Fisheries Management and Ocean Observations

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Main Points

- Ecosystem services, maximum sustainable yield, and rebuilding overexploited stocks are primary goals of fisheries management
- Use of ocean observations in fisheries management is in its infancy
- The next 10 years will see a large increase in the use of ocean observations for fisheries management through the enhancement of sensors, platforms, integrated observing systems, data delivery and use, and models
- Enhanced collaboration among the observing and fisheries communities is essential and should be a goal

OceanObs'09

Is ocean observing critical to fisheries management in 2009?

OceanObs'09

Is ocean observing critical to fisheries management in 2009?

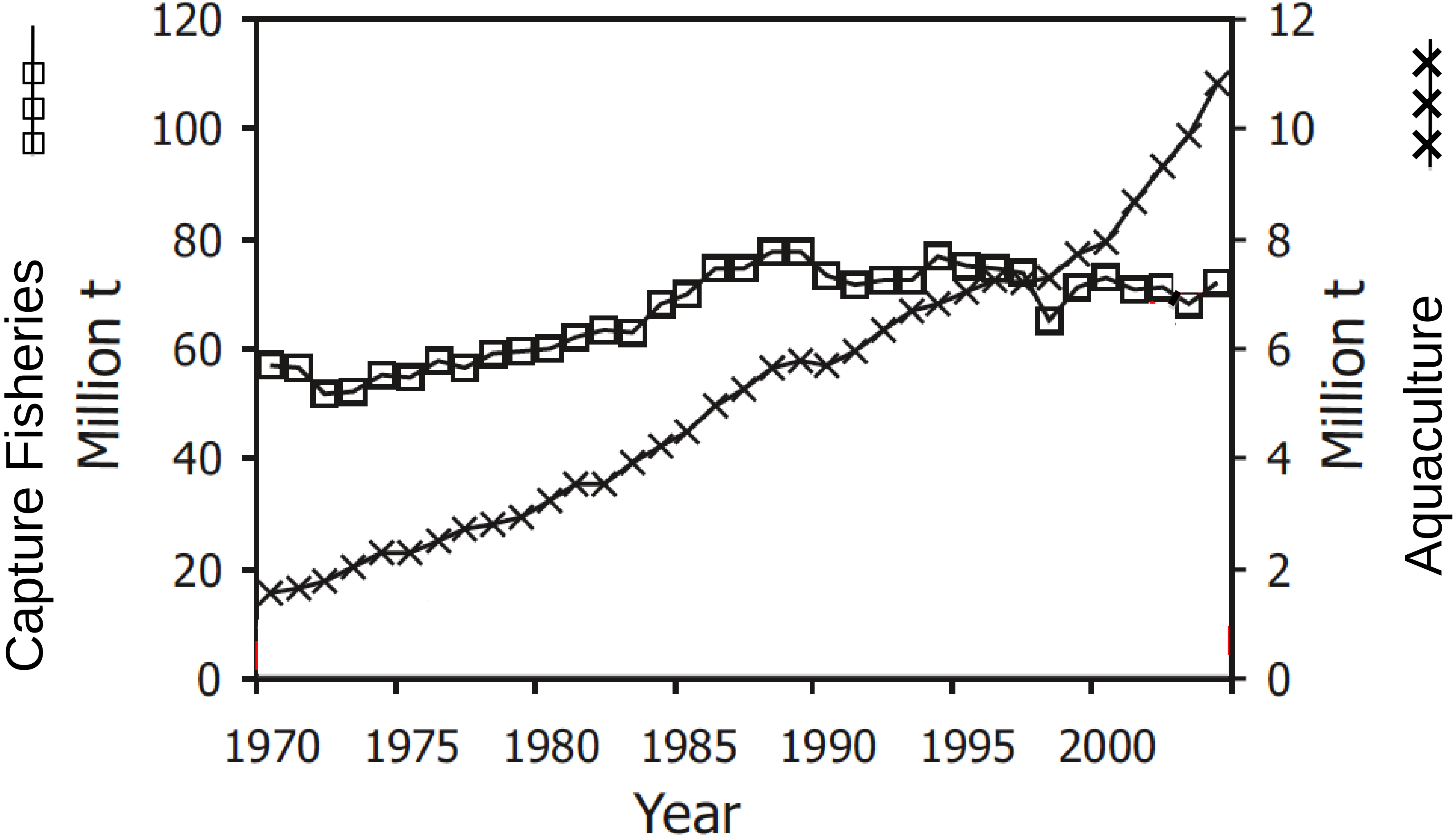
No - only in a very few cases

Fisheries

Removal of fish from the sea by humans

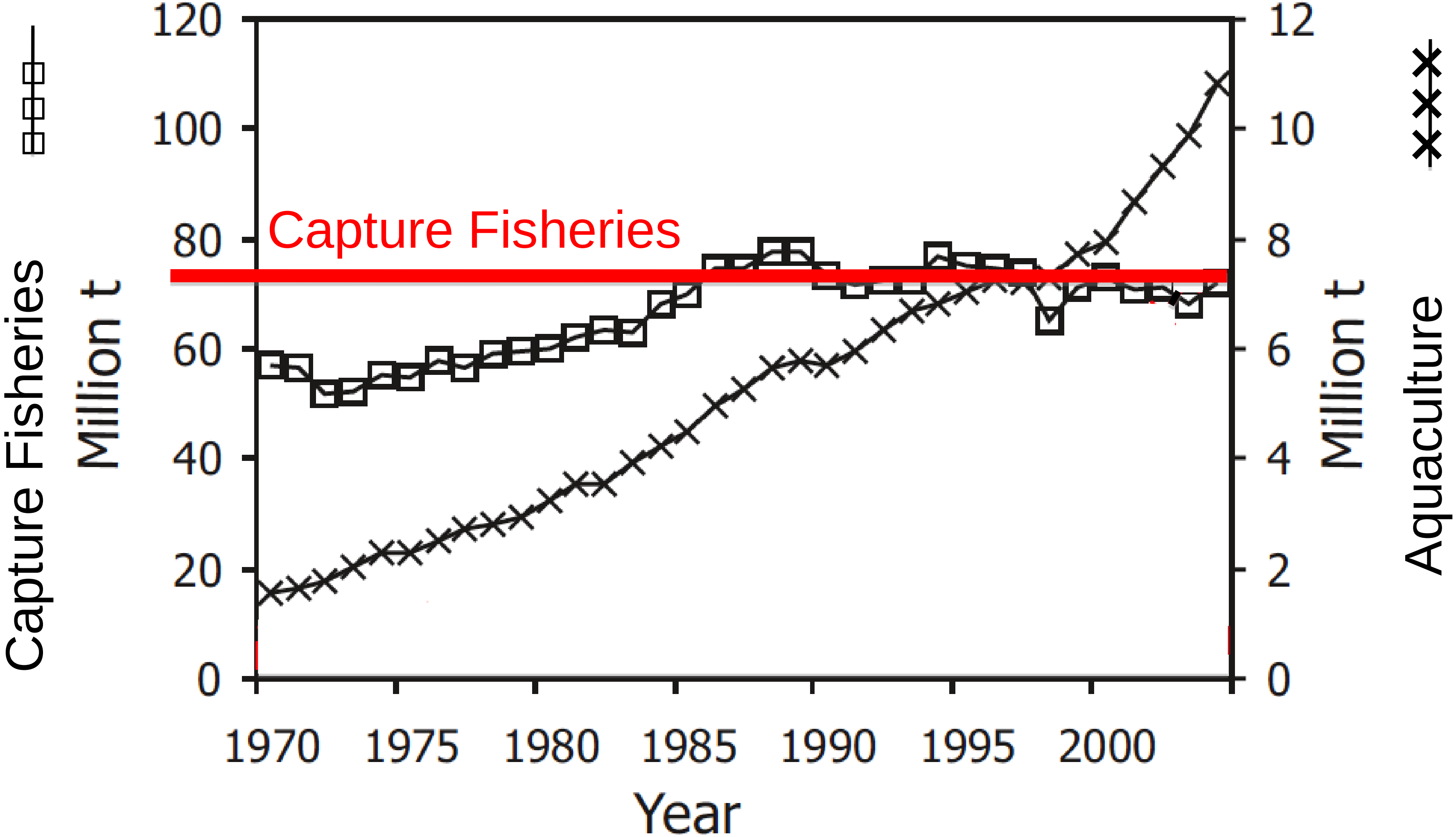
- Fisheries target single species populations – ‘stocks’
- Fishers, not fish, are managed (Ian Perry)
- Climate and fishing together affect fish populations

World Marine Fisheries Production



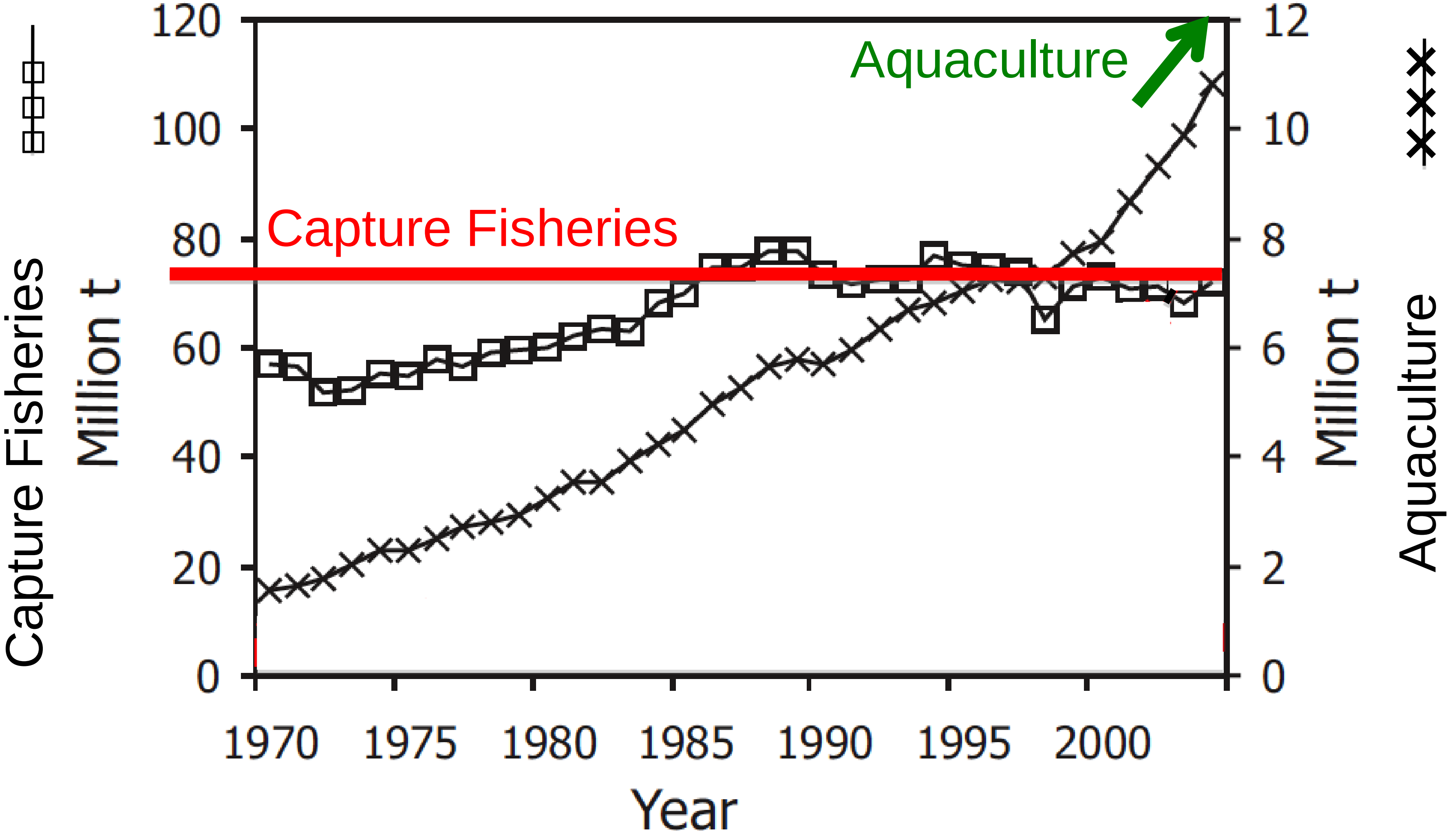
(Brander 2007)

World Marine Fisheries Production



(Brander 2007)

World Marine Fisheries Production



(Brander 2007)

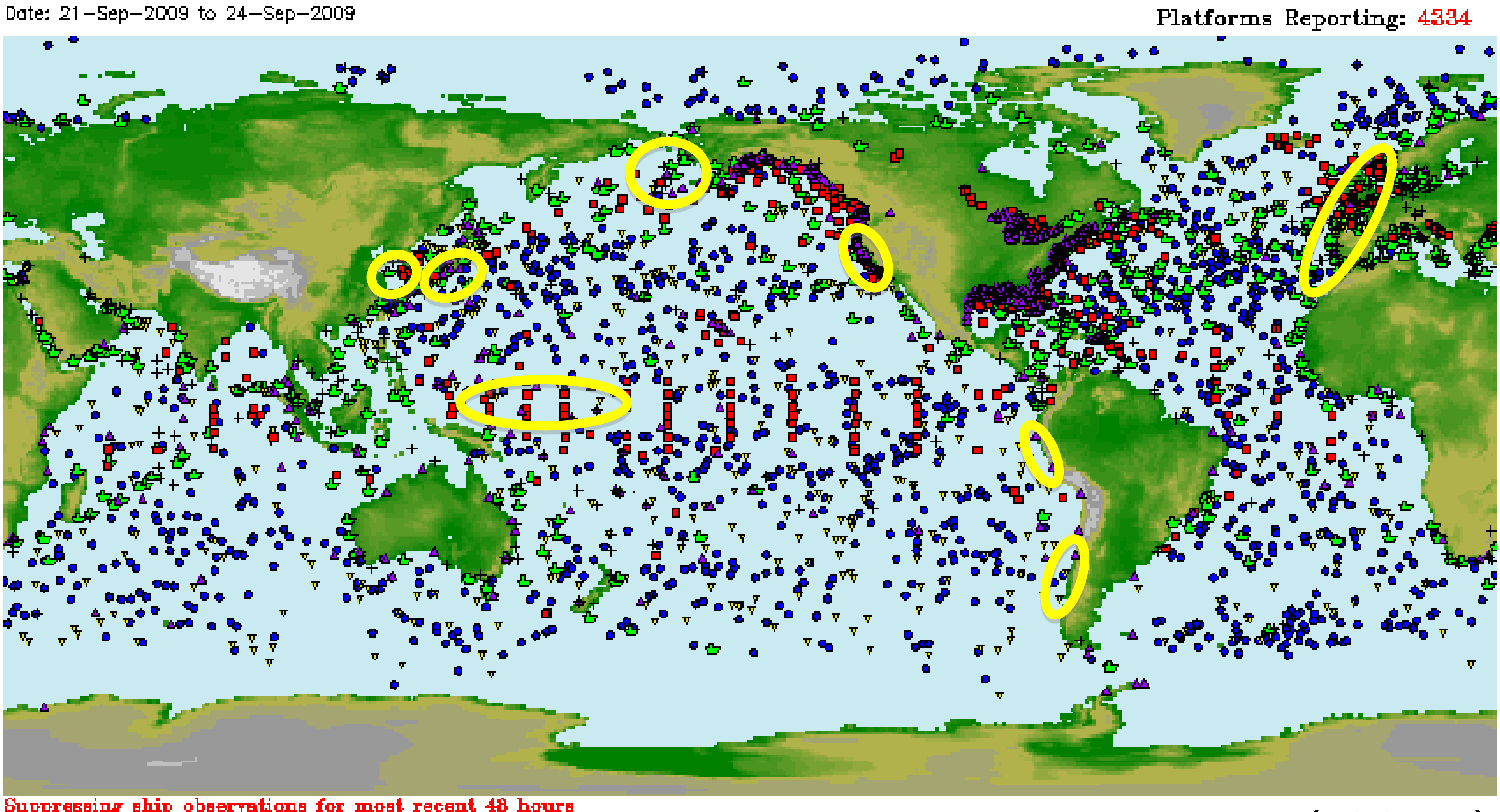
World Fish Landings – Top 10

Peruvian anchoveta	7 007 157	tons
Alaska pollock	2 860 487	
Skipjack tuna	2 480 812	
Atlantic herring	2 244 595	
Blue whiting	2 032 207	
Chub mackerel	2 030 795	
Chilean jack mackerel	1, 828 999	
Japanese anchovy	1, 656 906	
Largehead hairtail	1 587 786	
Yellowfin tuna	1 129 415	

(FAO)

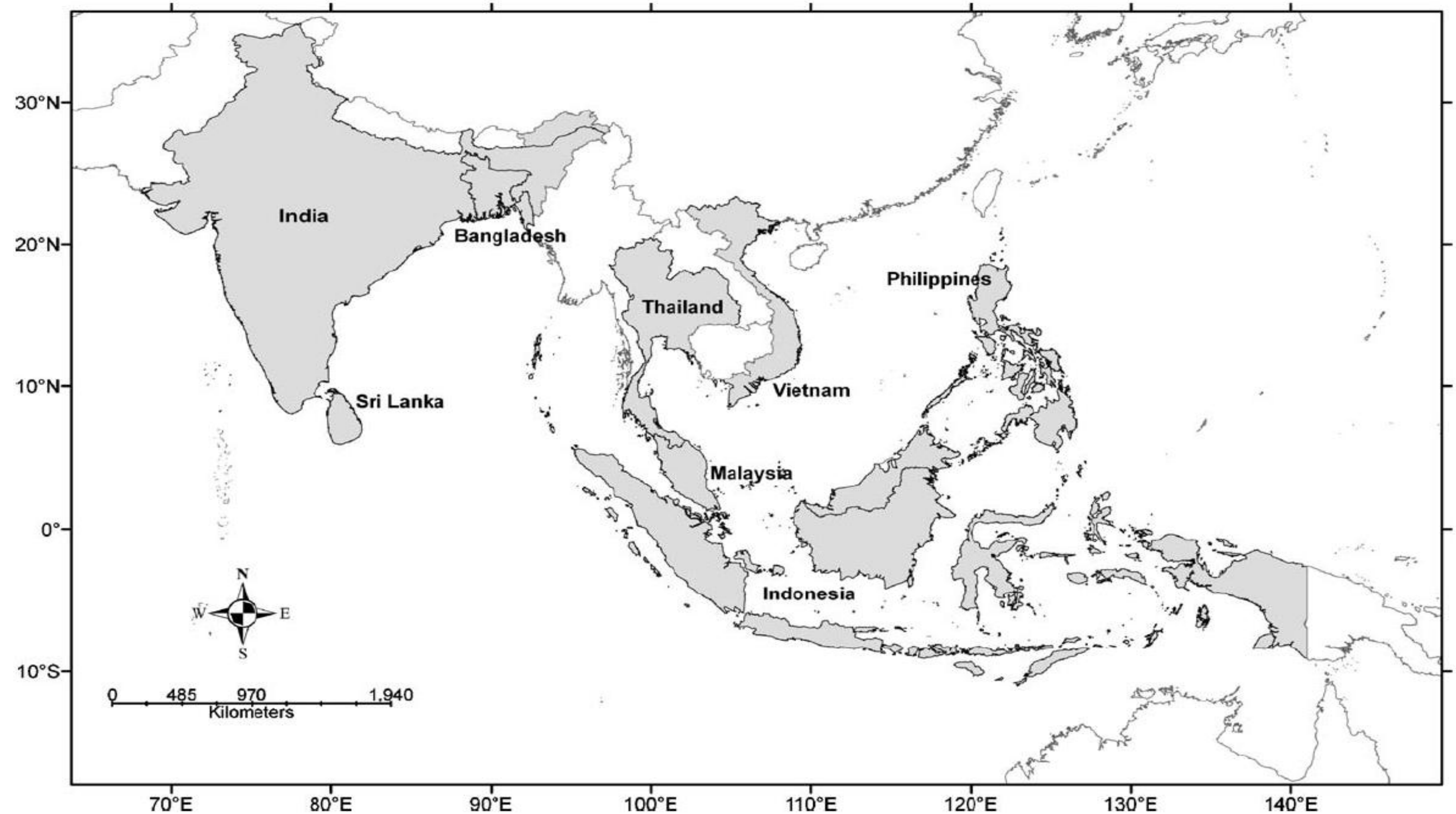
Observations of Last Three Days

Floats, buoys, and ships – not satellites



(JCOMM)

17% of Global Marine Fish Landings



(Stobutski *et al*. 2006)

Fisheries Management Objectives

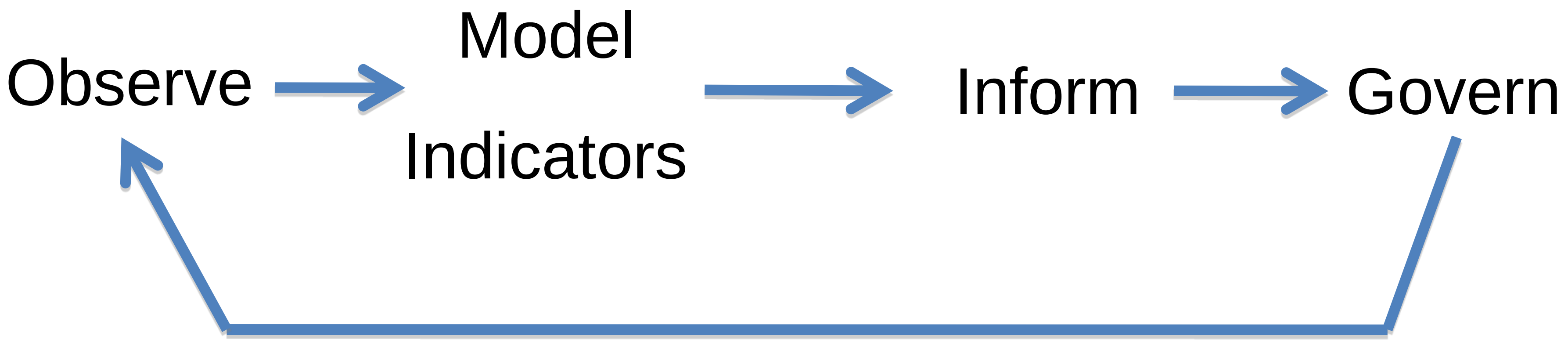
Greatest overall benefit, including ecosystem services

Maximum Sustainable Yield, reduced by other factors

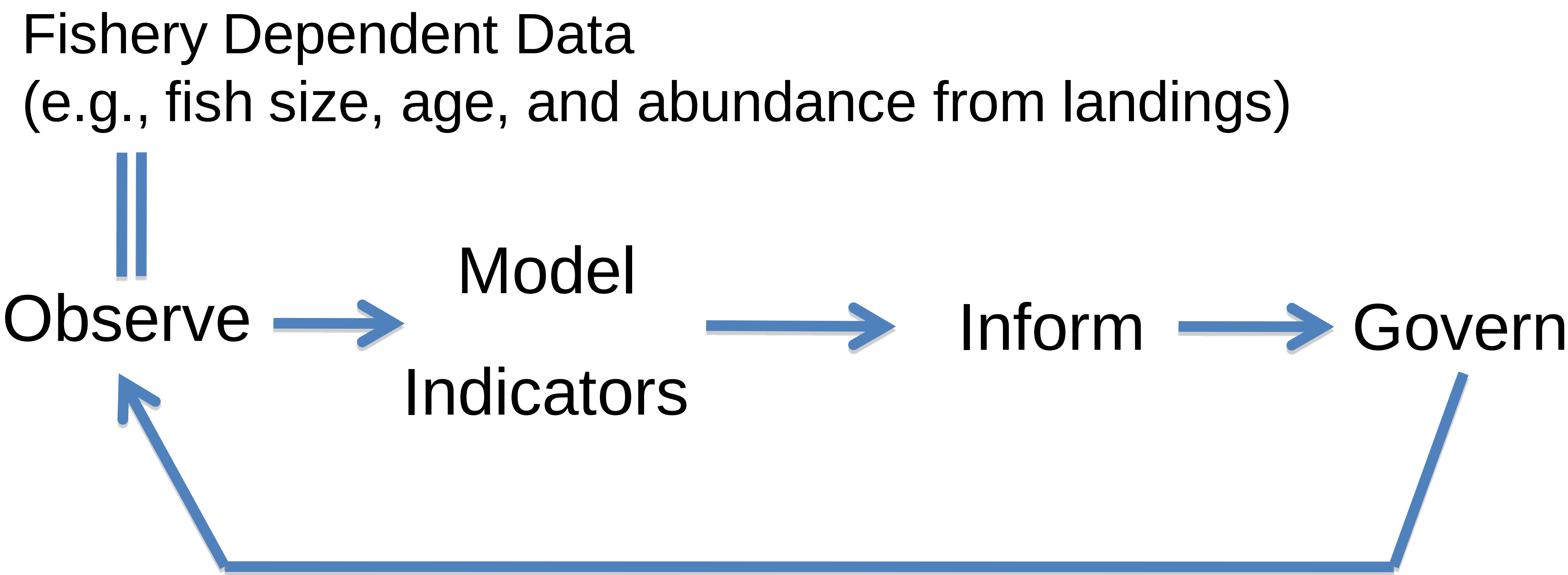
Rebuilding if overfished

(Magnuson-Stevens Reauthorization Act of 2007)

Management

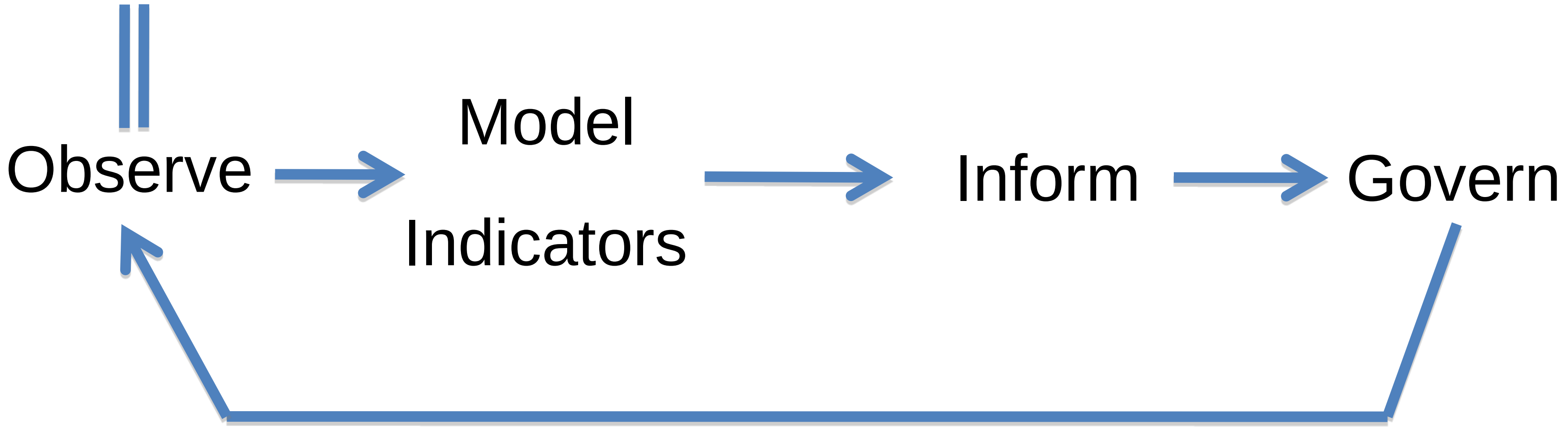


Canonical Management



Ideal Management

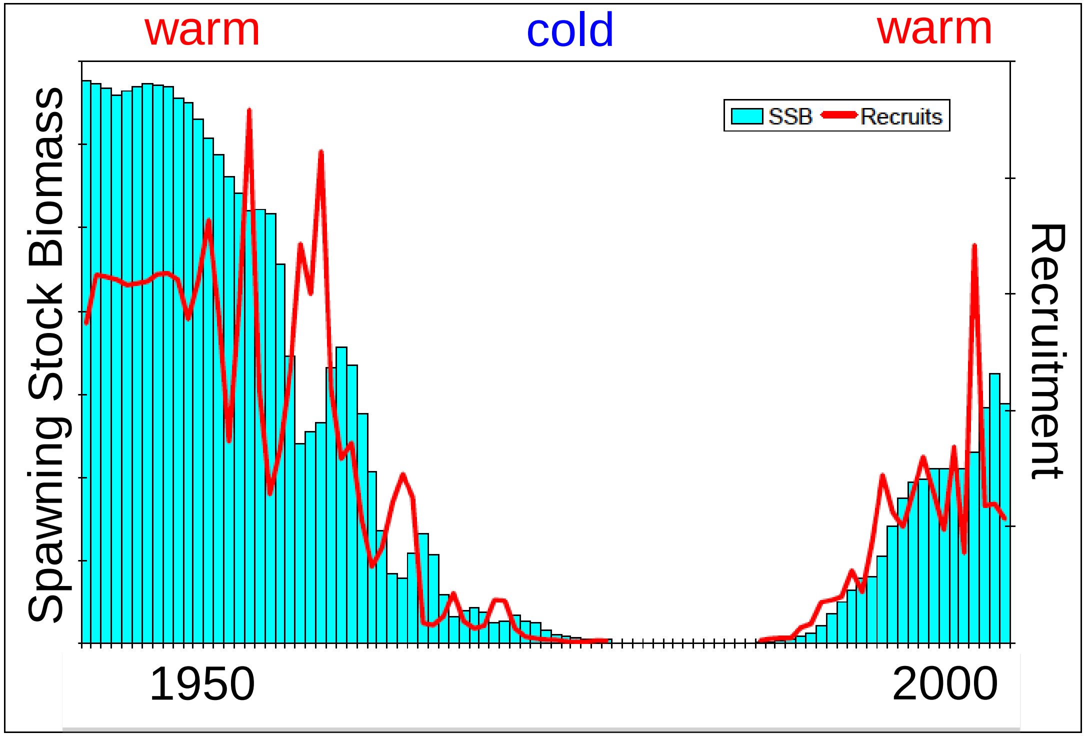
Fishery Dependent Data and Ocean Observations

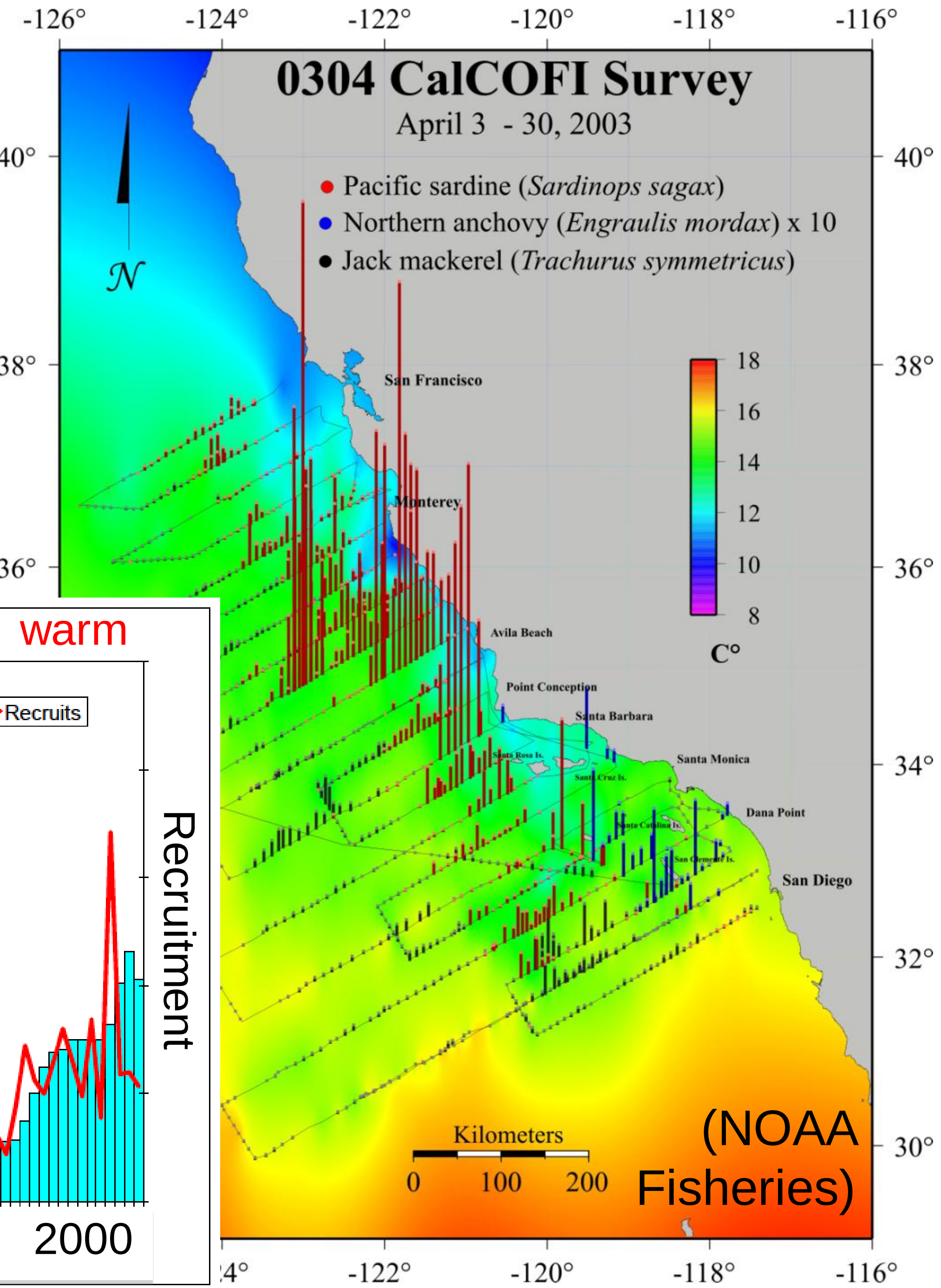


California Sardine

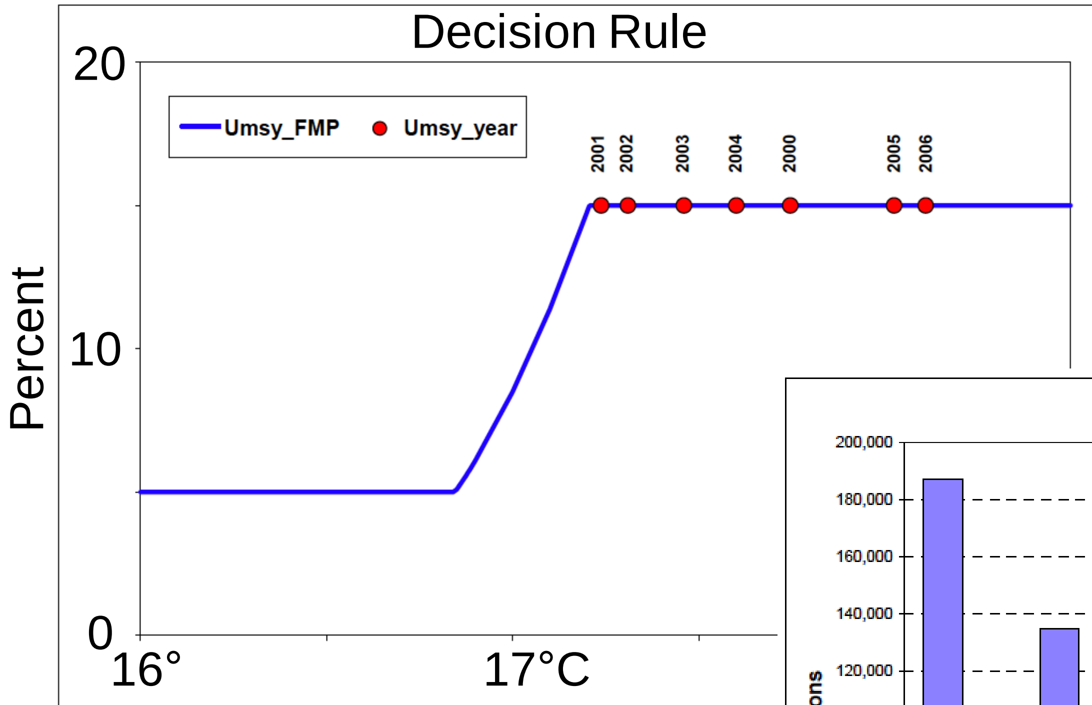
Varies with climate (PDO) on decadal scale

Prefers warm conditions

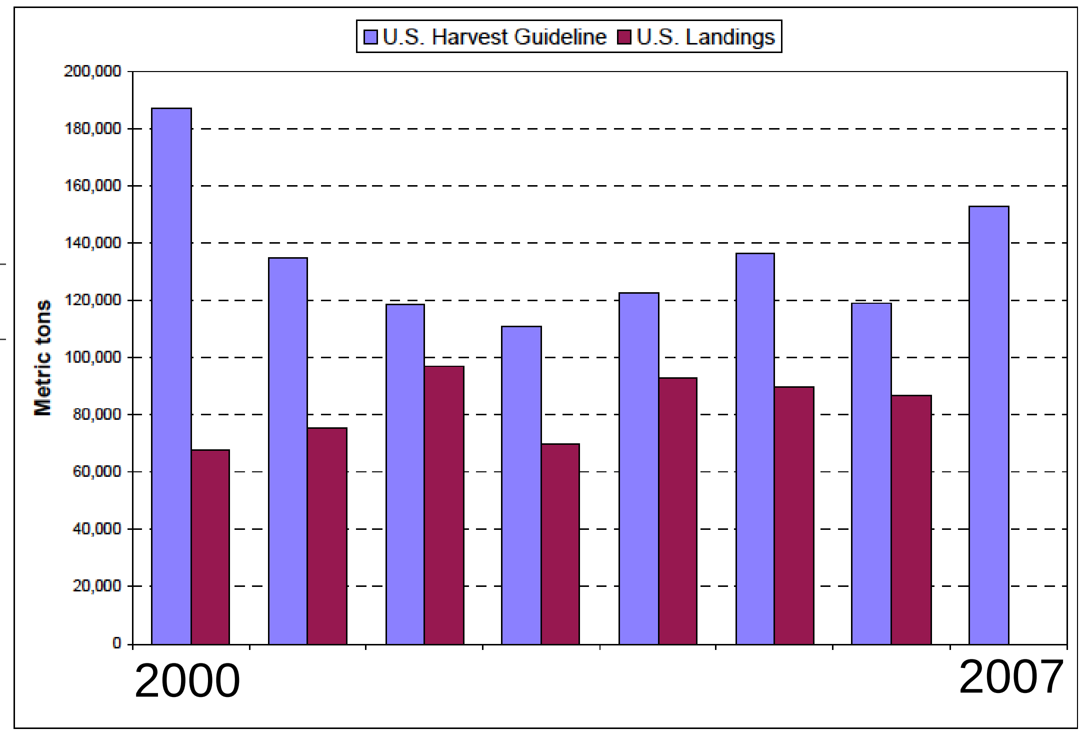




California Sardine



3-year running mean of SIO Pier temperature used to determine fraction of sardine biomass fished



(NOAA Fisheries)

Turtle By-Catch Reduction


(Duke U)

Problem

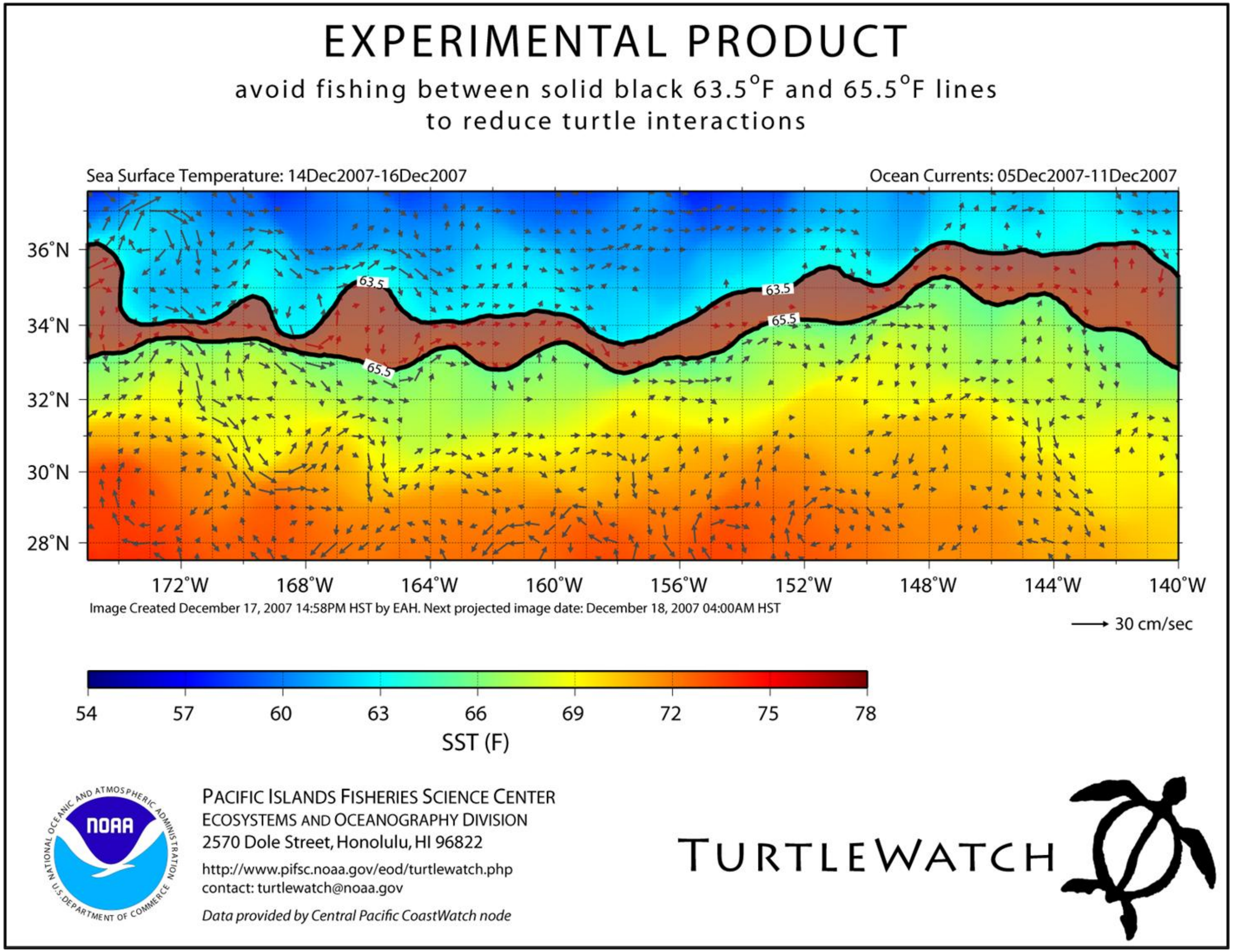
By-catch of loggerhead sea turtles in the North Pacific longline fishery for swordfish

Solution

Satellite tags and remote sensing define sea turtle habitat
SST and altimetry used to map habitat

Weekly advisory product to forecast the zone with the swordfish fishing ground which has the highest probability of interactions between sea turtles and longliners

Turtle By-Catch Reduction



(Polovina)

Bluefin Tuna By-Catch Reduction

Objective: Reduce BFT by-catch in tropical tuna longline fishery

Biological Data
(tags)

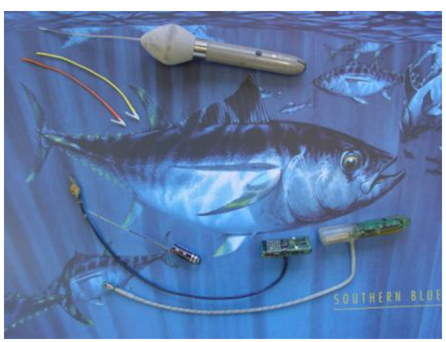
Habitat Preferences

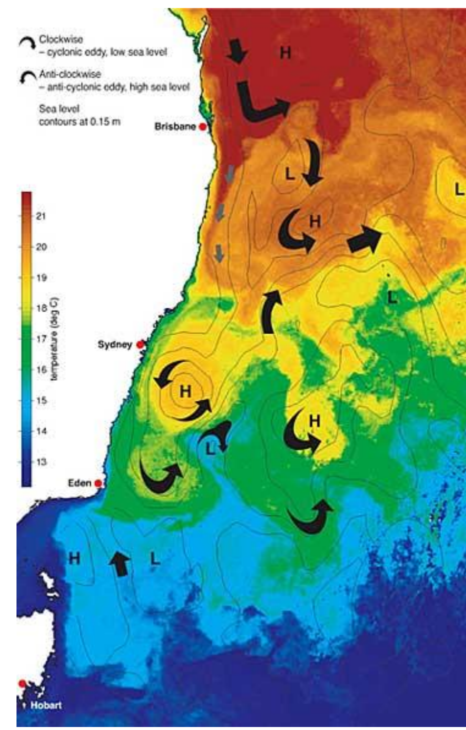
Physical Data
(near-real time distribution of environment)
Ocean Model (Bluelink)

Analysis and habitat prediction tools

Habitat Prediction Maps

Management Support
(sustainable use)



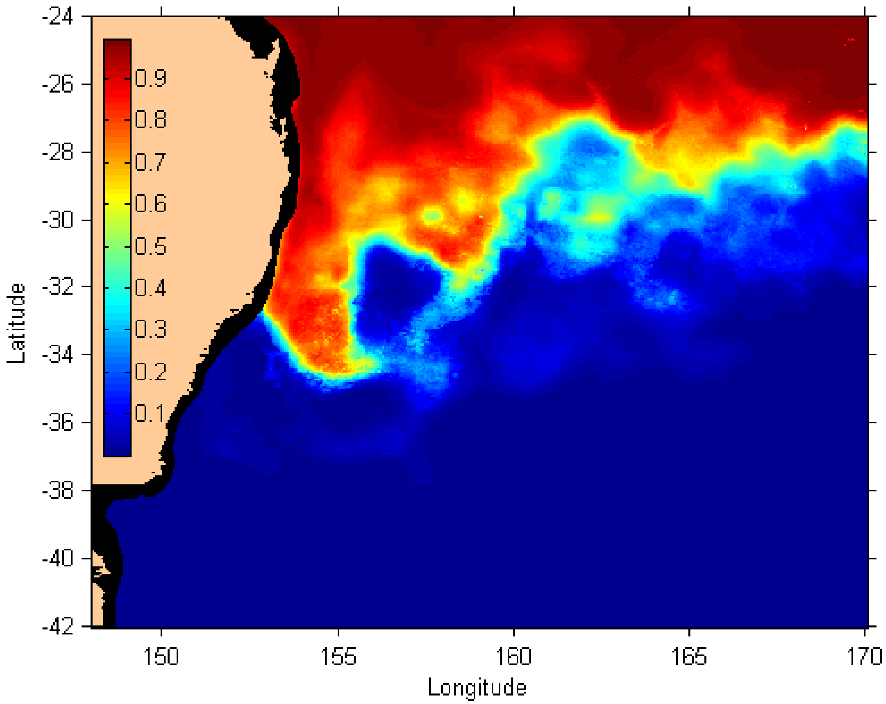


(Hobday, CSIRO)

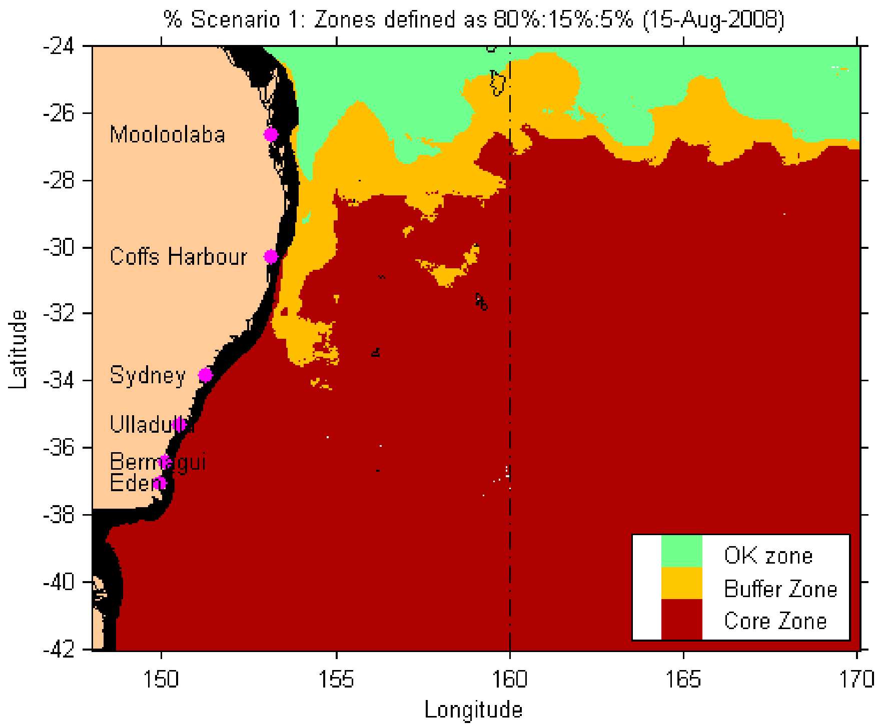
Bluefin Tuna By-Catch Reduction

Biweekly: SST & altimetry used with habitat prediction model then management meets to zone the area

Habitat Index

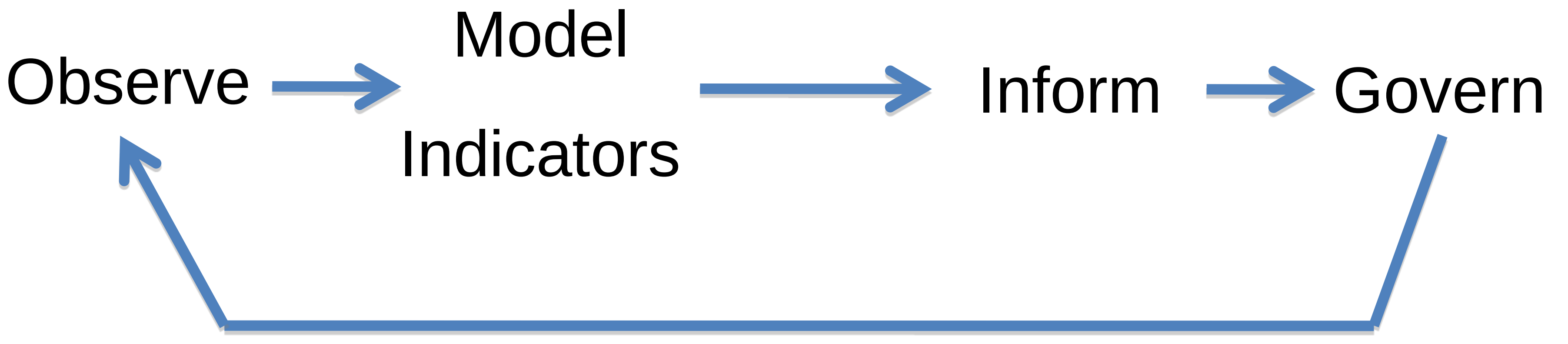


Habitat Management Zones



(Hobday. CSIRO)

Work backwards…



Work backwards…

Observe ← Model Indicators ← Inform ← Govern

Governance

Management Options

- Catch control
  - Total catch (race to fish)
  - Catch shares (rights-based fishing)

- Effort control
  - Time limits
  - Vessel or gear restrictions
  - Area (Marine Spatial Management)

Affected by: Natural science, socioeconomics, politics

Population & Ecosystem Models

Deterministic

- Limitation: fish behavior
    - (“like unmanageable children”…Oozeki-san)
- Example: NEMURO

Statistical

- Assumes past behavior
- Non-linear, short-term

Indexes

Single number indicating the state of a fish stock, fishery, ecosystem, or environment

Physical: SOI, PDO, NPGO, NPI, NAO, IOD, SIO Pier Temp

Biological: CPUE

Mean trophic level (Pauly)

Ocean Production Index – fraction released salmon returning to spawn (Peterson)

Indicator (sentinel) species – e.g., predatory seabirds (gannets diving on sardine) (van der Lingen)

Maximum species yield, food-web based yield, species-diversity based yield (Gifford and Steele)

Physical Data

Met data (e.g., T_{air}, wind, BP, humidity)

Light

Temperature, salinity, pressure

Stratification, mixing

u, v, w

Turbulence (ε)

Sea level height

Chemical Data

O_2

pH

pCO_2

Nutrients

Chl *a*

Biological Data

Phytoplankton and zooplankton

Fish

Birds, Reptiles, Mammals

Distribution and abundance

Migrations

Interactions (feeding and predation – gut contents)

Developmental stages: egg, larva, juvenile, and adult

Size spectra

Socioeconomic Data

Costs

Markets

Trading

Employment

Ecosystem services

Integrated Ecosystem Assessment

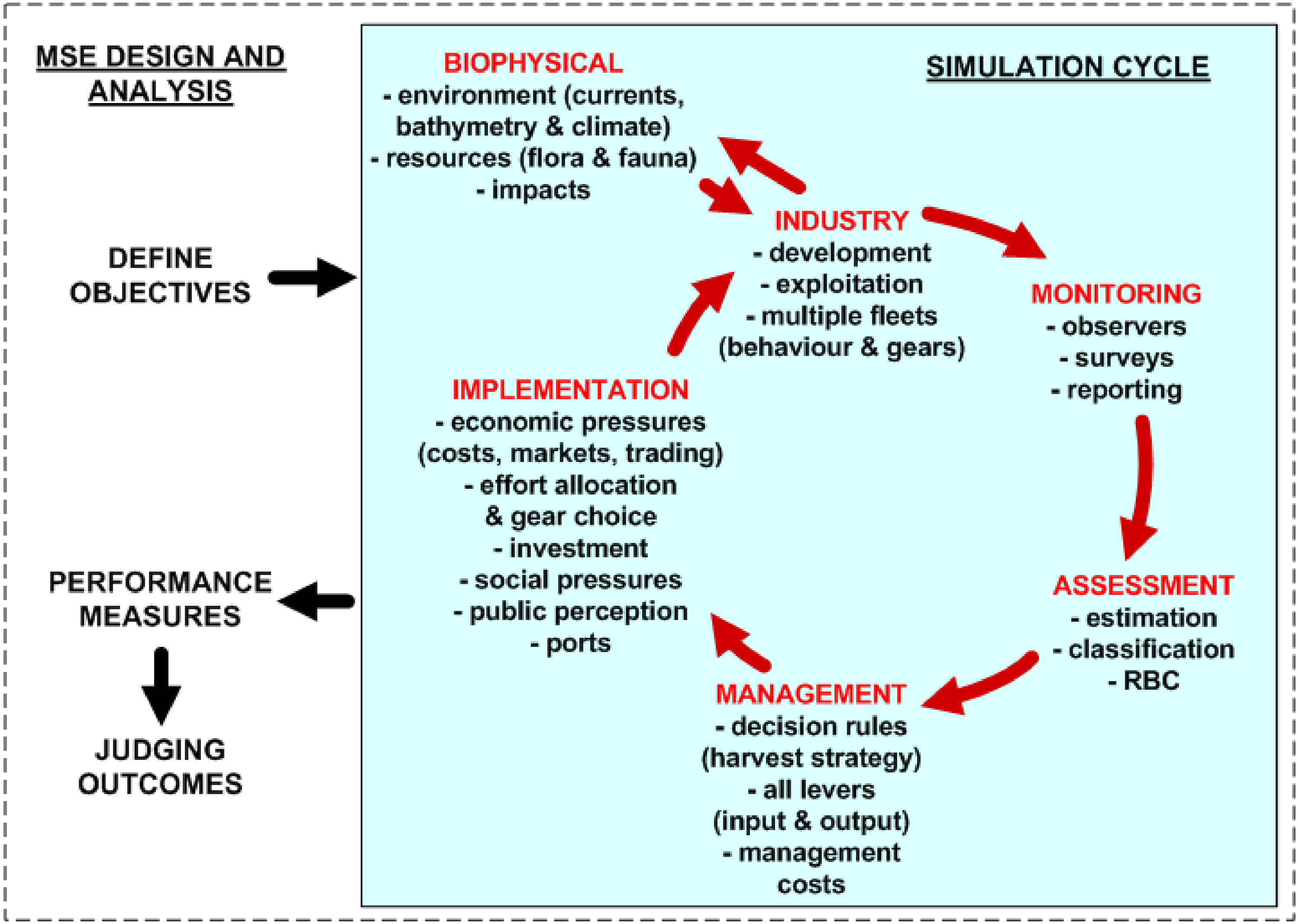
Formal synthesis and quantitative analysis of information on relevant natural and socioeconomic factors, in relation to specified ecosystem management objectives

Levin *et al.* 2009

End-to-End Fishery Model

Atlantis

19 systems



(Beth Fulton, CSIRO)

New Sensors

Acoustics

- Active: Multibeam (3D from moving ship) acoustics
- Passive: marine mammals, anthropogenic

Imaging (Sieracki CWP)

Molecular

- Genetics
- Proteomics

Holy Grail: Rapid, accurate, automated species identification and assessment

Platforms

Satellites SST, SLH, color, winds, salinity

Ships Station grids (e.g., CalCOFI)

Underway sampling (e.g., CPR, CUFES, MVP, SEASOAR)

VMS – (fishing) vessel monitoring systems

Lagrangian floats, gliders, AUVs

Eulerian moorings (buoys, subsurface profiling winches)

Animals tagging (archival, satellite)

bio-logging (Boehme, Costa CWPs)

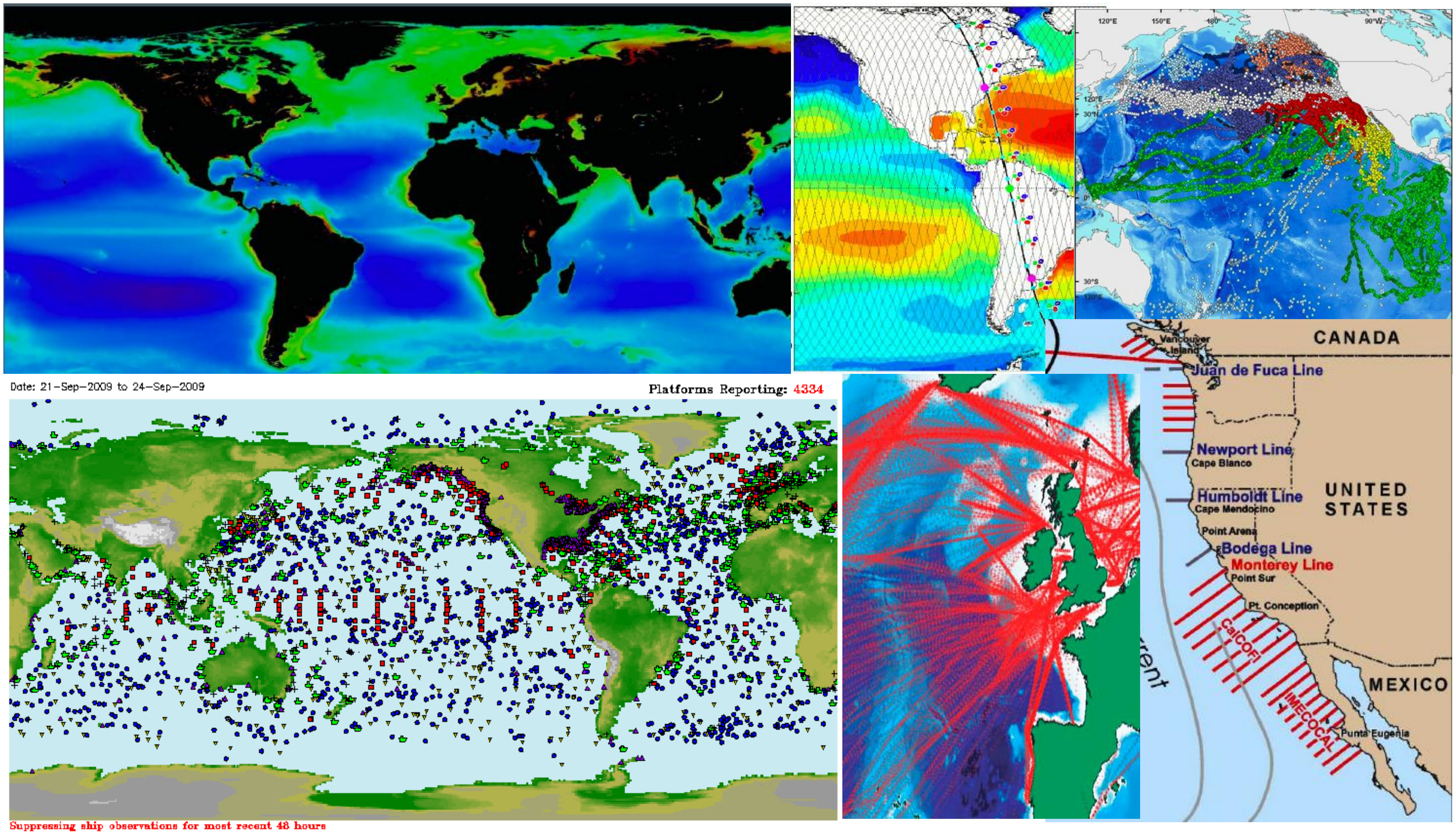
acoustic listening networks (e.g., POST; O'Dor CWP)

CWPs: Handegard, Koslow, Larkin, Malone

Observing Challenges

- No silver bullet (Beth Fulton)
- Timely and open access to data
- Sampling of aggregated (patchy) distributions
- Time resolution (e.g., spring bloom, spawning, phenology)
- Species interactions (feeding, predation)
- Relating physics, chemistry, and biology – scale mismatches
  - the need for comparable data
- Socioeconomics – human dimensions
- Risk and uncertainty
- Participation: stakeholders, scientists, managers
- Coastal observing and capacity building

The Future



Date: 21-Sep-2009 to 24-Sep-2009
Platforms Reporting: 4334
Suppressing ship observations for most recent 48 hours
CANADA
Vancouver Island
Juan de Fuca Line
Newport Line
Cape Blanco
Humboldt Line
Cape Mendocino
UNITED STATES
Point Arena
Bodega Line
Monterey Line
Point Sur
Pt. Conception
CalCOFI
IMECOCAL
MEXICO
Punta Eugenia

OceanObs’19 - Predictions

- Yes - ocean observations are critical to fisheries management
- Developing, as well as developed, countries use ocean observations for fisheries management
- Climate effects on fisheries will be much more apparent and ocean observing has contributed to detecting and understanding these, including rising, warming, deoxygenation, and acidification
- Progress on the understanding of the effects of climate and fishing on fish stocks, allowing NFP (Numerical Fisheries Prediction)

CWPs: Feely, Forget (SAFARI)

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