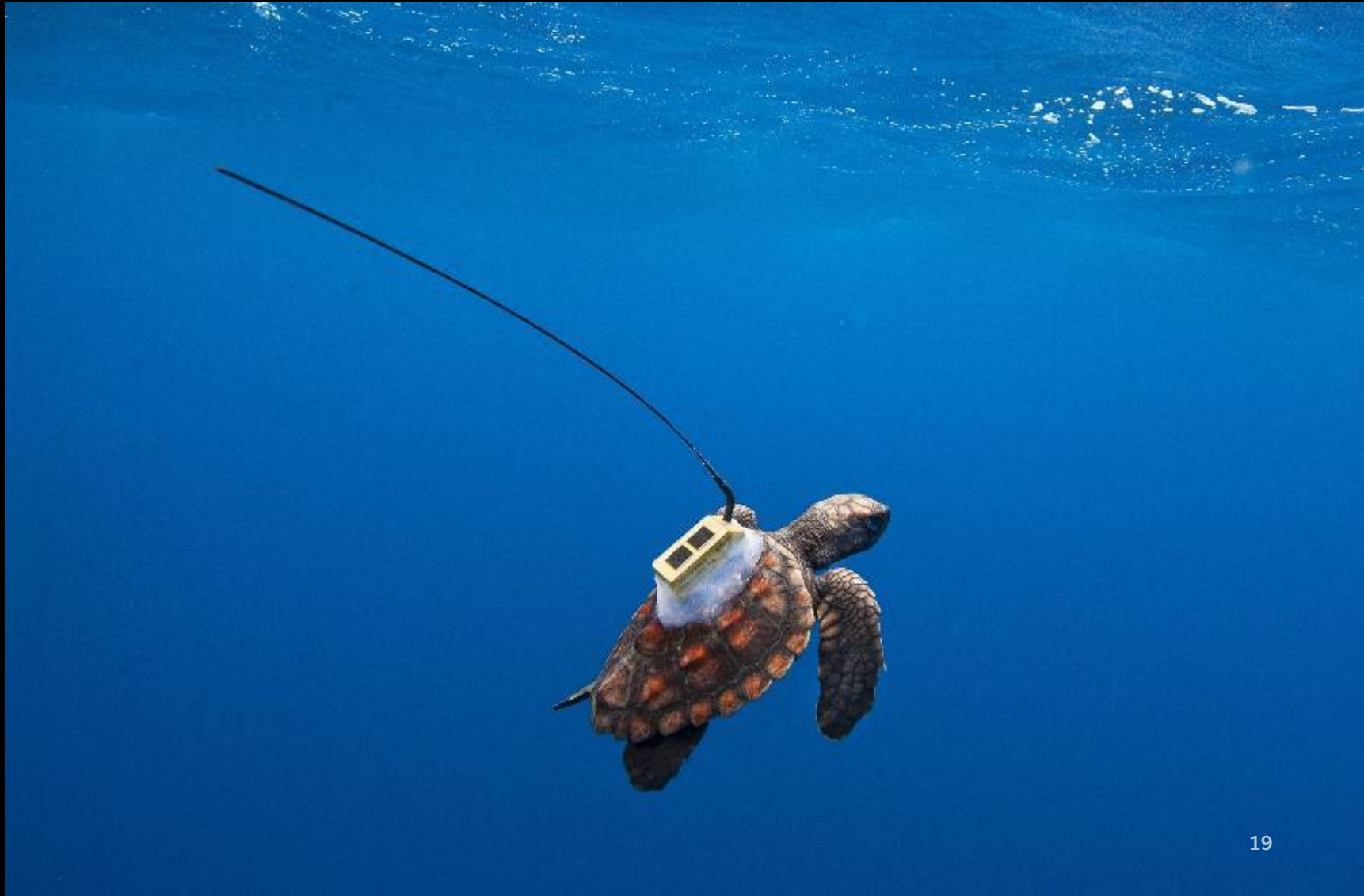


ICCAT Atlantic – Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP)



A week of daily diving behaviour by a yellowfin tuna determined from an internal data-logger tag.

Speaking about tagging...



Fishery dependent surveys

Global Fishing Watch



Global Fishing Watch



REQUIRED

- Better use of existing data
- Surveys for commercial species
- Surveys for endangered species
- Relevance for society

Gaps



- Missing or not enough communication between communities
- Missing data exchange protocols
- Missing survey protocols

Synergies

- a lot 😊
- Adding value to observations by bringing data together







So long, and thanks for all the fish!