Aquaculture 101 for Coral Reef Managers

Presenters:

Robert Jones
Global Aquaculture Strategy Lead
The Nature Conservancy

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University of Miami

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Marine Spatial Scientist
The Nature Conservancy

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Micronesia Program Director
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Hosts: Cherie Wagner, Reef Resilience Network
Tiffany Waters, The Nature Conservancy

The Nature Conservancy

Reef Resilience Network

Questions:

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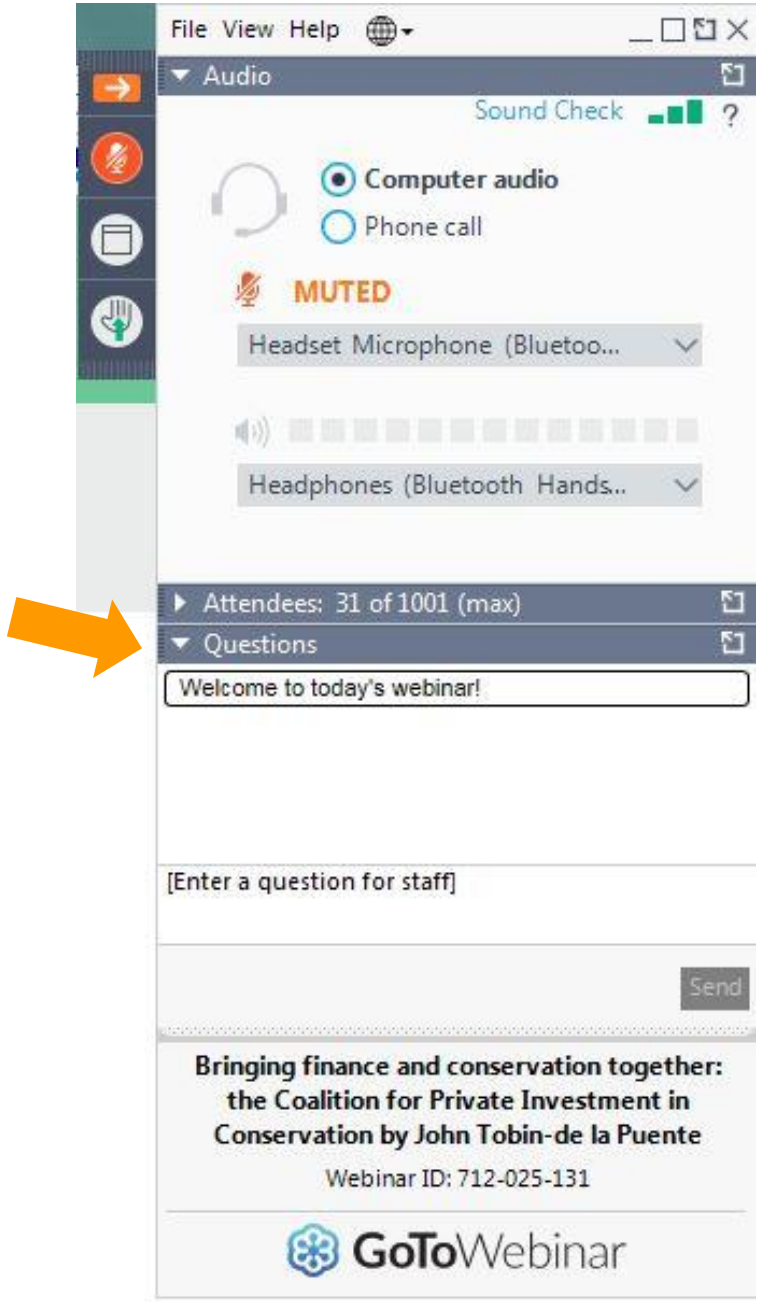

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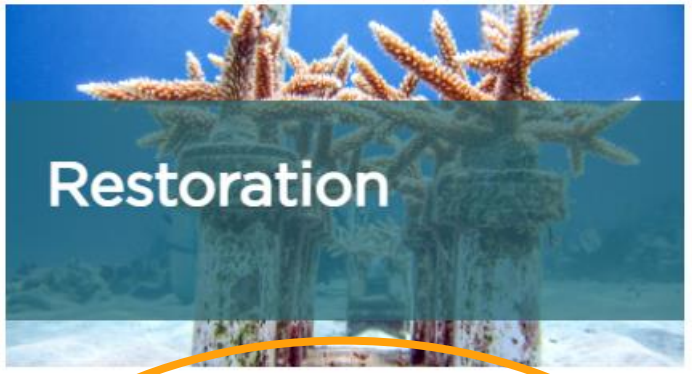

English

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Aquaculture

Management Strategies

- Threat Reduction
- Marine Protected Areas
- Managing for Disturbance
- Restoration
- **Aquaculture**
  - Aquaculture Introduction
  - Environmental Impacts & Mitigation
  - Regulations to Support Sustainable Management
  - Community Planning

We face an unprecedented challenge ahead. How can we feed a growing world population in the face of decreasing wild fish stocks and increasing environmental impacts from our current food systems? Most importantly, how do we do so in a way that is environmentally sustainable and that benefits coastal communities?

Communities, governments, the private sector, and scientific institutions can and must protect our oceans, increase food security, and improve livelihood opportunities. Sustainable aquaculture and fisheries can be part of the solution to this global challenge, but we must fish and farm in the right ways.

This toolkit explains aquaculture concepts in the context of coastal environments and tropical reef ecosystems, with a special focus on finfish farming:

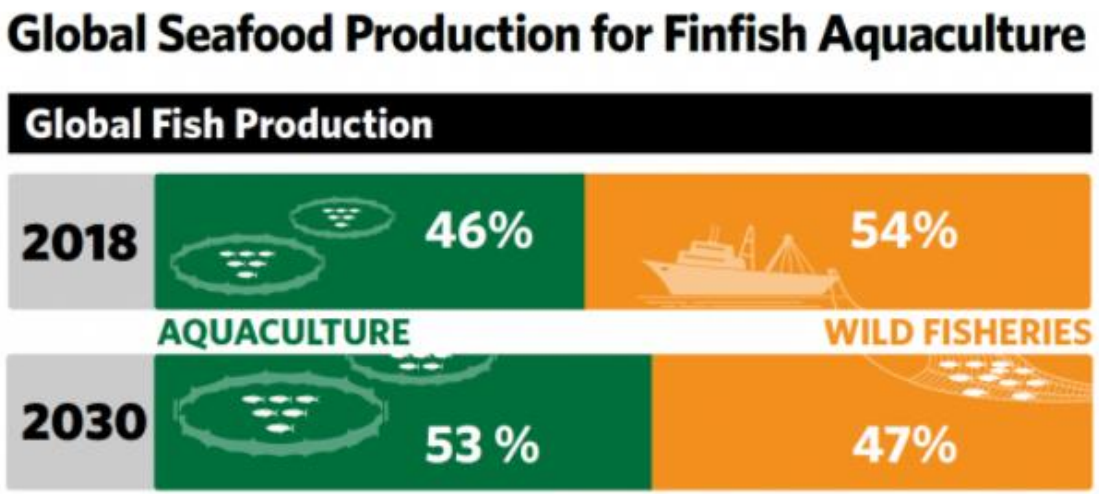
- What is aquaculture? – basic concepts of aquaculture and its importance for food security and livelihoods of coastal communities.
- Global status of finfish aquaculture – the global status of marine finfish

This toolkit is designed for marine managers and practitioners that are working in a reef system that contains nearshore fish aquaculture cages or are considering management decisions on whether or how to permit finfish

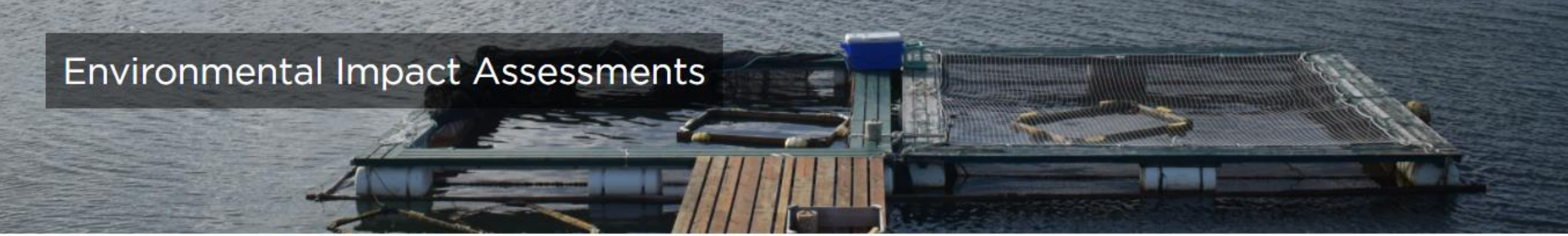
Aquaculture Status

Management Strategies

Global fish production (wild and farmed) is estimated to have reached 179 million tons in 2018, with a total value estimated at $401 billion. While aquaculture makes up less than half of total production at 82 million tons, it is valued at $250 billion, which is 62% of the total value. Aquaculture's total value per pound is higher than wild fisheries. In 2018, aquaculture production consisted of 82.1 million tons of aquatic animals, 32.4 million tons of aquatic algae, and 26 thousand tons of ornamental shells and pearls. The aquatic animals were dominated by finfish at a total of 54.3 million tons of which 47 million were from inland, and 7.3 million were from marine and coastal areas. [ref] Global seaweed production from finfish aquaculture is expected to continue to grow and outpace wild fisheries by 2030.

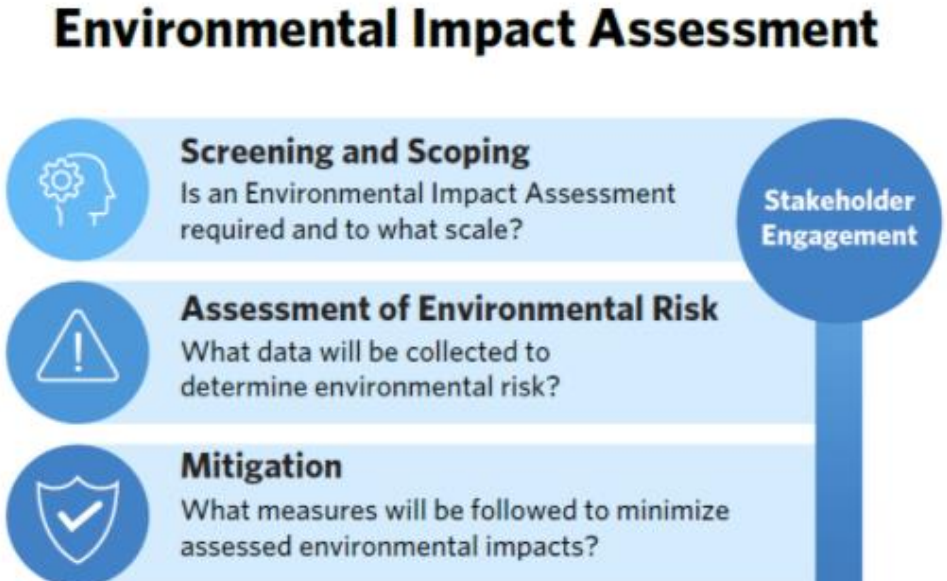


Source: FAO 2020



Environmental Impact Assessments

Many countries have environmental legislation that requires a review of the potential environmental impacts of a proposed operation before a government permit can be issued (e.g., the United States National Environmental Policy Act). Environmental impact assessments can be defined as "the process of evaluating and mitigating the biophysical, social and other relevant effects of development proposals prior to major decisions being taken or commitments made". [ref] Environmental impact assessments are most frequently applied, and are potentially most useful, in cases where a country may not have a well developed set of aquaculture legislation and regulations that clearly define or constrain which aquaculture operations and practices may be allowed.



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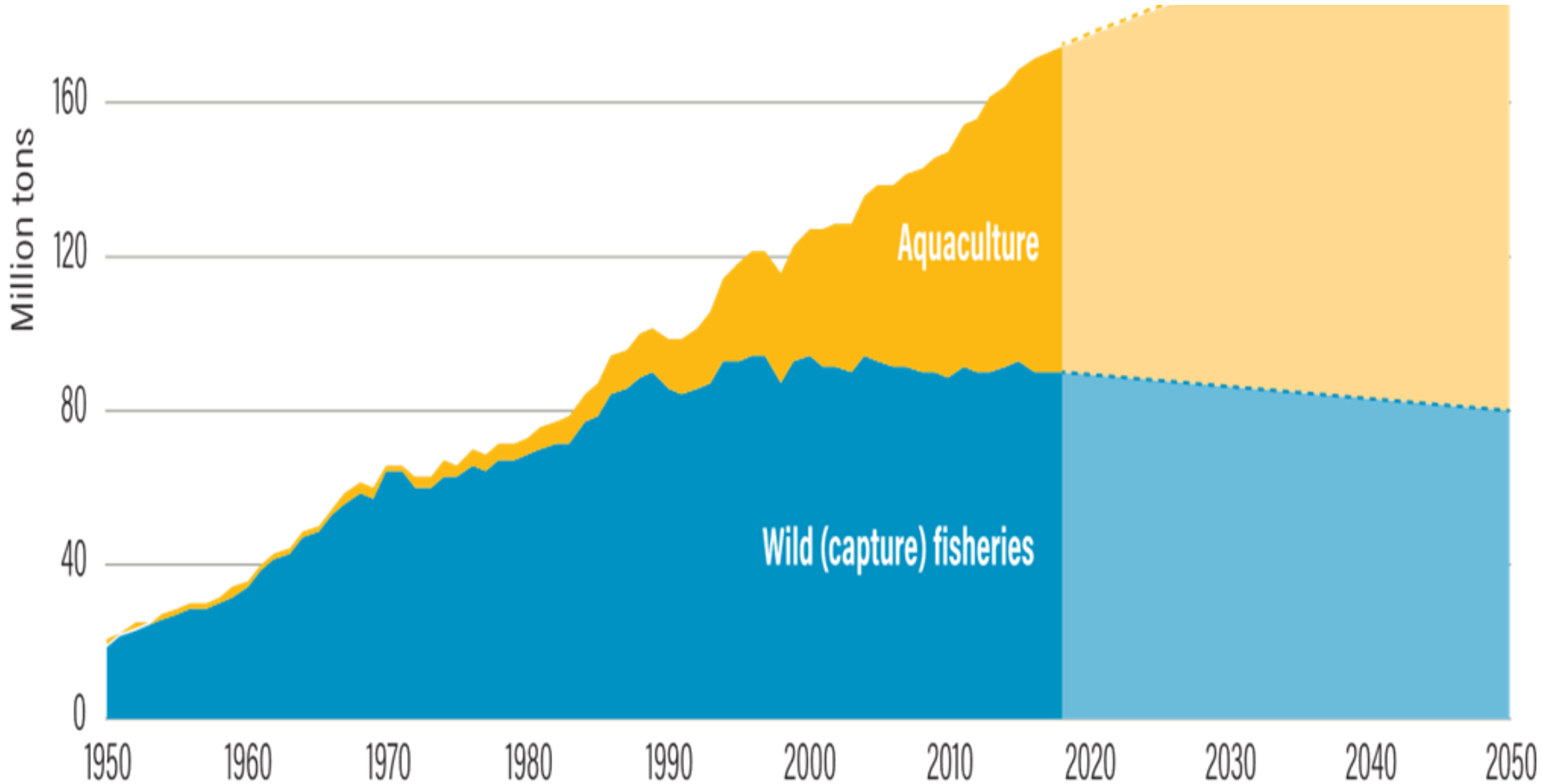
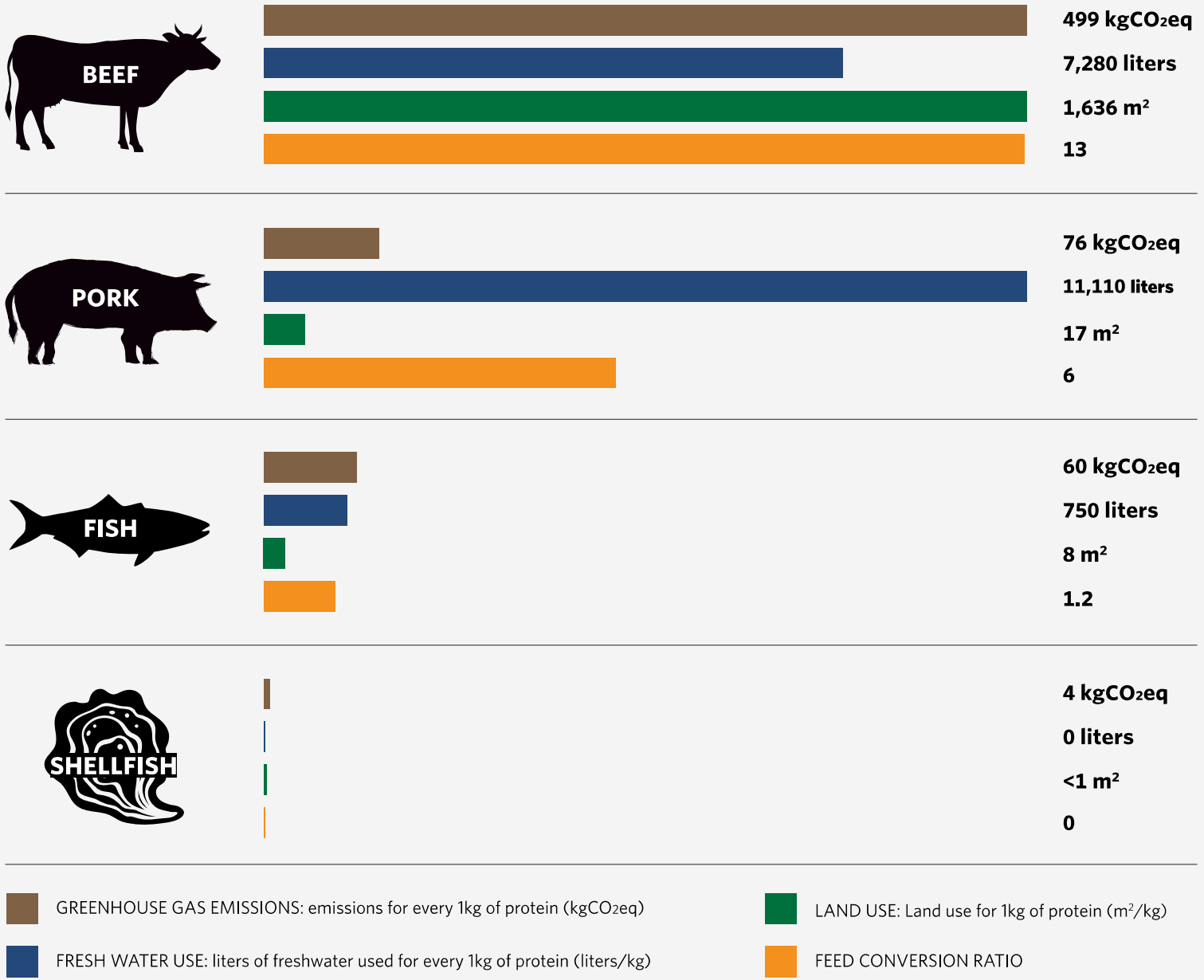
Finfish Aquaculture 101 for Coral Reef Managers

Robert Jones, Global Aquaculture, The Nature Conservancy


Million tons
160
120
80
40
0
Aquaculture
Wild (capture) fisheries
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050

Environmental Impact of Animal Protein Production



90% of fisheries are fully or overfished

Benefits of Seafood

PROTEIN
Provides a low-fat heart-healthy form of protein

LONG CHAIN OMEGA-3 FATS
Essential for optimal brain development and improving risk factors for heart diseases

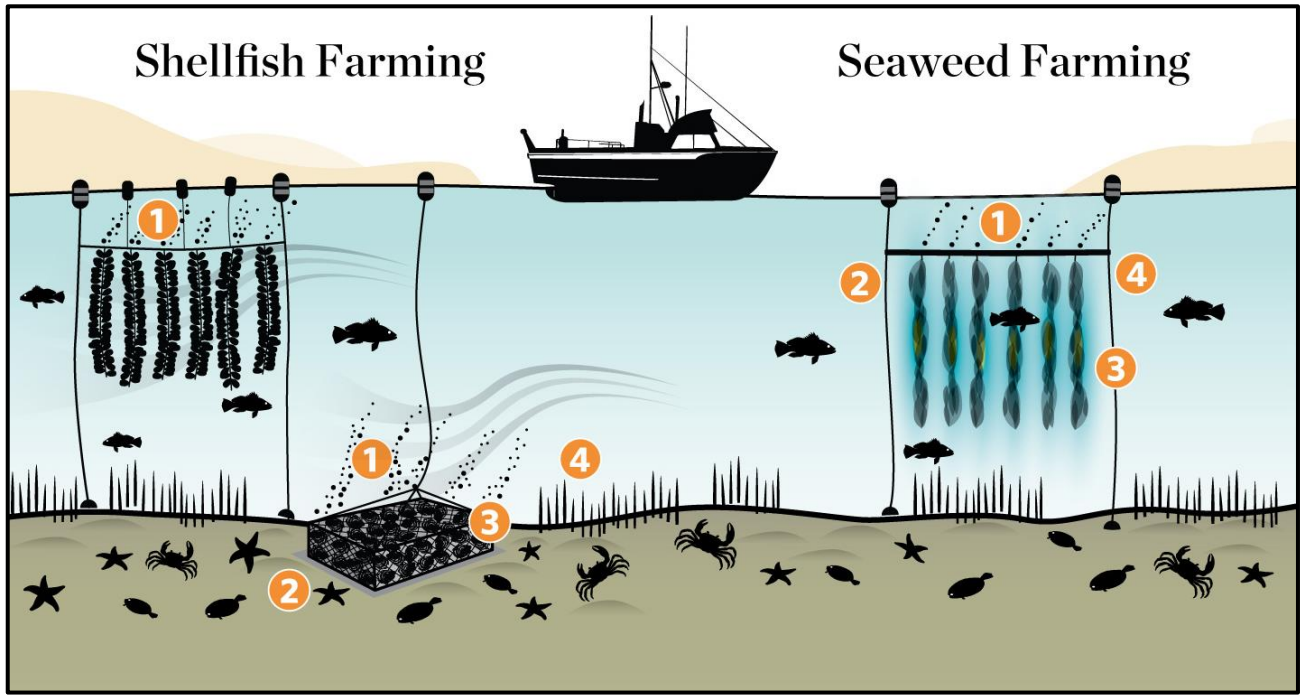
IODINE
Aids in thyroid function and health and neurodevelopment

VITAMIN D
Crucial in immune system regulation, mental development, and bone health

IRON
Vital during pregnancy to allow the mother to produce additional blood for the baby

CALCIUM, ZINC, OTHER MINERALS
Deficiencies in essential minerals can slow the development of children

Restorative Aquaculture



1. Mitigate Pollution

Shellfish and seaweed aquaculture can improve water quality by extracting nitrogen and phosphorous from coastal waterways. As filter feeders, bi-valve shellfish can improve water clarity. These factors can lessen the symptoms of eutrophication, which effects 415 estuaries worldwide

2. Habitat Provision

85 percent of native oyster populations have been lost worldwide and many seaweed communities are similarly in decline. Shellfish and seaweed aquaculture can provide some of the benefits of these lost habitats.

3. Support Fish Stocks

Shellfish and Seaweed aquaculture gear provides refuge for macro-fauna including fish, crustaceans, and other invertebrates.

4. Reduce Local Climate Change Impacts

Aquaculture can reduce carbon dioxide and oxygenate waterways, and thereby locally mitigate the effects of ocean acidification. Through increased water clarity, shellfish aquaculture may promote the growth of eelgrass beds, a carbon sink.

Hainan, China

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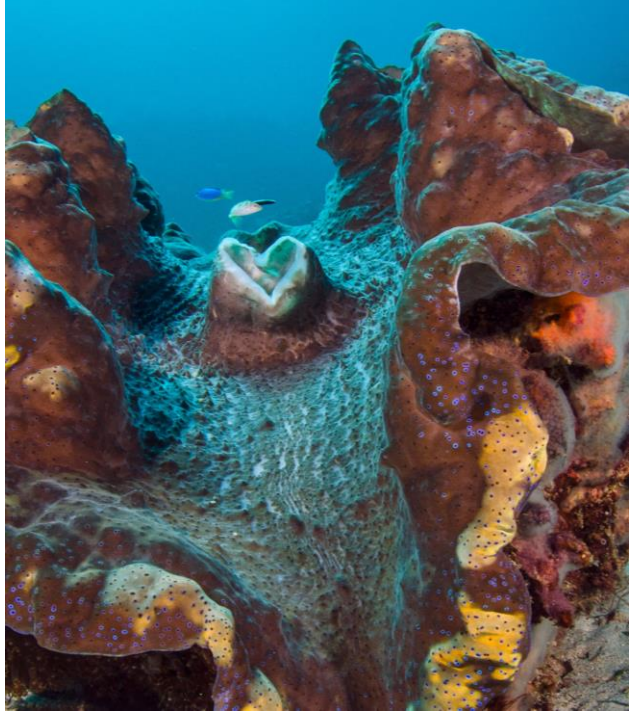
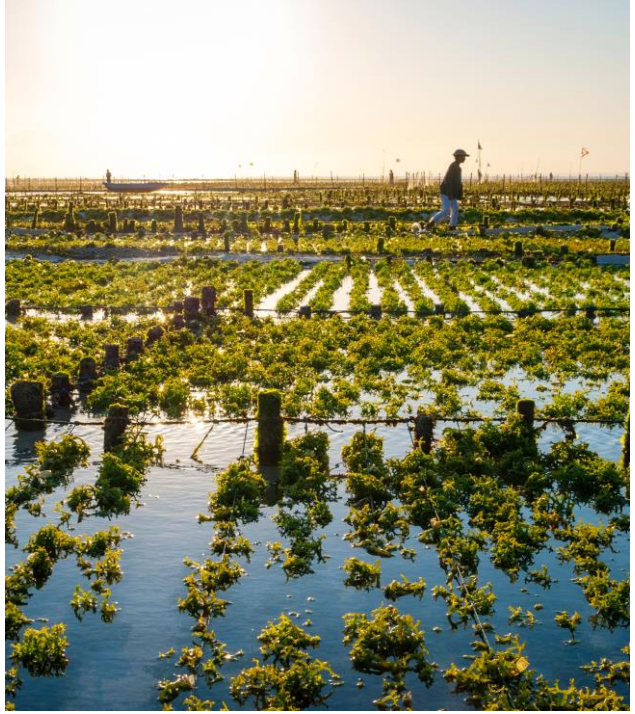
Environmental Impacts & Mitigation

Julio Camperio


Marine aquaculture:

Culture of marine organisms in a confined and controlled environment

Possible Impacts to be Mitigated

- Any source of protein production can have impacts on the environment
- Impacts can be minimized if proper planning, correct management, and appropriate mitigation strategies are carried out

Impacts to Wild Stocks

Habitat Impacts

Water Pollution

Disease

Impacts to Wild Stocks

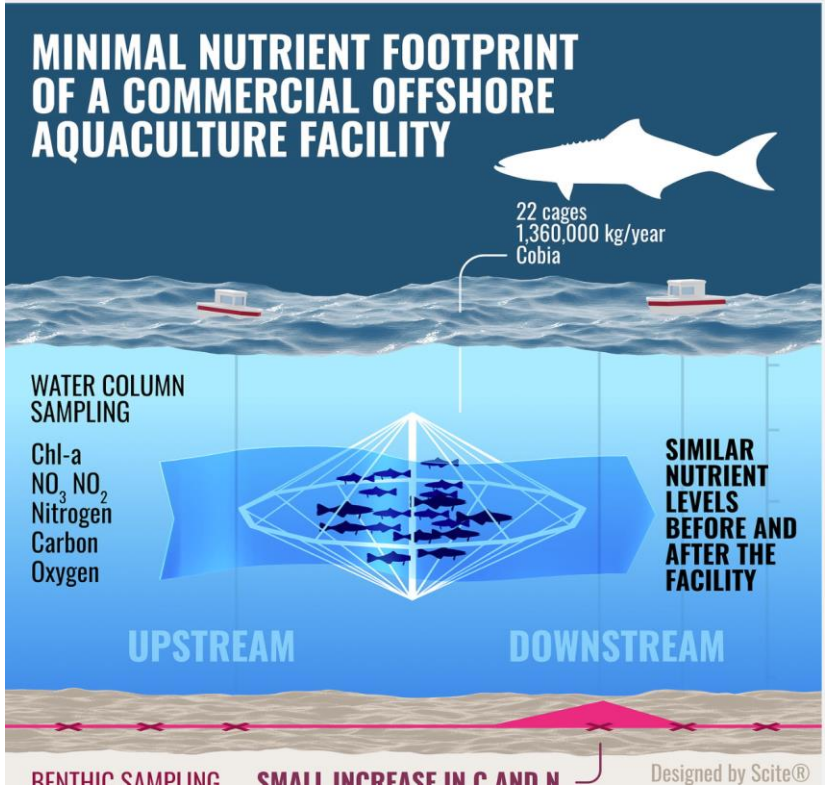
- Removal of wild species to use as fry
- Farmed fish escapes
- Entanglement of wild species
- Feed impacts

Impacts to Wild Stocks

IMPACT	MITIGATION STRATEGY
Removal of wild species to use as fry	Source fry from hatcheries If no hatchery is available, farm species not overfished
Farmed fish escapes	Engage in regular gear monitoring and maintenance Farm local species Be proactive in gear repairs
Entanglement of wild species	Site cages away from known areas frequented by protected species Carry out regular monitoring to detect nearby animals that might get entangled with gear
Feed impacts	Use commercial pellets rather than whole fish, fish trimmings, and/or animal slaughter waste Do not overfeed fish in cages

Impacts to Habitat

- Impacts to local sensitive habitats
- Gear loss
- Reduction of water quality

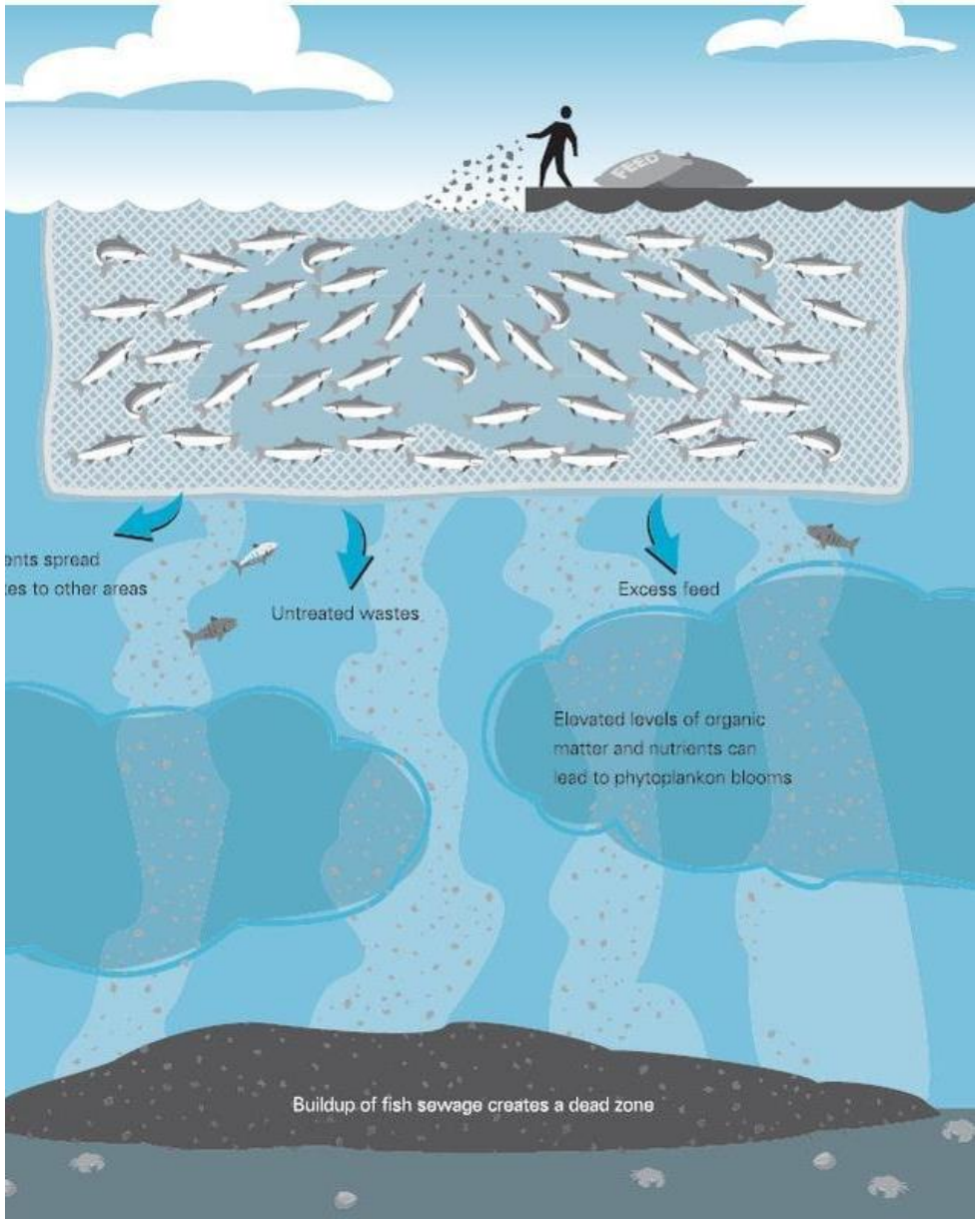


Impacts to Habitat

IMPACT	MITIGATION STRATEGY
Impacts to local sensitive habitats	Appropriate planning and siting is imperative to prevent damage to mangroves, reefs, and nurseries Account for vertical and horizontal distance from sensitive habitats Assess current velocity and direction to dissipate excess nutrients
Damaging of gear	Regular monitoring and maintenance needs to take place
Reduction of water quality	Attempt to carry out an environmental impact assessment for proposed site and production Monitor local water quality before and during finfish production to observe for changes in water quality

Water Pollution

- Excess feed and waste
- Environmental parameters
- Carrying capacity

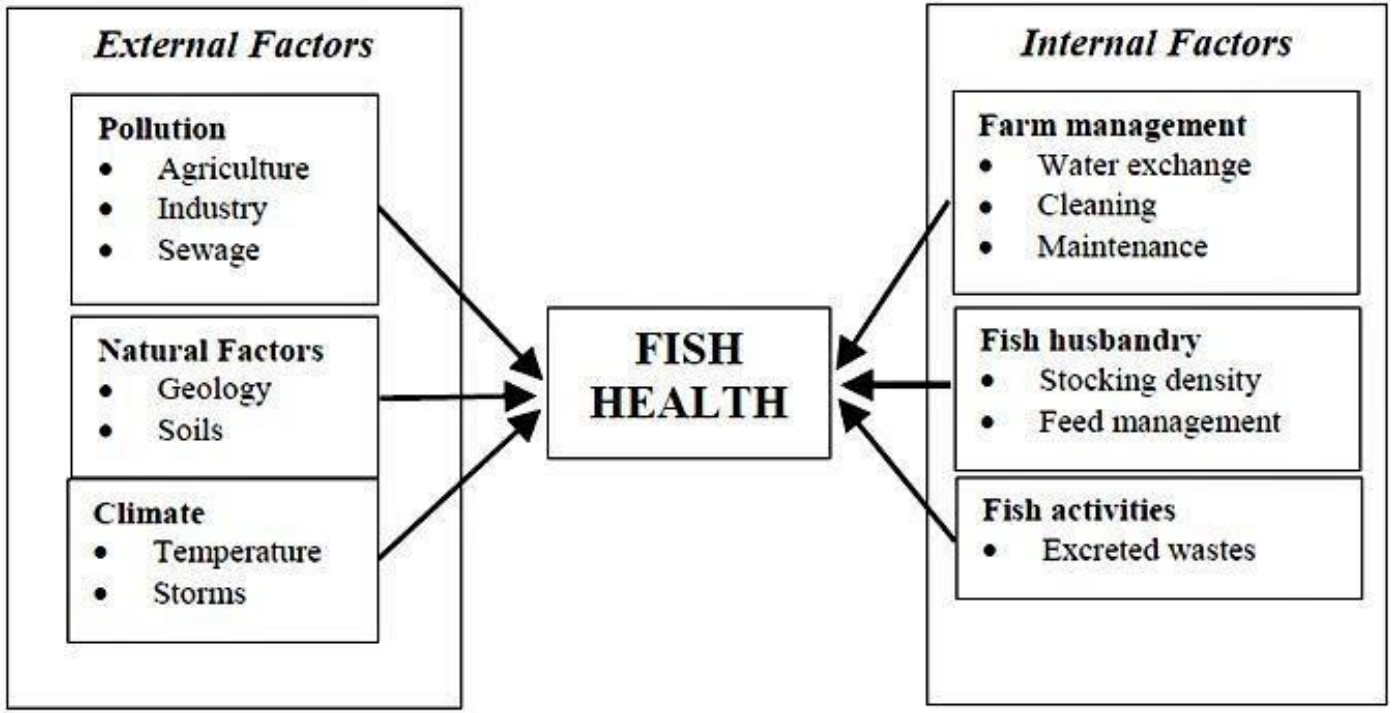


Water Pollution

IMPACT	MITIGATION STRATEGY
Excess feed and feces	Do not overfeed fish and use commercial pellets Site cages in area with enough depth and distance from sensitive areas Assess and determine current velocity and direction to dissipate nutrients Regular monitoring of water quality before and during production
Excess of carrying capacity	Carry out or determine carrying capacity limit Do not overstock as ecosystem will not be able to sustain nutrient accumulation Proper planning during site and cage type selection are essential

Disease

- Disease can greatly impact productivity
- Internal factors can be controlled
- Be proactive not reactive



Disease

IMPACT	MITIGATION STRATEGY
Biofouling on nets that reduce water flow, reduce oxygen, allow parasites	Regularly clean nets when cages are empty to remove biofouling
Prevalence of diseases and parasite	Maintain a reduced stocking density Do not install cages too close to each other Observe behavioral and physical changes
Nutritional deficiency	Feed with commercial pellets rather than whole fish, fish trimmings, or other animal parts

Take home message

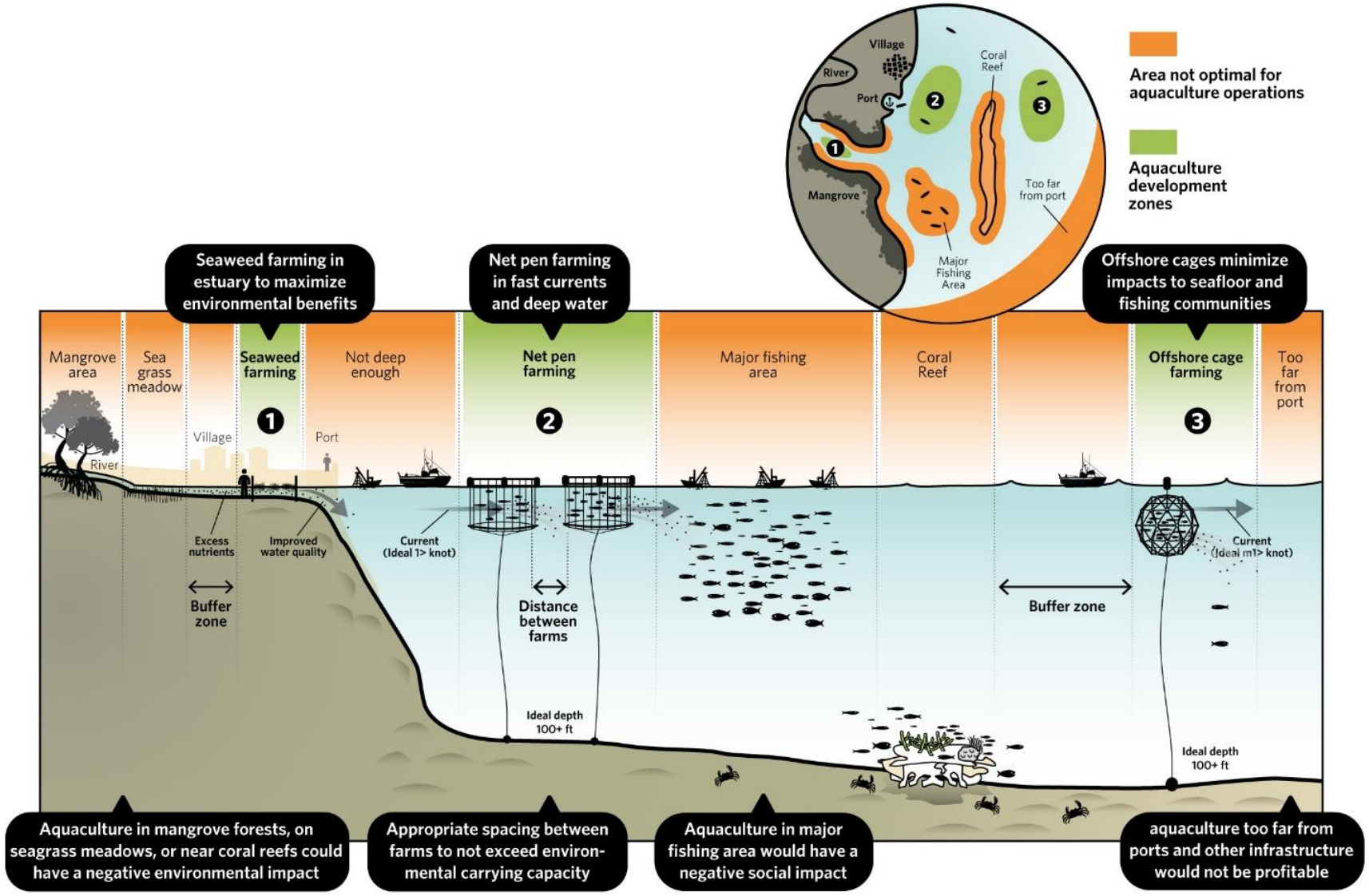
- Plan before any construction takes place
- Locate potential areas through site selection
- Assess environmental parameters of proposed sites
- Monitor environmental quality and health of fish

Finfish Aquaculture 101: Area Management Approaches

Jonathan MacKay

Marine Spatial Scientist

Contractor CSS, Inc.


Village
River
Port
Coral Reef
Mangrove
Too far from port
Major Fishing Area
Area not optimal for aquaculture operations
Aquaculture development zones
Seaweed farming in estuary to maximize environmental benefits
Net pen farming in fast currents and deep water
Offshore cages minimize impacts to seafloor and fishing communities
Mangrove area
Sea grass meadow
Seaweed farming
Not deep enough
Net pen farming
Major fishing area
Coral Reef
Offshore cage farming
Too far from port
Excess nutrients
Improved water quality
Current (Ideal 1> knot)
Buffer zone
Distance between farms
Buffer zone
Current (Ideal m1> knot)
Ideal depth 100+ ft
Ideal depth 100+ ft
Aquaculture in mangrove forests, on seagrass meadows, or near coral reefs could have a negative environmental impact
Appropriate spacing between farms to not exceed environmental carrying capacity
Aquaculture in major fishing area would have a negative social impact
aquaculture too far from ports and other infrastructure would not be profitable

Site Selection Checklist

20 Key Factors

Environmental Factors

Depth profile / availability of hydrographic maps showing seafloor

- Are there maps available that show the seafloor along with type of bottom?
- Are bathymetry maps available to evaluate seafloor depth? Is the recommended depth of 20-60m reached?

Water quality, temperature, and salinity

- Have water quality tests been carried out for fecal coliforms, excess nutrients, and harmful algae blooms?
- Has dissolved oxygen been measured?
- What are the temperature ranges for this area and is there a thermocline?

Political, Regulatory, Socio-cultural Factors

Use conflicts, number of ocean users in area

- Is this an area that local fishermen use and could create user conflict?
- Is this an area with significant tourists that use the marine space?

Operational and Logistical Factors

COSTS

- Availability and cost of fingerlings
- Availability and cost of feeds
- Distance from shore

Availability and cost of fingerlings

- Is there a hatchery in the local area where fry can be sourced from? If not local, where are the fingerlings procured from and are there risks in the supply chain?
- What is the cost of fingerlings of the chosen species?

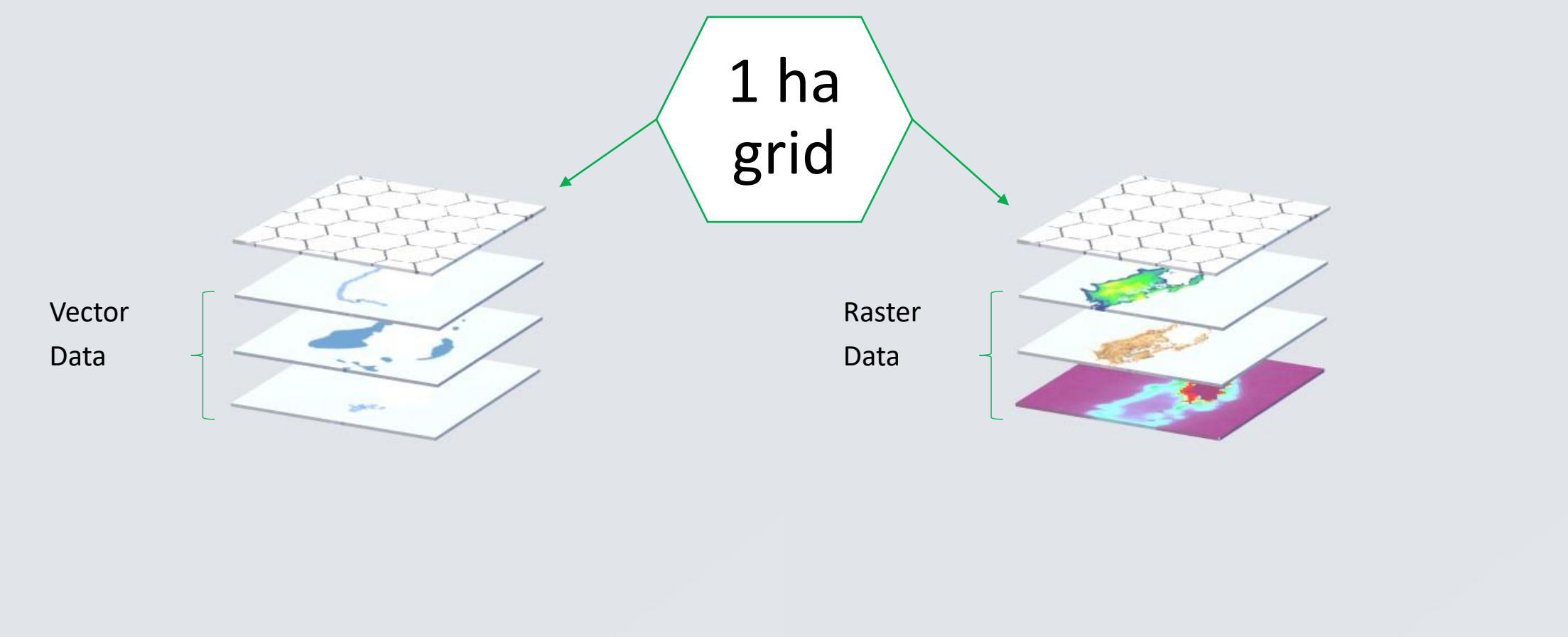
Availability and cost of feeds

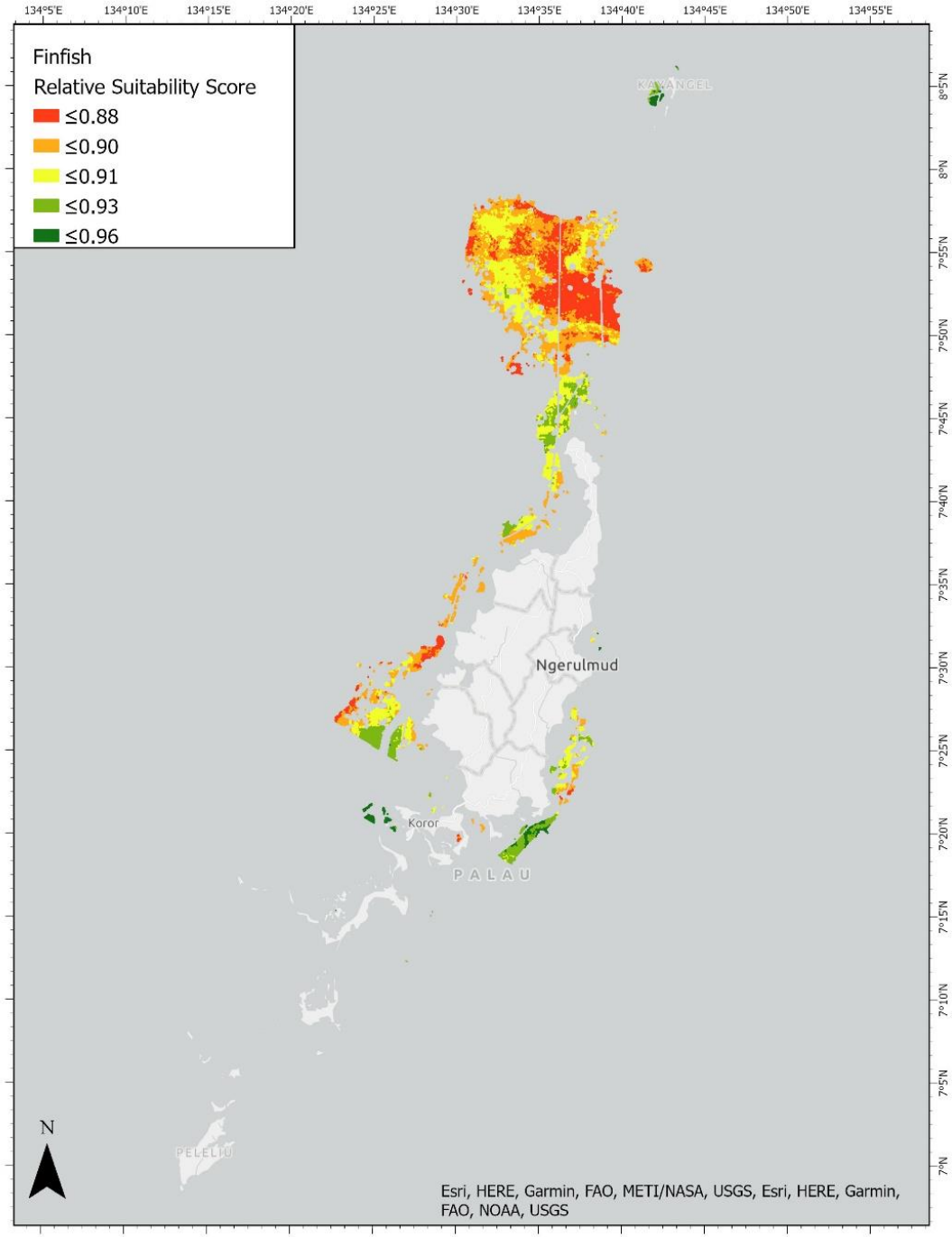
- Is there a local source of feed in the nearby area? If not local, where is feed procured from and are there risks in the supply chain?
- What is the cost and ingredients for the feed?

Distance from shore

- What is the distance from shore and how are the cages reached?
- Is the recommended distance of 0.2-6km achieved?

Marine Spatial Analysis - Palau




Finfish
Relative Suitability Score
≤0.88
≤0.90
≤0.91
≤0.93
≤0.96
134°5'E
134°10'E
134°15'E
134°20'E
134°25'E
134°30'E
134°35'E
134°40'E
134°45'E
134°50'E
134°55'E
8°5'N
8°N
7°55'N
7°50'N
7°45'N
7°40'N
7°35'N
7°30'N
7°25'N
7°20'N
7°15'N
7°10'N
7°5'N
7°N
KAYANGEL
Ngerulmud
Koror
PALAU
PELELIU
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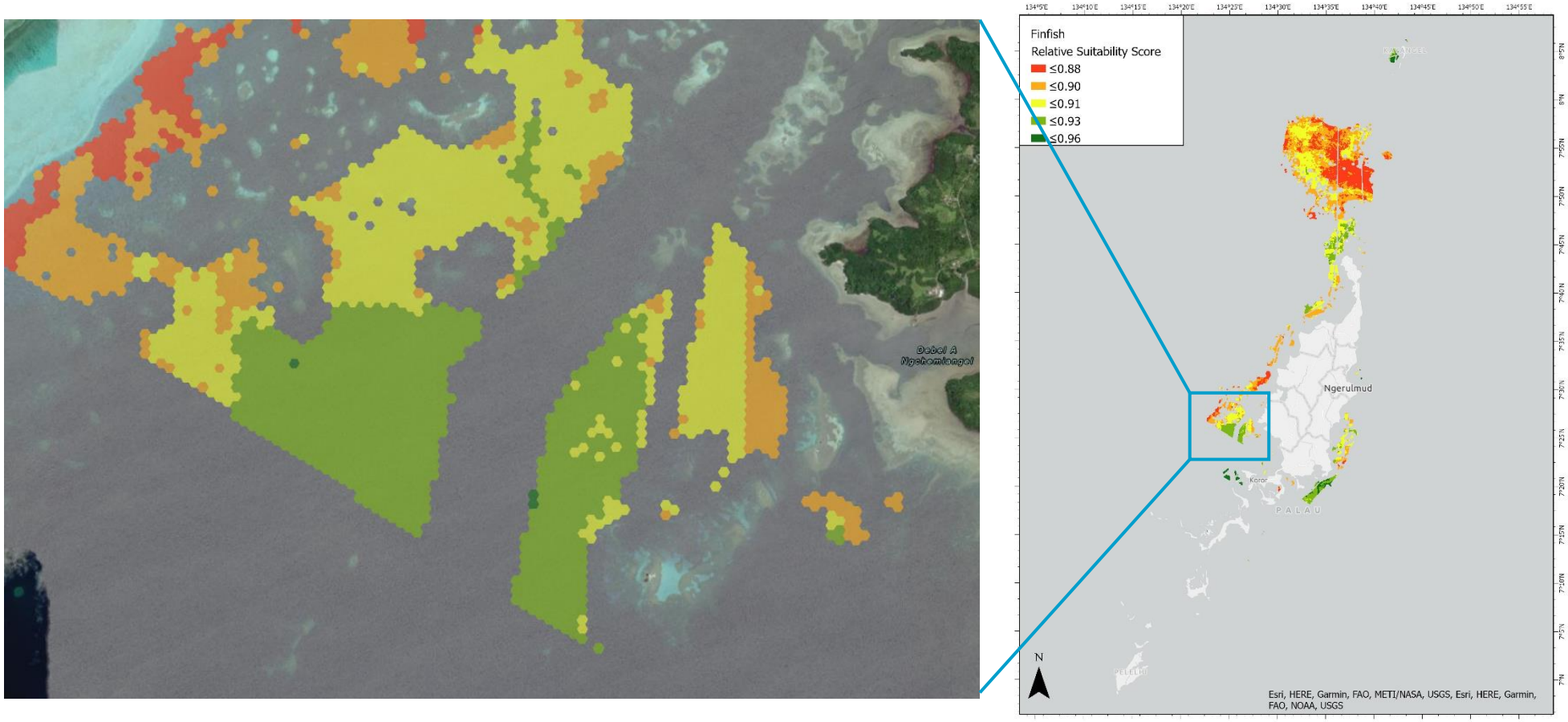
Esri, HERE, Garmin, FAO, METI/NASA, USGS, Esri, HERE, Garmin, FAO, NOAA, USGS

https://maps.coastalresilience.org/palau/

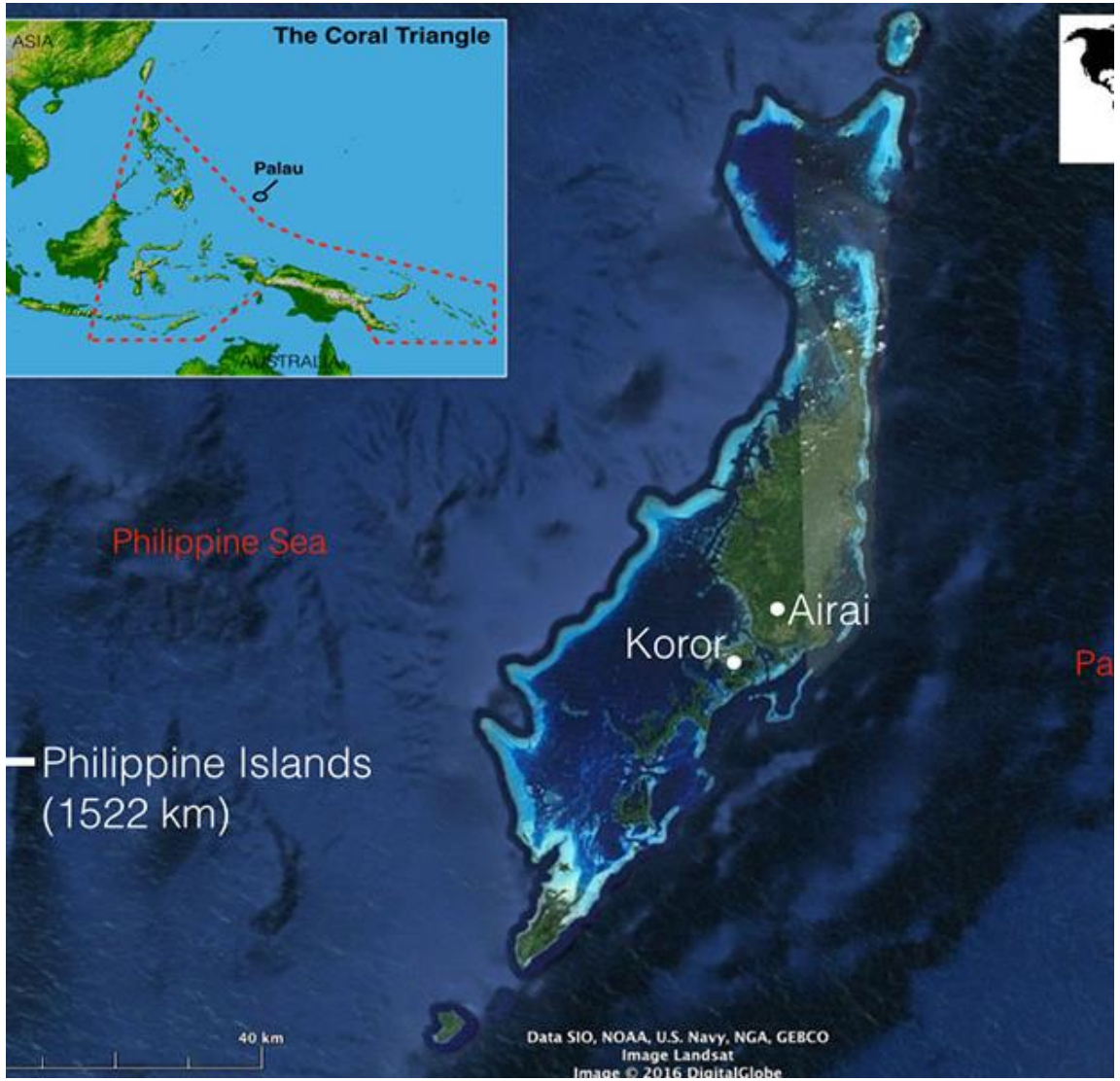
RESULTS



Palau Community Based Rabbitfish Aquaculture

Steven Victor, The Nature Conservancy Micronesia Program

- 20,000 population
- Over 120,000 annual visitors
- Main economy is tourism
- Over 30 PA
- 80% of EEZ to be closed from fishing
- Over 500 islands
- Over 450 coral species
- Over 1500 species of fish
- Some of the most intact coral reef habitat



Heavy Reliance on Imported Food

Climate Impacts

Declining Fisheries

Fishermen catching fish before they have had a chance to reproduce

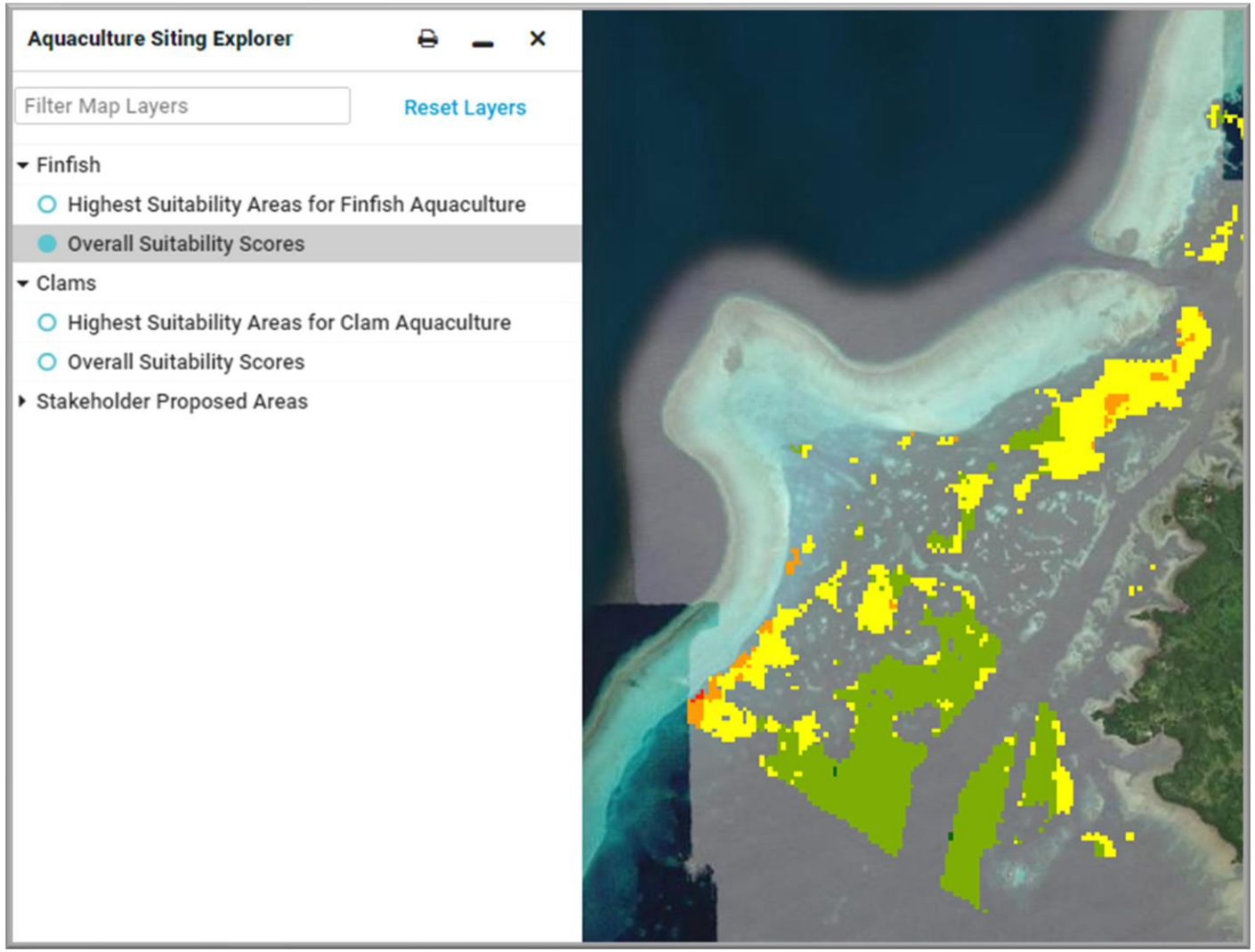
Why Rabbitfish?

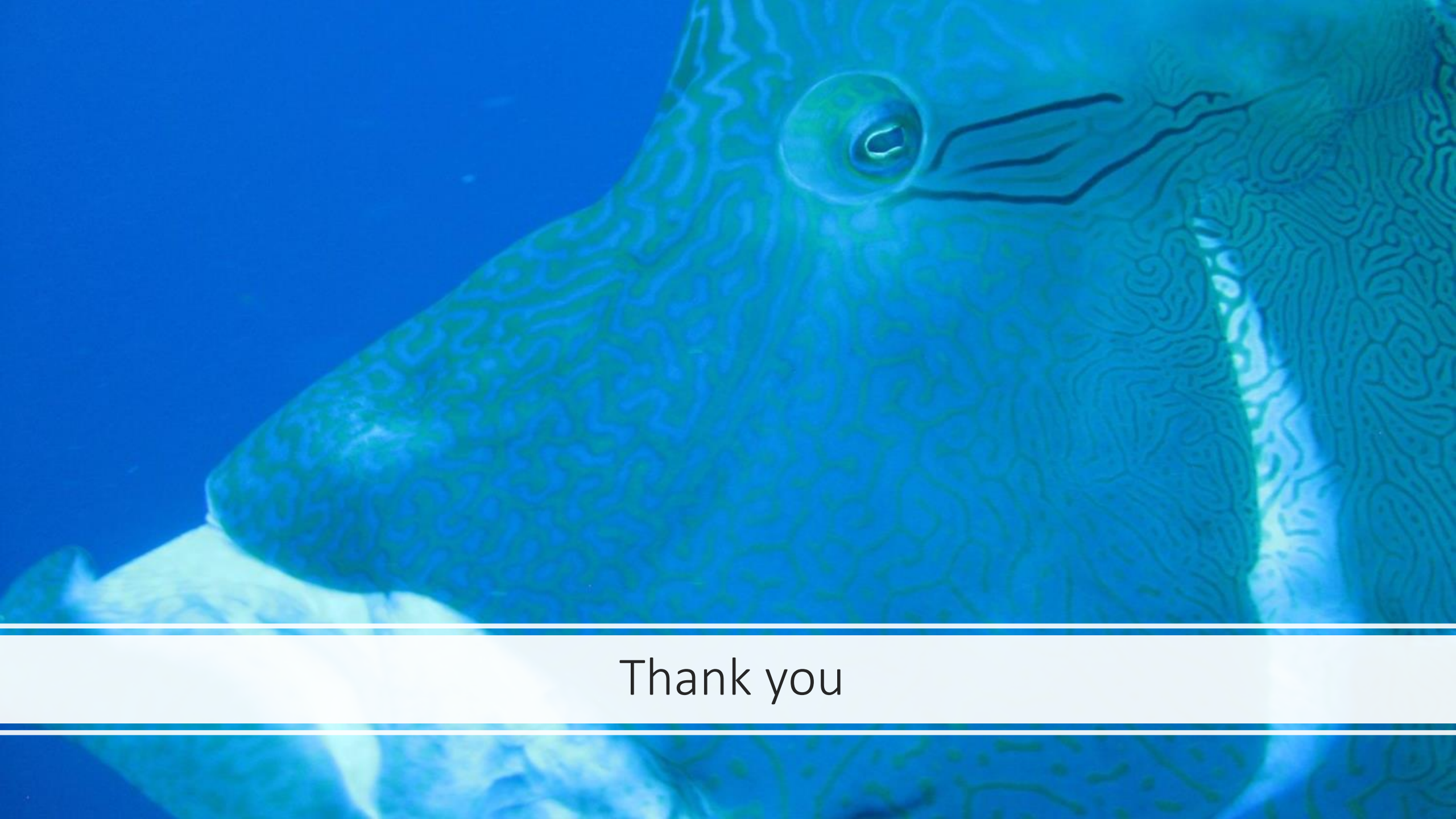
Partnership with Government

Partnering with Fishermen as Farmers

LOOKING AHEAD

- Siting analysis to identify most suitable marine areas to support aquaculture
- Developing regulatory framework to support sustainable aquaculture
- Expanding sustainable aquaculture (giant clam, mangrove crab, milkfish)





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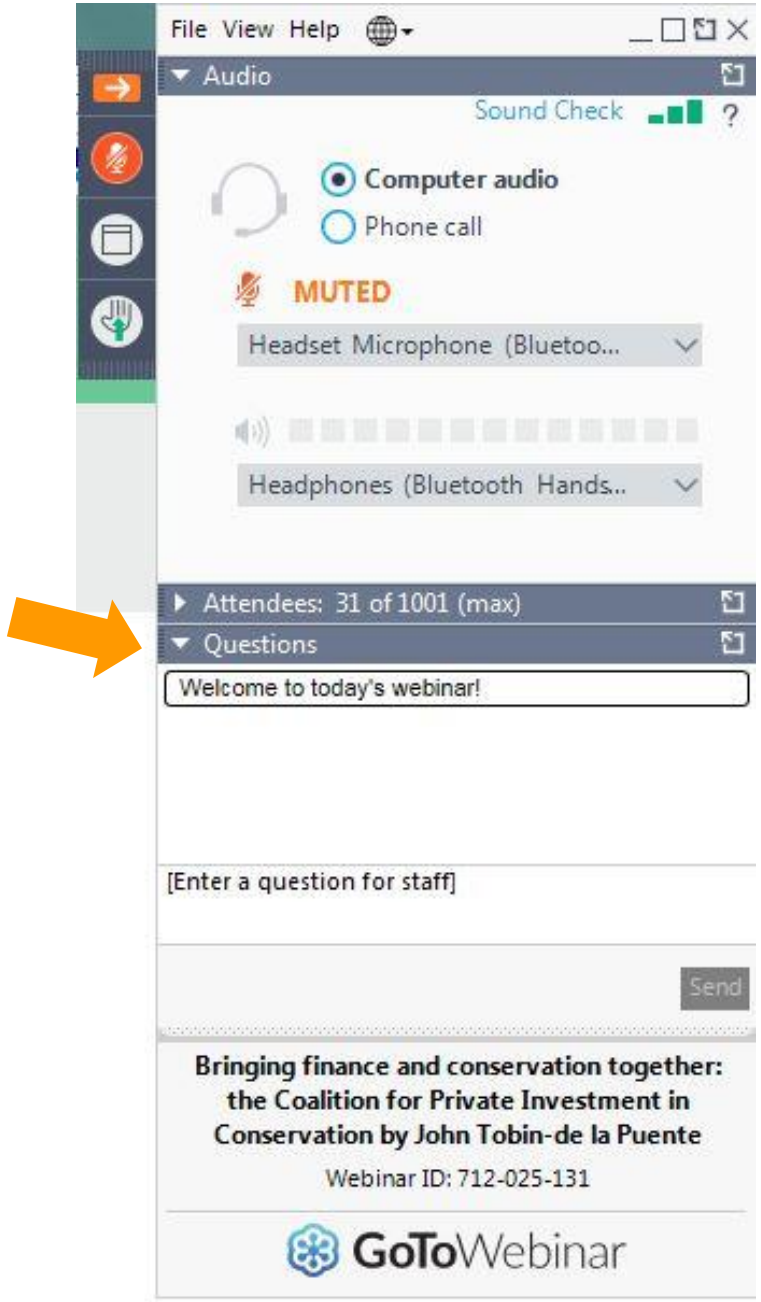

Questions & Discussion

Resources

- Reef Resilience Network Aquaculture toolkit: https://reefresilience.org/aquaculture/

- Reef Resilience Network Forum: https://forum.reefresilience.org/network-forum/

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