

# Environmental interactions of seaweed cultivation

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<https://www.nmbu.no/fakultet/biovit/om/institutt/iha/forskning/biofeed>

An aerial photograph of a coastal town and bay. The town is built on a peninsula with a large building complex. The bay is filled with water and has a marina with many boats. In the background, there are mountains with snow-capped peaks under a blue sky with some clouds.

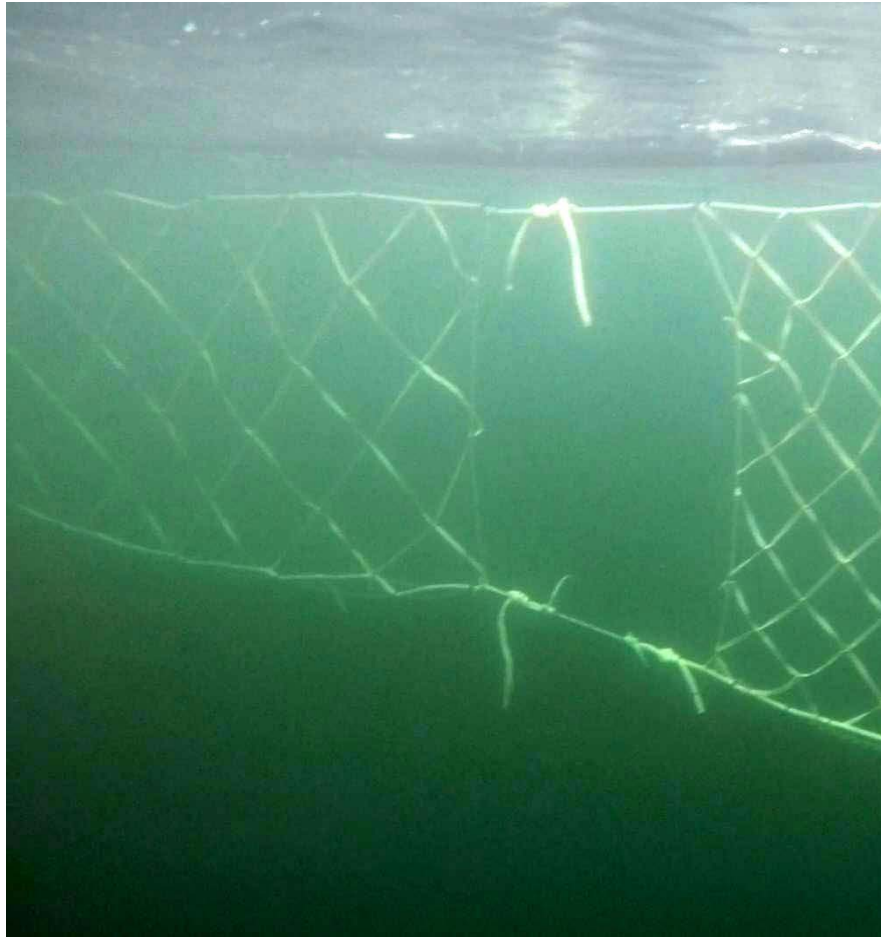
**At present the challenge is to increase productivity at cultivation sites through:**

- **More complete understanding of the biological conditions that maximise growth**
- **Selection of high yield strains**
- **Designing cultivation systems that automate seeding, harvesting and storing of products**

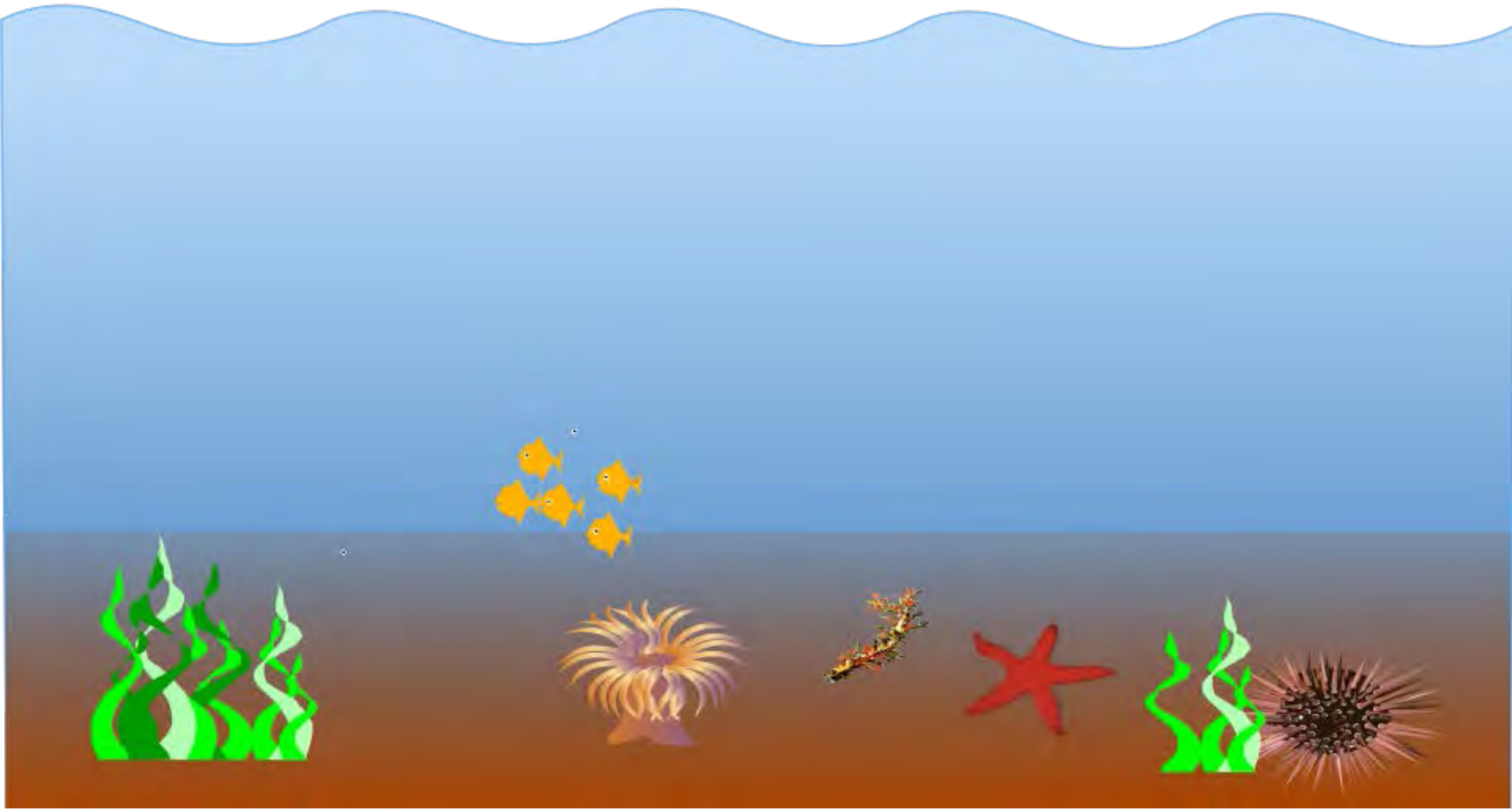


Understand the benefits and costs of seaweed aquaculture

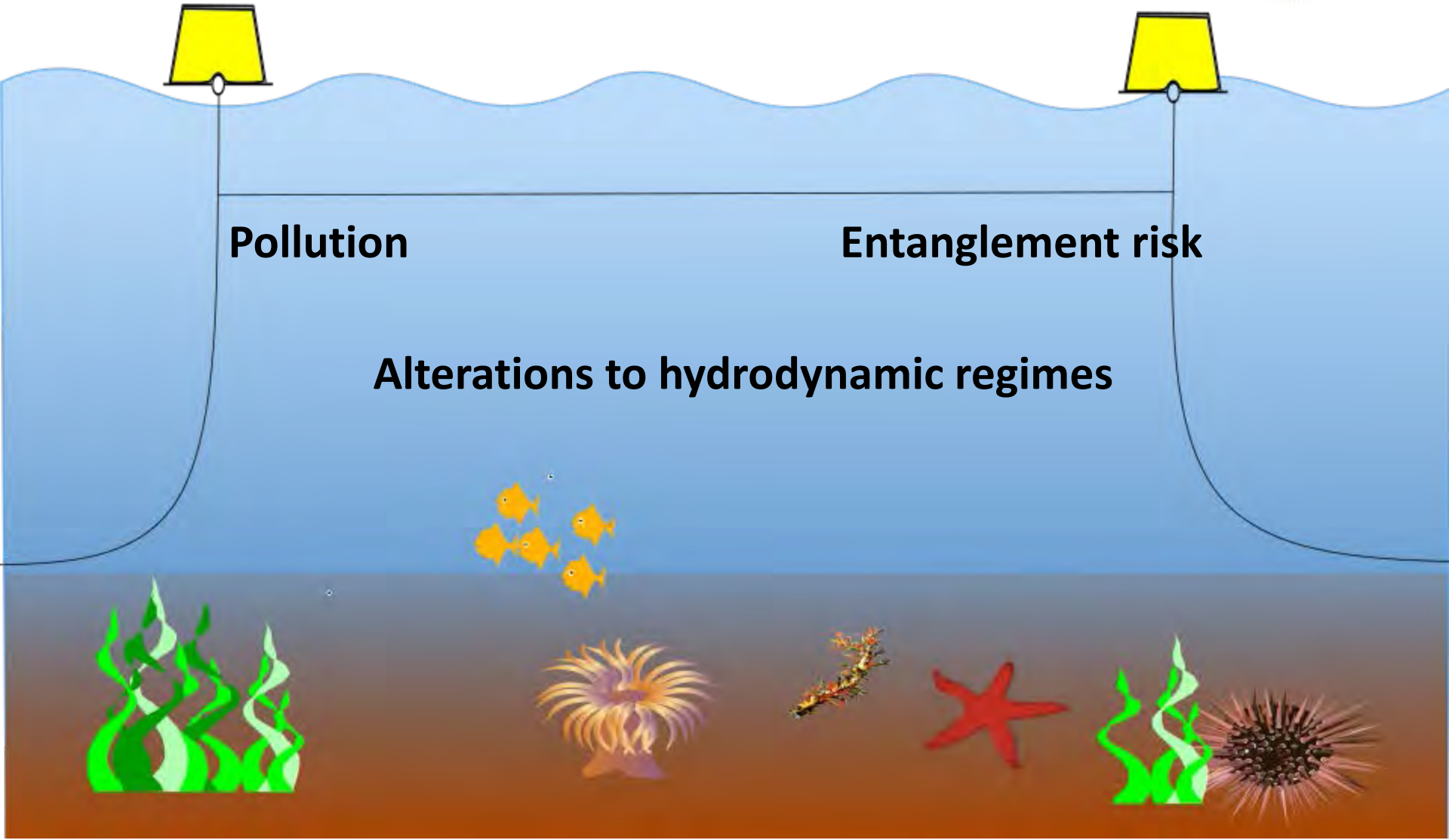
# Why consider the environment interactions?



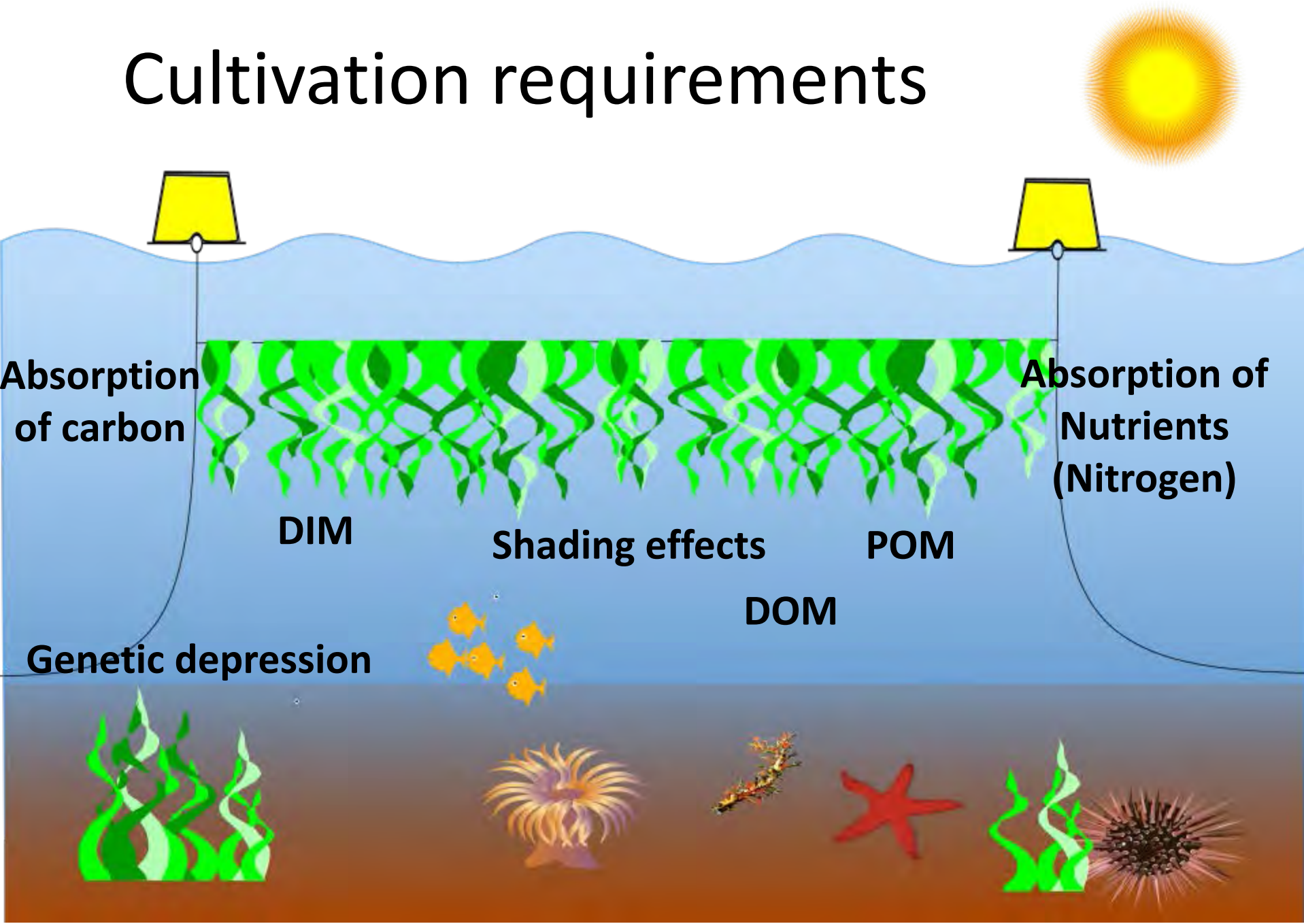
# What are the possible environmental interactions?



# Deployment of growing structures



# Cultivation requirements



# Novel habitat creation



Habitat creation



Disease and parasites

Habitat for  
invasive non-  
native species





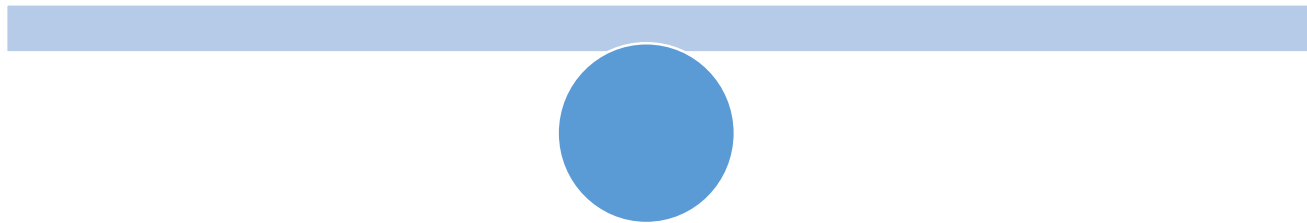
# Review of impact pathways

Change	Mitigation options	Monitoring options
Pollution	Good farm design and management	Reporting
Entanglement risk	Good sites selection. Siting projects away from sensitive areas. Farm design	Reporting
<b>Alteration of hydrodynamic regimes</b>	<b>Good site selection. Modelling at a strategic level.</b>	<b>Monitoring of local hydrodynamics</b>
<b>Absorption of nutrients (Nitrogen)</b>	<b>Good sites selection. Siting projects in enriched areas (e.g. IMTA). Modelling at a strategic level.</b>	<b>Ecosystem monitoring</b>
Shading effects	Good site selection. Siting projects away from sensitive areas	Ecosystem monitoring
<b>Genetic depression</b>	<b>Provision of seed sourced in a way that maintains the genetic diversity of wild populations and crops.</b>	<b>Monitoring of wild population genetic diversity</b>
Release of DIM, DOM, POM	Good site selection through ecosystem modelling	Ecosystem monitoring
Absorption of Carbon	-	Ecosystem monitoring
Habitat creation	Good site selection	Ecosystem monitoring
Habitat for invasive species	Biosecurity measures	Monitoring for invasive non-native species
<b>Habitat for disease</b>	<b>Biosecurity measures</b>	<b>Monitoring for disease</b>

# Null hypothesis testing in impact assessment

Detecting a change  
where there is no  
change (type 1 error)

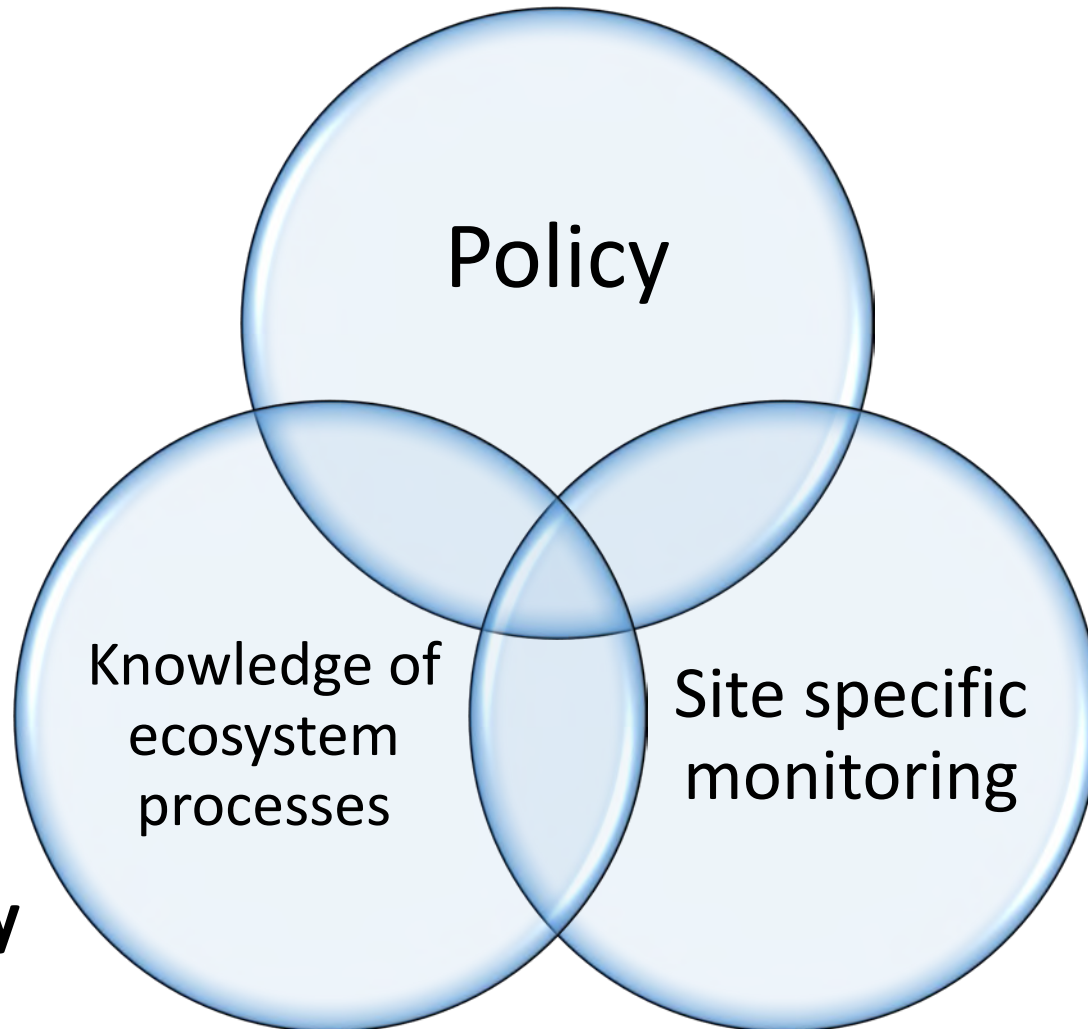
Not detecting a change  
where there is change  
(type 2 error)



There is a requirement to move away from null hypothesis testing based on 'no environmental change' and agree threshold limits of change which are 'acceptable' (e.g. level of nitrogen removal under differing scenarios).

# Future monitoring approaches

**Governing body**



**Research  
community**

**Grower**

How might cultivation practices develop in a European context?

What are the current policies governing cultivation?



Scottish Government  
Riaghaltas na h-Alba  
gov.scot

# Seaweed Cultivation Policy Statement

<http://www.gov.scot/Publications/2017/03/1340>

# Scale

## **Small-medium (0-50 x 200m lines)**

The Scottish Strategic Environmental Report indicated that there is likely to be limited environmental impact from smaller sites, but potential negative environmental impacts from larger sites of 30-100 200m lines. Such farms will be required to demonstrate mitigation measures, particularly in relation to sensitive areas. (Policies: 1-6)

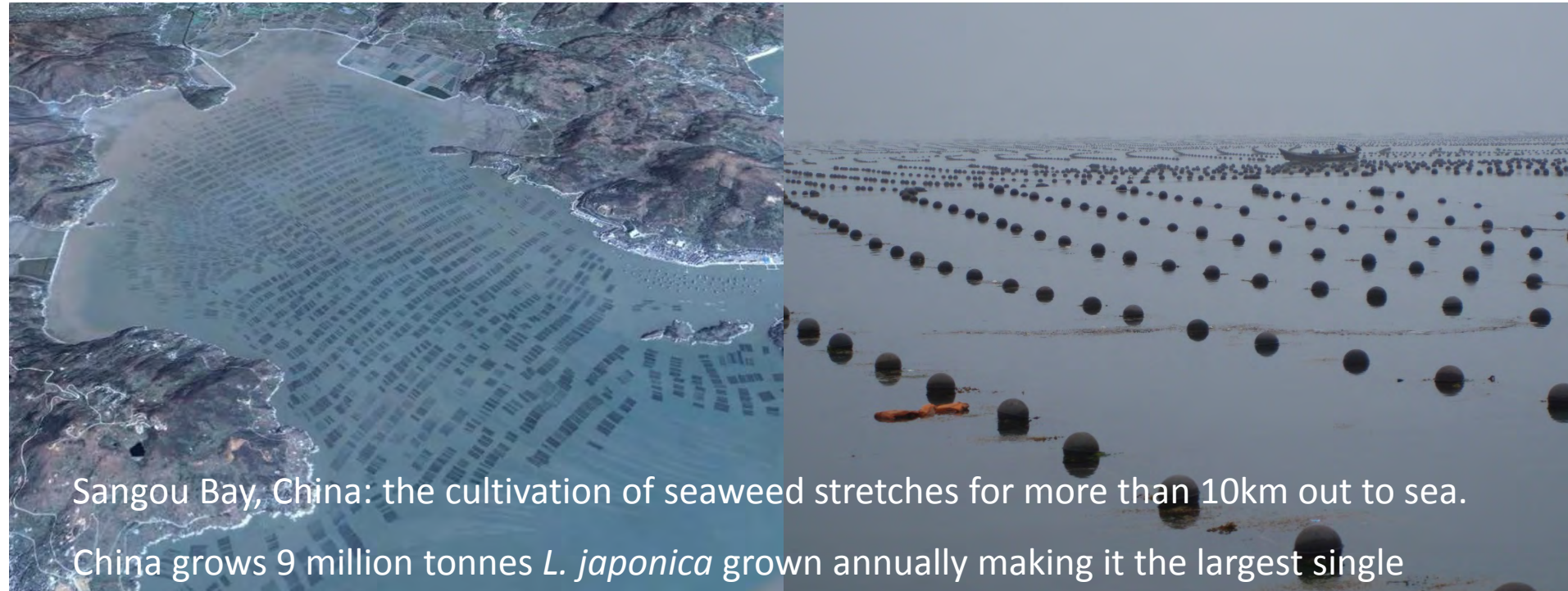


SAMS's 1 hectare farm (25 x 100m line)

# Scale

## Large (>50 x 200m lines)

This scale refers to larger sites that may utilize different equipment to that used in shellfish production. Such sites would have the potential for development for biofuel production.



Sangou Bay, China: the cultivation of seaweed stretches for more than 10km out to sea.

China grows 9 million tonnes *L. japonica* grown annually making it the largest single

# Scottish seaweed policy statement

**Policy 1 - In principle, the Scottish government is supportive of small-medium farm seaweed cultivation, subject to regulatory consideration; the General Policies set out in Chapter 4 of Scotland's' National Marine Plan; and any other relevant policies within that Plan. Applications for such seaweed farms should demonstrate that mitigation measures have been considered to prevent adverse environmental impacts, and set out how these will be delivered.**

**Policy 2 – Only species native to the area where seaweed cultivation will take place should be cultivated, to minimise the risk from non-native species.**

**Policy 3 – Where seaweed is grown for human consumption, cultivators should site farms away from sewage outfalls and other potential sources of pollution.**

**Policy 4 – Equipment used in seaweed cultivation should be fit for purpose to withstand damage from adverse weather conditions.**

**Policy 5 - Other marine users and activities should be considered in the siting of farms.**

**Policy 6 – Small-medium size farming is unlikely to be spatially limited, and may be located anywhere in Scotland, subject to agreement and appropriate local conditions.**

**Policy 7 – The Scottish Government is supportive of IMTA.**



# Scottish seaweed policy statement

**Policy 1 – Projects must demonstrate with a degree of certainty that proposals will not result environmental changes which could be considered ‘significant’ under the laws of that country.**

**Policy 2 – Non-native species should not be cultivated**

**Policy 3 – Seaweed should be grown in clean water**

**Policy 4 – Projects should be well managed and demonstrate good practice**

**Policy 5 - Other marine users and activities should be considered in the siting of farms.**

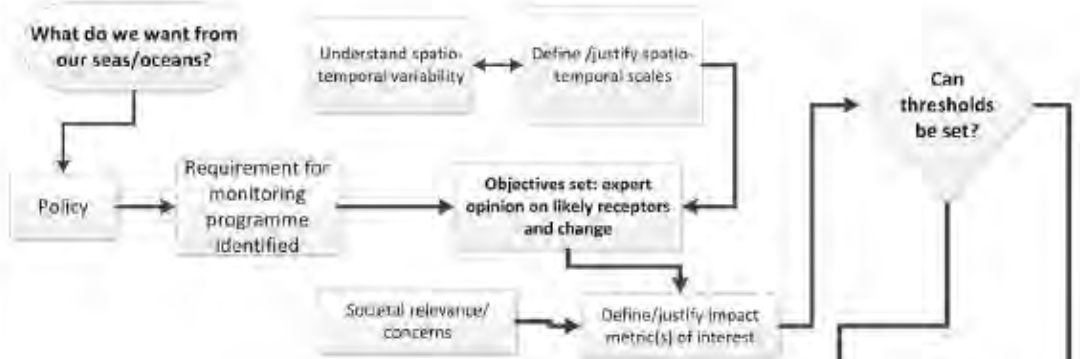
**Policy 6 – Small-medium size farming is unlikely to be spatially limited, and may be located anywhere in Scotland, subject to agreement and appropriate local conditions.**

**Policy 7 –IMTA should become a primary focus**

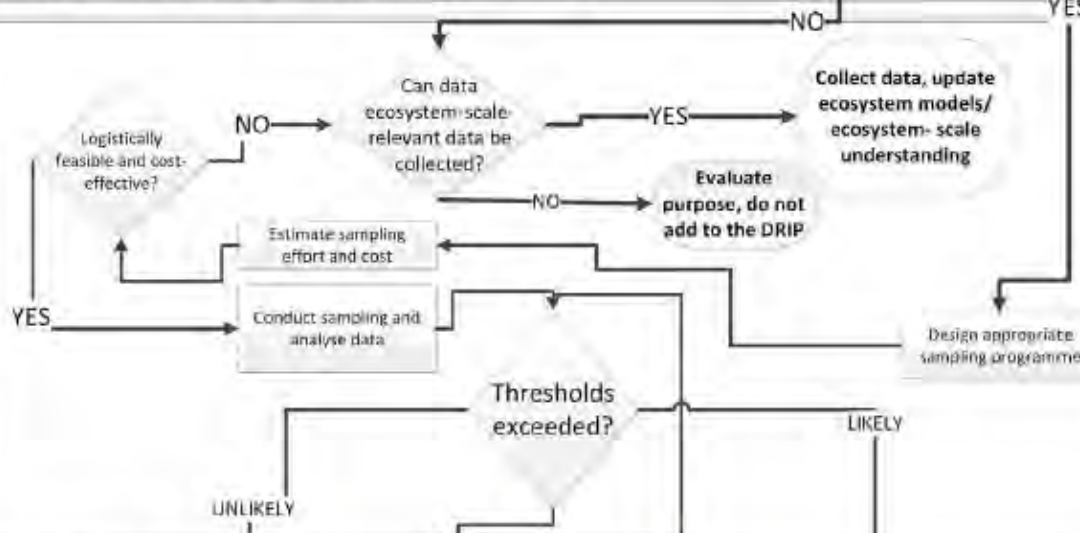
# Final thoughts

- **Generate understanding of principle changes**
- **Develop tools that are industry specific**
- **Set reasonable limits for environmental change**
- **Grow seaweed!**

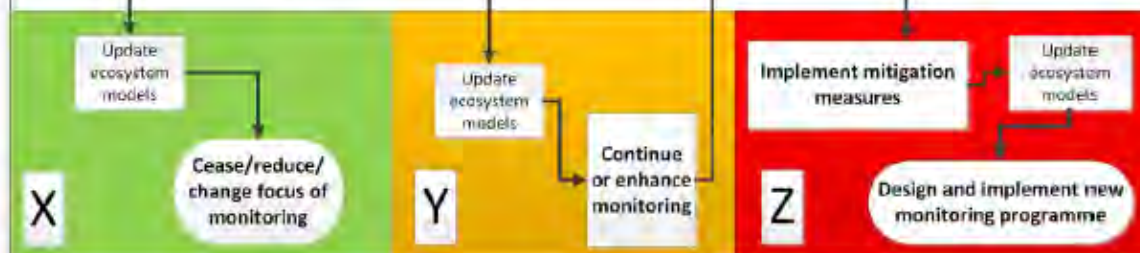
Phase I – Pre-sampling receptor/metric identification, threshold setting /justification



Phase II – Evaluation and data analysis (comparison against threshold)

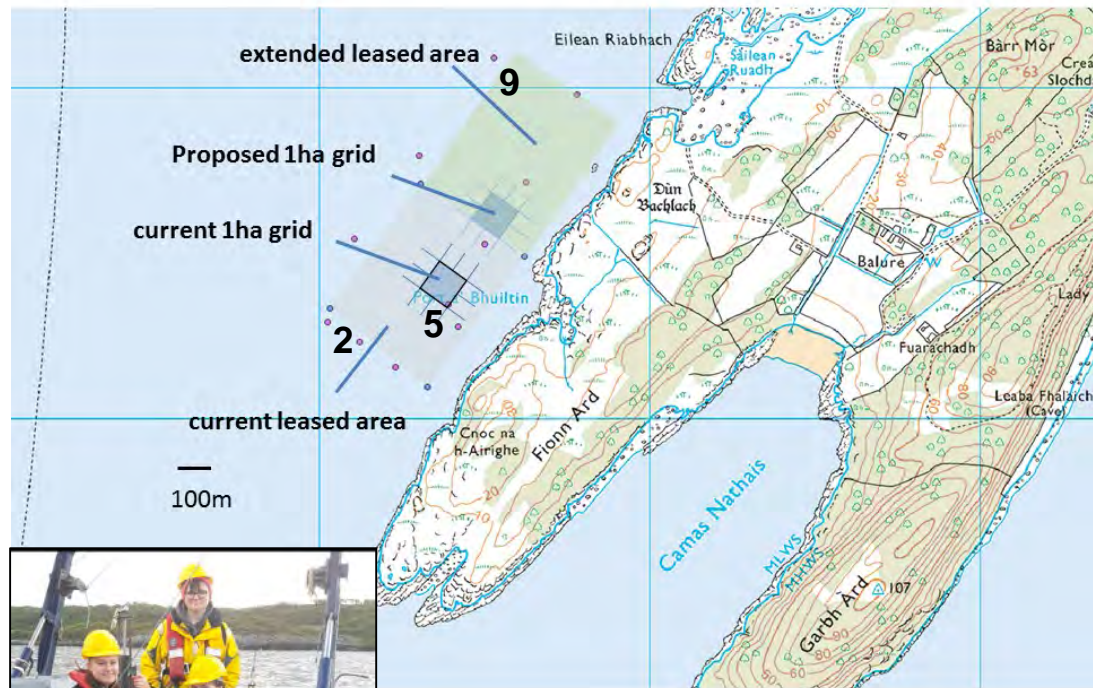


Phase III Decision making



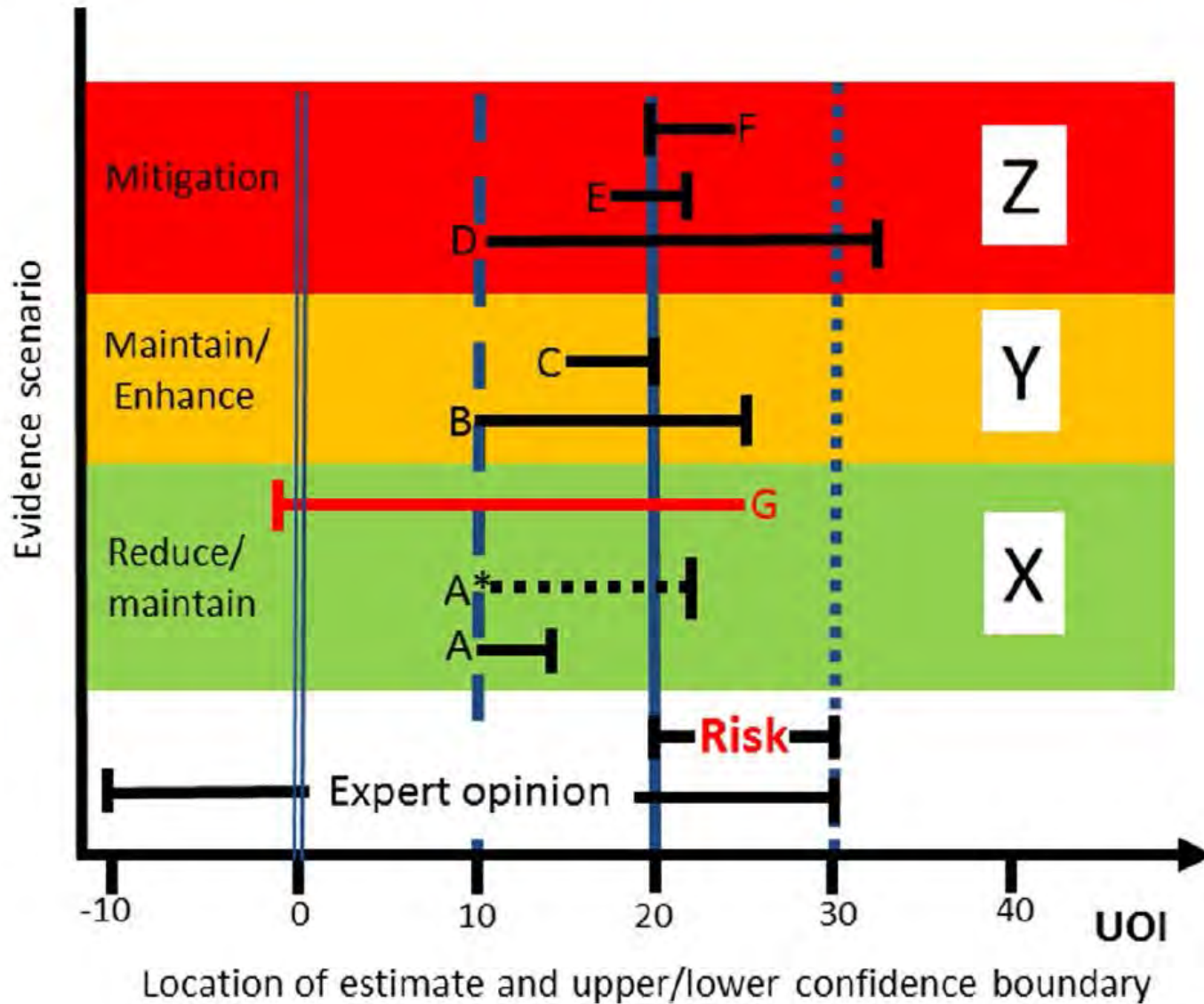
# Environmental impact of the SAMS seaweed farm

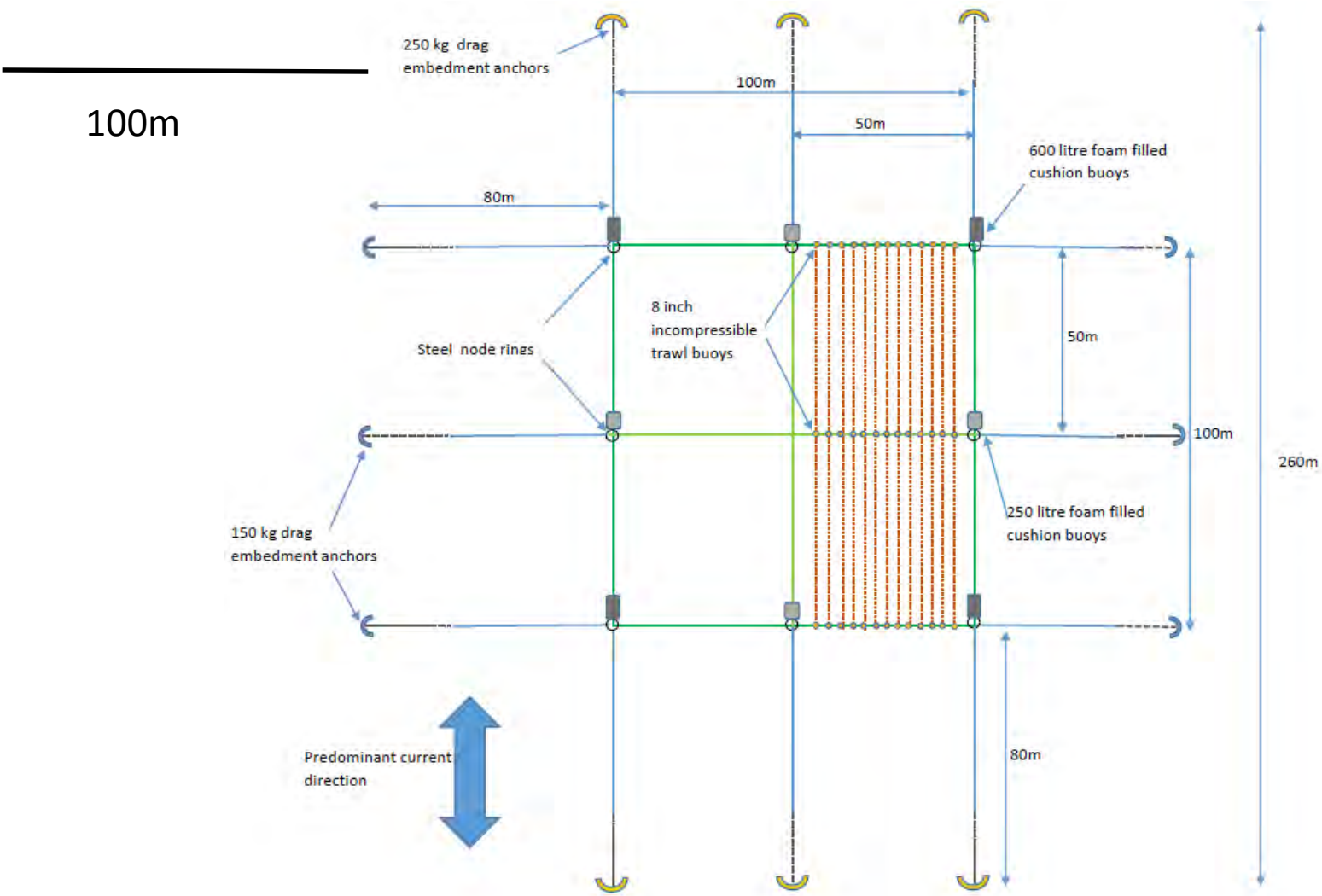
- Sites chosen based on original impact assessment
- Sampled 3 times before & after harvest (June, Aug & Sept)
- Sediment (sectioned 8cm cores) and water (T, M, B) samples collected
  - Water: Nutrients, oxygen, DOC/POC, chlorophyll
  - Sediment: geochem (particle size, chlorophyll, TOC), macrofauna (Grab), microbial
- Go pro & CTD



Carnegie trust funded student- Hanna Ewen

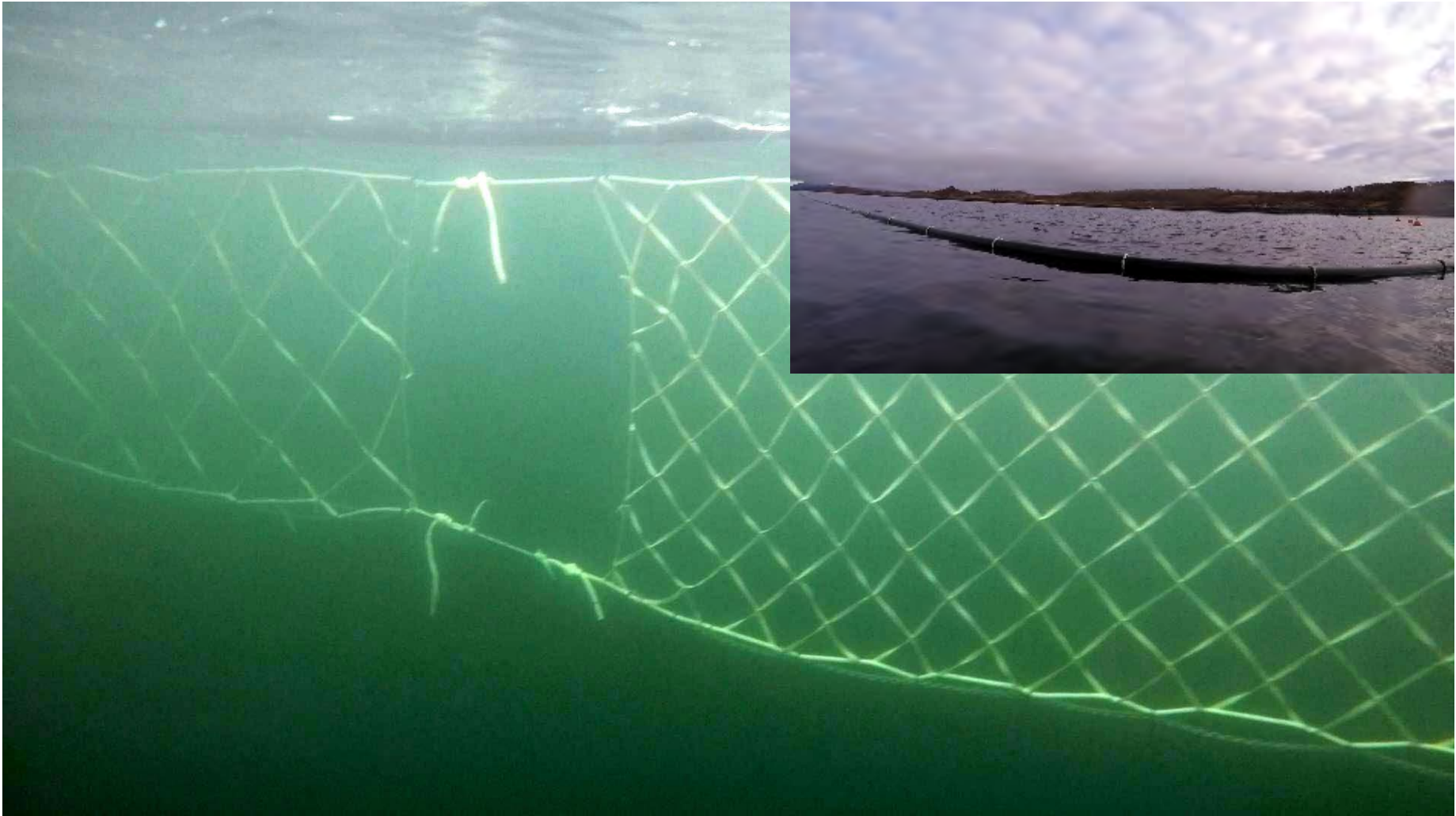
# Agreeing limits!





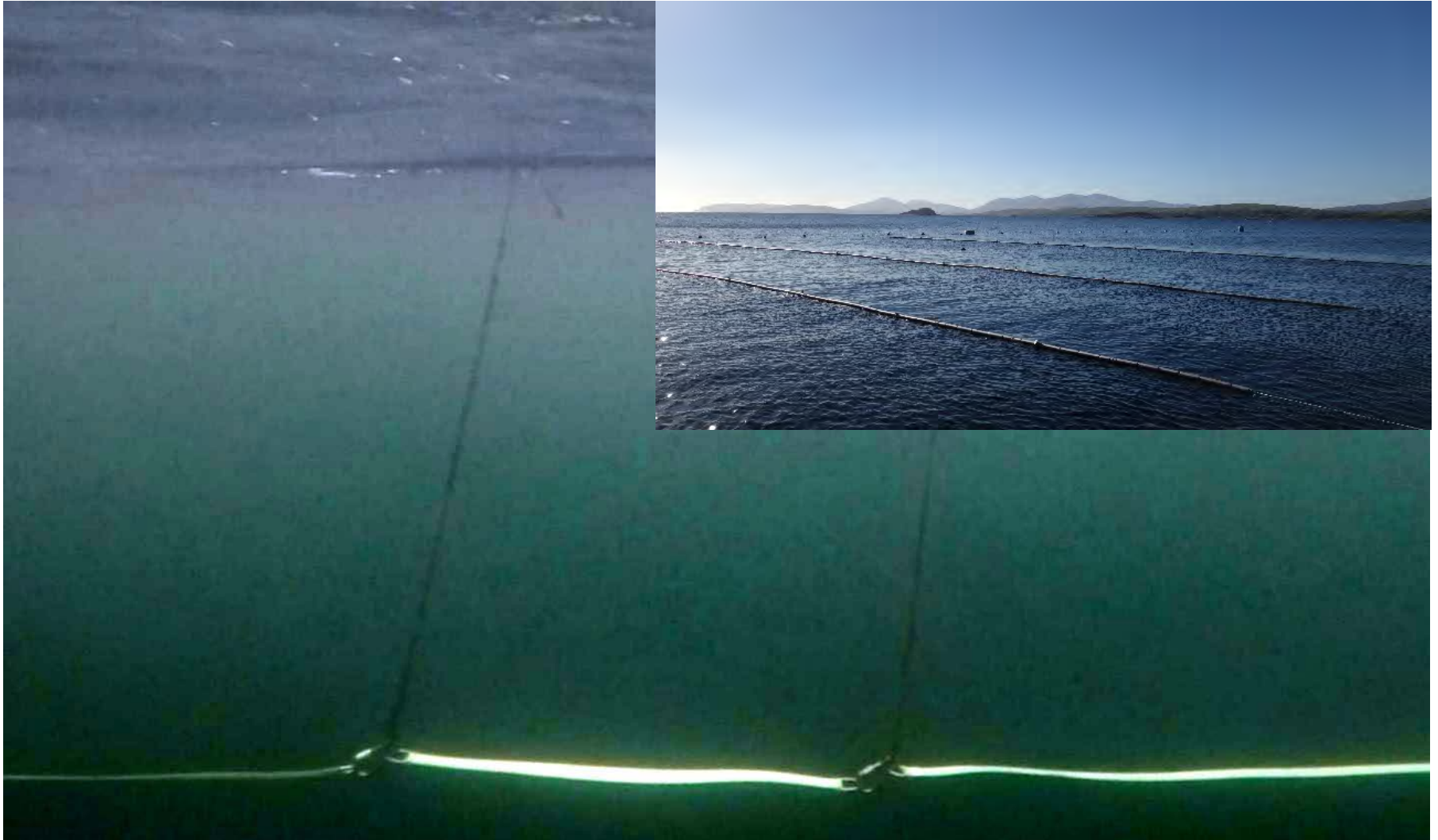
Currently utilising a single 100x100m grid with the capacity for 2.4 kilometre of line. We would like to expand our site by deploying a second larger grid whilst increasing stocking densities

# Trailing different growing systems



Nets suspended from a HDPE pipe (SDR11-90mm) to provide floatation and a suitable vessel lifting point during harvest. *Alaria esculenta* and *Saccharina latisima* were seeded on one net of each mesh size.

# Optimising growing conditions



**Seeding time and coppicing experimental lines with 1 m test section.**



# Conclusions



Image taken from AT-SEA TECHNOLOGIES

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There is a need to clearly articulate the benefits of this type of aquaculture whilst ensuring management is proportionate to the risks.





Image taken from AT-SEA TECHNOLOGIES

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This work will identify impact-pathways which should be given particular attention whilst the industry develops.



Image taken from AT-SEA TECHNOLOGIES

# Conclusions

There is a need to clearly articulate the benefits of this type of aquaculture whilst ensuring management is proportionate to the risks.

This work will identify impact-pathways which should be given particular attention whilst the industry develops.

Monitoring efforts need to be strategic and acceptable limits of change agreed.

# Key messages

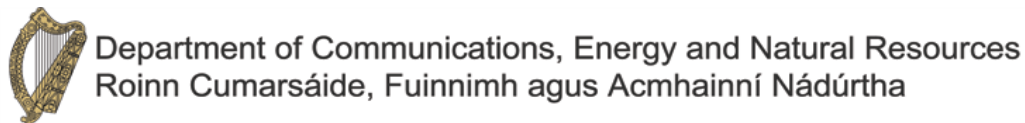
- **Generate understanding of principle impacts**
- **Develop tools that are industry specific**
- **Set reasonable limits for environmental change**
- **Grow seaweed!**



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