

4TH GEO

BLUE PLANET SYMPOSIUM

4-6 July 2018 – Toulouse, France

Oceans and
Atmosphere



Ocean Information for Aquaculture: Status & Perspectives

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Research Director - Coasts

1



#GEOBluePlanet4

What do You think of as Aquaculture?



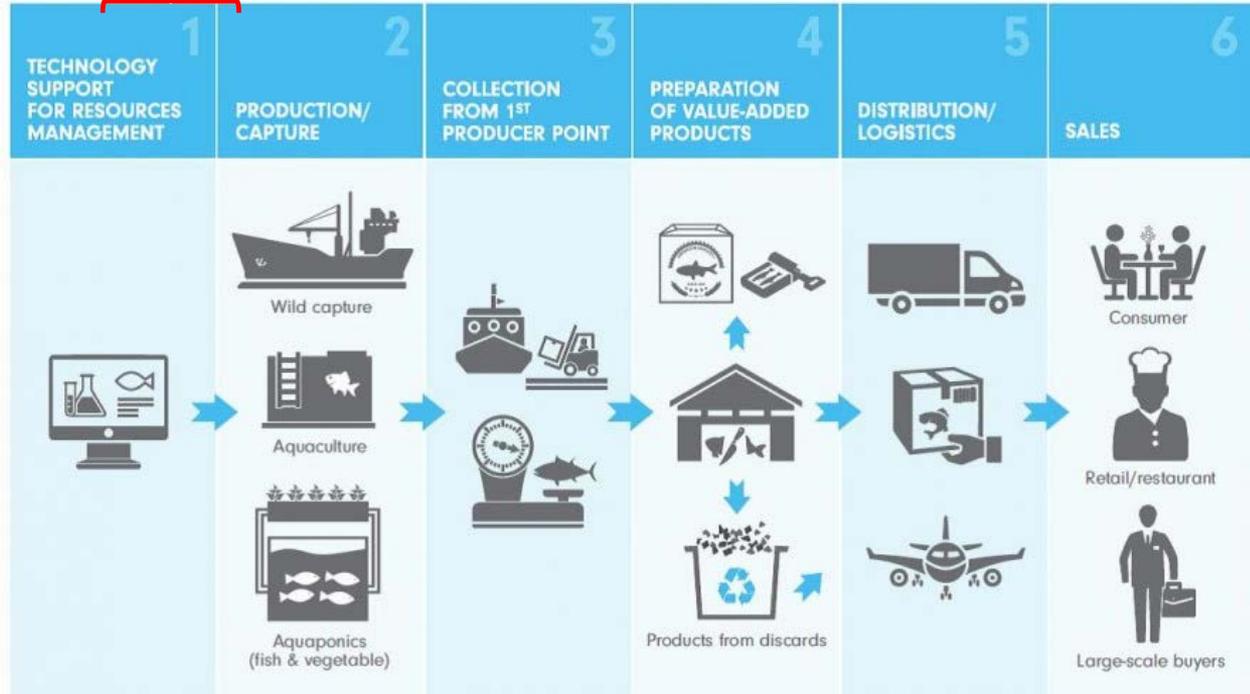
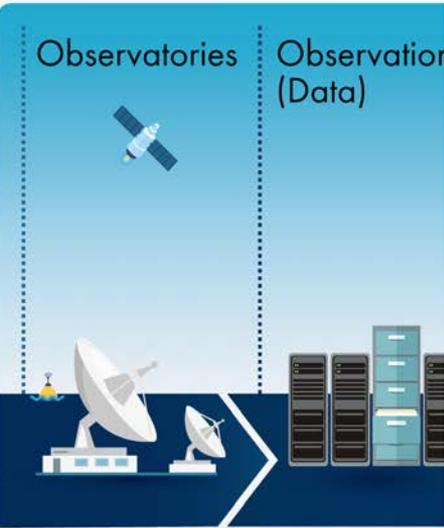
Whose Value Chain?

EO Data, Products, Services SEAFOOD SUPPLY CHAIN SUMMARY

EARTH AI

Observatories

Observation
(Data)



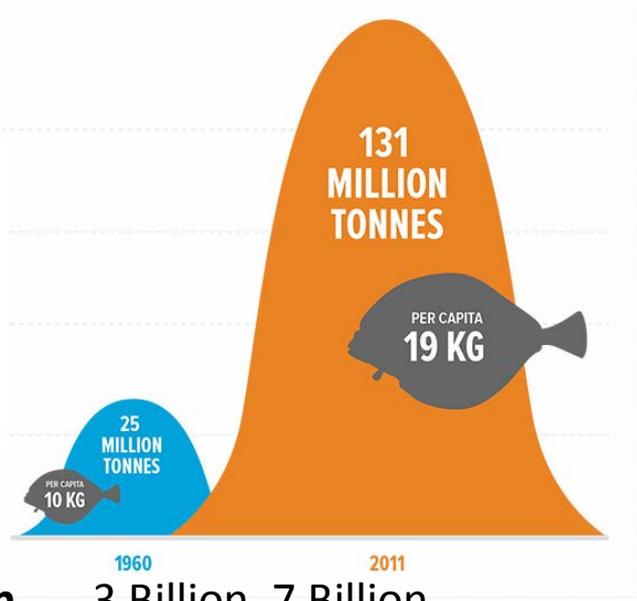
Aquaculture Growth

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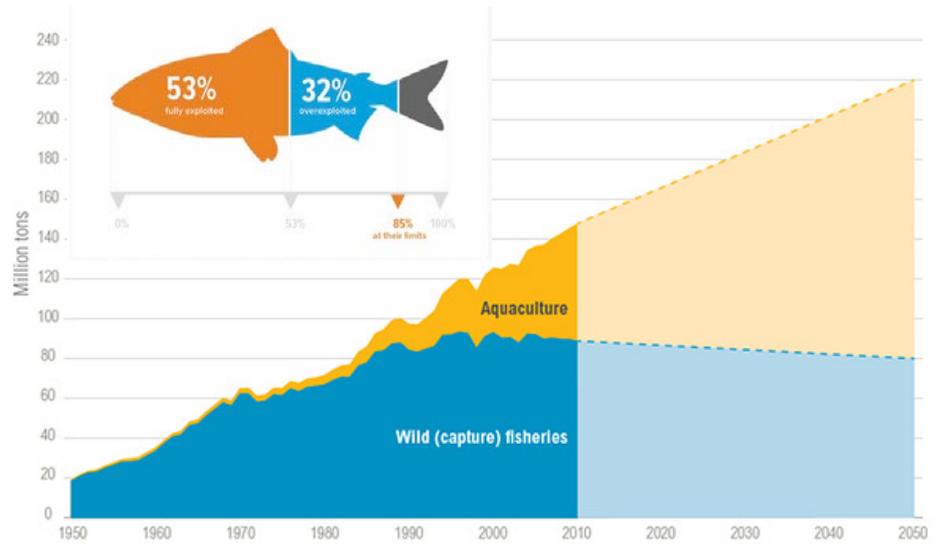
FISH TO 2050
Prospects for Fisheries and Aquaculture

Food and Agriculture Organization of the United Nations

WORLD AQUACULTURE 2010: A BRIEF OVERVIEW

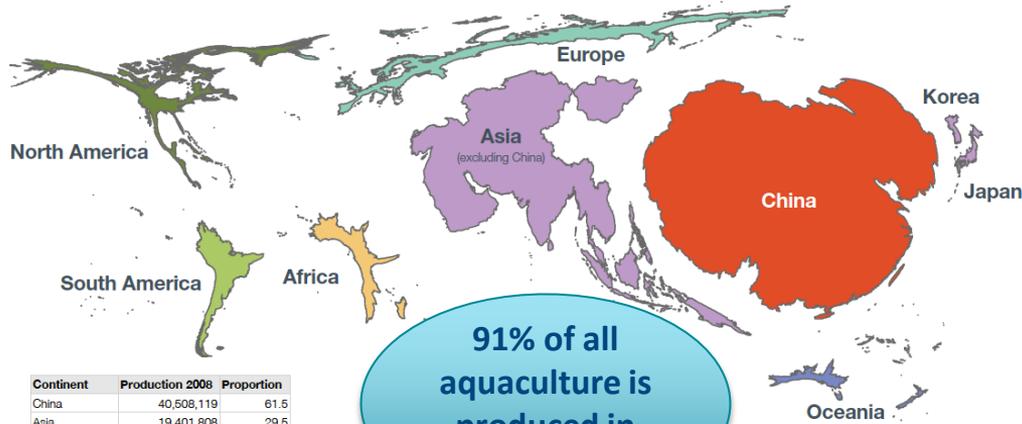


Aquaculture Is Expanding to Meet World Fish Demand



Source: Historical data 1950–2010: FAO. 2014. "FishStatJ." Rome: FAO. Projections 2011–2050: Calculated at WRI, assumes 10 percent reduction in wild fish catch between 2010 and 2050, and linear growth of aquaculture production at an additional 2 million tons per year between 2010 and 2050. See www.wri.org/publication/improving-aquaculture for full paper.

Aquaculture Distribution

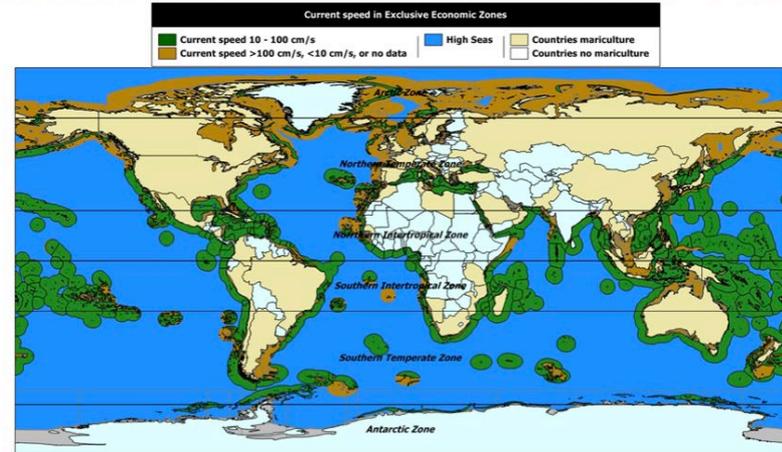


91% of all aquaculture is produced in Asia

Continent	Production 2008	Proportion
China	40,508,119	61.6
Asia (excluding China)	19,401,808	29.6
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	176,191	0.3

Offshore aquaculture

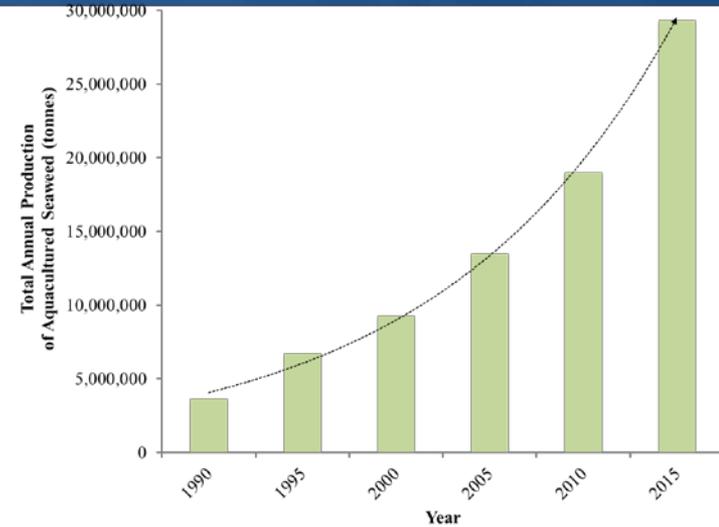
Current speeds: 0.1-1 m s⁻¹, suitable depth range for cages and longlines
 123 countries with at least 100 km² that meet these criteria: 10⁶ - 10⁷ ton y⁻¹



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

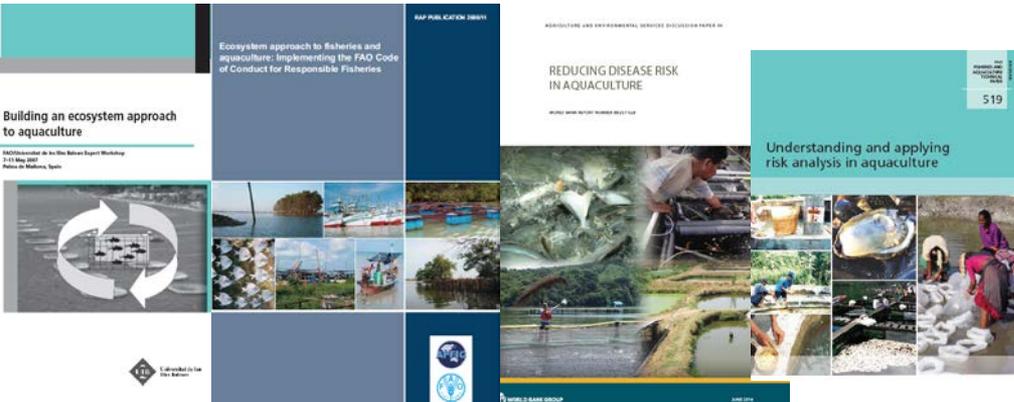
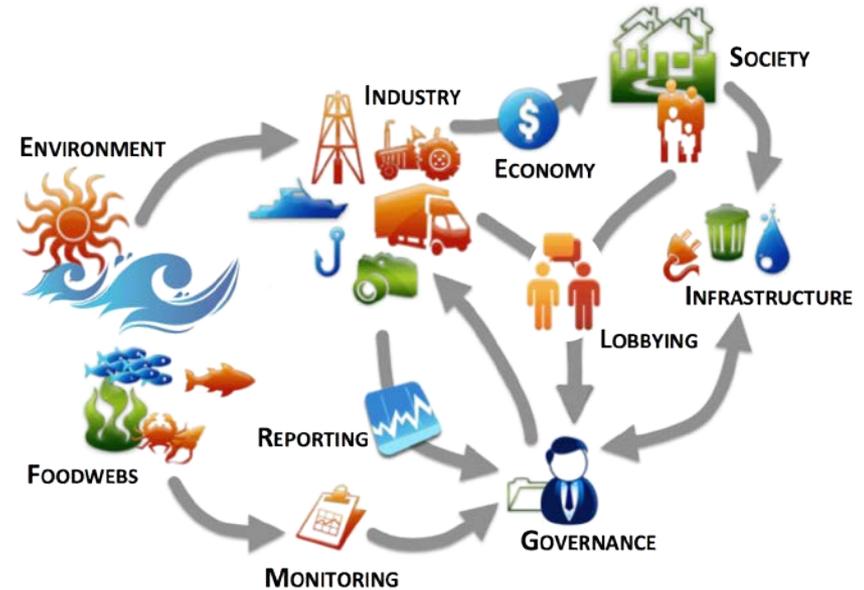
Seaweed Farming

- 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



Food and Agriculture
Organization of the
United Nations

SUSTAINABLE
DEVELOPMENT
GOALS

FAA/C1141 (En)

FAO
Fisheries and
Aquaculture Circular
and process

THE 2030 AGENDA AND THE SUSTAINABLE DEVELOPMENT GOALS:
THE CHALLENGE FOR AQUACULTURE DEVELOPMENT AND
MANAGEMENT

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

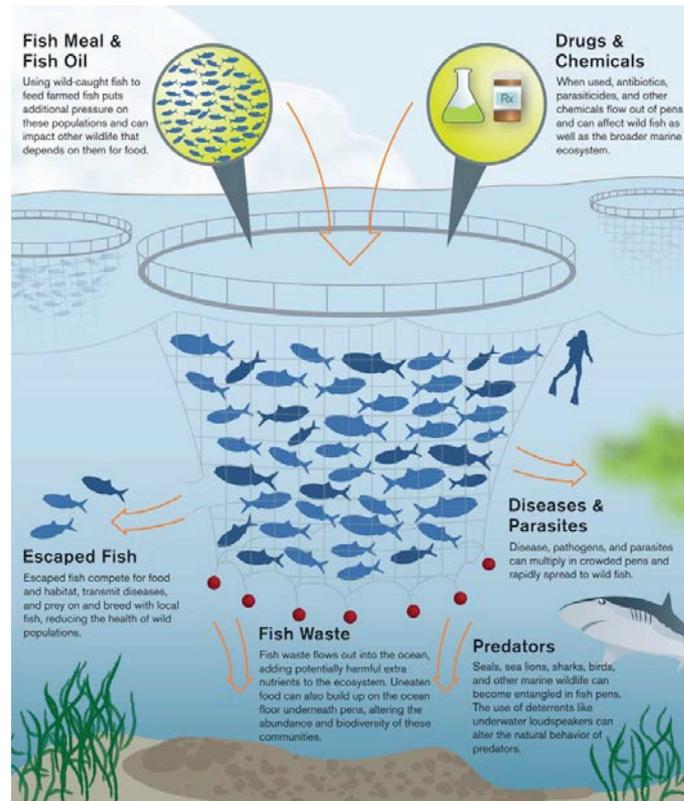
EO Applications to Aquaculture (1)

Environmental Compliance Assessment and Reporting *Industry and Regulator*

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

Operational Production monitoring *Industry*

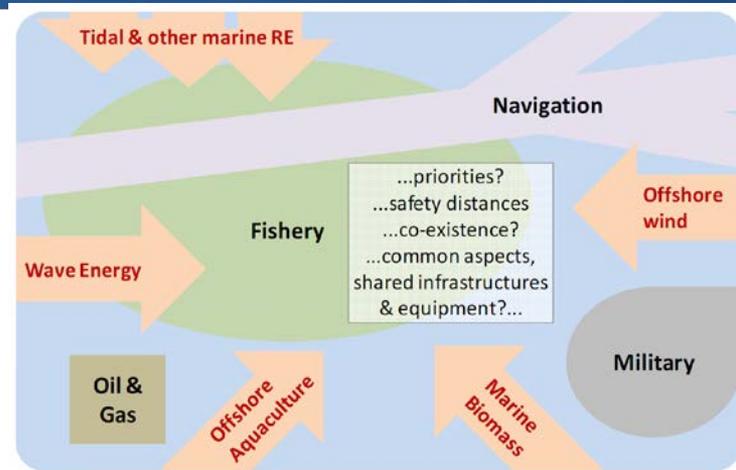
- Fish stocking numbers and feed rates
- Escapes and predation
- Disease Outbreak and spread
- Potential Impacts of Environmental conditions and events (e.g. HABs)



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



BLUEFARM

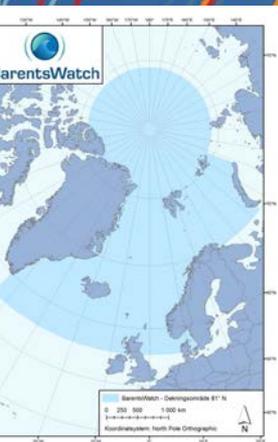
CAPES
NCCOS

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

BarentsWatch - a Regional Information System

<https://www.barentswatch.no>

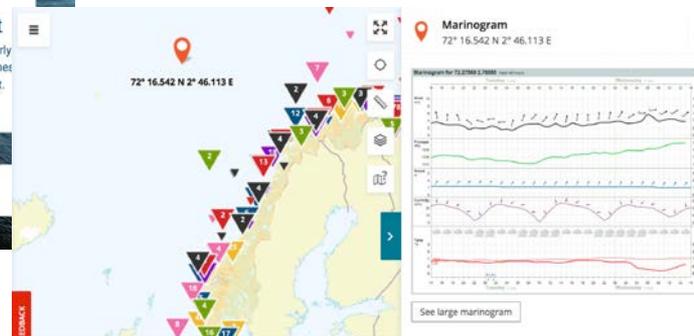
Collect, develop, share information about Norwegian coastal & marine areas



The screenshot shows the BarentsWatch website homepage. At the top, there is a dark blue header with the BarentsWatch logo and the text 'Norsk | Login'. Below the header, there are navigation links for 'SERVICES', 'ARTICLES', 'ABOUT US', and 'MY PAGE'. The main content area features three large cards: 'Fishhealth' (Weekly overview including diseases and sures down at y level), 'FishInfo' (See fishing relevant map information from Norwegian authorities and download files for use in chartplotter), and 'Wave forecast' (Wave forecast for particularly vulnerable areas and stretches along the Norwegian coast). Below these cards, there is a 'Show more services' button.



The screenshot shows a section of the BarentsWatch website titled 'WEEK 27' with the dates '2. Jul - 8. Jul 2018'. It contains two main sections: 'ABOVE LICE LIMIT' and 'BELOW CURRENT LICE LIMIT'. The 'ABOVE LICE LIMIT' section shows '0' and '0 % of the aquaculture sites which have reported lice'. The 'BELOW CURRENT LICE LIMIT' section shows '0' and '0 % of the aquaculture sites which have reported lice'. Below these sections, there are two statistics: 'PD 142' (142 of the aquaculture sites have pancreatic disease (PD) or are suspected of having PD) and 'ISA 6' (6 of the aquaculture sites have infectious salmon anemia (ISA) or are suspected of having ISA). At the bottom, there is a section titled 'Amount of aquaculture sites above lice limit' with a value of '34'.



! 24 Oct 2017: Fishery regulations/j-meldinger - Closed areas is now available
The maps are meant as an aide to the users. BarentsWatch is not responsible for errors and omissions/fraskriver. The written regulations issued by the Directorate of Fisheries are still binding.

Salmon farming in Chile

High value

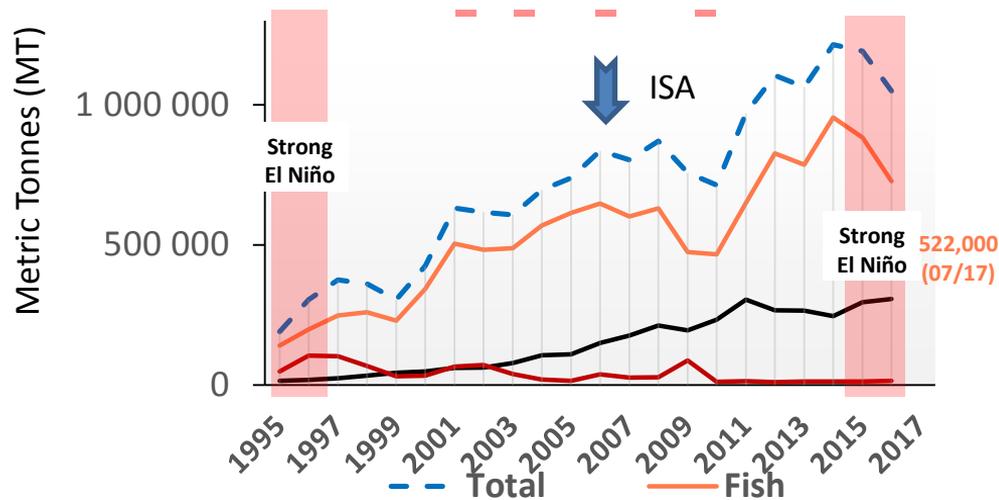
- US\$ 3.8b, up to
- 40% regional labor force

Rapid growth,

- 3,832 leases
- Development to south

Social License Issues

- Regionally Internationally
- Need for evidence-based management



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home > environment > climate change wildlife energy pollution

Fishing Chile's salmon farms lose \$800m as algal bloom kills millions of fish

SIMA-Austral:

Integrated Management System for Aquaculture

Products and Services

Strategic Planning

Regional plans
Industry spatial planning
Territorial planning
Marine parks & reserves

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

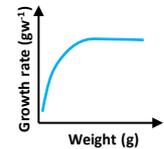
Risk models

Bioeconomic models

Connectivity models

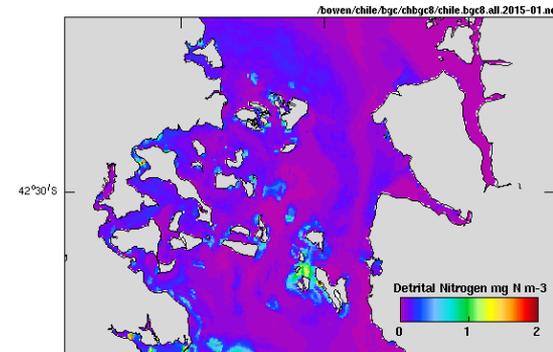
Epidemiological models

SALMON



Disease model

Growth model



SIMA-Austral: Reporting Products

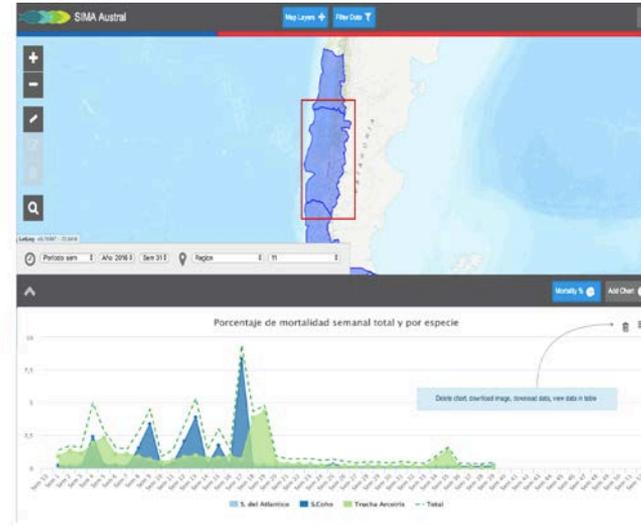
Daily alerts

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

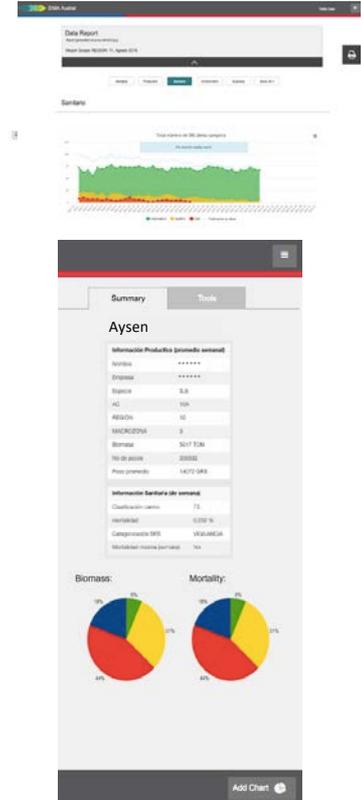


Example: SRS - Aysen

Monthly Reports



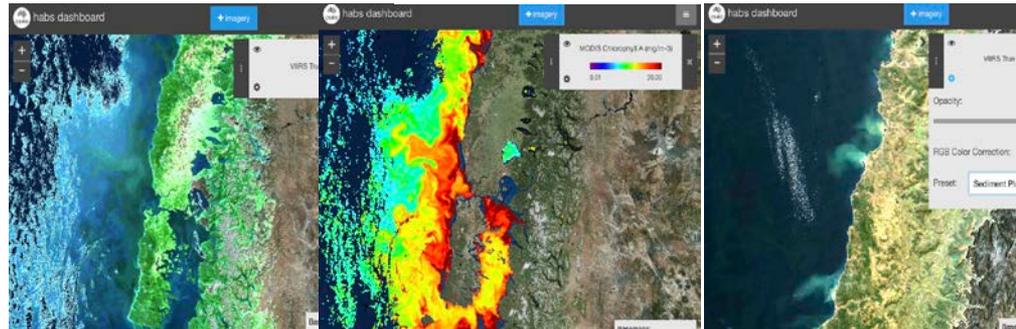
Example: Mortalities - Aysen



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

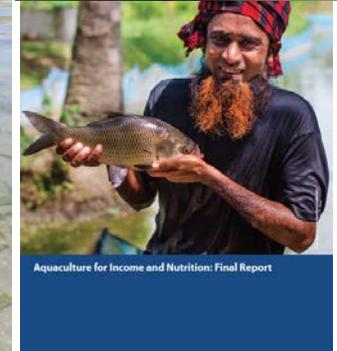
these layers provide imagery for visual reference

- + Enhanced RGB
- + MODIS True Colour
- + VIIRS True Colour
- + GHR SST
- + MODIS Chlorophyll A
- + Sentinel-3A OLCI Level-2 (geophysical) products.



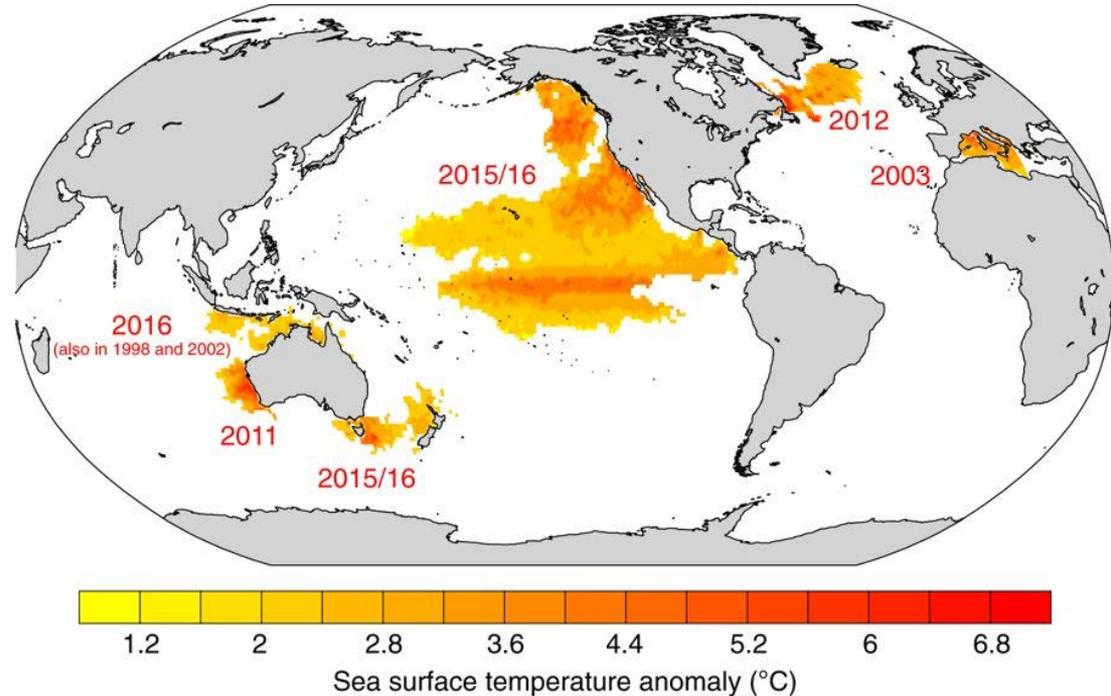
EO for Artisanal Aquaculture (1)

- 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

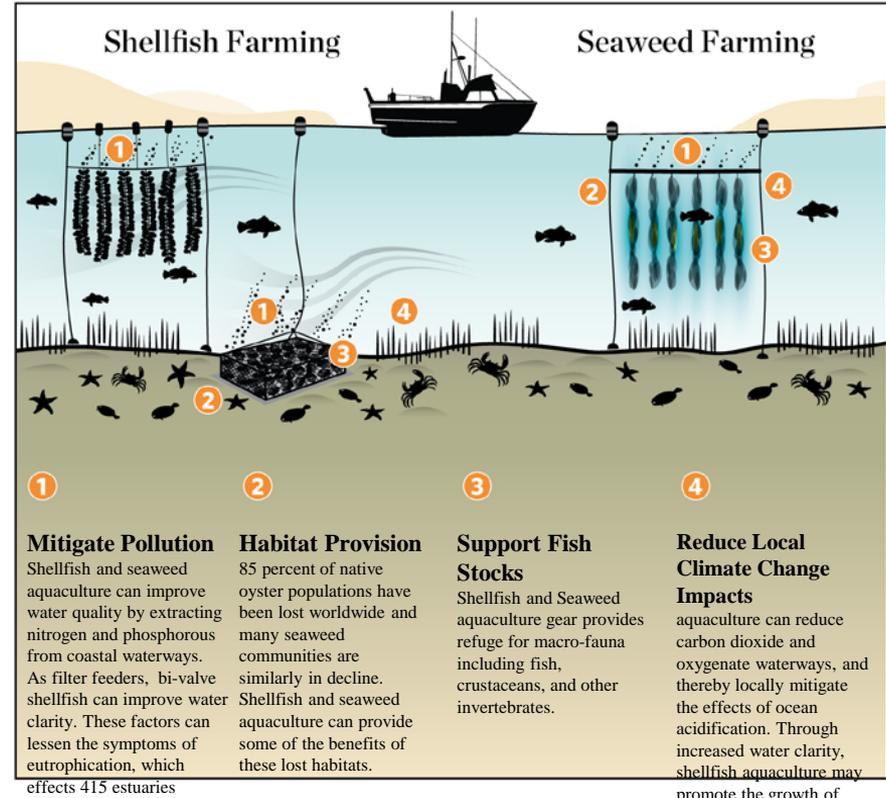
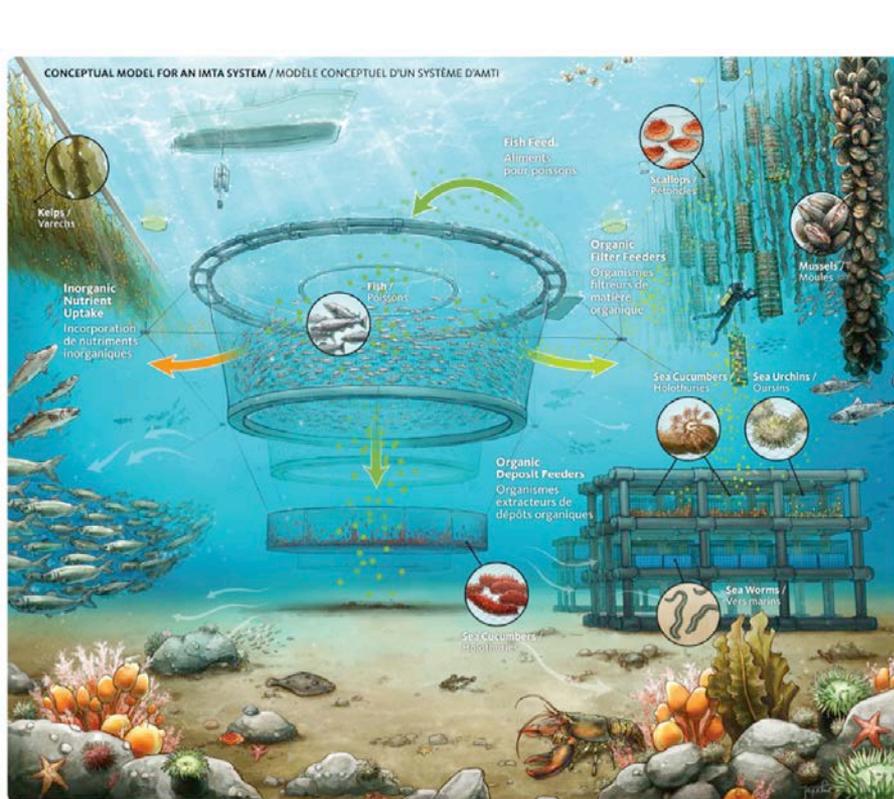


EO for Artisanal Aquaculture (2)

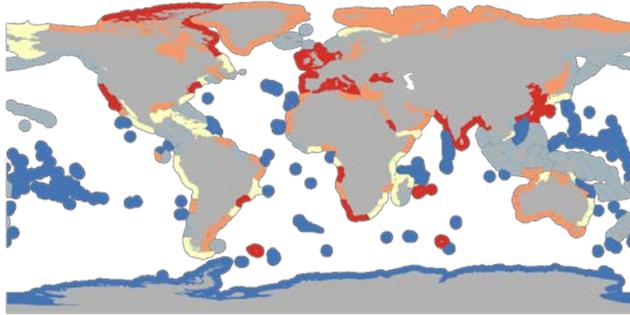
- Significant and widespread loss of Seaweed across Indo-Pacific from 2015
- Most probably related to marine heatwave
- Disease outbreaks – associated with loss of resilience from elevated Temperatures
- Loss of livelihoods
- Adaption-deeper sites-



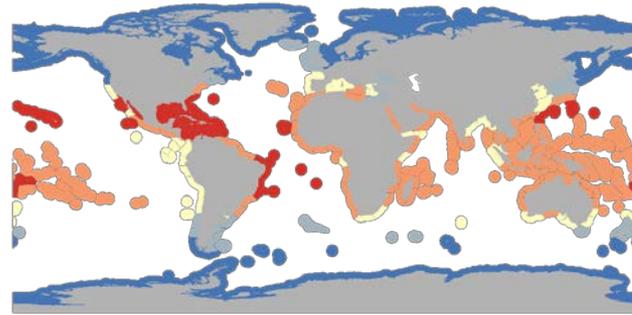
Future Trends- Integrated Mixed Trophic Aquaculture



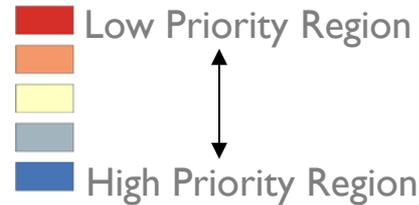
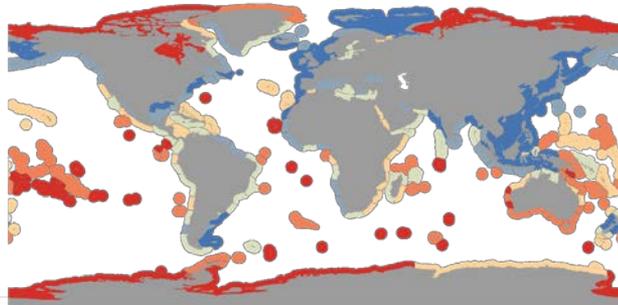
Potential of Restorative Aquaculture



mitigate eutrophication



mitigate ocean acidification



Future Trends- Biosensing

Optical Imaging, Mapping, Habitat Surveying

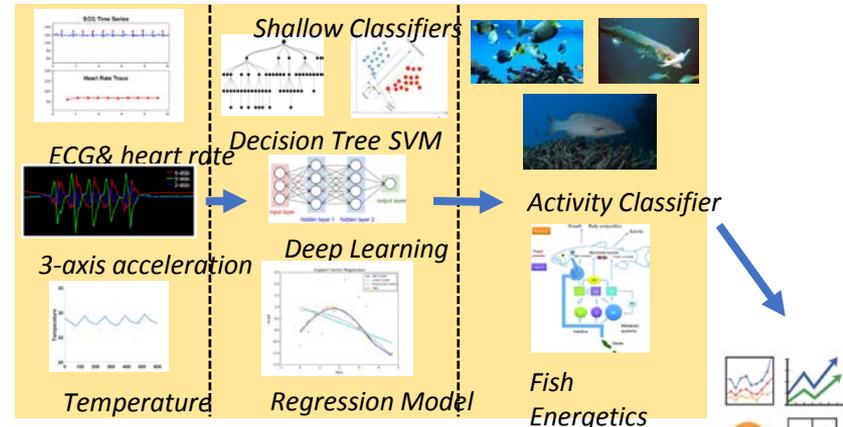


Coral Trout with implanted biosensor

Monitoring & Modelling Animal Physiology



eDNA for Species Detection



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

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

III. Spatial-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