Oceans and Atmosphere

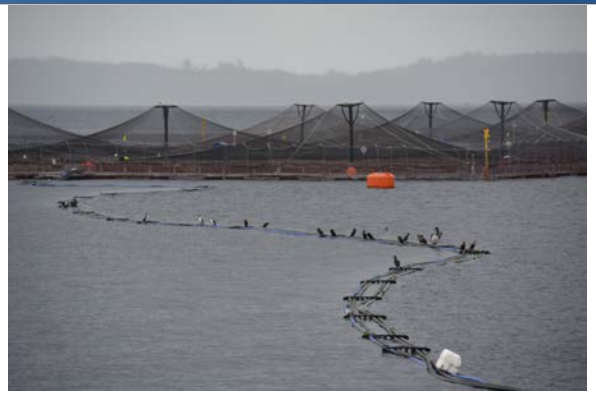
CSIRO

Ocean Information for Aquaculture: Status & Perspectives

Andy Steven

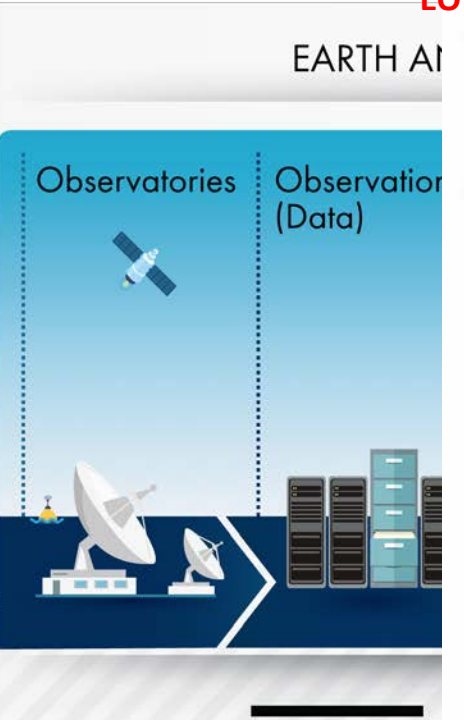
Research Director - Coasts

What do You think of as Aquaculture?

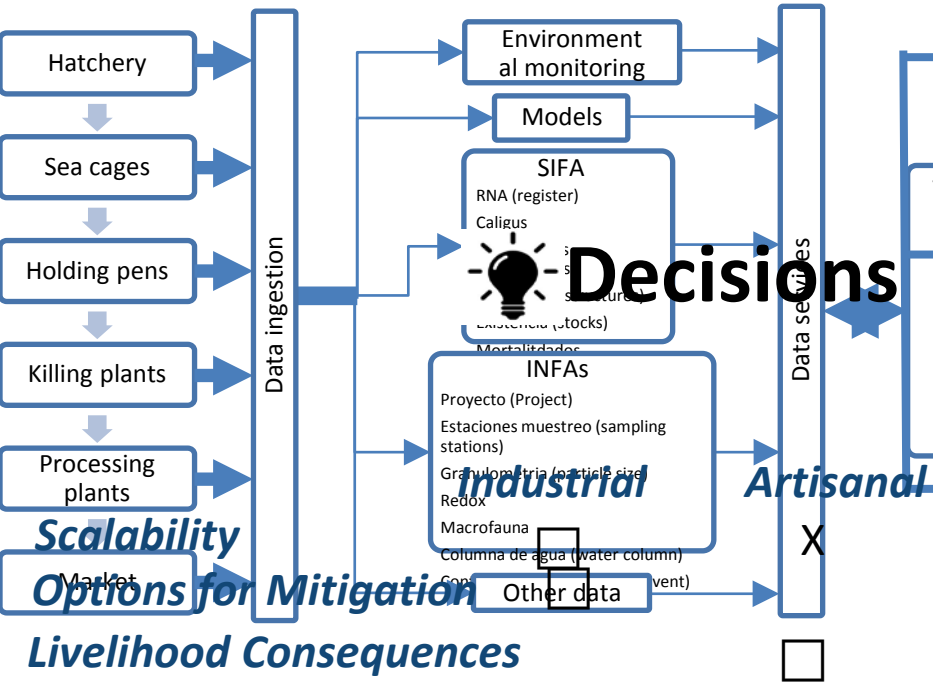


Whose Value Chain?

EO Data, Products, Services



Decisions determine Data & Consequences



About **thresholds: It is time to act?**

- Disease outbreak
- level of organic enrichment of sediments

With **fixed options: Which is best?**

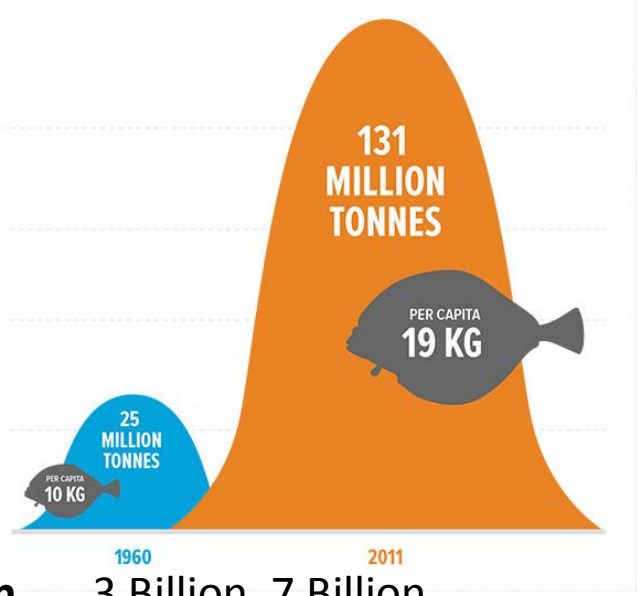
- Best fish treatment,
- best strategy for recovery

Decisions

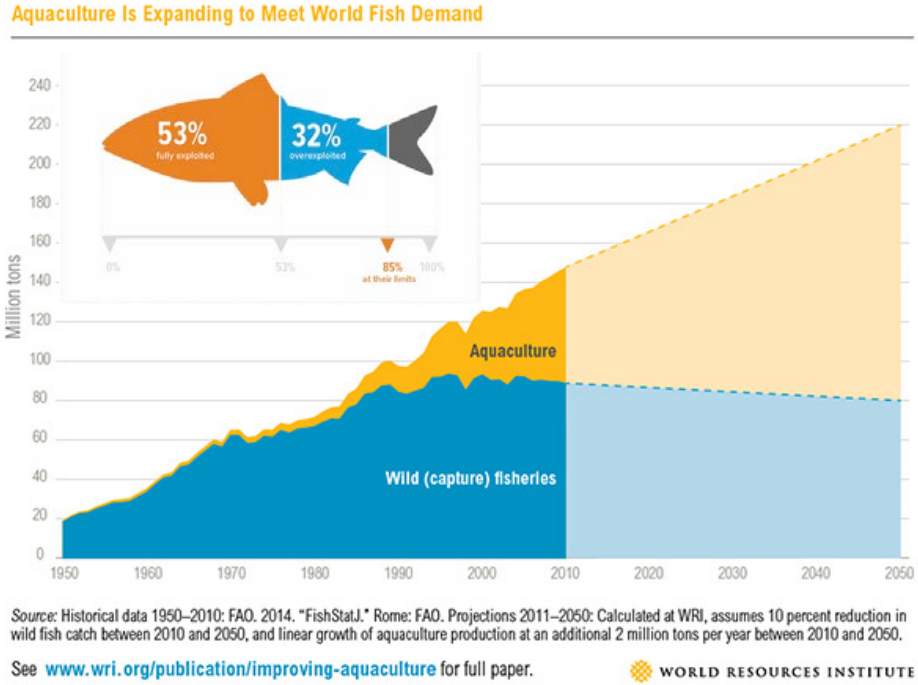
About **potential options: What is possible?**

- new management strategies for Harmful Algal Blooms, how to regulate

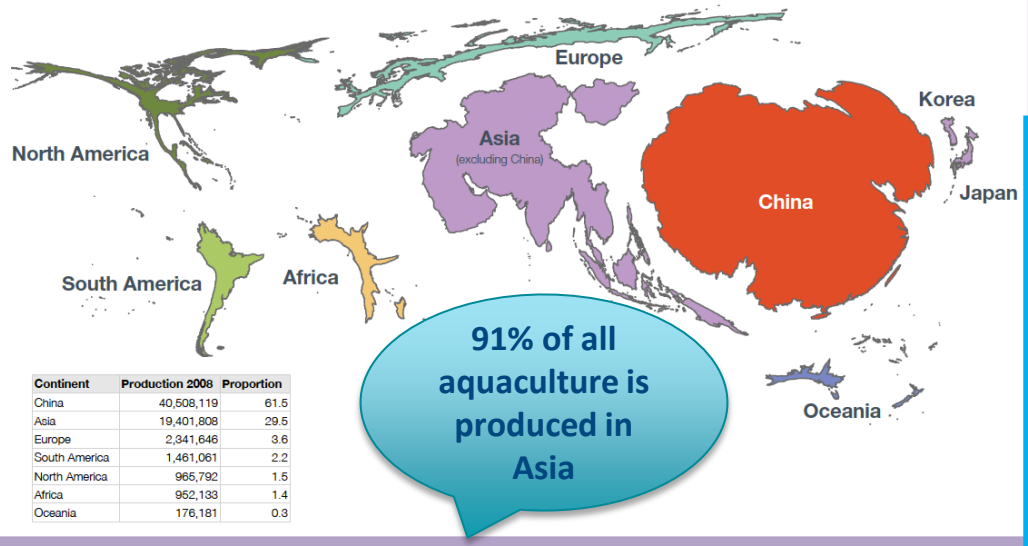
Aquaculture Growth



Population 3 Billion 7 Billion



Aquaculture Distribution



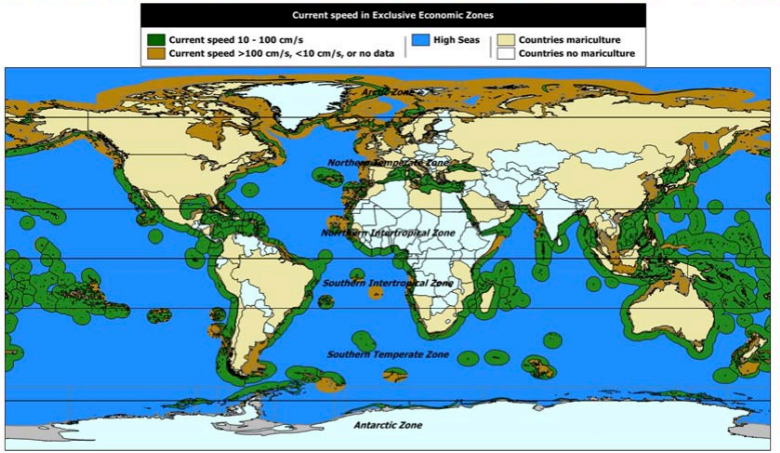
Continent	Production 2008	Proportion
China	40,508,119	61.5
Asia	19,401,808	29.5
Europe	2,341,646	3.6
South America	1,461,061	2.2
North America	965,792	1.5
Africa	952,133	1.4
Oceania	176,181	0.3

91% of all aquaculture is produced in Asia

Offshore aquaculture

Current speeds: 0.1-1 m s^{-1}, suitable depth range for cages and longlines

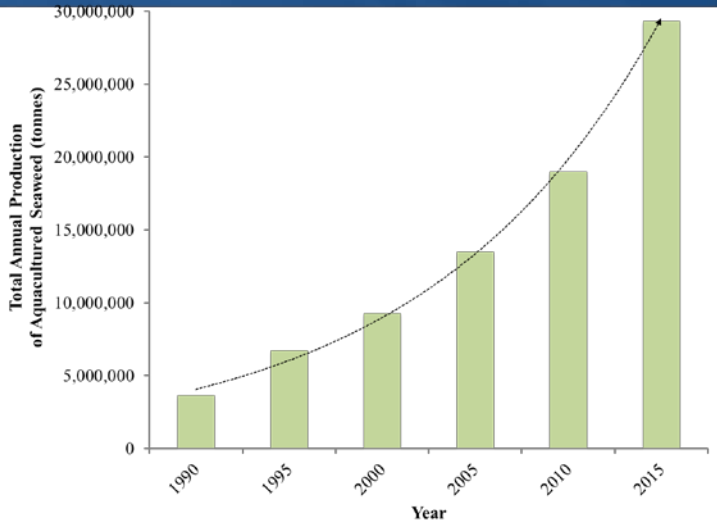
123 countries with at least 100 km^2 that meet these criteria: 10^6 - 10^7 ton y^{-1}



Kapetsky et al., 2010. FAO Workshop, Rome, 2010.

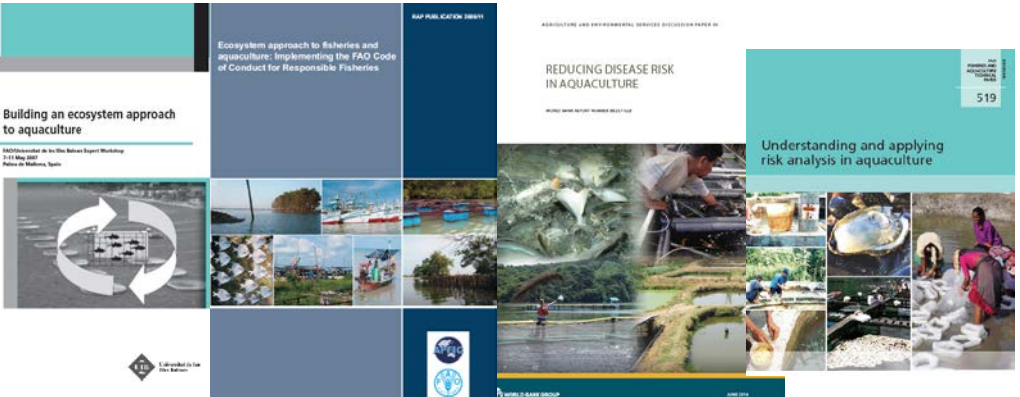
Seaweed Farming

- World production of farmed seaweeds **doubled** between 2000 and 2012.
- Farmed seaweeds provide ~95% of all seaweed production
- 24 million tons of farmed seaweed are produced each year for **direct food consumption,** thickening agents, and animal feeds.
- Projected ~$50B industry by 2023 for seaweed/algae products Mostly From Demand of Chinese Market



Management Principles Best Practice

- Risk-based
- Ecosystem and Carrying Capacity
- Certification
- Whole Value Chain
- Social License



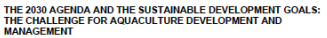
Aquaculture and the SDGs (1)

Intersects with many SDGs

- SGG 14 core but also 13, 2,1 & 5

Practical Issues

- Trade-offs between different SDG objectives;
- Nature of environmental capacity or limits to growth;
- Adaptive planning and management systems;
- capacity development of institutions



Buy-in

- Endorsed by Corporate Aquaculture Companies and Associations as part of Corporate Sustainability
- For Artisanal Aquaculture- little to no awareness or capacity

Aquaculture and the SDGs (2)

SUSTAINABLE DEVELOPMENT GOAL 14

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

10 TARGETS and **INDICATORS**

Themes

- Marine pollution
- marine and coastal ecosystems
- ocean acidification
- **Overfishing**
- Illegal, unreported and unregulated fishing
- **small-scale artisanal fishers**
- Improve ocean health
- **Economic benefits to Small Island States**

Actions

- prevent and reduce
- Conserve, sustainably manage and use,
- international law
- Minimize
- Regulate,
- Prohibit
- **access to marine resources & markets**
- research capacity and transfer marine technology
- sustainable use of marine resources

EO Applications to Aquaculture (1)

Environmental Compliance Assessment and Reporting

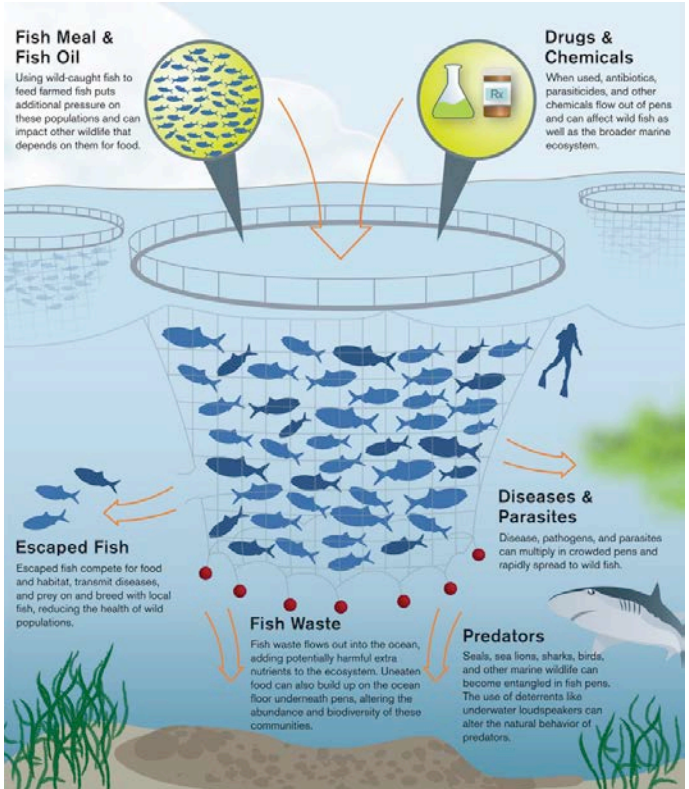
Industry and Regulator

- Establishing farm footprints
- Environmental Condition Compliance Monitoring
- Lease domains

Operational Production monitoring

Industry

- Fish stocking numbers and feed rates
- Escapes and predation
- Disease Outbreak and spread
- Potential Impacts of Environmental conditions and events (e.g. HABs)

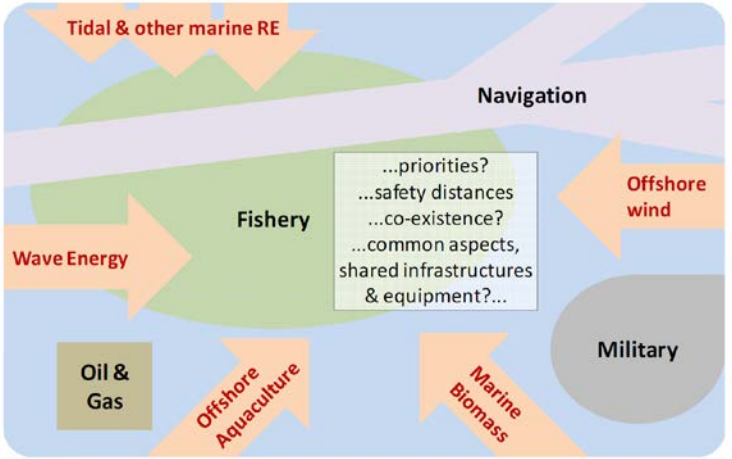


EO Applications to Aquaculture (2)

Regional Strategic Development planning

- Planning to harmonize Multi-sector use
- Constraint Mapping & Feasibility Assessment
  - New Coastal Regions
  - Offshore Sites
- Planning carrying capacity and setting thresholds

- **Environmental Monitoring, Event Detection and Forecasting**
- HABs, / Productivity
- Hypoxia
- heat waves



EO for Industrial Aquaculture

- Many Public good and commercial services in Europe
  - Less so elsewhere
- Make extensive use of Copernicus and H2020 developed services
- Relatively few have integrated EO and models and even fewer with other socio-ecological information

BlueBRIDGE

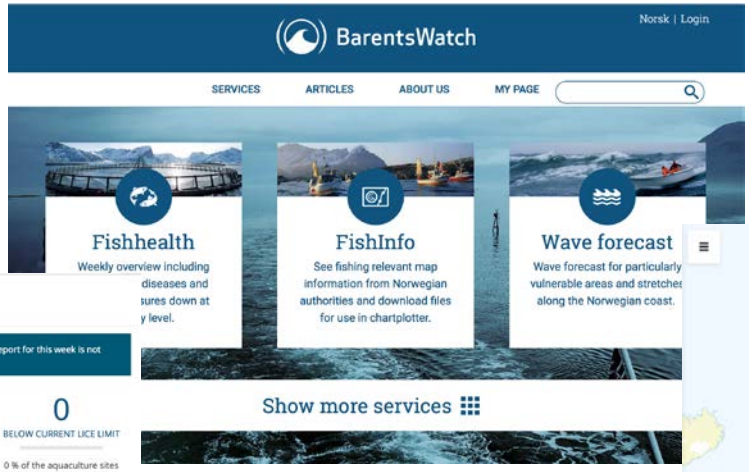
BLUEFARM

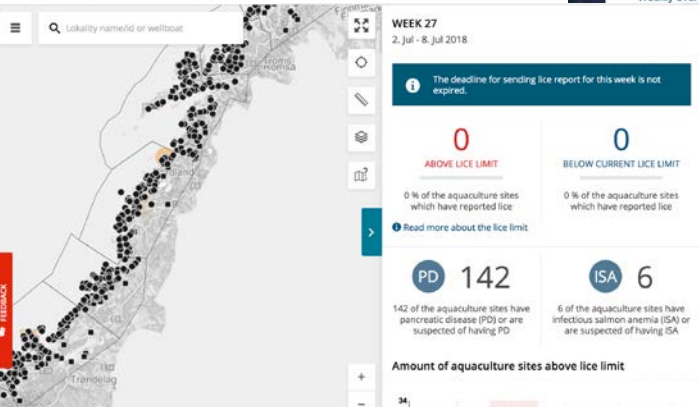
CAPES
NCCOS
COASTAL AQUACULTURE PLANNING & ENVIRONMENTAL SUSTAINABILITY
NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

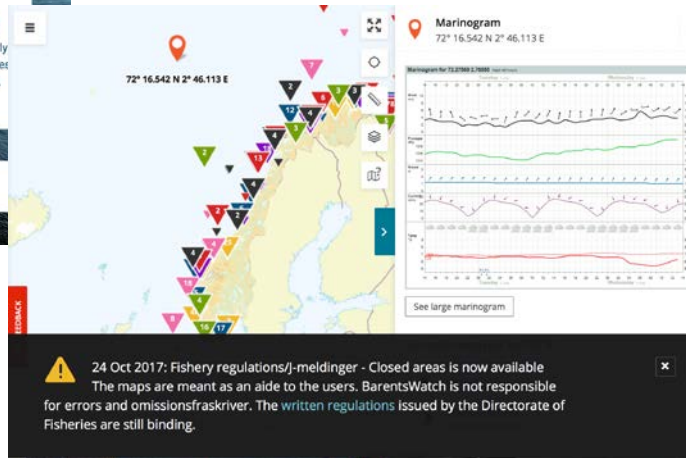
BarentsWatch -a Regional Information System

https://www.barentswatch.no

Collect, develop, share information about Norwegian coastal & marine areas





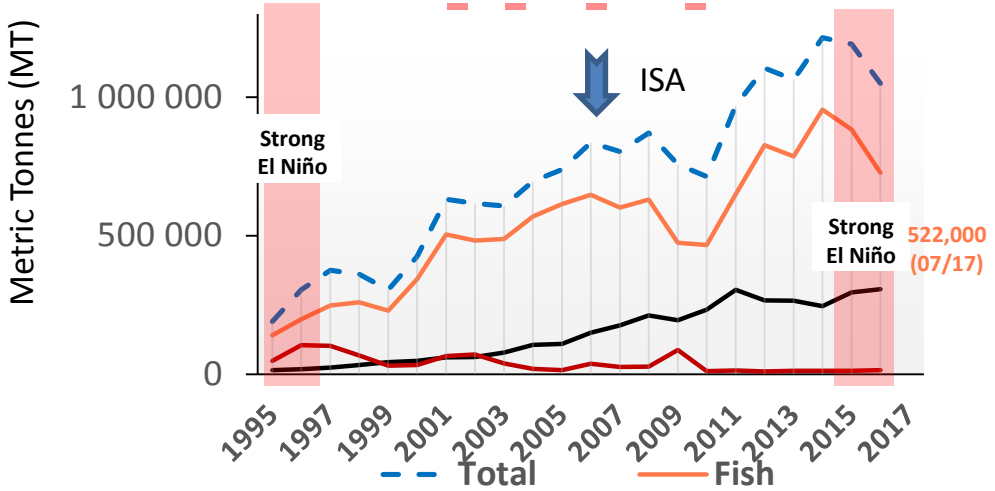


Salmon farming in Chile

High value
- US$ 3.8b, up to
- 40% regional labor force

Rapid growth,
- 3,832 leases
- Development to south

Social License Issues
- Regionally Internationally
- Need for evidence-based management



SIMA-Austral:

Integrated Management System for Aquaculture

Products and Services

Strategic Planning
Regional plans
Industry spatial planning
Territorial planning
Marine parks &

Production of Reports
Production and Mortalities
Compliance and Evaluation

Incident Response
Oil spills
Harmful algal blooms
Storm losses

Forecasts
Disease Outbreaks
Floods / Storms
Climate Change

Integration and Data Access

Ingestion | Rules | Services | Visualization

Components

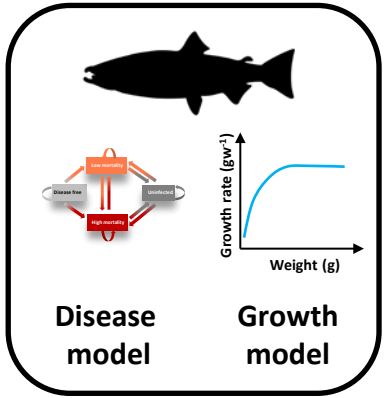
Data Processing

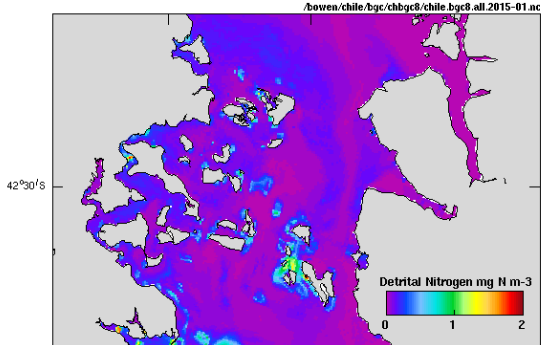
Data services | Analysis of data | Computing

Models

Biophysical model | Risk models | Bioeconomic models | Connectivity models | Epidemiological models

SALMON





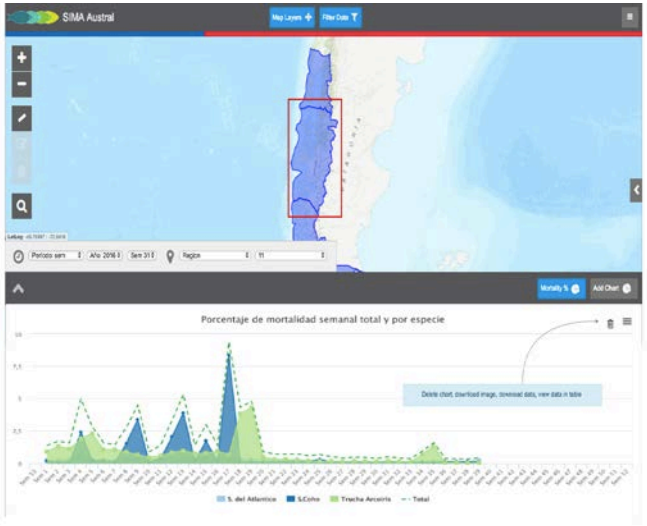
SIMA-Austral:
Reporting Products

Daily alerts

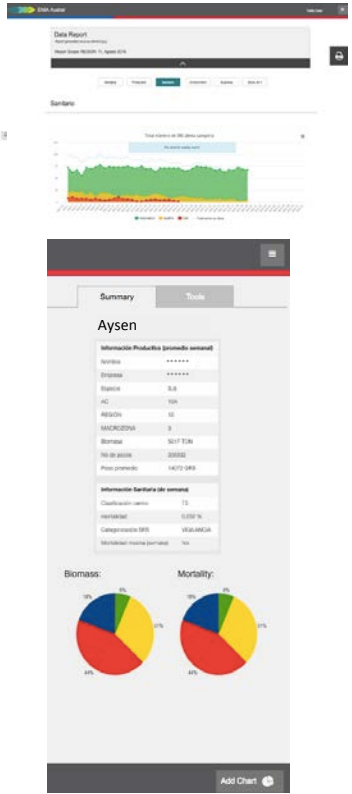
VIGILANCIA	70	83.3%
ALERTA	11	13.1%
CAD	3	3.6%
TOTAL	84	100%

Example: SRS - Aysen

Monthly Reports



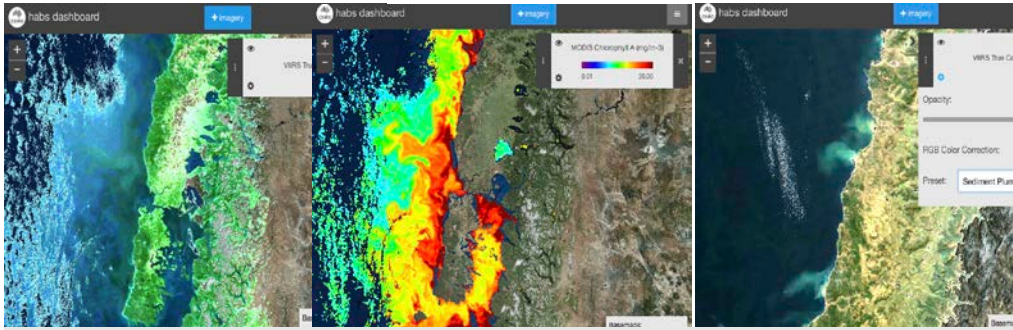
Example: Mortalities - Aysen



SIMA-Austral:
Assessment and Forecasting

Disease Risk analysis- Caligus Sea Lice

Harmful Algal Bloom Monitoring



Data Layers

these layers represent data that may be interrogated

+ Normalised Fluorescence Line Height
+ Sea Surface Temperature
+ Ocean Color Index (Chl-a) Algorithm
+ Chl-a warning
+ Total Absorption Coefficient
+ Combined Detrital/Gelbstoff Absorption Coefficient
+ Total Backscattering Coefficient

Tile Layers

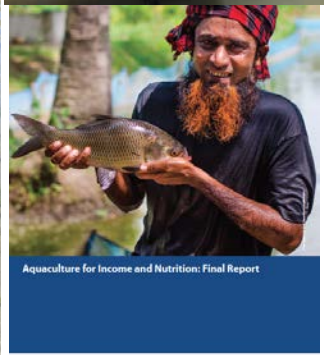
these layers provide imagery for visual reference

+ Enhanced RGB
+ MODIS True Colour
+ VIIRS True Colour
+ GHR SST
+ MODIS Chlorophyll A

+ Sentinel-3A OLCI Level-2 (geophysical) products.

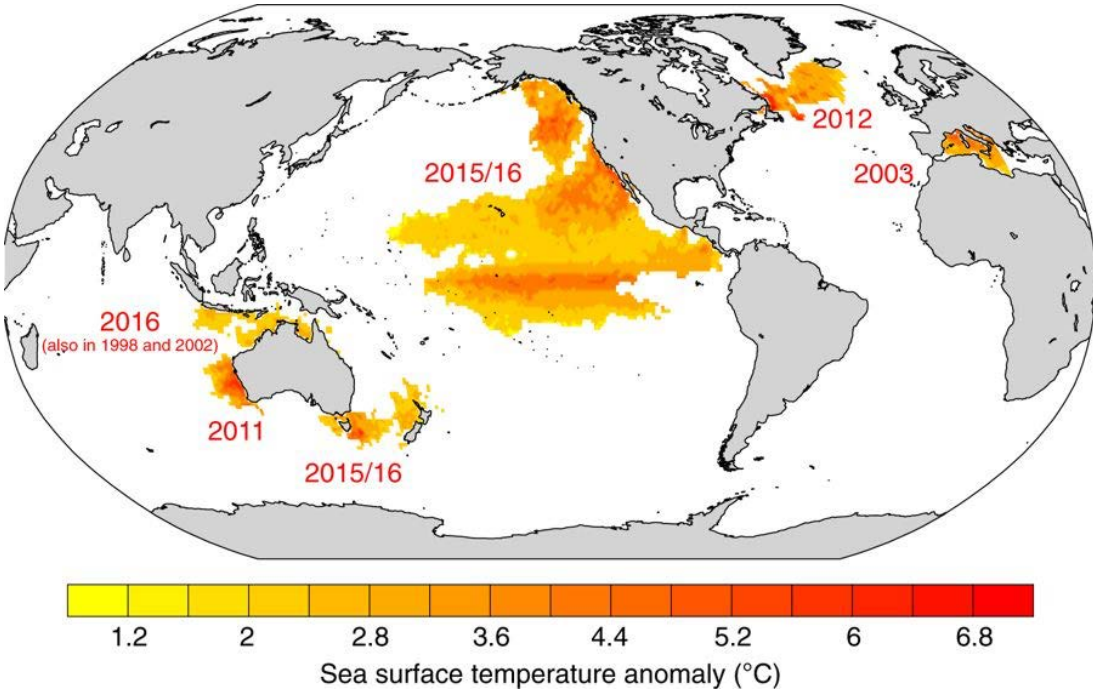
EO for Artisanal Aquaculture (1)

- One of the most environmentally benign types of aquaculture
- Promoted in developing countries where communities have reduced access to alternative livelihoods
- Algae / cucumber
- However: Only ~ 20% of Value chain is local
- Key questions from growers is quality and
- continuity of seaweed
- Options relate to adaption rather than mitigation
- Delivery of EO patchy
- Products and Delivery Mechanisms must be considered

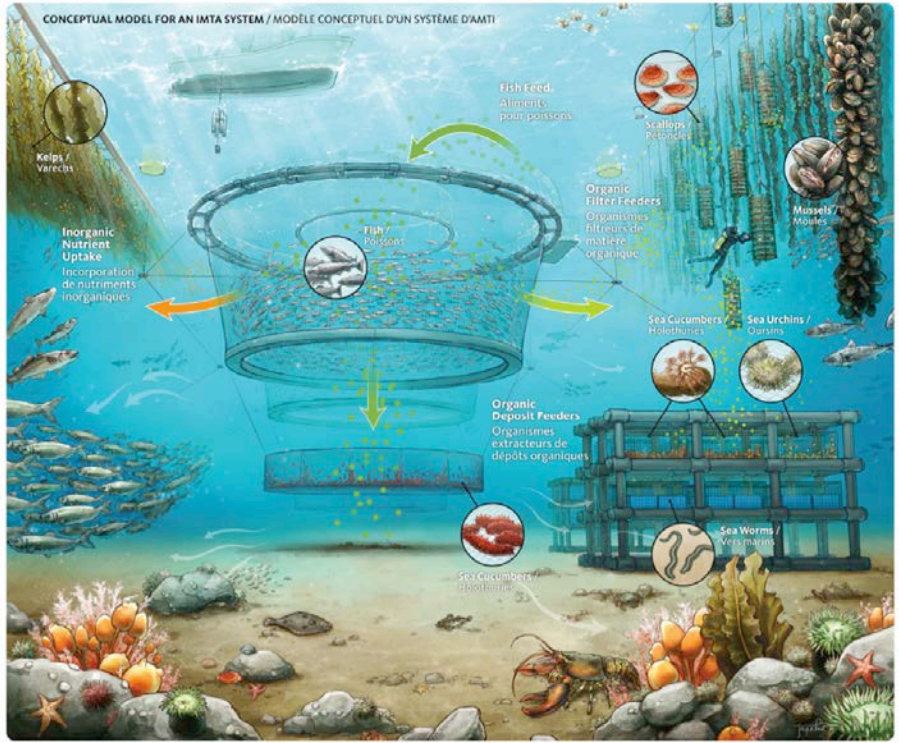


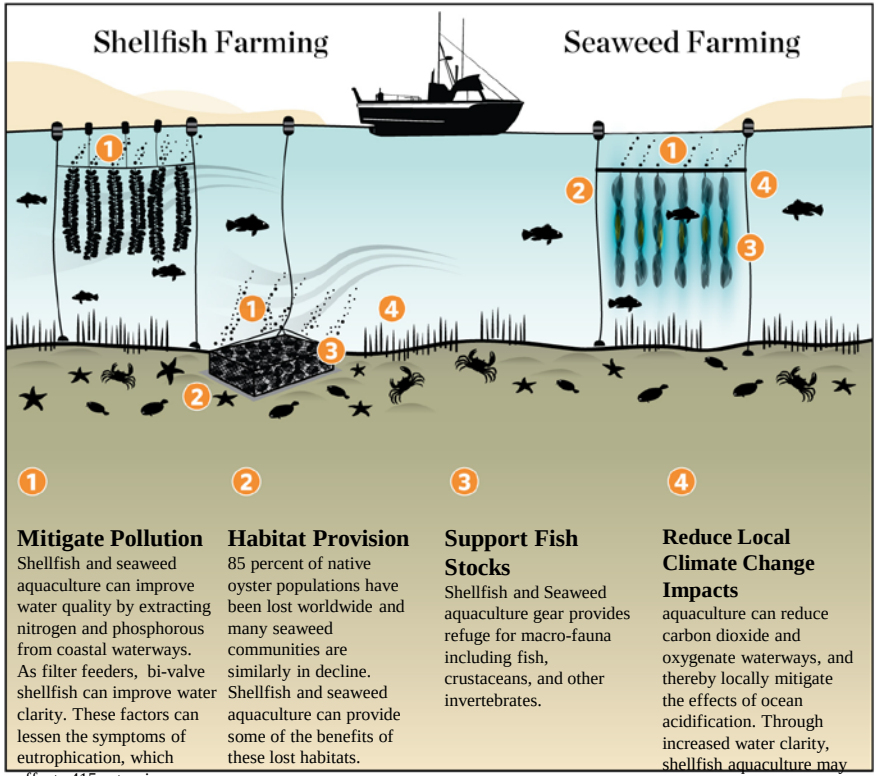
EO for Artisanal Aquaculture (2)

- Significant and widespread loss of Seaweed across Indo-Pacific from 2015
- Most probably related to marine heatwave
- Disease outbreaks – associated with loss of resilience form elevated Temperatures
- Loss of livelihoods
- Adaption-deeper sites-

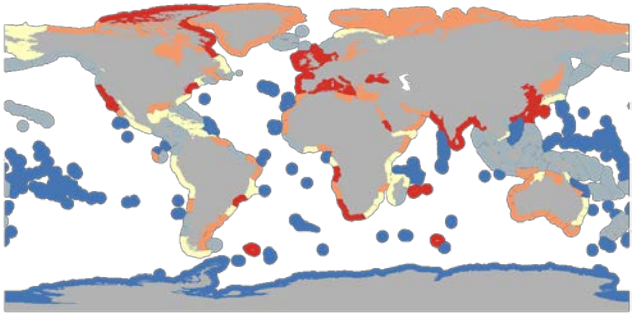


Future Trends- Integrated Mixed Trophic Aquaculture

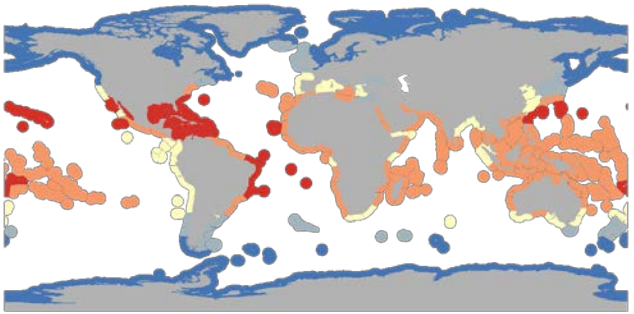




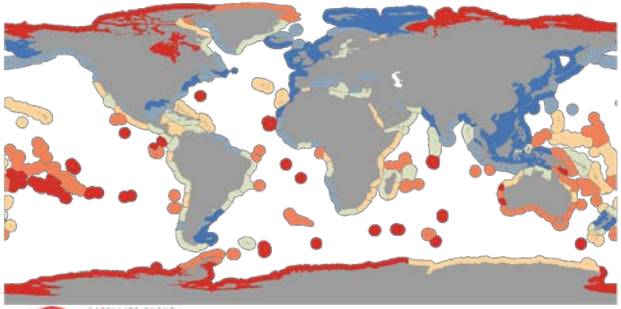
Potential of Restorative Aquaculture

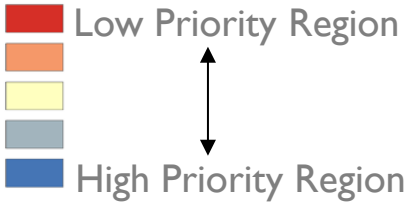


mitigate eutrophication



mitigate ocean acidification



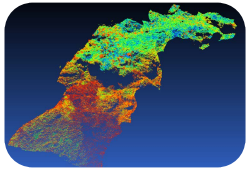


Source: Nature Conservancy

Future Trends- Biosensng

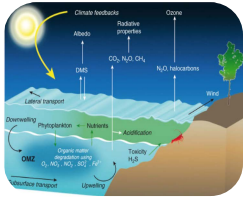
Optical Imaging, Mapping, Habitat Surveying





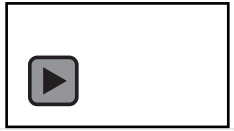
Monitoring & Modelling Animal Physiology



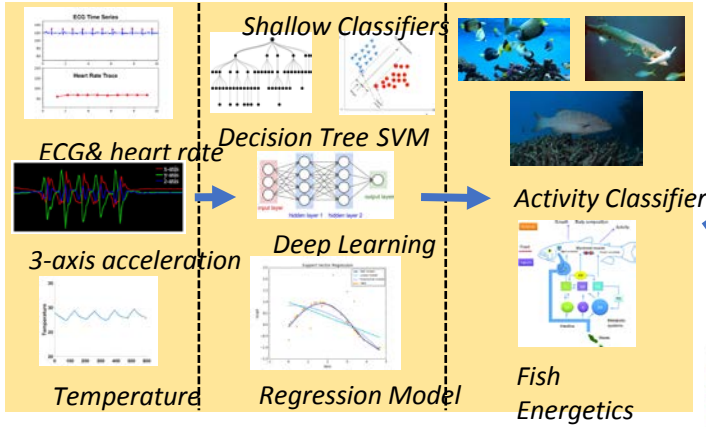


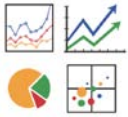
eDNA for Species Detection





Coral Trout with implanted biosensor





I. Raw physiology data collection, time-series signal processing, filters

II. Machine learning classifiers for behaviour, feeding, data quality

III. Spatio-temporal data summarization, trending, anomaly detection

Parting Thoughts

Artisanal Farmers

- Define user needs and develop **relevant, accessible** products
- Promote/ Collaborate for Regional information systems/portals

Industry

- develop and validate regional-scale forecasting capability for HABS and Disease detection

Regulators

- Increase awareness of /standards for of EO potential for informing siting of coastal and offshore facilities and environmental reporting

EO to support Pacific Ocean Island States

2-3 October 2018 : Brisbane, Australia

- Define a plan of action for coordinated ongoing EO support and capacity building in the Pacific Ocean island states