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Mariculture and Oceanography

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Introduction

- Mariculture is a specialized branch of aquaculture involving the cultivation of marine organism for food and other products in the open ocean or in tanks, ponds and raceways which are filled with sea water

  Example: Fin fish, Shell fish, Bivalves and Sea weeds

- Mariculture involves three phases

  1)Brood bank and hatchery

  2)Nursery

  3)Grow out

Source:CMFRI

Why Mariculture ?

- Aquaculture has emerged as the fastest growing food production sector with an annual rate of >6%
- Last two decades and reached 4.9 million tonnes in 2017
- Most of the world's fishing areas have reached their maximal potential for capture fisheries production
- Demand for seafood worldwide is steadily increasing
- Aquaculture now supplies one third of seafood consumed worldwide Aquaculture production needs to increase by 50 mmt by the year 2050 (Tacon and Forster, 2001)

Source:FAO

Contd.,

- Global review of the marine capture fisheries scenario reveals that 80% of the world's fish stocks
- The maximum wild capture fisheries potential from world's oceans have almost been exploited and a more closely controlled approach to fisheries management is required

FISH

F - Food
I - Income
S - Self employment
H- Health

Source:FAO

Three types based on location area

1.Coastal mariculture

2.Off-the-coast mariculture

3.Offshore mariculture

Source:FAO

General criteria for coastal, off-the-coast and offshore aquaculture based on some environment and hydrographic characteristics

	Coastal	Off-the-coast	Offshore
Location/ hydrography	• < 500 m from the coast • ≤10 m depth at low tide • Within sight • Usually sheltered	• 500 m–3 km from the coast • 10–50 m depth at low tide • Often within sight • Somewhat sheltered	• > 2 km, generally within continental shelf zones, possibly open ocean • > 50 m depth
Environment	• Hs usually < 1 m • Short period winds • Localized coastal currents, possibly strong tidal streams	• Hs < 3–4 m • Localized coastal currents, some tidal streams	• Hs 5 m or more, regularly 2–3 m • Oceanic swells • Variable wind periods • Possibly less localized current effect
Access	• 100% accessible • Landing possible at all times	• > 90% accessible on at least once daily basis • Landing usually possible	• Usually > 80% accessible • Landing may be possible, periodic, e.g. every 3–10 days
Operation	• Regular, manual involvement, feeding, monitoring, and more	• Some automated operations, e.g. feeding, monitoring, and more	• Remote operations, automated feeding, distance monitoring, system function

Note: Hs = significant wave height – a standard oceanographic term, approximately equal to the average of the highest one-third of the waves.

Source: Lovatelli, Aguilar-Manjarrez and Soto (forthcoming).

Courtesy : Lovatelli, Aguilar-Manjarrez and Soto

Site selection

- Site selection and water quality in mariculture is one of the most important factors
- Choice of site for mariculture is of supreme importance
- Clean water and suitable sites for coastal aquaculture are lesser
- Open sea culture is a major avenue for expansion of culture of marine fish
- Offshore culture of marine fish is usually practiced in cages

Source:CMFRI

Environmental and Water Quality

Physical	Chemical	Biological	Geological
Colour Temperature Light Depth Turbidity TSM Wave Height Current Speed	Salinity DO pH Inorganic Nitrogen Total Inorganic Phosphorus COD Chlorine and Ammonia Heavy metals and Pesticides	Plankton BOD	Bottom Substratum Dynamics

Source:CMFRI

Harmful algal blooms(HAB)

- Site away from HAB
- Producing highly potent toxins that are harmful
- Difficult to predict if any area is prone to be affected by these toxic blooms
- Enquiry of the past history

Source:CMFRI

Key assumptions about the near-future

- Limited by technical constraints on mariculture system installation, maintenance and endurance
- Mainly take place within exclusive economic zones
- Use cages for fish and loglines for molluscs as culture systems, relatively close to coastlines
- Dependent on onshore facilities
- Protect from storm damage
- Minimize distance

Source: Drumm(2010)

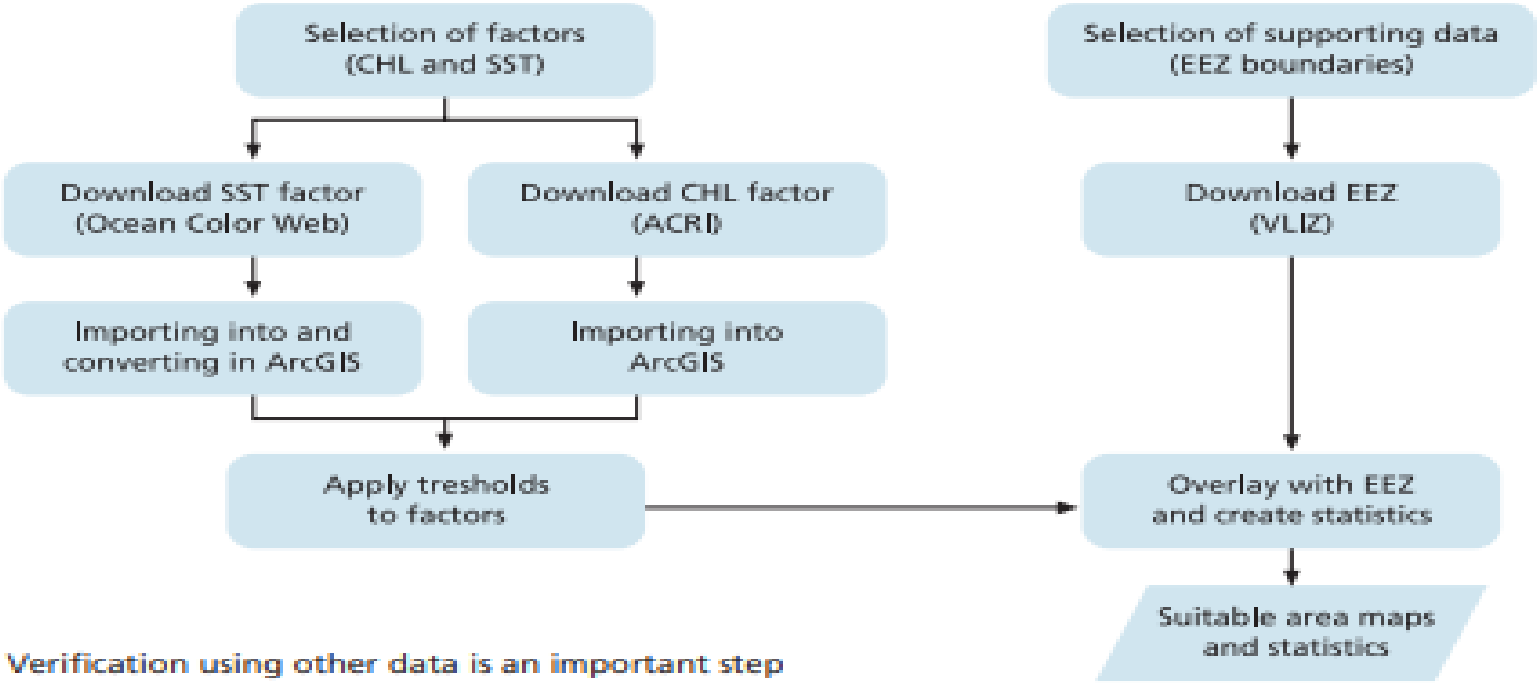
Example of fed aquaculture of fish in cages

COURTESY OF F CARDIA

Courtesy : FAO

FIGURE A3.7

Image processing steps to create offshore mariculture suitability map products



Note: Verification using other data is an important step following development of a preliminary suitability map

Courtesy : FAO

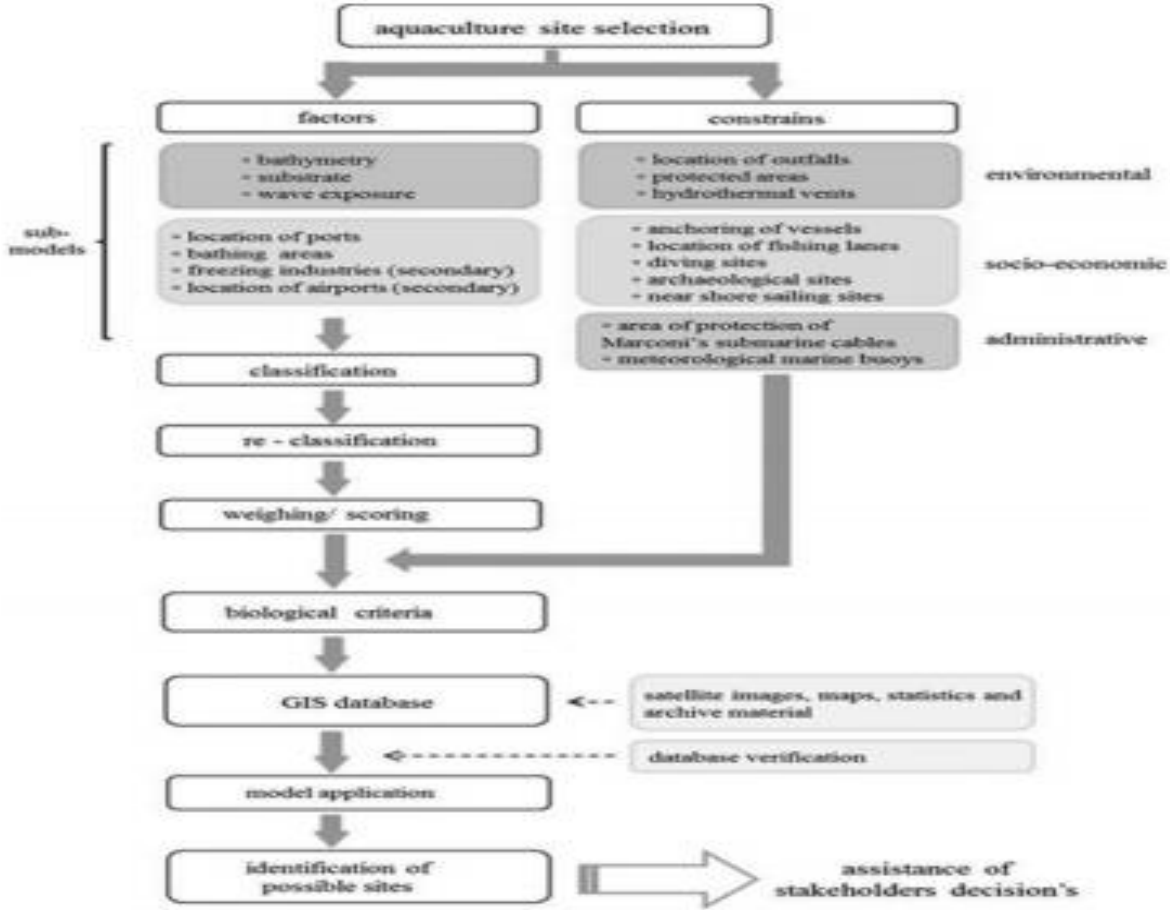


Figure 2. Conceptual structure of a multi-criteria analysis for optimal site selection for mariculture cages with the identification of variables (sub-models).

Courtesy:J.Micael et al

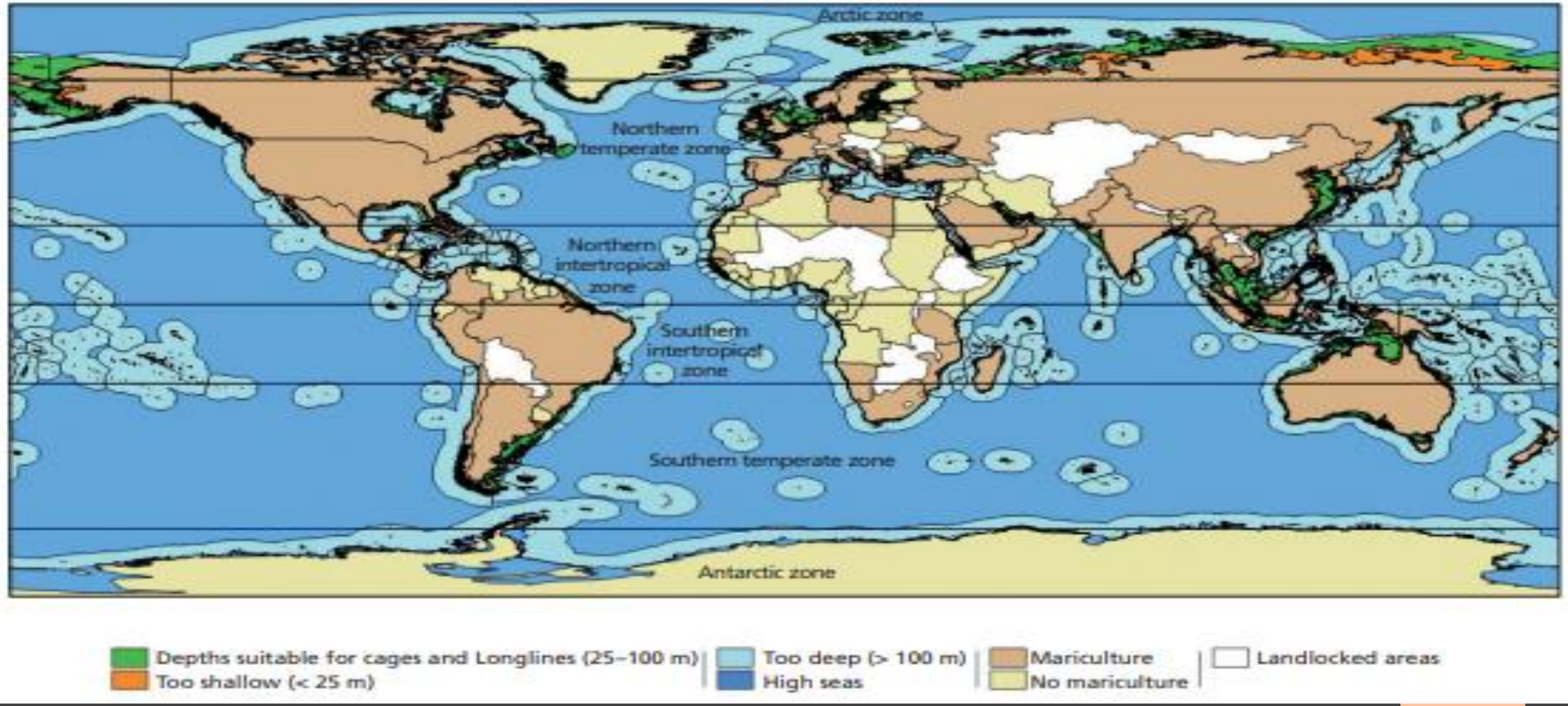
Parameters	Unsuitable	Least suitable	Suitable	Highly suitable
Depth (m)	< 5	5–10	10–50	50–100
SSC (cm/s)	< 3	3–10	10–15	15–100
SWH (m)	> 3	2–3	1–2	< 1
Wind speed (m/s)	> 8	7–8	5–7	< 5
TSM (mg/L)	> 50	25–50	10–25	< 10
Temperature (°C)	< 24	24–26	26–28	28–32
Salinity (PSU)	< 24	24–26	26–32	32–37
DO (mg/L)	< 3	3–5	5–6	6 -7.5
Chlorophyll-a (mg/m^3)	> 15	6–15	2–6	< 2

FIGURE 4a
HDPE floating circle cage

FIGURE 4b
Inauguration of a HDPE floating cage

Courtesy : CMFRI

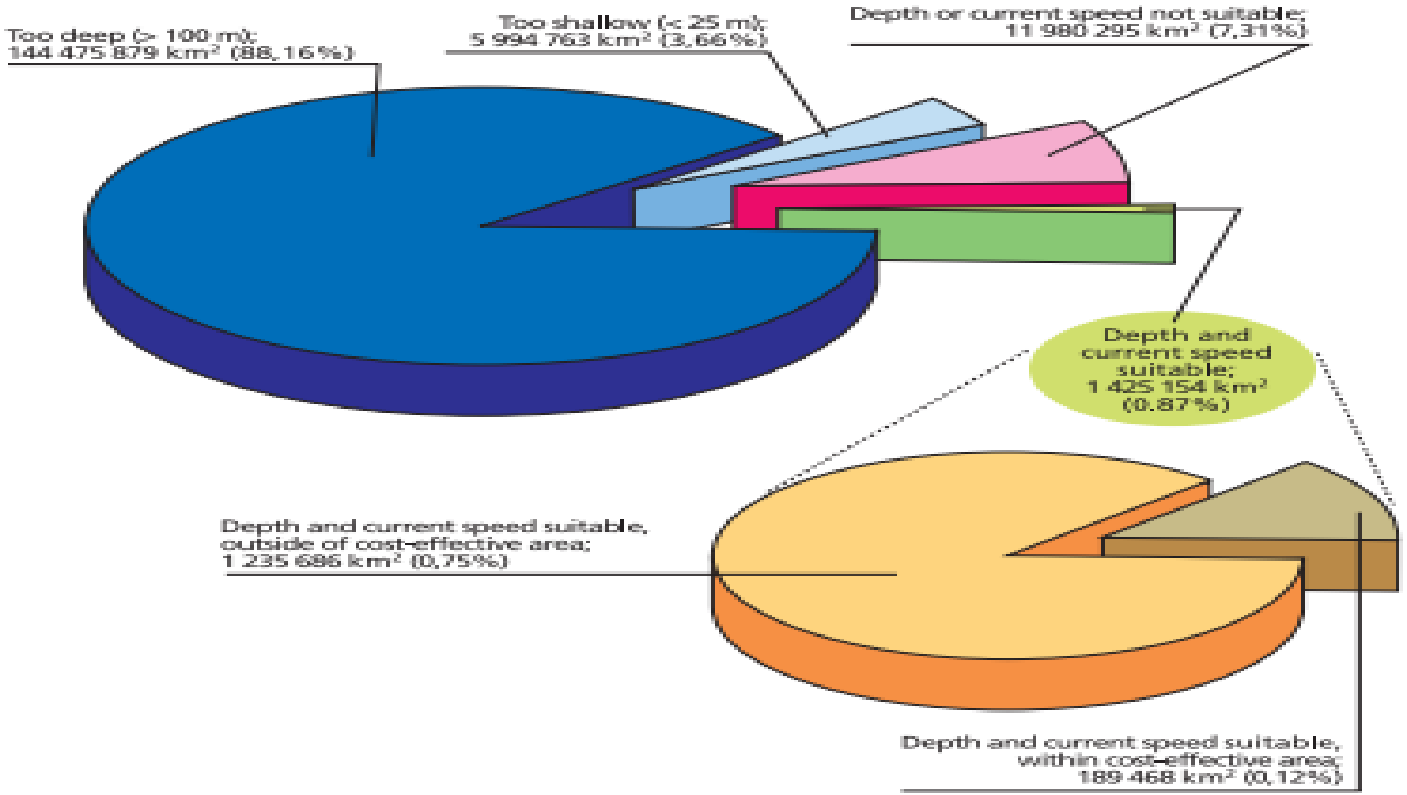
Areas with depths suitable for sea cages and longlines within economic zones



Courtesy : FAO

FIGURE 50

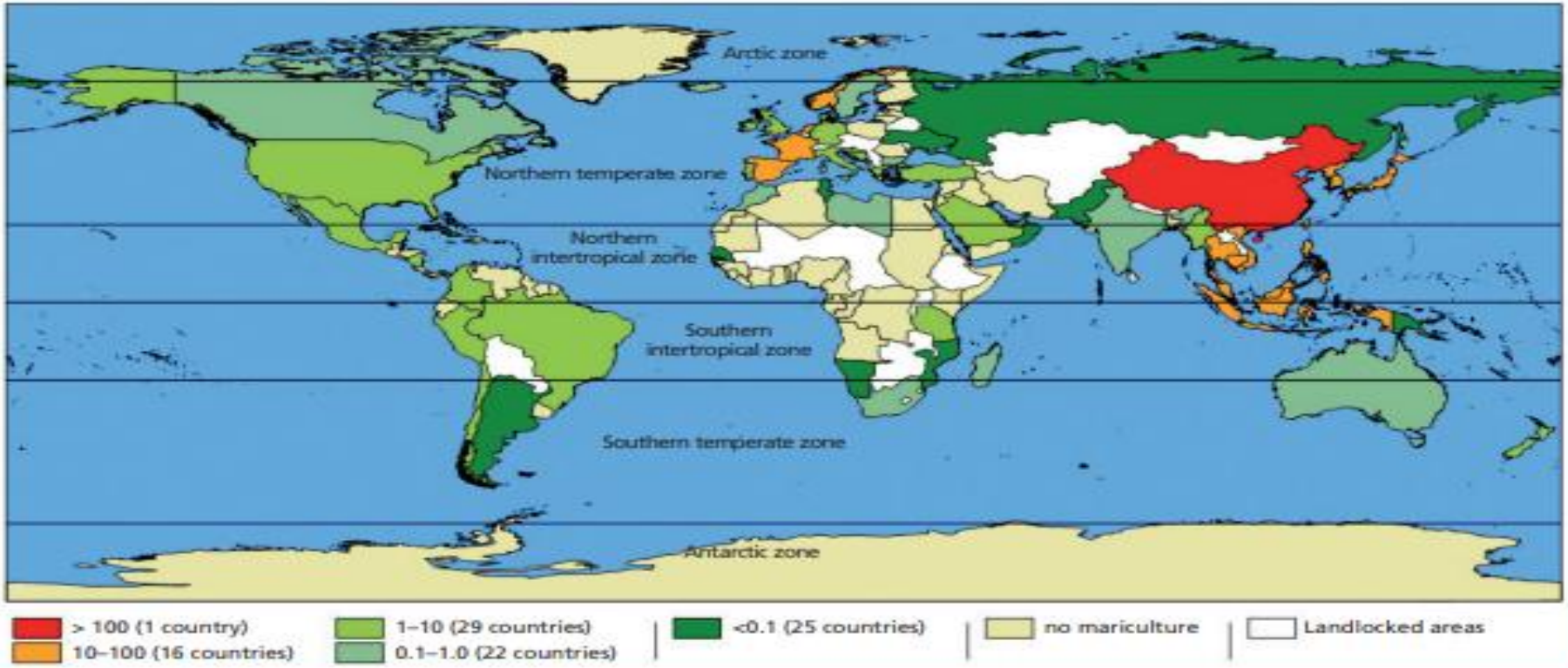
Areas (km²) within EEZs relative to depths and current speeds suitable for sea cages and longlines and to the cost-effective area for development



Courtesy : FAO

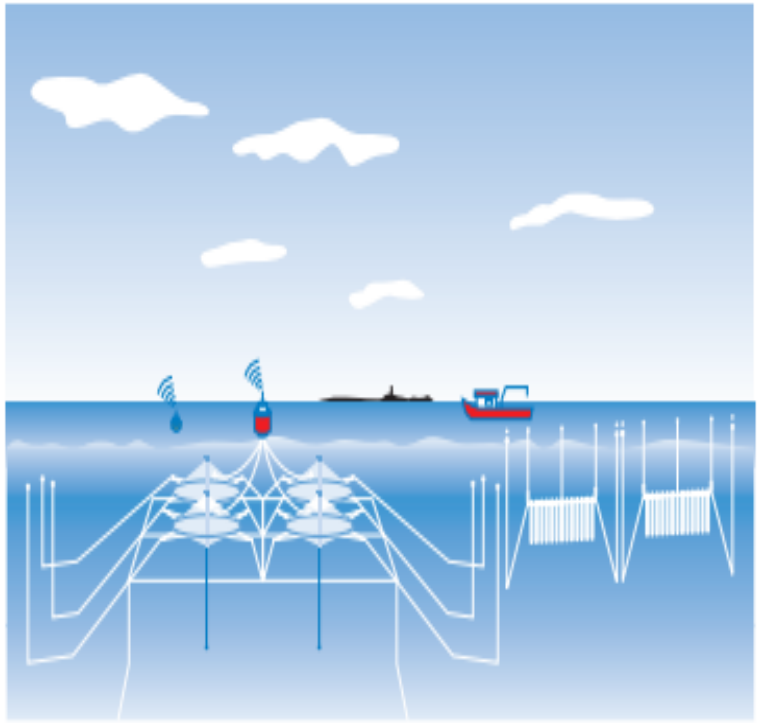
FIGURE 4

Intensity of mariculture production (2004–2008) in tonnes per kilometre of coastline and numbers of countries in the range



Courtesy : FAO

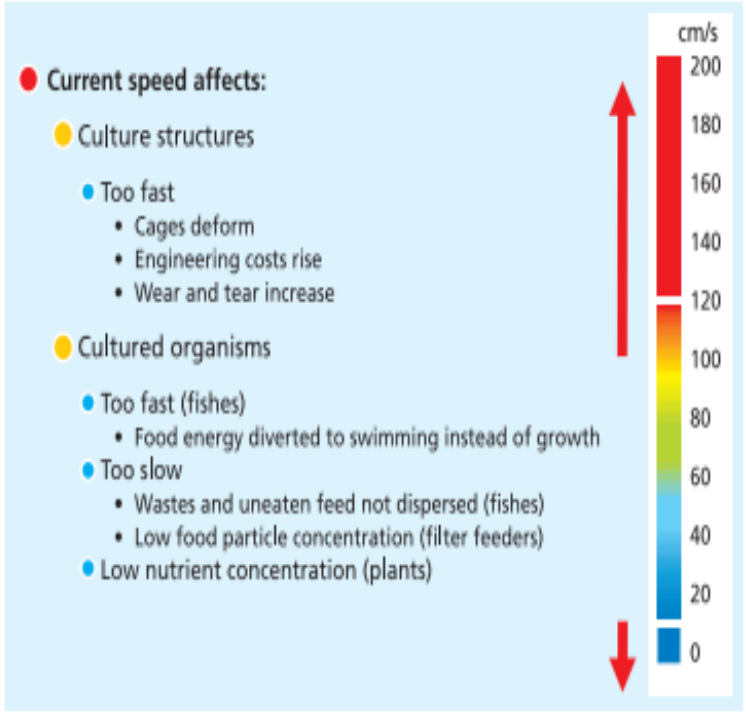
Sea cages and longlines for offshore mariculture



Source: NOAA (2011).

FIGURE 2

Effects of current speed on culture structures and on cultured organisms



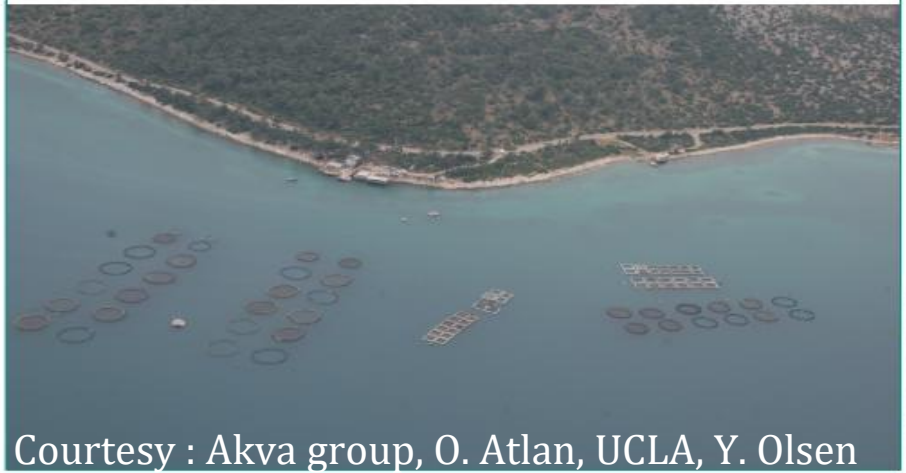
Courtesy : NOAA

Fish cages in rough weather in Norway

COURTESY OF AKVA GROUP

Note: Square plastic collar gravity cage in rough conditions, Kingdom of Norway. Polarcirkel, Kingdom of Norway.

Net cages along the coast of Turkey



COURTESY OF O. ALTAN

Net cages along the coast of Norway

COURTESY OF Y. OLSEN

Courtesy : Akva group, O. Atlan, UCLA, Y. Olsen

PLATE 2

Species indicative of different kinds of offshore mariculture potential

COURTESY OF /OUTDOOR

Cobia (*Rachycentron canadum*)

COURTESY OF CORNELL UNIVERSITY

Atlantic salmon (*Salmo salar*)

COURTESY OF NOAA

Blue mussel (*Mytilus edulis*)

Courtesy : NOAA

Status of mariculture from a spatial perspective

Criteria	Mariculture nations		Non-mariculture nations		Total	
Production	Countries and territories*	Mean production (tonnes) 2004–08	Countries and territories	Mean production (tonnes) 2004–08	Countries and territories	
	93	29 976 736	72	0	165	
Coastline length	Nations	km	Nations	km	Nations	km
	80	1 472 111	83	302 548	163	1 774 659

Mariculture intensity of 93 countries and territories	Production of aquatic plants and animals (tonnes/km coastline)
Mean (tonnes/km)	15
Median (tonnes/km)	1
Maximum (tonnes/km)	519

Courtesy : FAO

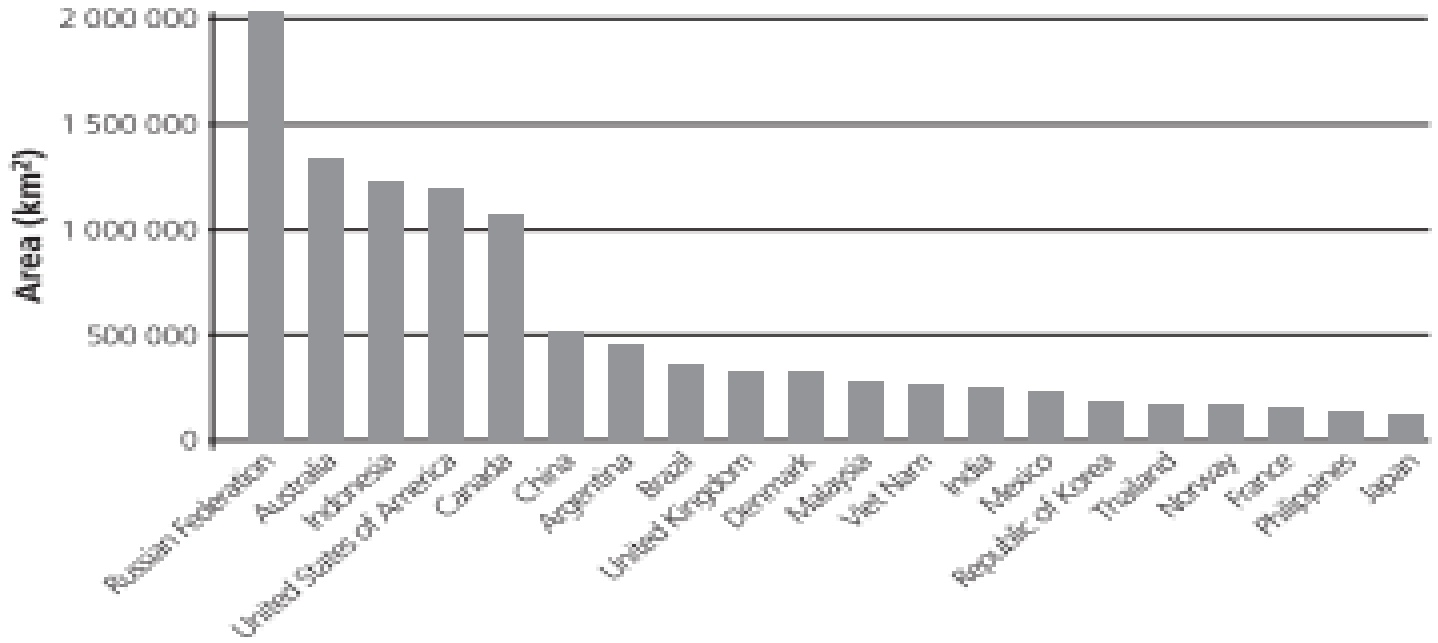
Number of nations and corresponding areas meeting depth, current speed and cost-effective area criteria for offshore mariculture development

Technical and economic feasibility	Mariculture nations		Non-mariculture nations		Total	
	Nations	Area (km^2)	Nations	Area (km^2)	Nations	Area (km^2)
Depths suitable for cages and longlines (25–100 m)	82	12 405 003	71	1 000 446	153	13 405 449
Current speed suitable for cages (10–100 cm/s)	77	84 244 659	69	16 790 002	146	101 034 662
Depths (25–100 m) and current speeds (10–100 cm/s) suitable for cages and longlines	73	1 234 771	65	190 383	138	1 425 154
Cost-effective area (25 nm, or 46.3 km, from a port)	79	5 119 018	74	1 015 430	153	6 134 448
Cost-effective area (25 nm, or 46.3 km, from a port) and depths and current speeds suitable for cages	69	146 820	52	42 648	121	189 468

Courtesy : FAO

FIGURE 10

Ranking by area of main mariculture nations in depths suitable for sea cages and longlines



Courtesy : FAO

Courtesy : World fish

Questions & Answers

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Courtesy: DoF, MFAHD, INDIA