Developing a new era for seafood production for a sustainable ocean

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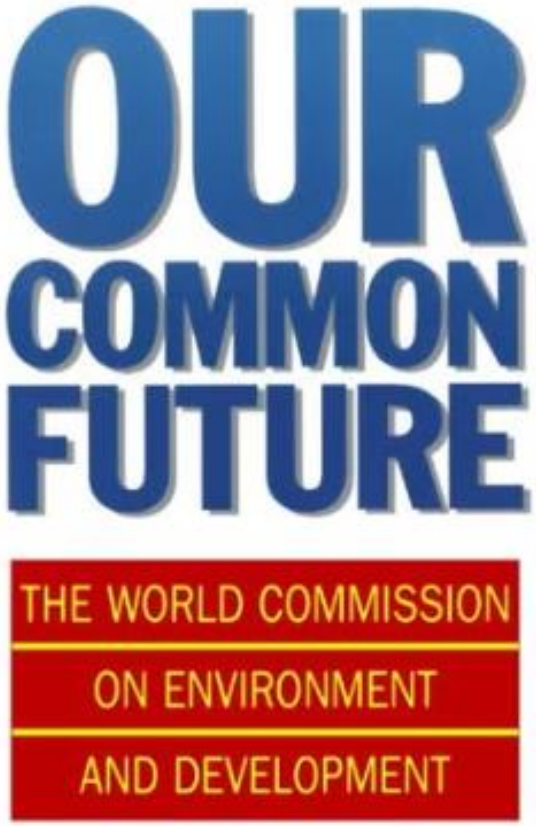
What is sustainability?

Brundtland report (1987): “meeting the needs of the present without compromising the ability of future generations to meet their own needs”.



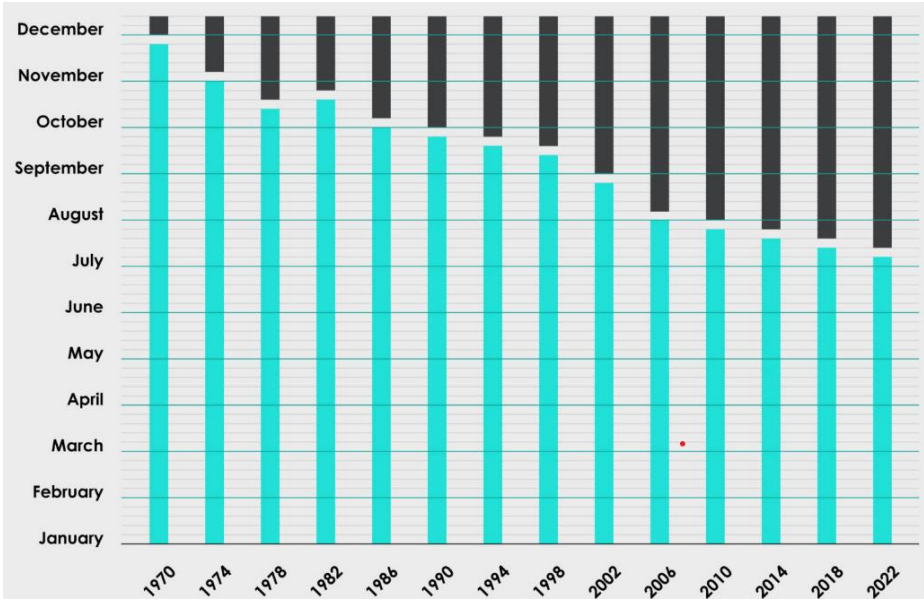
Are we achieving it?

Locally – some areas – yes
Regionally - ???
Globally - No

Metrics:

Ecological footprint: measures the impact of human activities measured in terms of the area of biologically productive land and water that is required to produce the goods consumed and to assimilate the wastes generated.

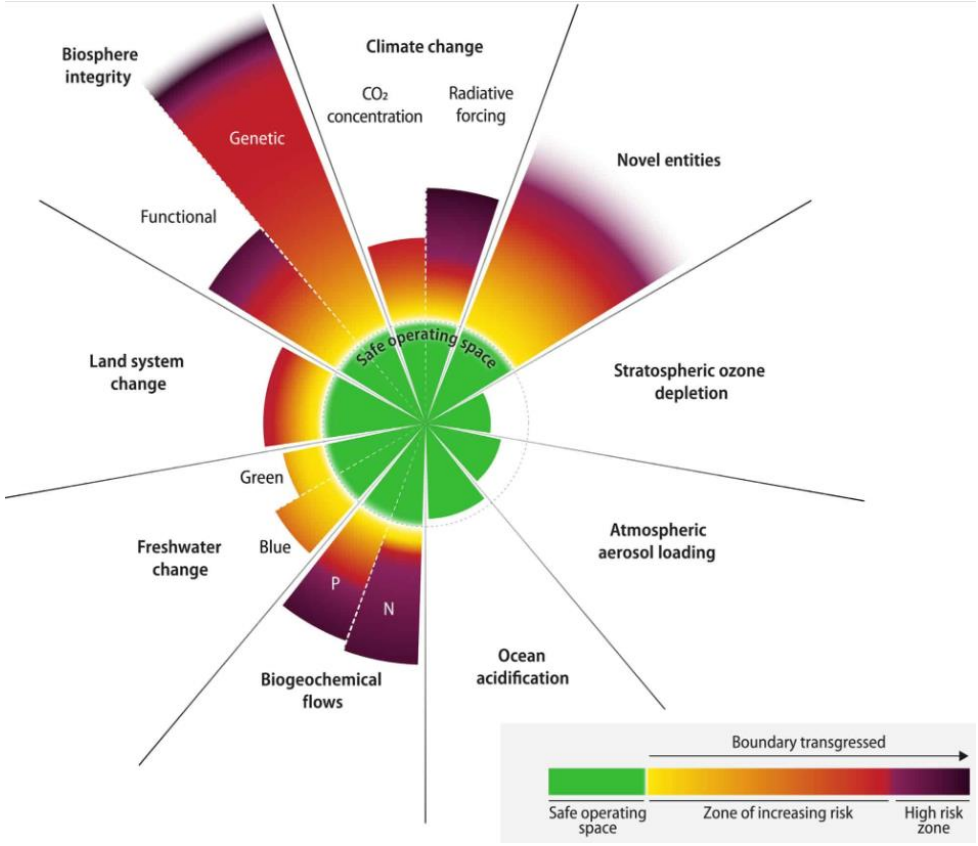
Earth overshoot day: occurs when humanities ecological footprint exceeds the earths biocapacity.



Since the publication of Our Common Future in 1987, Earth Overshoot Day has declined from October 23rd to August 2nd in 2023.

Planetary boundaries:

aims to define the environmental limits within which humanity can safely operate.



What do we need to do if we are to reverse our current trend towards increasingly unsustainable outcomes for the future:

Plenty!!!

To name a few:

Restoring damaged ecosystems,
Reversing climate change
Decreasing pressure on natural systems

There is a need to move beyond sustainability.

How can we increase sustainability outcomes?

Drawing on carbon as an example:
Carbon neutral results in net greenhouse gas emissions being equal to zero and carbon positive goes beyond this, making additional positive contributions to the environment with the ultimate aim of an overall reduction in carbon emission associated with the development.

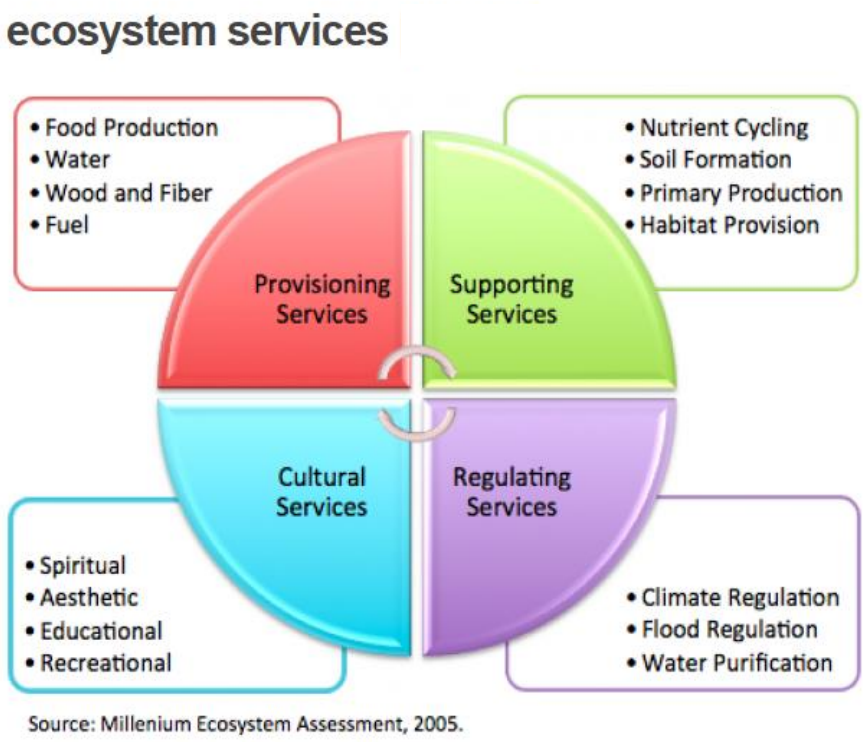
A Sustainability positive outcome?

A sustainability positive outcome results in an increase in overall sustainable outcomes from a proposed development. That is, the sum of the activities creates an overall positive benefit to the environment.

How might we achieve sustainability positive outcomes?

Ecosystem Services

ECOSYSTEM SERVICES: Services that ecosystems provide to support human life and well-being



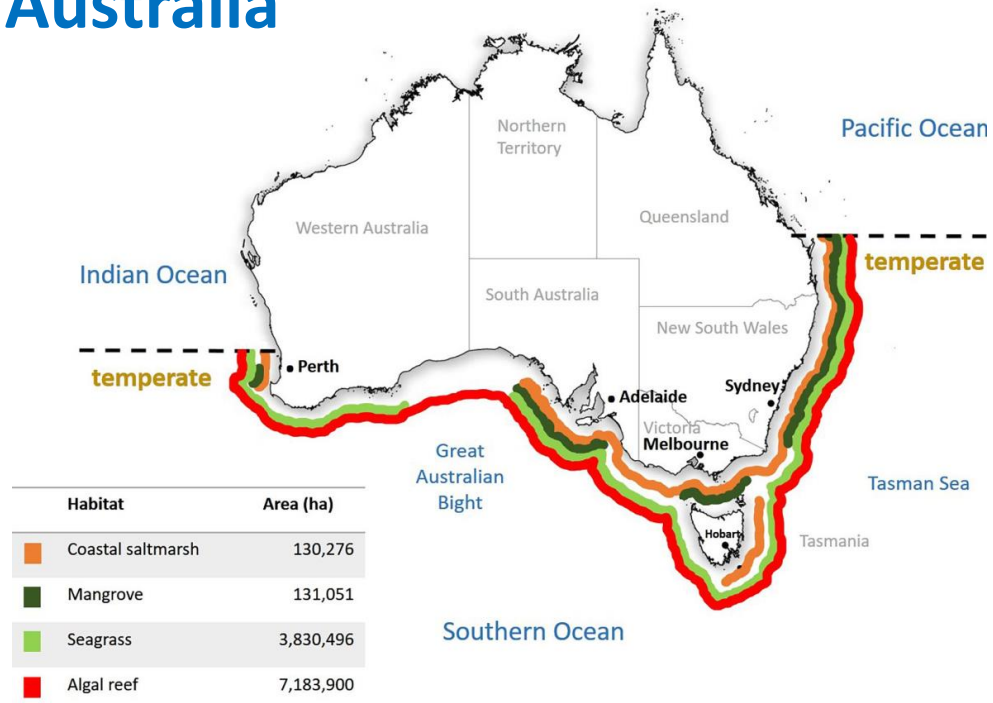
Source: Millenium Ecosystem Assessment, 2005.

Can we develop food production systems that enhance or build on these services?

Ecosystem services from COASTS (8% of the ocean)

GLOBALLY
seagrass and algal beds (temperate reef systems)
~ 33% of the coastal ecosystem services; ~ 11% of all ecosystem services

Australia



Habitat	Area (ha)
Coastal saltmarsh	130,276
Mangrove	131,051
Seagrass	3,830,496
Algal reef	7,183,900

NATIONALLY (temperate Australia)

"vegetated coastal ecosystems, including algal reefs, provide provisioning services and nutrient cycling (support services) and could be worth as much as $120 billion per year or $17,608 per hectare per year."

Gaylard et al., Front. Mar. Sci., 19 June 2020

Coasts and their habitats are important

United Nations Sustainable Development Goals

Provides social and economic benefits for current and future generations;

Restores, protects and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems;

Is based on clean technologies, renewable energy and circular material flows.

Can we develop systems that meet multiple SDG's

The implementation of the goals will require global partnerships and collaboration across the public and private sectors, and civil society. While all goals are interrelated, SDG17 underpins the achievement of all other goals.

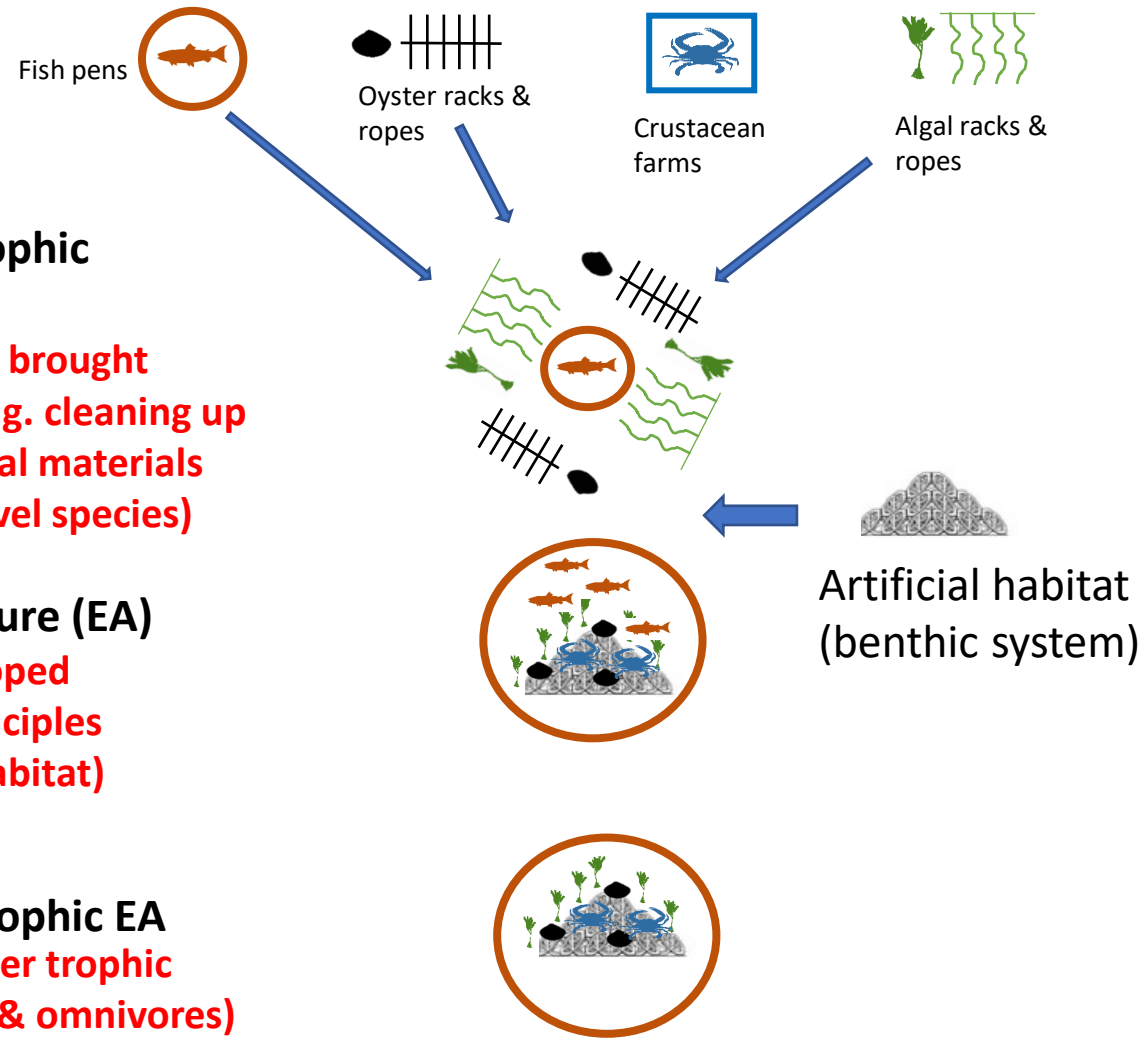
Re-designing aquaculture systems

Aquaculture
(monoculture/ independent systems)

Integrated Multi-Trophic Aquaculture (IMTA)
(Monoculture systems brought together to interact. E.g. cleaning up food remains and faecal materials from higher trophic level species)

Ecosystem Aquaculture (EA)
(Culture system developed around ecosystem principles through inclusion of habitat)

Integrated Lower Trophic EA
(Species limited to lower trophic levels (e.g. herbivores & omnivores)



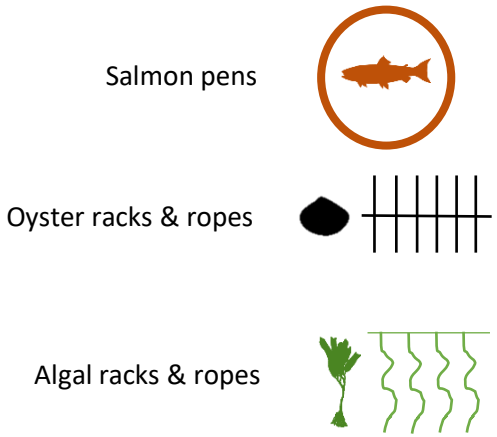
Ecosystem services

PROVISIONING

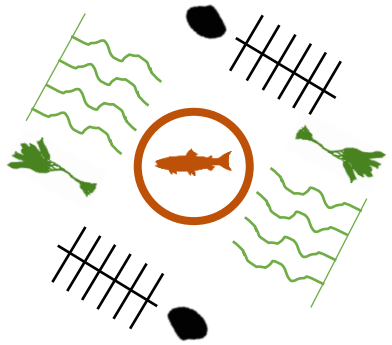
PROVISIONING SUPPORTING

PROVISIONING REGULATING SUPPORTING

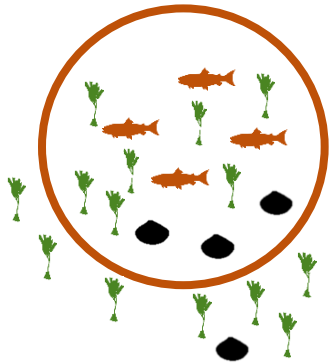
1- Modern/current Mariculture



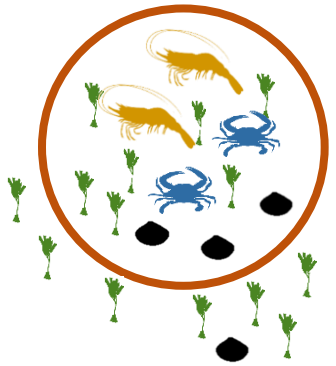
2- Integrated Multi-Trophic Aquaculture



3- Ecosystem mariculture



4- Integrated Low Trophic Ecosystem Mariculture



Cost of production	Low	Low	Medium	High
Food input	High	High	Medium	Low
Density	High	High	Medium	Medium
Environmental impacts & disease	High	Medium	Medium-Low	Low
Ecosystem service	Provision	Provision, Regulation	Provision, Regulation, Support	Provision, Regulation, Support

Artificial reef systems

Artificial reefs have been around for a long period in time – with a primary focus on recreational fishing and diving or conservation. There have been very limited attempts to focus on commercial outcomes and all have been placed in coastal regions on the seafloor.

By **floating** artificial reefs, it should be possible to obtain the productivity and ecosystem services of natural reefs beyond coastal margins – offshore floating artificial reef systems.

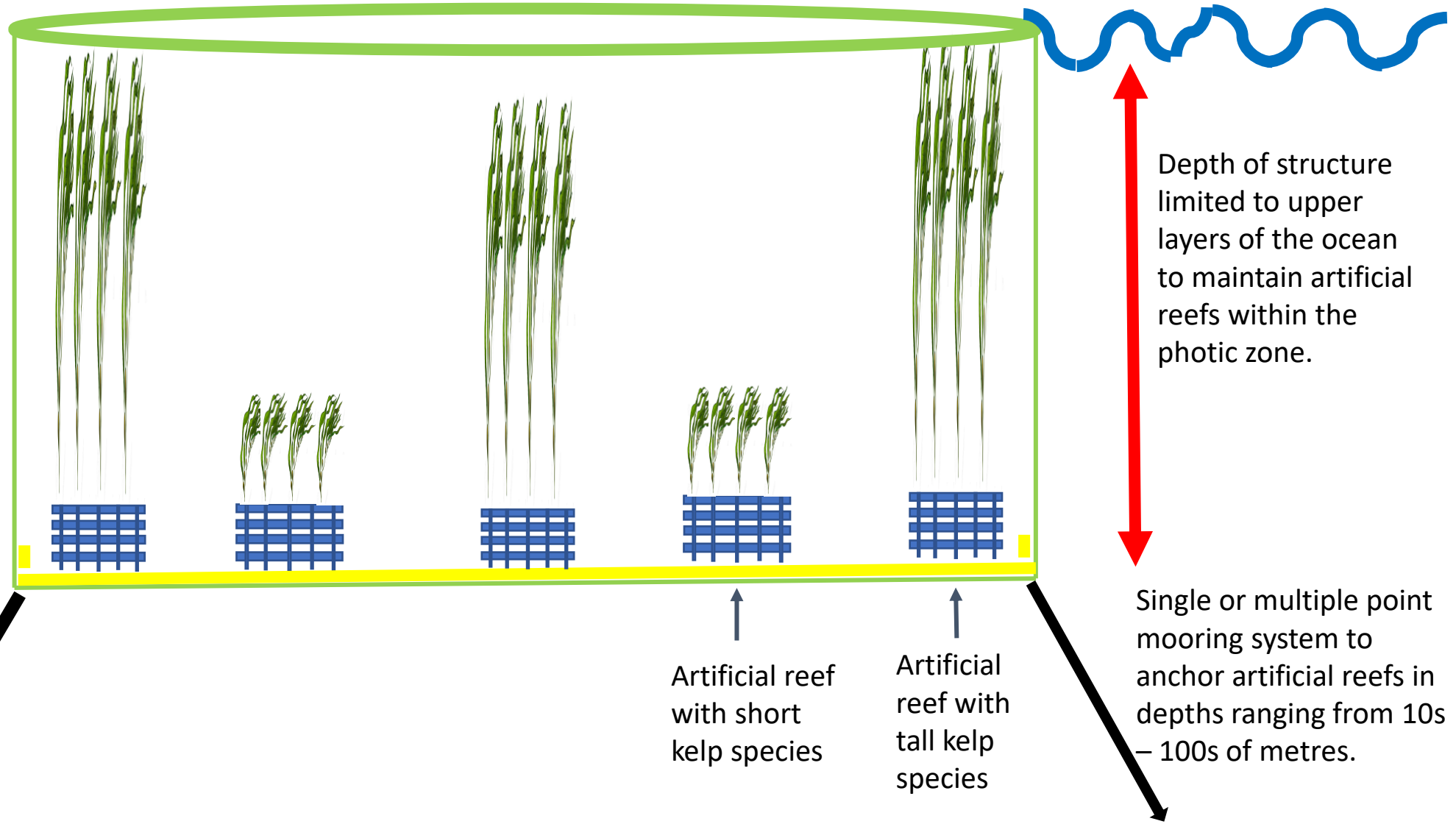



Schematic of a hypothetical floating artificial reef design highlighting design considerations

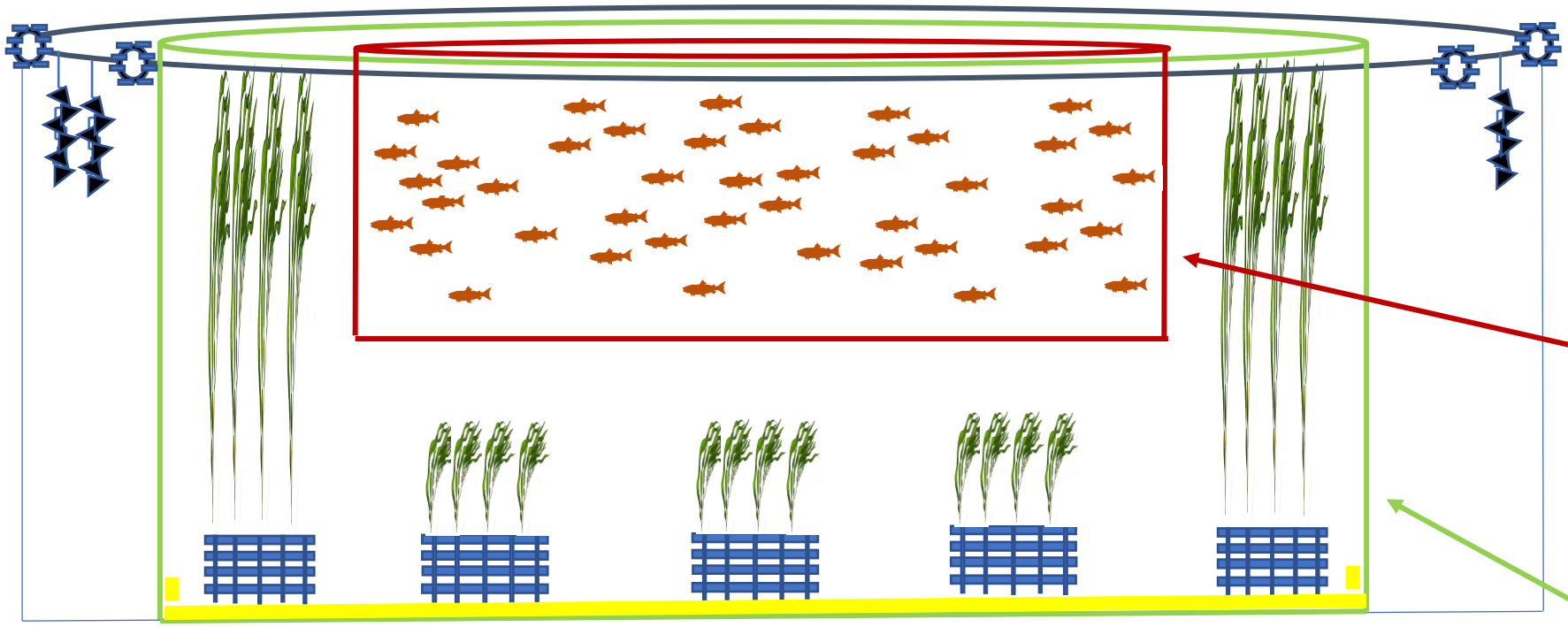
Surface floatation device to support enclosure and artificial reefs.

Enclosing barrier to allow for maximum water flow, to exclude predators and to prevent escape of cultured products.

Bottom of enclosure consists of an impermeable liner that collects sediment and provides a solid surface for cultured animals to move between reefs and within the enclosure.



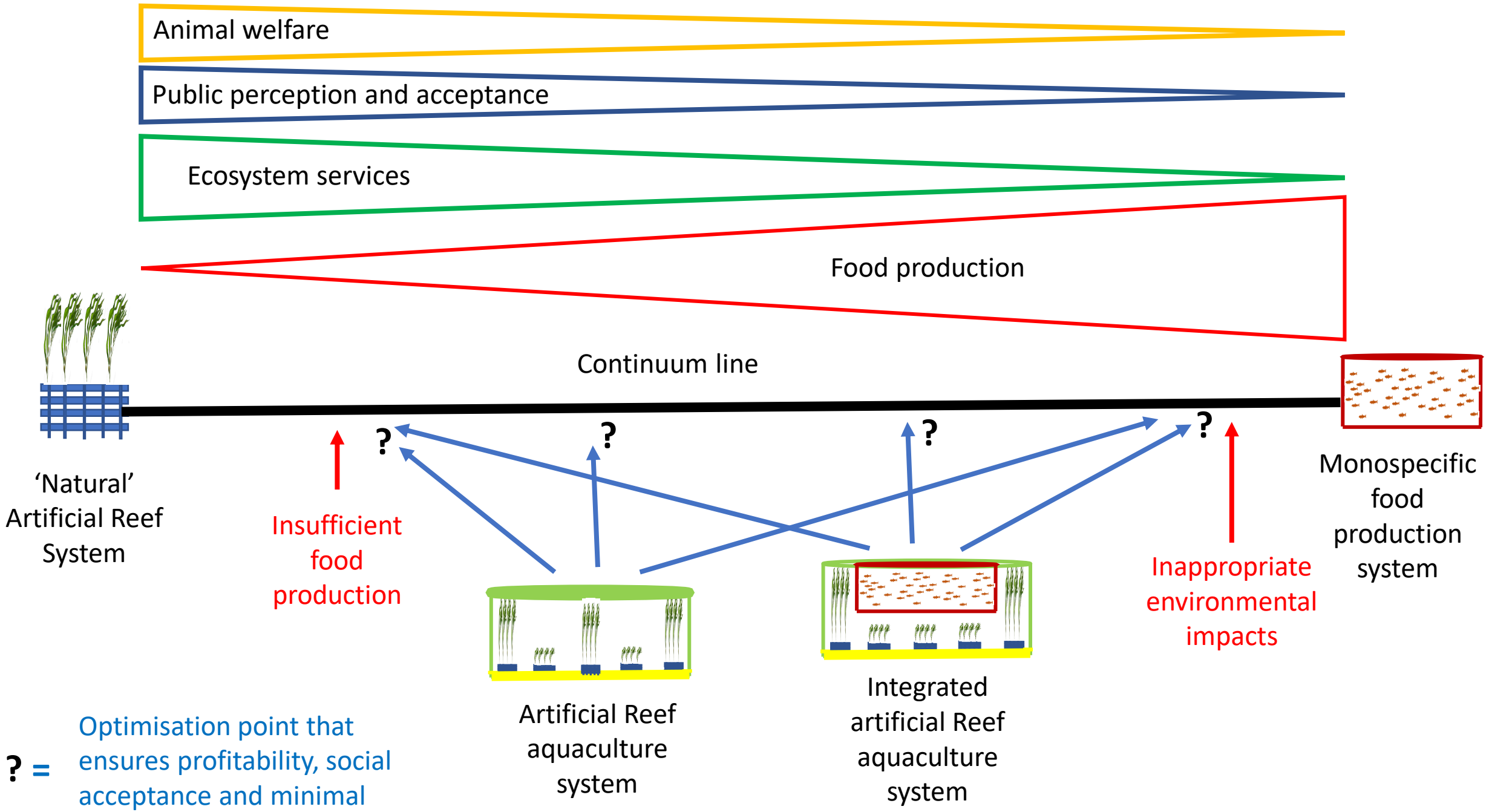
Schematic of hypothetical integrated shellfish, artificial reef and finfish design



Oyster and mussel ring: *main infrastructure at surface*
Dampen surface waves.

Standard finfish cage design: fish distributed throughout cage

Artificial reef design: *main infrastructure at bottom with algal growth extending from near surface to bottom.*
Dampen currents/swells


Animal welfare
Public perception and acceptance
Ecosystem services
Food production
Continuum line
'Natural' Artificial Reef System
Insufficient food production
?
?
?
?
Artificial Reef aquaculture system
Integrated artificial Reef aquaculture system
Inappropriate environmental impacts
Monospecific food production system
? = Optimisation point that ensures profitability, social acceptance and minimal environmental impacts

Artificial floating offshore reefs

Improved ecosystem services (reduced pressure). Return to MPAs or Indigenous peoples

Conservation

Livelihoods

Inshore natural reef

Offshore artificial reefs

Artificial ecosystem services

Food production (export)

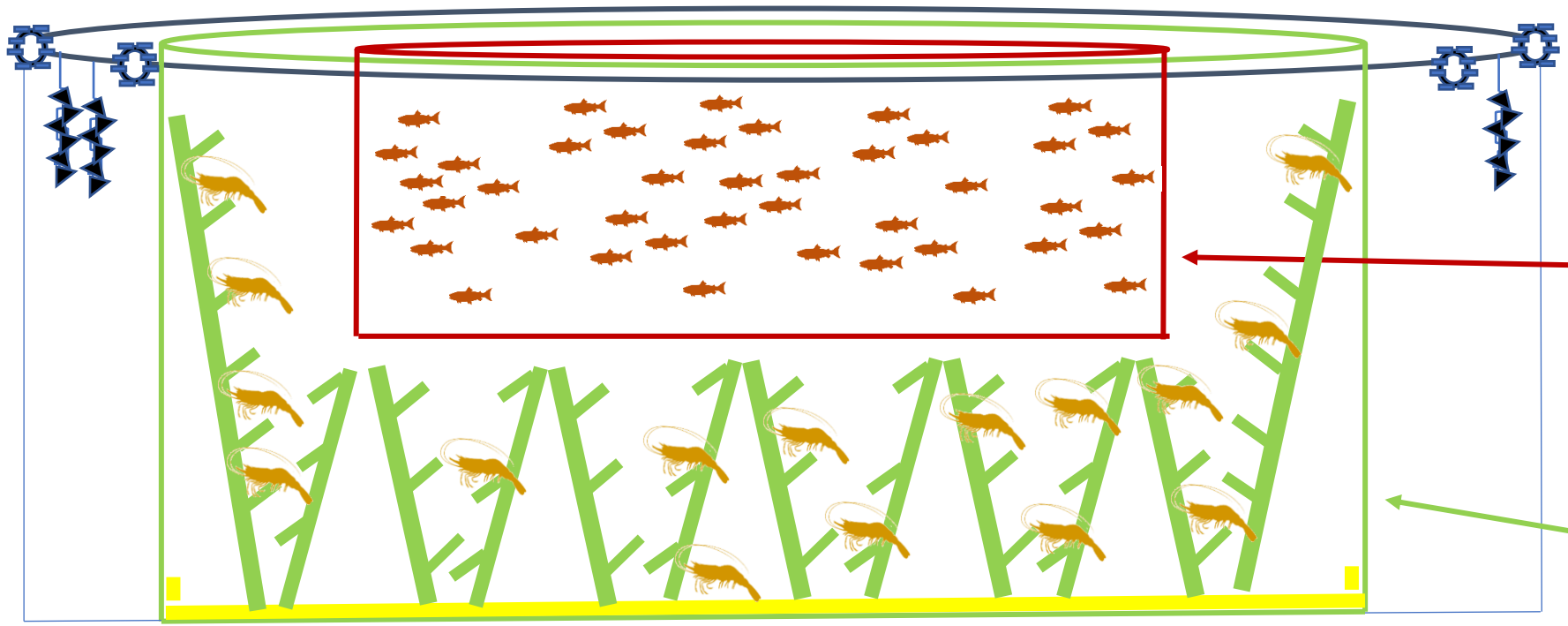
Carbon sequestration

Alternative livelihoods (e.g. tourism)

Reef restoration

Food Security (domestic and self sufficiency)

Schematic of hypothetical integrated shellfish, seagrass, prawn and finfish design



Oyster and mussel ring: *main infrastructure at surface.*

Standard finfish cage design: fish distributed throughout cage

Artificial seagrass design: *main infrastructure at bottom with extension from near surface to bottom at sides.*

Offshore prawn farming

Improved ecosystem services

Alternative livelihoods (e.g. carbon credits & sequestration)

Inshore prawn farm

Livelihoods[2]

Livelihoods [1]

Mangrove revegetation

Offshore prawn farming

Artificial ecosystem services

Food production (export)

Carbon sequestration

[1] Policy to transfer lease
[2] Farmer moves offshore

Embedding offshore seafood production in a sustainability positive framework requires new thinking around system design and governance that incorporates ecosystem and, equity principles.

It is our responsibility to ensure sustainable and ethical development of our oceans for future generations.

OUR COMMON SUSTAINABLE FUTURE