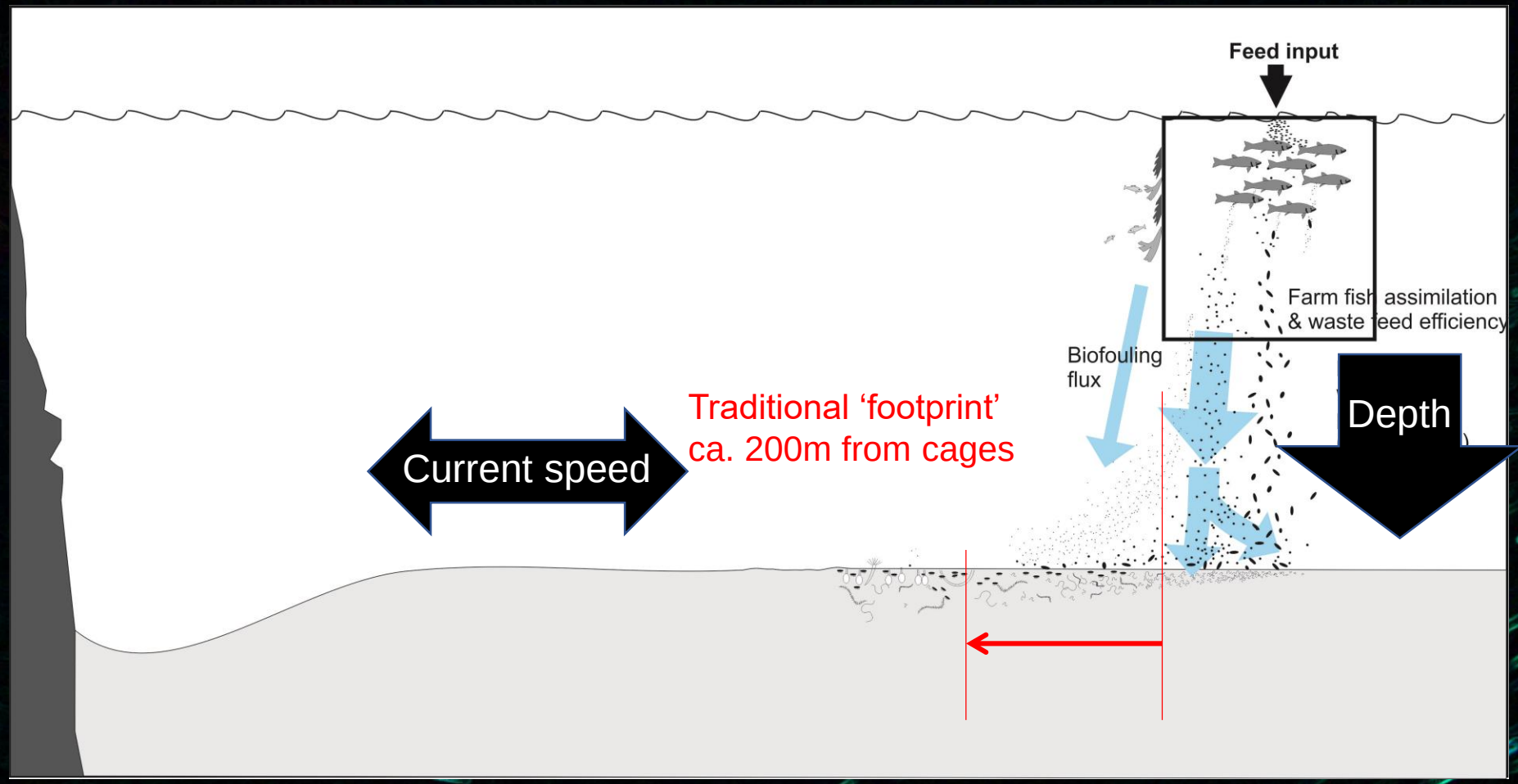
# Akvakultur og effekt på havbunn

Nigel Keeley

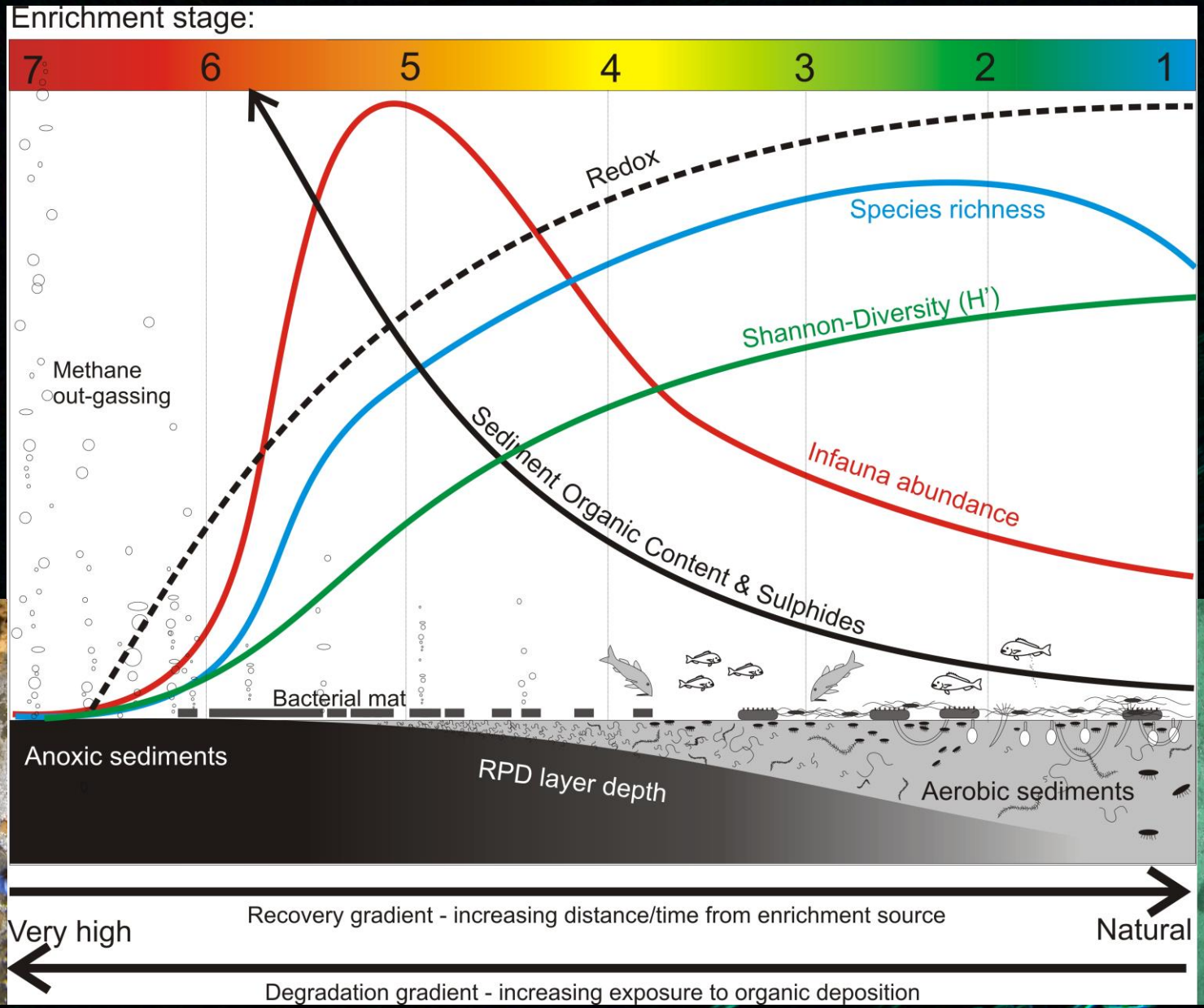
# The conventional benthic ‘footprint’

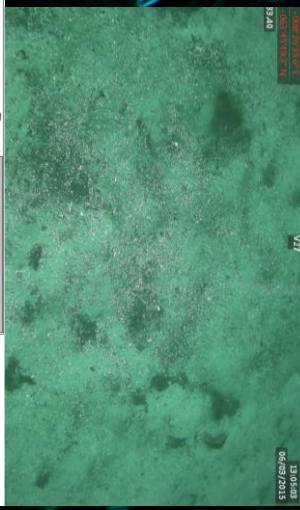
## Benthic effects traditionally concern near-field macrofauna and sediment chemistry



# The conventional benthic ‘footprint’

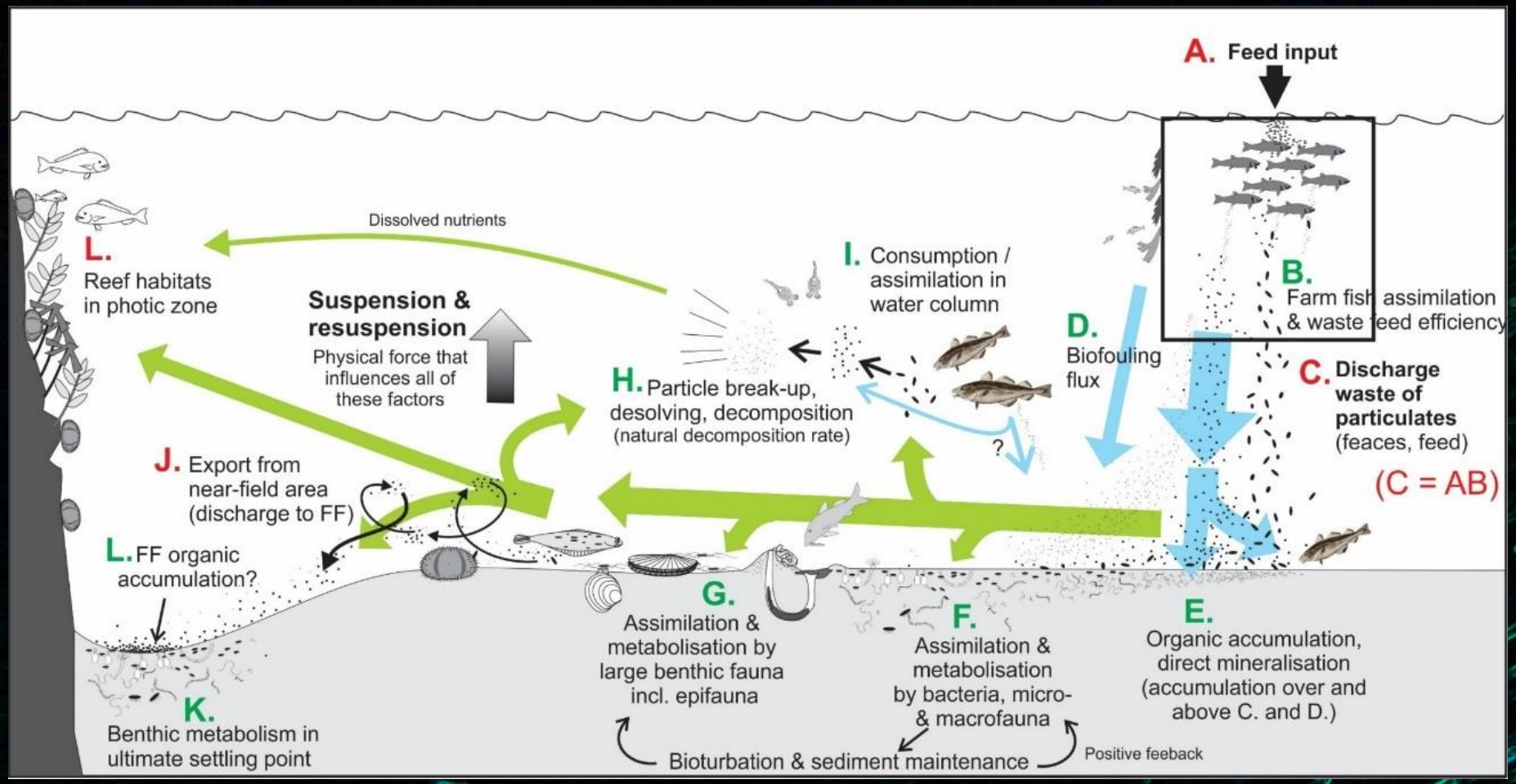
Soft-sediment effects are simple to measure and reasonably predictable



# *Beyond* the conventional footprint:

## The flow of organic waste through the ecosystem – a little more complicated…



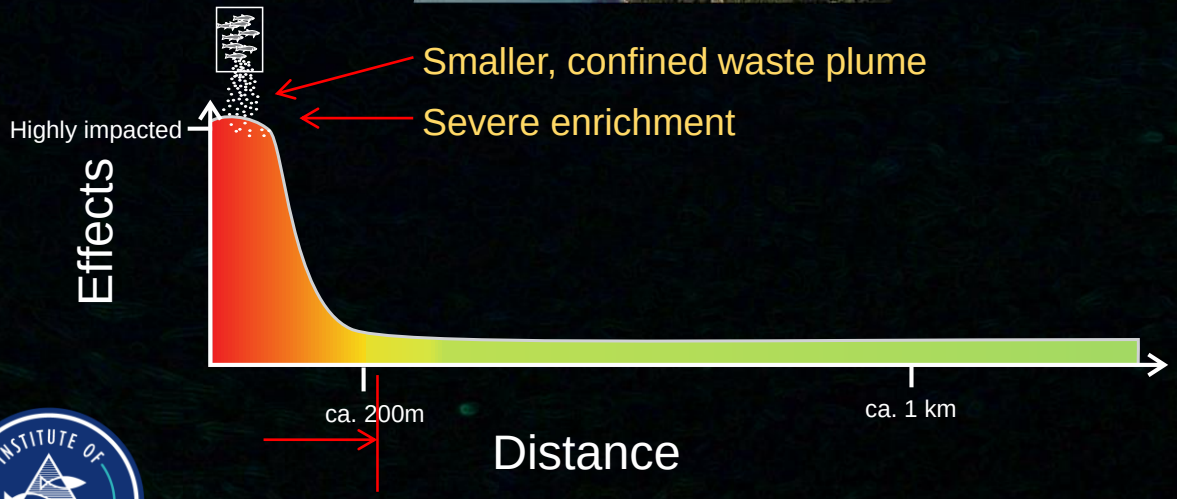
# Changing pressures: 1. Greater production, bigger footprint

**Big farms = More dispersive sites = More waste & different 'footprint'**

- 1970's & 80's: 100's Tons fish/farm/yr., today: 1000's or 10,000's Ton
- Better sites = more waste = different receiving environments

# Changing pressures: 1. Greater production, bigger footprint

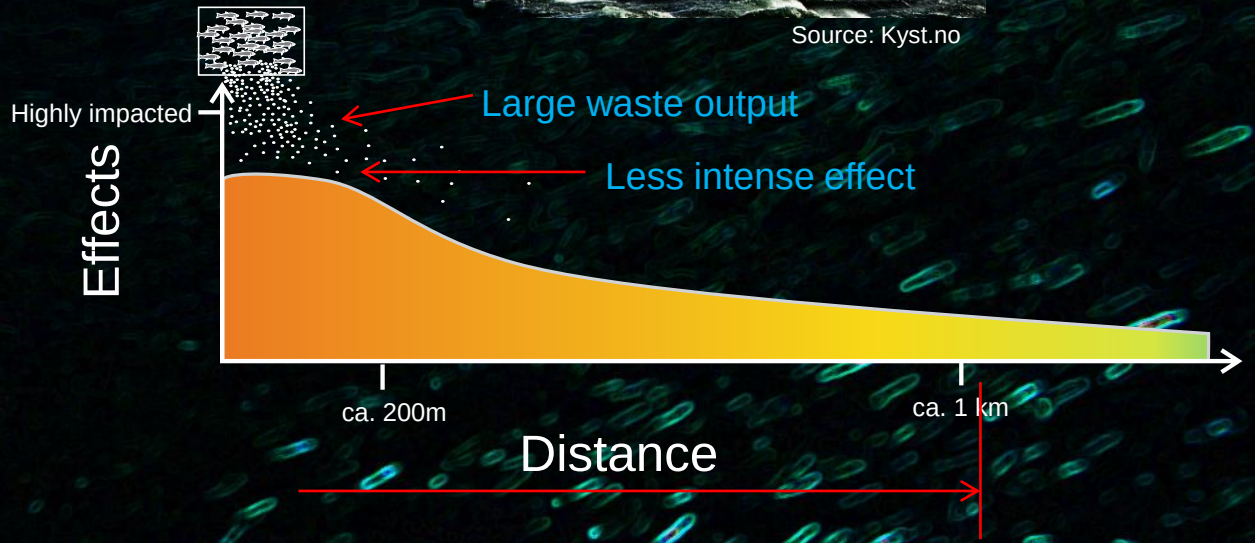
## Traditional farming




Localised effects
(ca. 200m dist.)

## Large dispersive sites

Source: Kyst.no

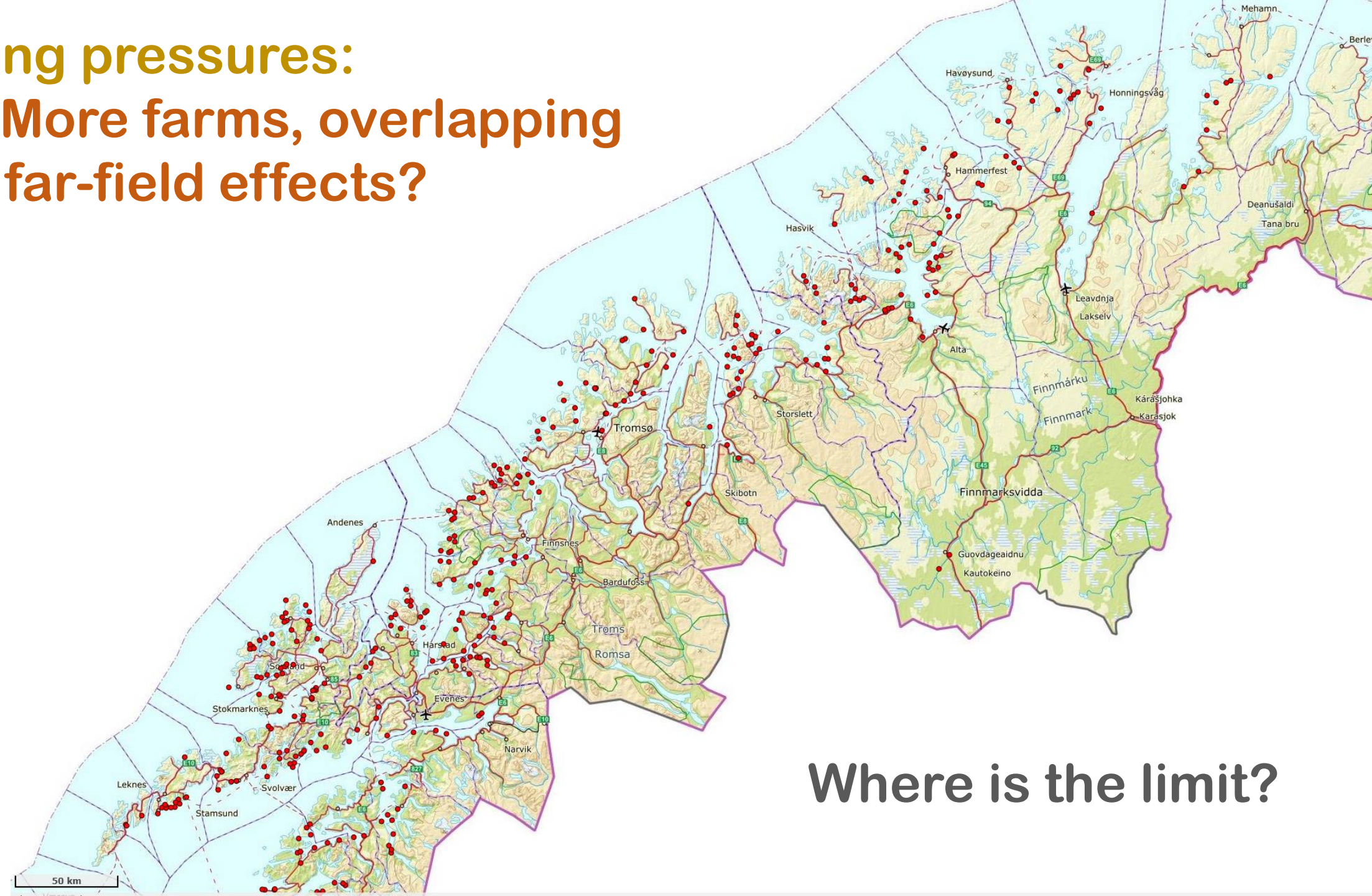



Large diffuse footprint
(ca. 1000m +/-)

Uncertainty

# Changing pressures:

## 2. More farms, overlapping far-field effects?

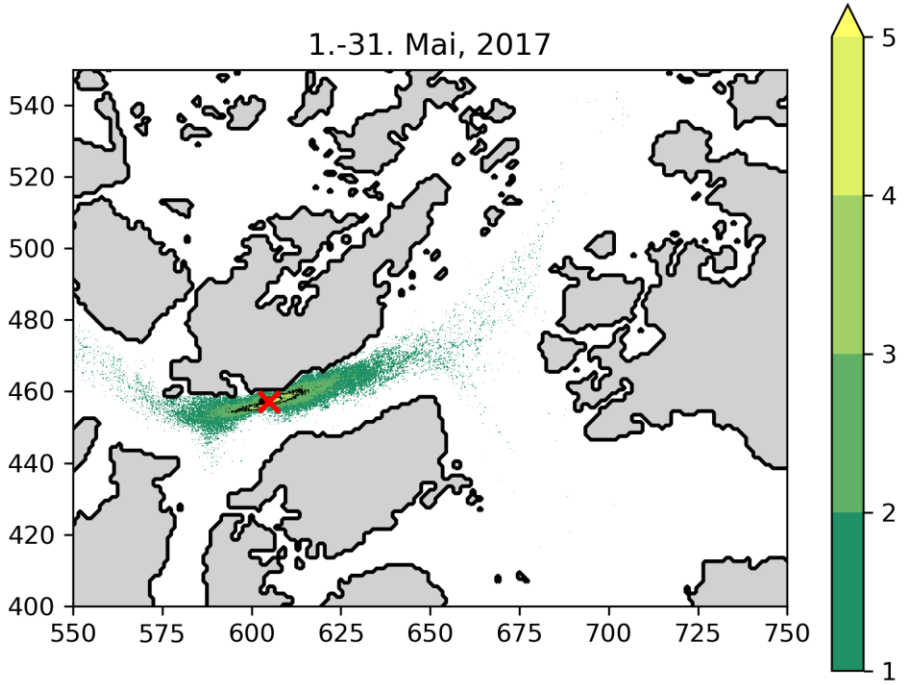



**Where is the limit?**

# Changing pressures:

## 2. More farms, overlapping far-field effects?

Predicted waste dispersal:
Farm-A

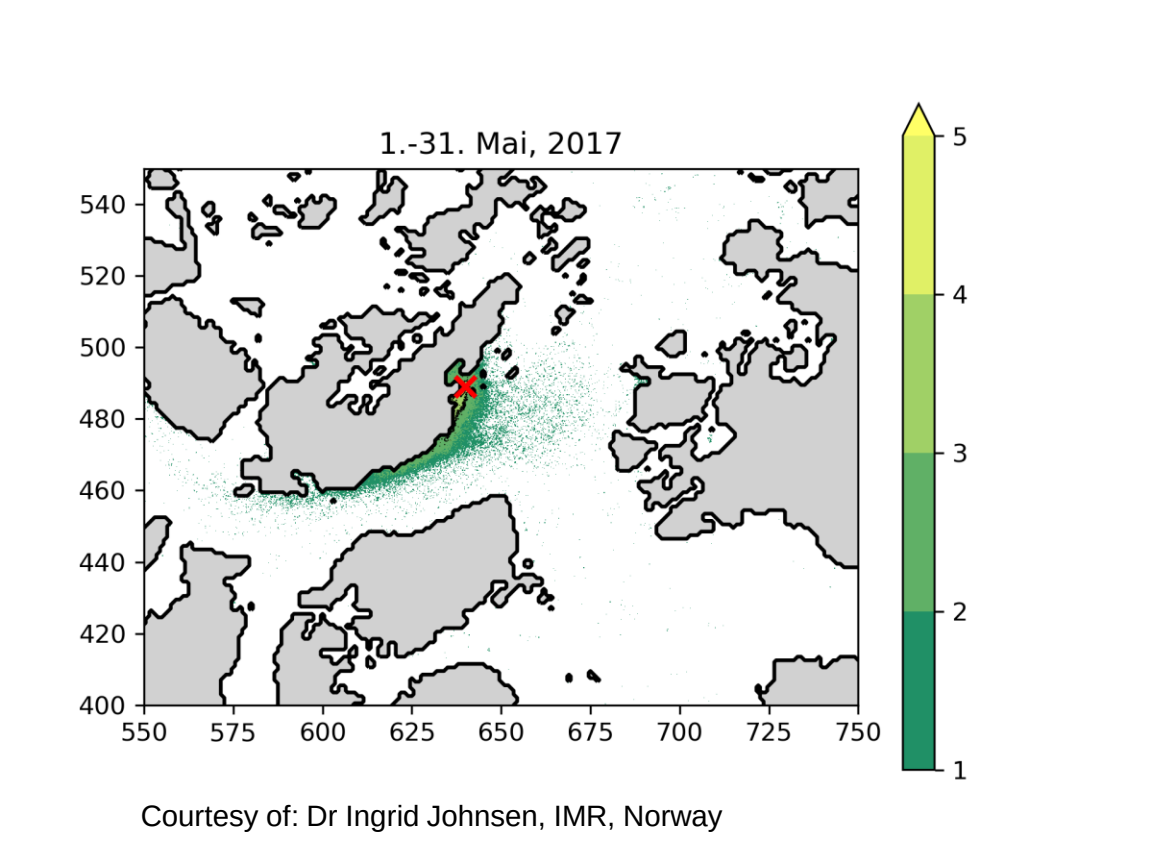



Courtesy of: Dr Ingrid Johnsen, IMR, Norway

# Changing pressures:

## 2. More farms, overlapping far-field effects?

Predicted waste dispersal:
Farm-B

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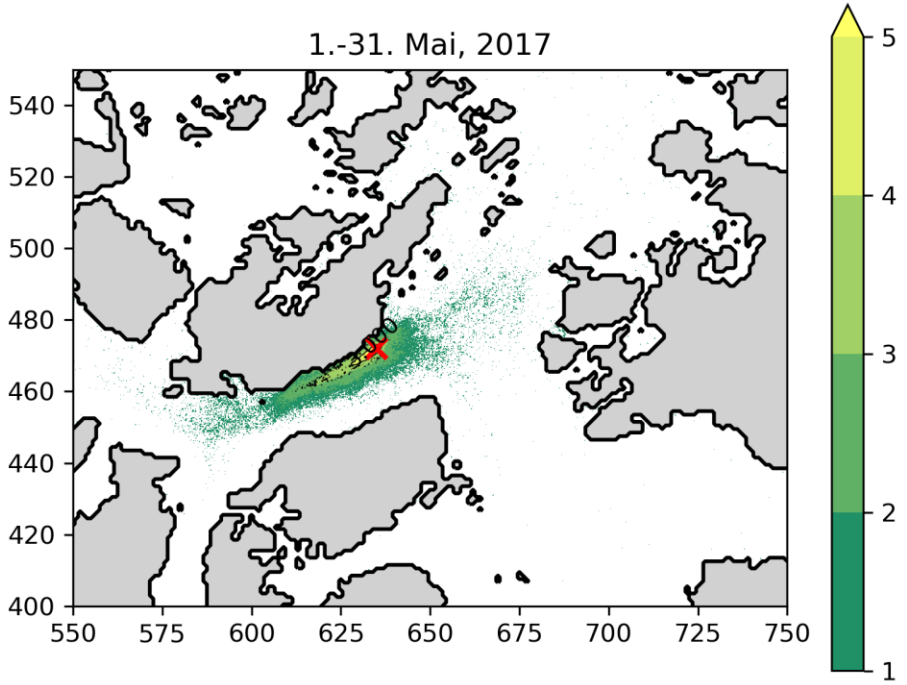
# Changing pressures:

## 2. More farms, overlapping far-field effects?

Predicted waste dispersal:
Farm-C

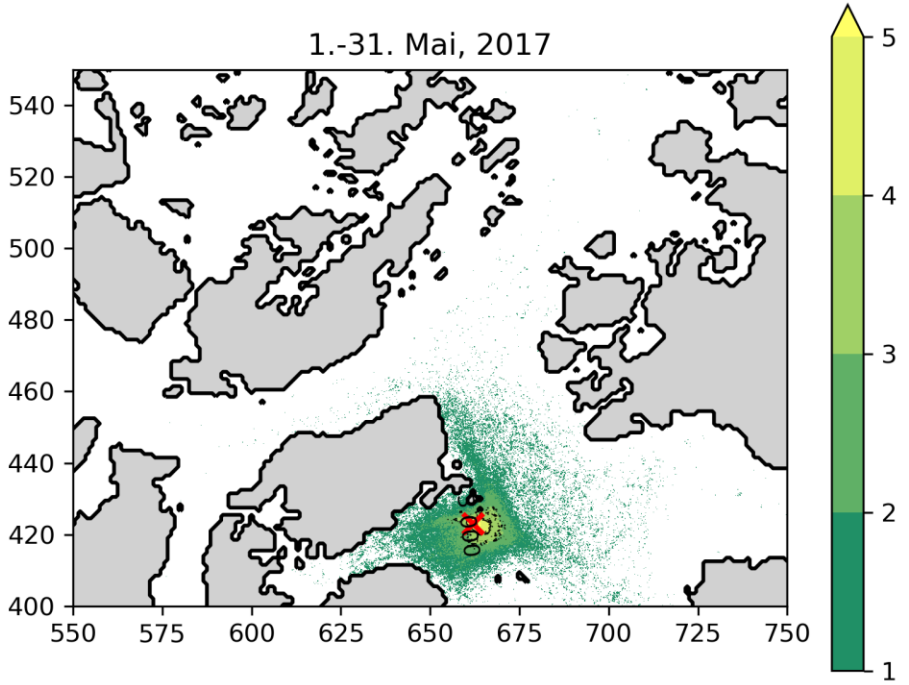



Courtesy of: Dr Ingrid Johnsen, IMR, Norway

# Changing pressures:

## 2. More farms, overlapping far-field effects?

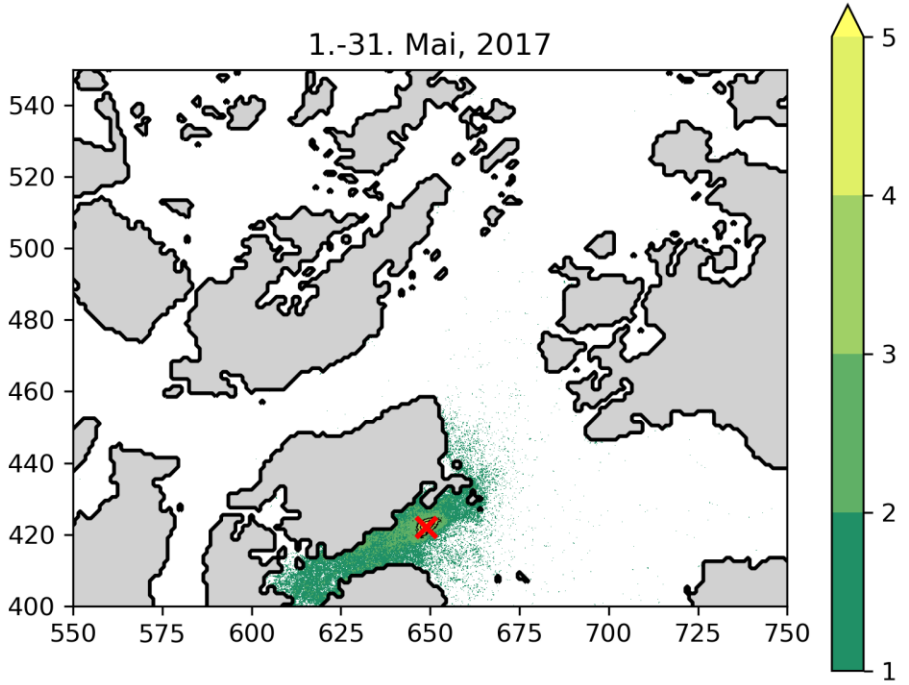
Predicted waste dispersal:
Farm-D




Courtesy of: Dr Ingrid Johnsen, IMR, Norway

# Changing pressures:
## 2. More farms, overlapping far-field effects?

Predicted waste dispersal:
Farm-E

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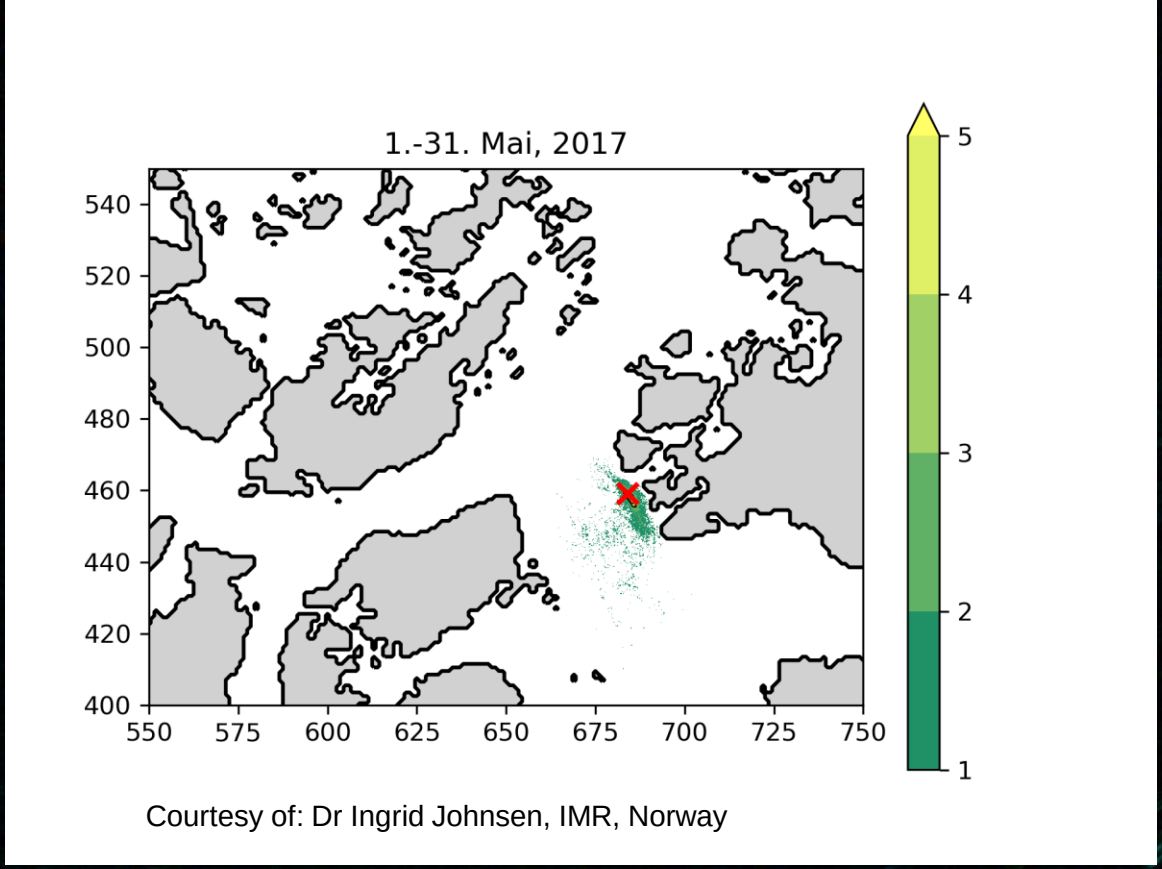
# Changing pressures:

## 2. More farms, overlapping far-field effects?

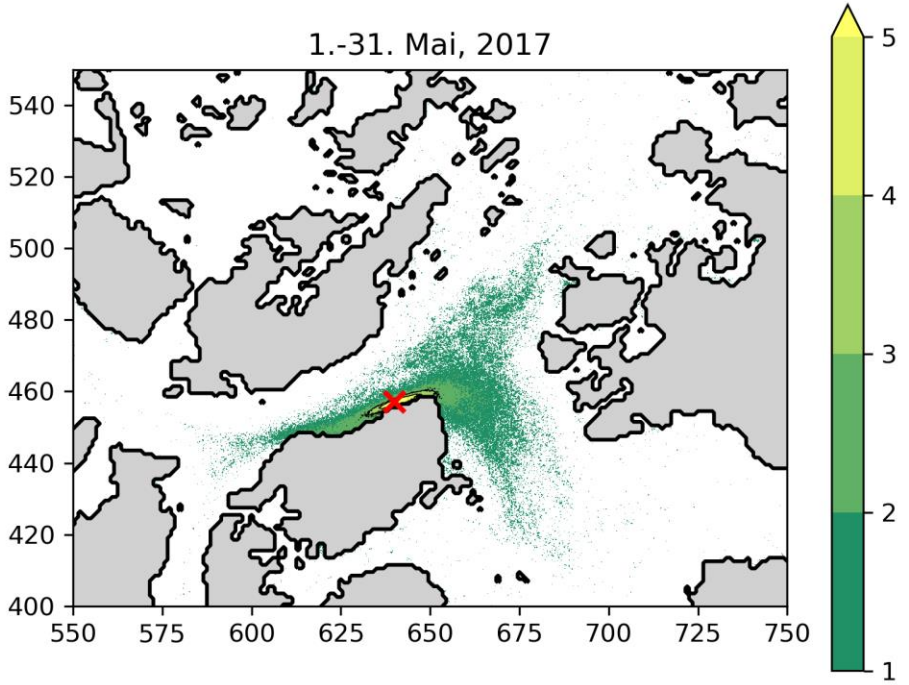
Predicted waste dispersal:
Farm-F




Courtesy of: Dr Ingrid Johnsen, IMR, Norway

# Changing pressures:
## 2. More farms, overlapping far-field effects?

Predicted waste dispersal:
Farm-G

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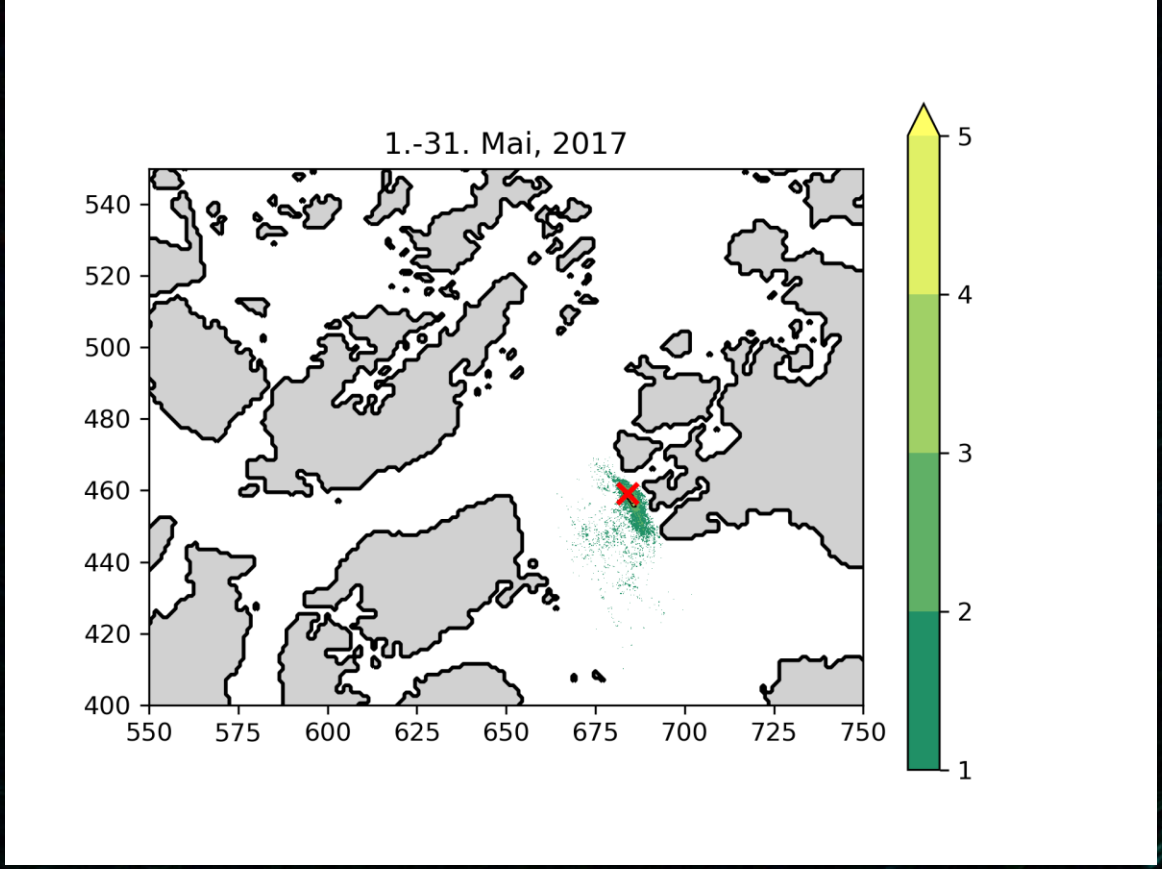
# Changing pressures:

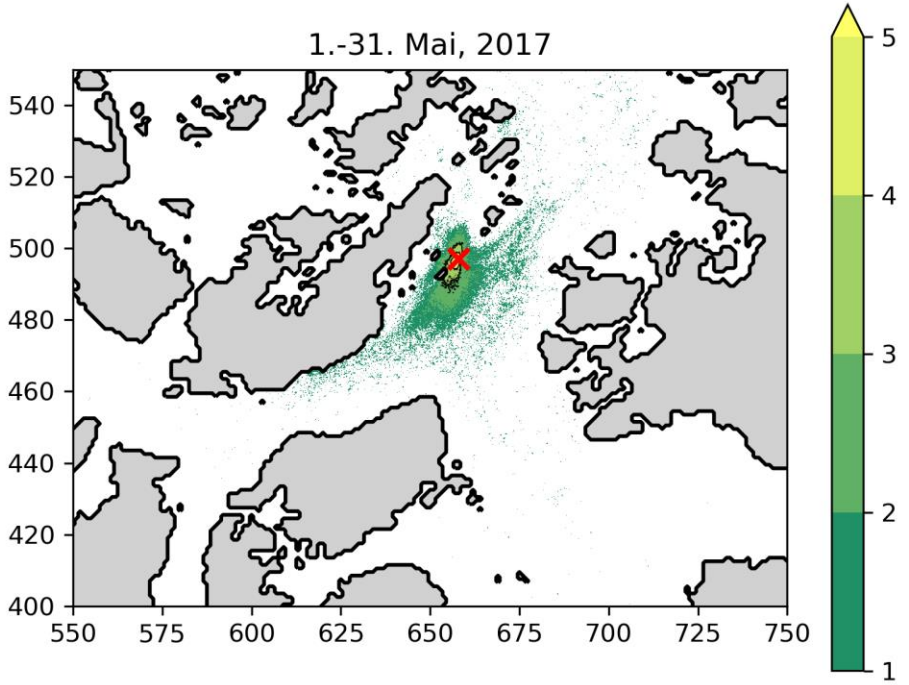
## 2. More farms, overlapping far-field effects?

Predicted waste dispersal:
Farm-H



# Changing pressures:
## 2. More farms, overlapping far-field effects?

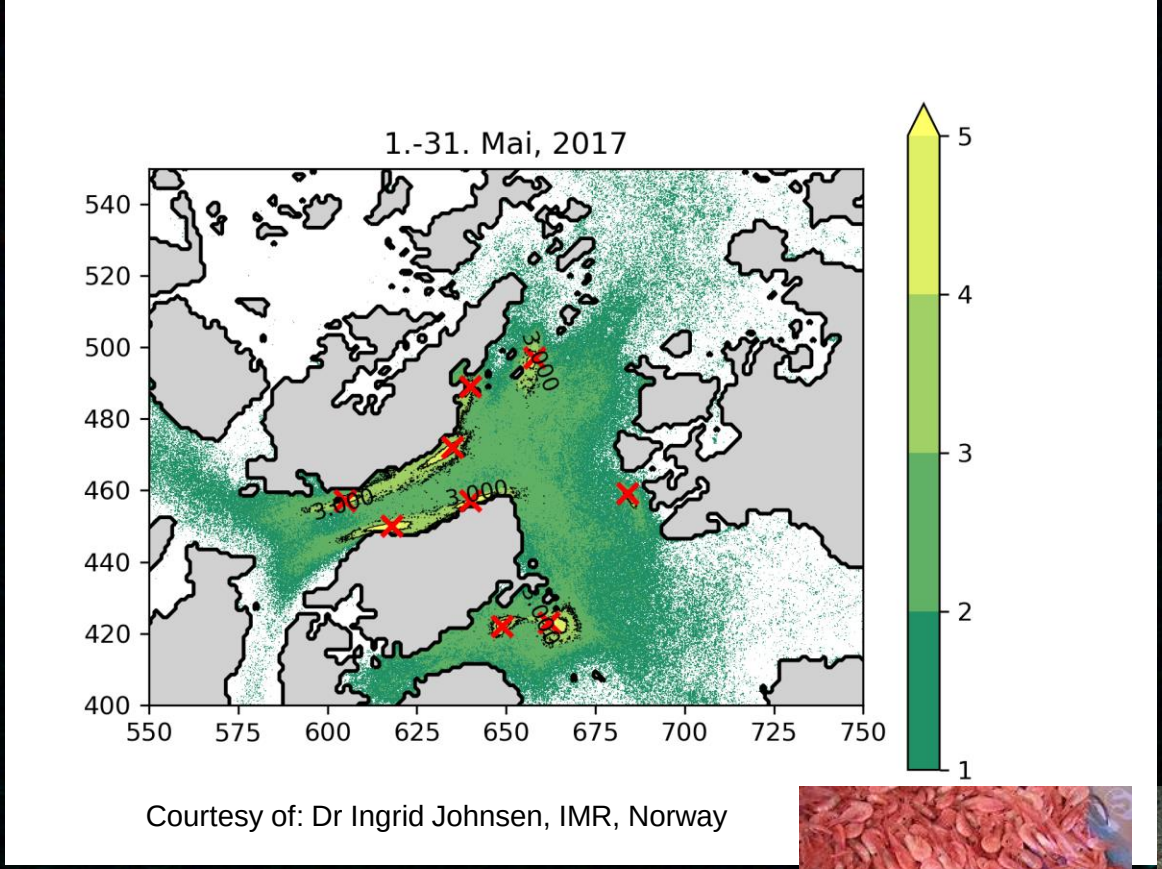
Predicted waste dispersal:
Farm-I




Courtesy of: Dr Ingrid Johnsen, IMR, Norway

# Changing pressures:
## 2. More farms, overlapping far-field effects?

**Predicted waste dispersal:**
**All farms combined**




Courtesy of: Dr Ingrid Johnsen, IMR, Norway

**+Fate / longevity of particle?**

**+Resuspension?**

Reference site?

**Threshold for ecological effects?**

*Resuspension NOT included

# Control sites in the face of a sliding background…

**pristine** adjective

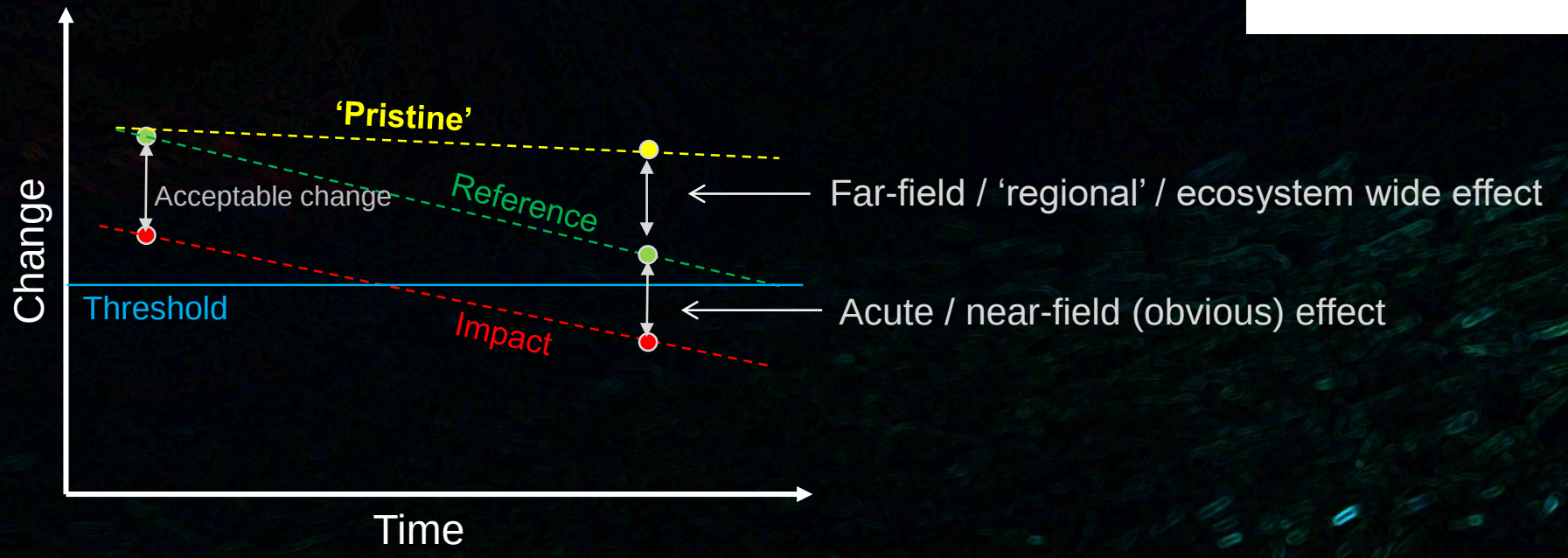
pris·tine | \ ˈpri-ˌstēn, pri-ˈstēn, *especially British* ˈpri-ˌstīn\

**Definition of *pristine***

1 : belonging to the earliest period or state : ORIGINAL
// the hypothetical *pristine* lunar atmosphere

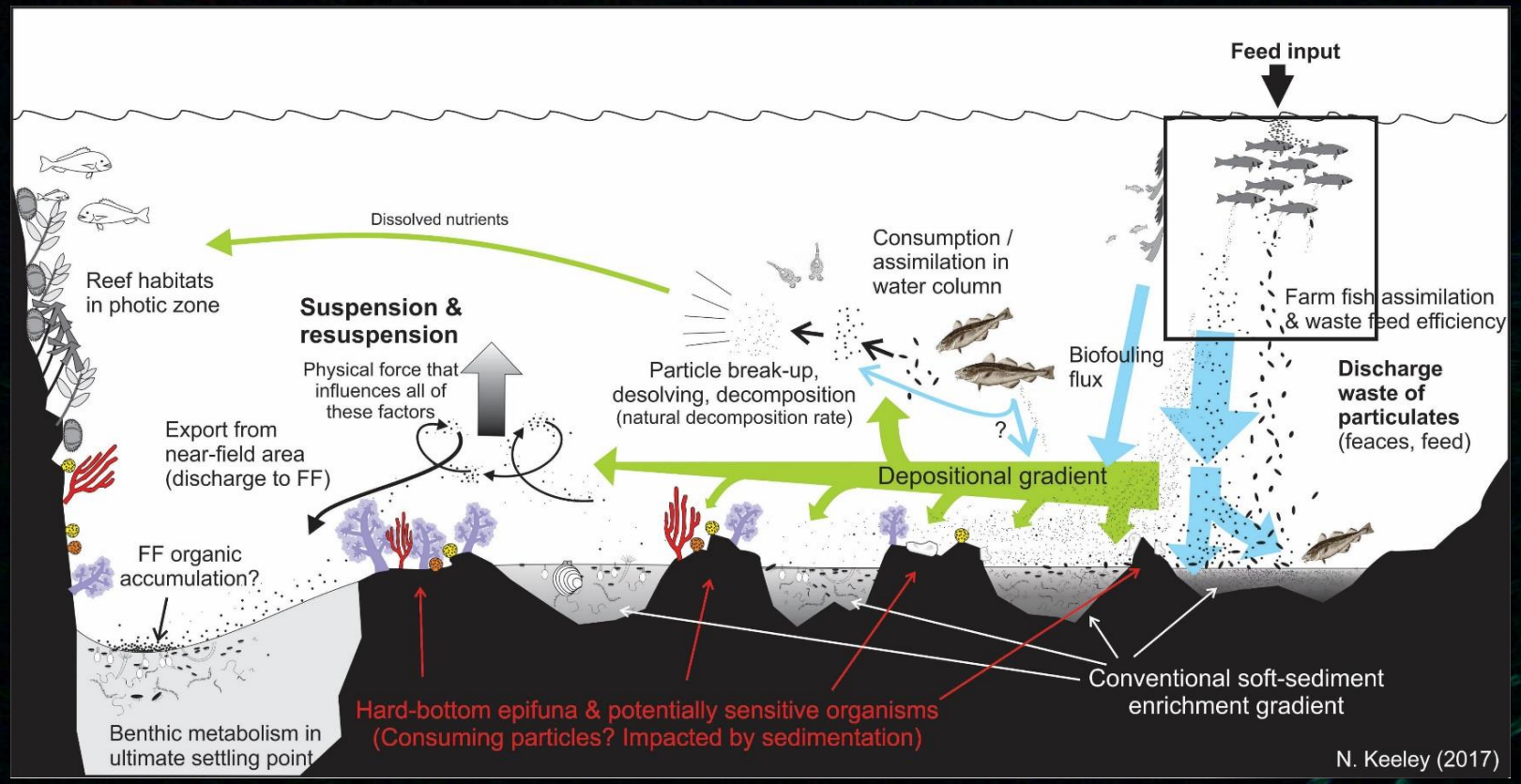
2 a : not spoiled, corrupted, or polluted (as by civilization) : PURE
// a *pristine* forest

b : fresh and clean as or as if new
// used books in *pristine* condition




Strong argument for MPA's to facilitate resource management?

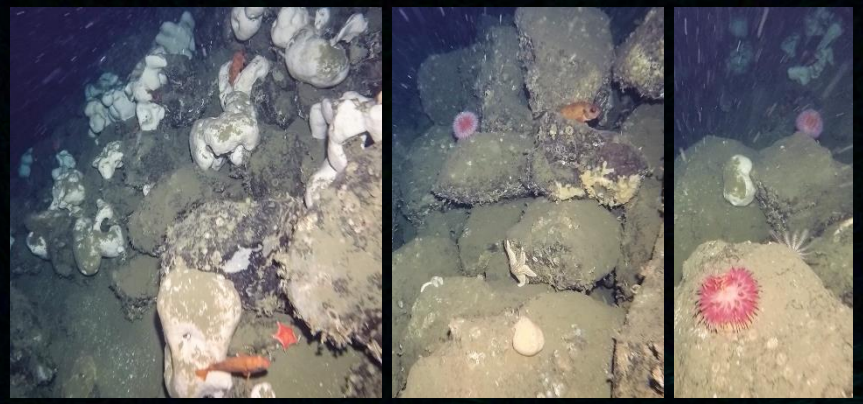
# Farming in northern ecosystems - new habitats, new species, unknown tolerances



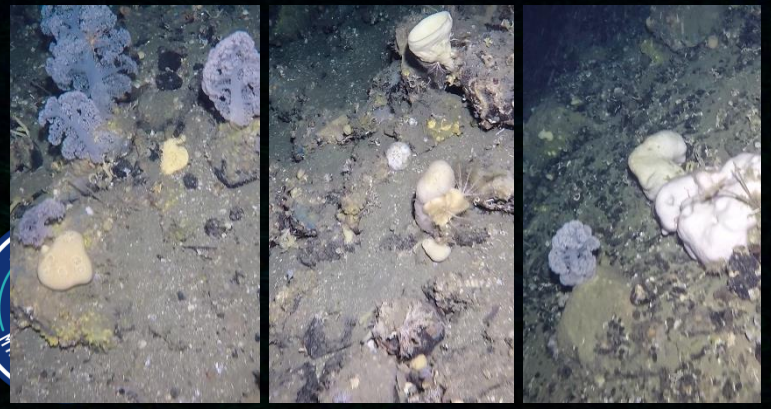

# ‘The hard bottom problem’ (SustainAqua)

Bedrock

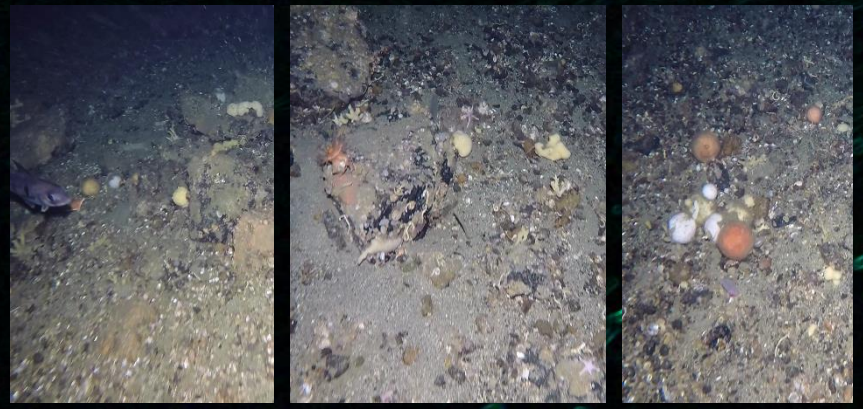
Boulder



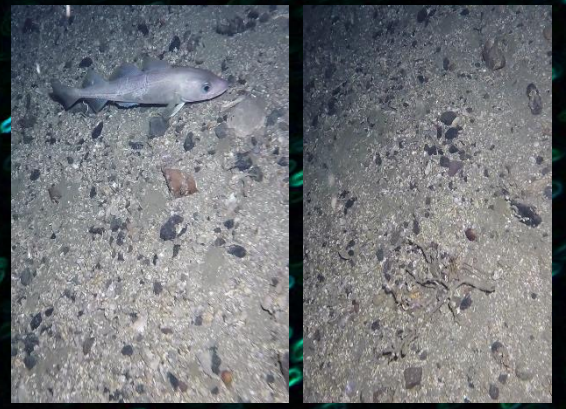
Broken rocks, gravel & cobbles on sediment



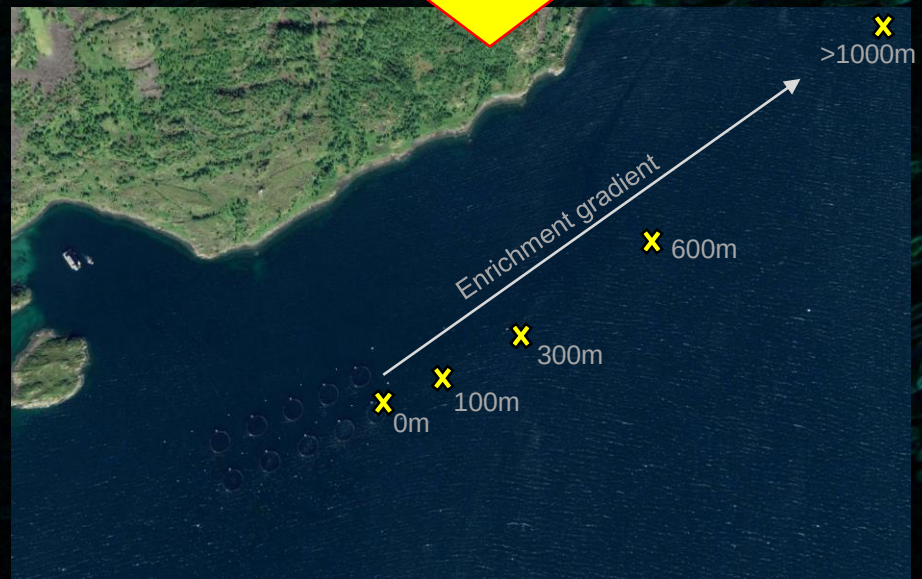
Gravel & cobbles, medium sand



Coarse sand



# Use of epibiota as visual indicators – ecological tolerances



*Polymastia sp.*

*Craniella zetlandica*

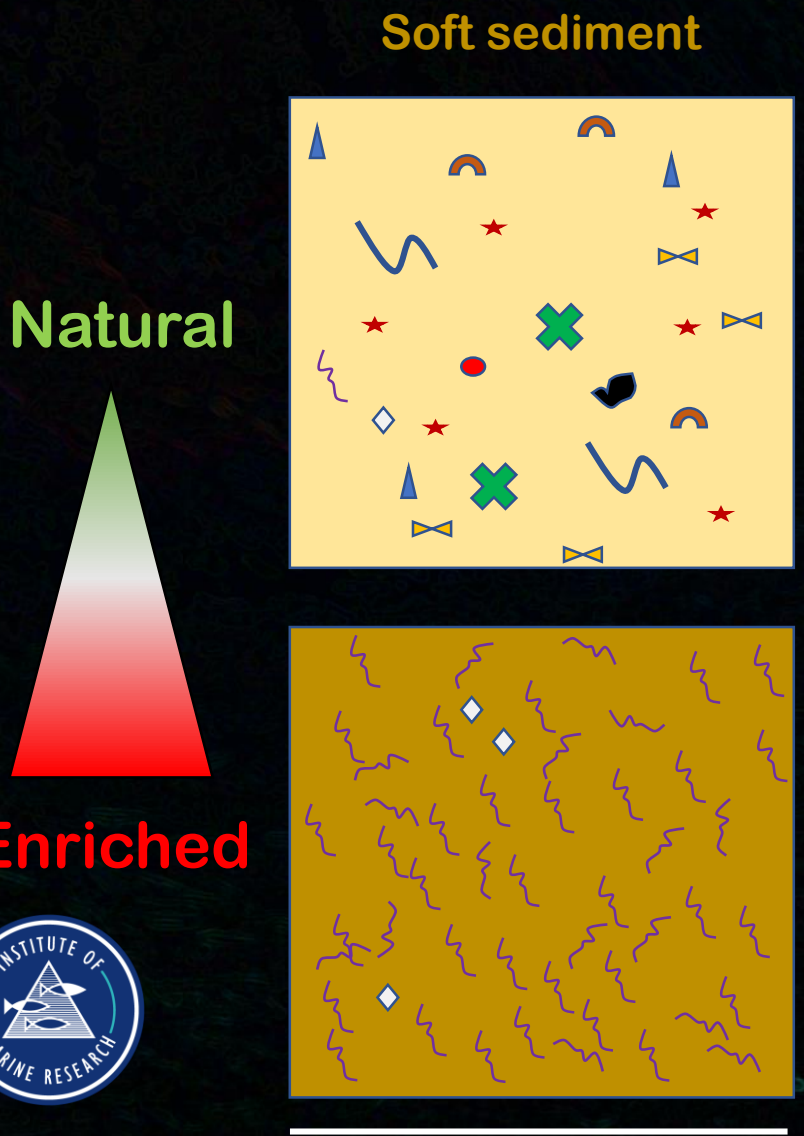
*Hormathia digitata*

*Drifa glomerata*

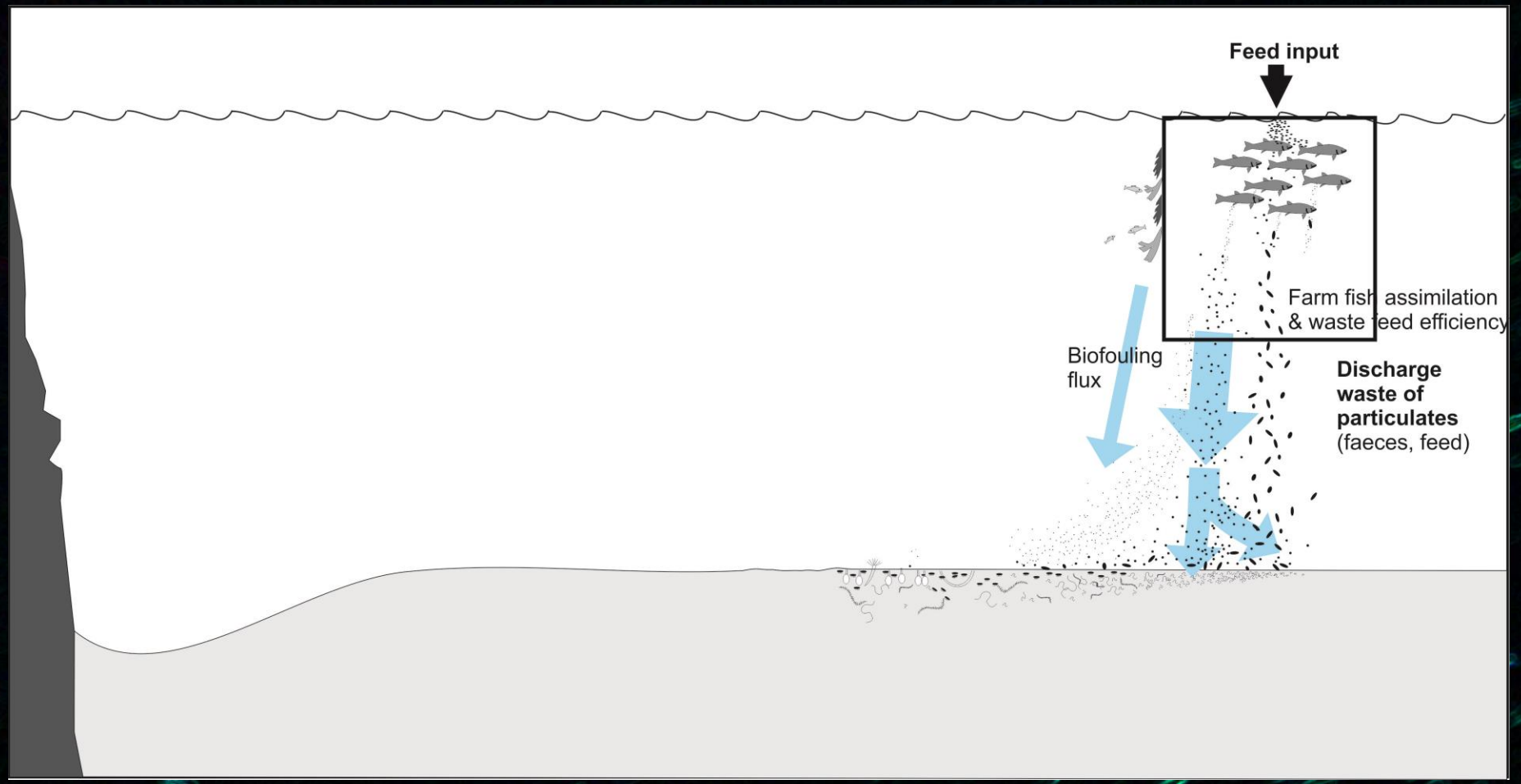
- Survival
- Growth
- Respiration rates
- Terrestrial fatty acid uptake
- Microflora (eDNA)
- Metabolomics

***Only 4 species!***

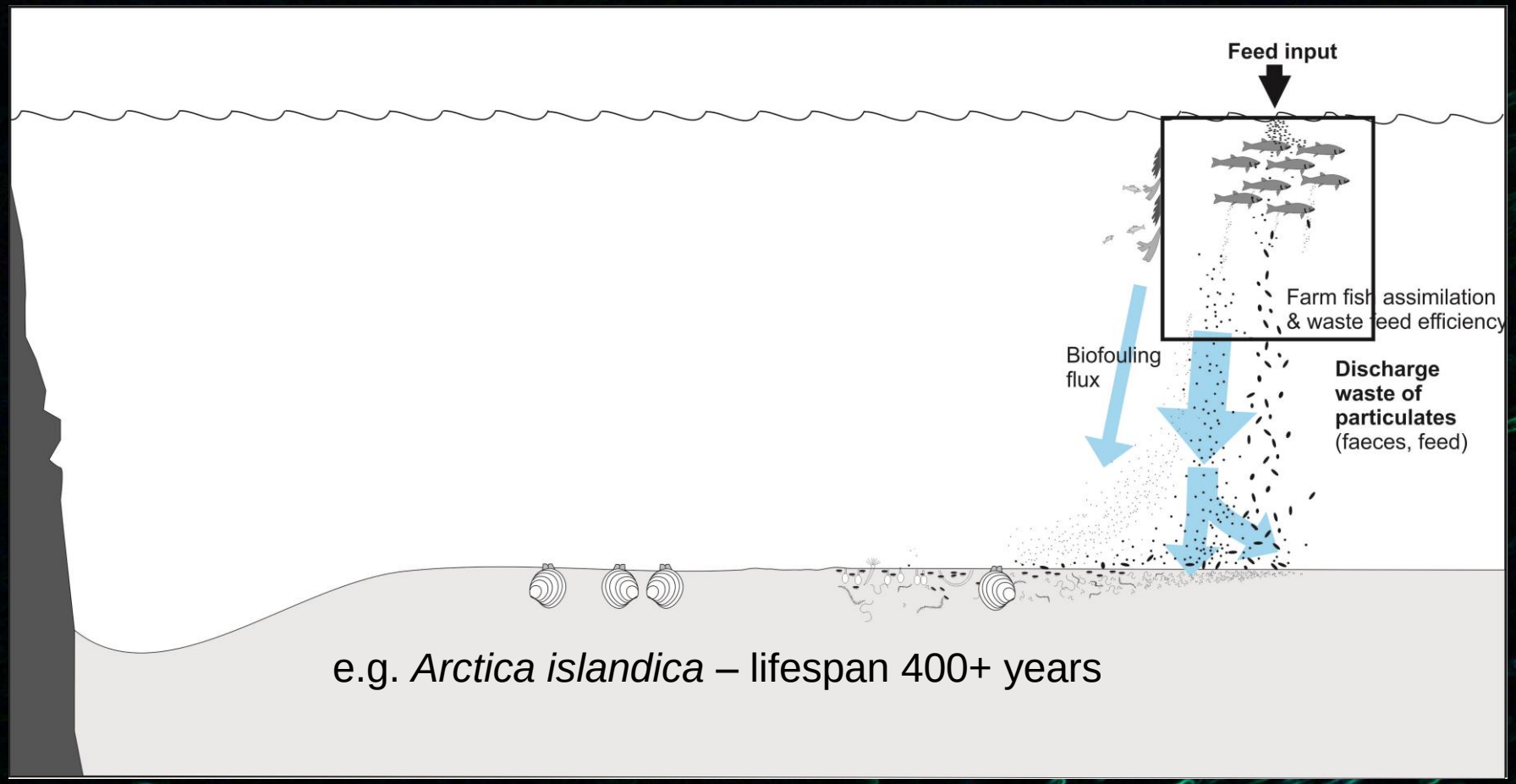
# Visual indicators can be lacking



# The effects of organic enrichment are reversible



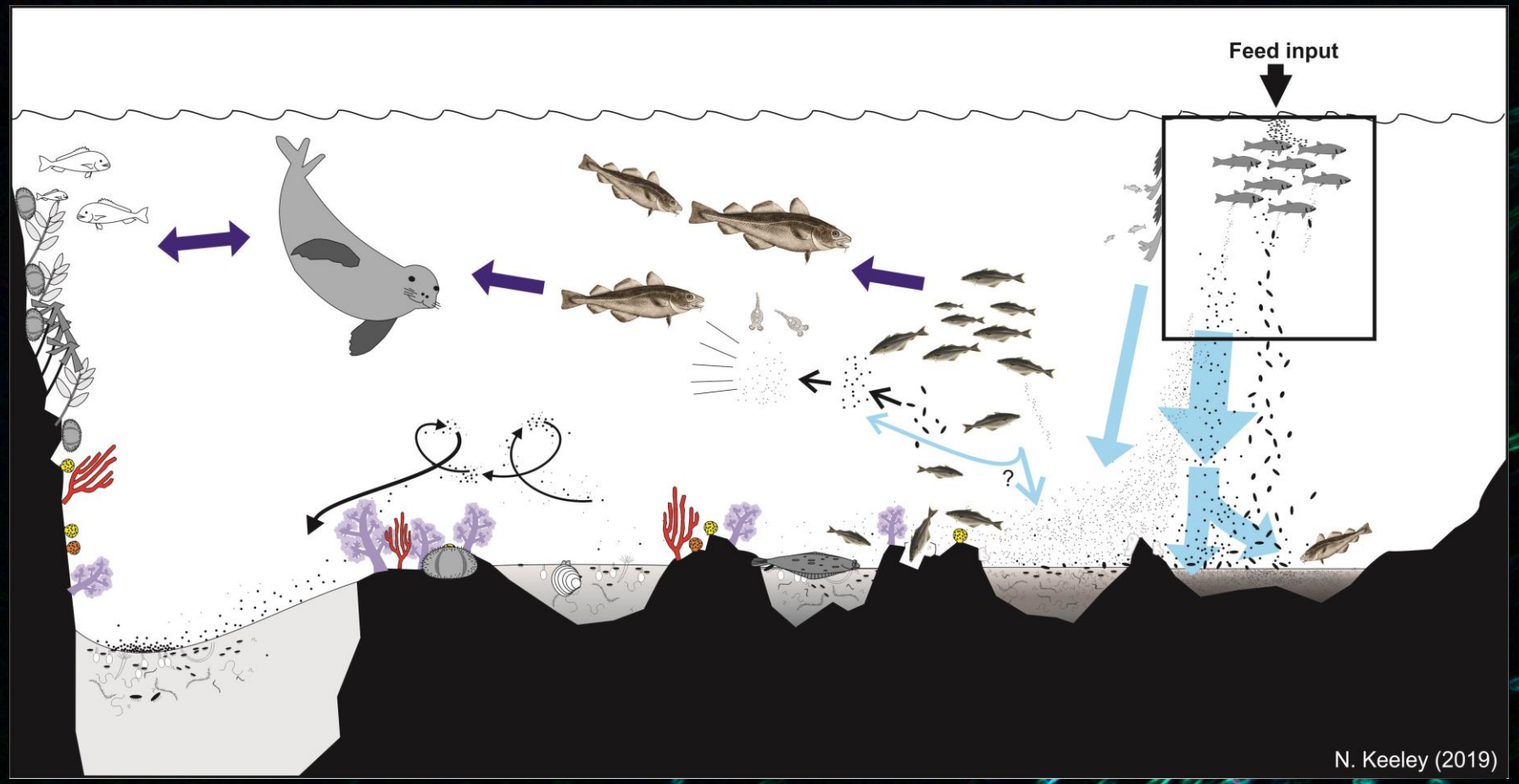
# The effects of organic enrichment are reversible – are they?




e.g. *Arctica islandica* – lifespan 400+ years

# The effects of organic enrichment are reversible – are they?

- Altered movements
- Altered feeding behavior
- Dependence
- Ecosystem effects?
- Recovery??



# Summary - things to think about:

- Effective management on non-soft-bottom habitats?
- How much is too much? Why?
- Overlapping effects – other industries also?
- How are other resources / fisheries etc. being affected?
- What is the true reference / baseline? Is this being protected for the future?
- Reversibility of effects in the bigger picture?
- What do you really want / expect from this ecosystem?


Thank you for your time