Towards upscaling active reef restoration

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WAARDEN BURG Ecology

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The value of reefs …

Tropical sea floor

Tropical coral

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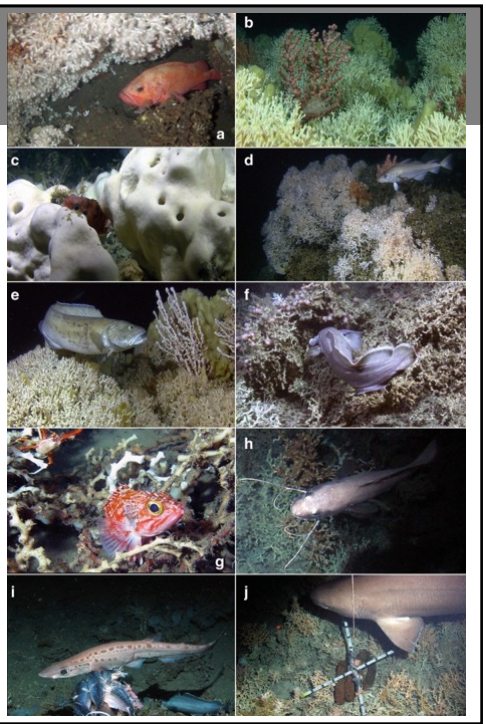
The value of reefs …

North sea floor

Cold water coral



3

Why always the question:

- Does restoring reefs raise fish populations?
- *OR* make fish shift location?

4

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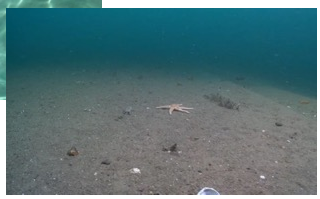


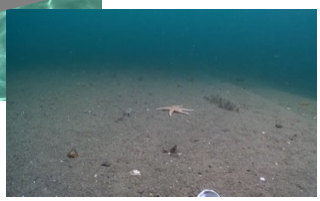
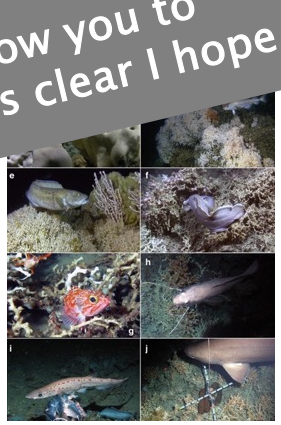

- Would you ask the same if discussing reef loss ?

5

Why always the question:

- Does restoring reefs raise fish populations?
- *OR* make fish shift location?



Indeed, laws of logical reasoning does not allow you to turn the argument around, but my message is clear I hope

- Would you ask the same if discussing reef loss ?

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If we had changed *Veluwe* into *Kootwijkerzand* …

- Would you ask if we need ACTIVE restoration ?

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If we had changed *Veluwe* into *Kootwijkerzand* …

Active restoration would most likely NOT be necessary, unless there are strong establishment thresholds

- Would you ask if we need ACTIVE restoration ?

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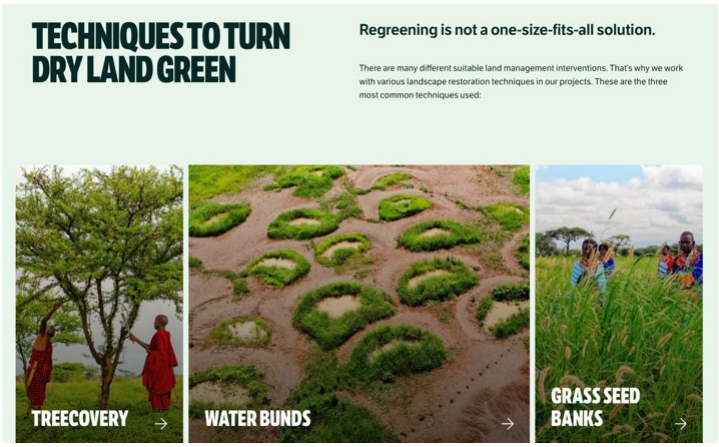
ACTIVE restoration → overcome establishment thresholds

- **Deserts** → hard to green *unless* i) human help *or* ii) WoO



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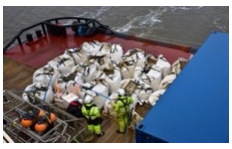
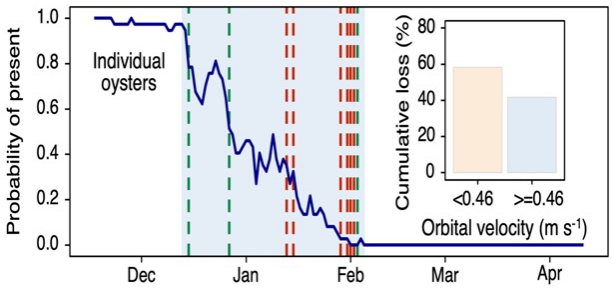
ACTIVE restoration → overcome establishment thresholds

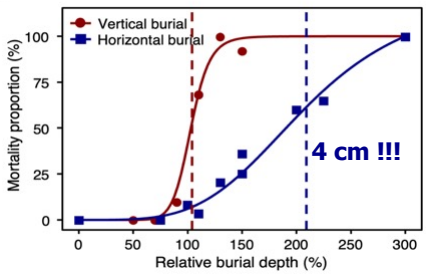
- **Oyster reefs** → hard to get *unless* i) human help *or* ii) WoO



Zhiyuan Zhao et al. in prep



Hydrodynamics-induced loss



sediment burial-mortality

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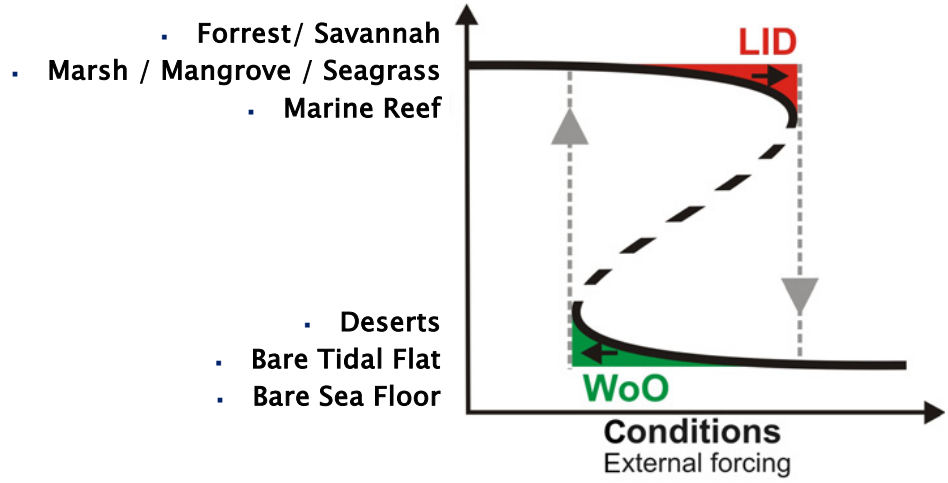
WoO = Window of Opportunity
→ moment to overcome establishment thresholds



LID: Large Infrequent Disturbance
WoO: Window of Opportunity

Balke et al. J Ecol. 2014

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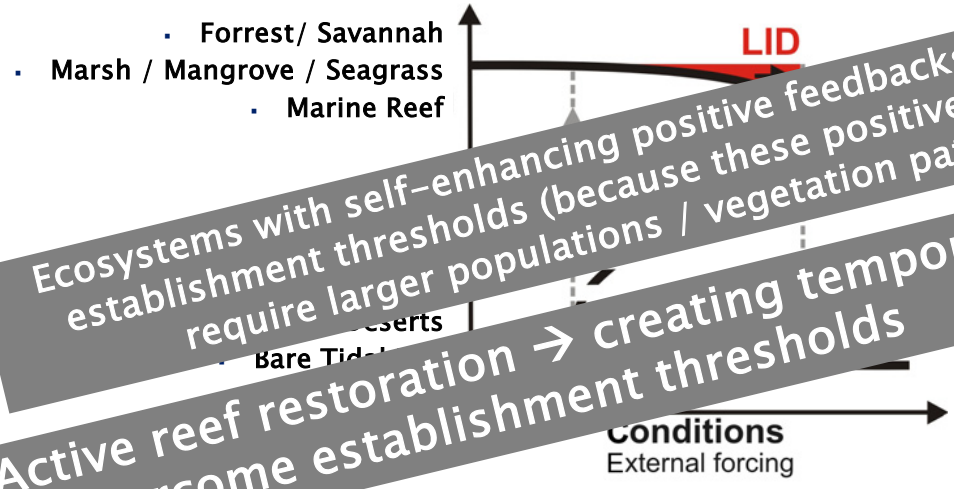
WoO = Window of Opportunity
→ moment to overcome establishment thresholds



Ecosystems with self-enhancing positive feedbacks often have establishment thresholds (because these positive feedbacks require larger populations / vegetation patches)

Active reef restoration → creating temporary WoO to overcome establishment thresholds

LID: Large Infrequent Disturbance
WoO: Window of Opportunity

Balke et al. J Ecol. 2014

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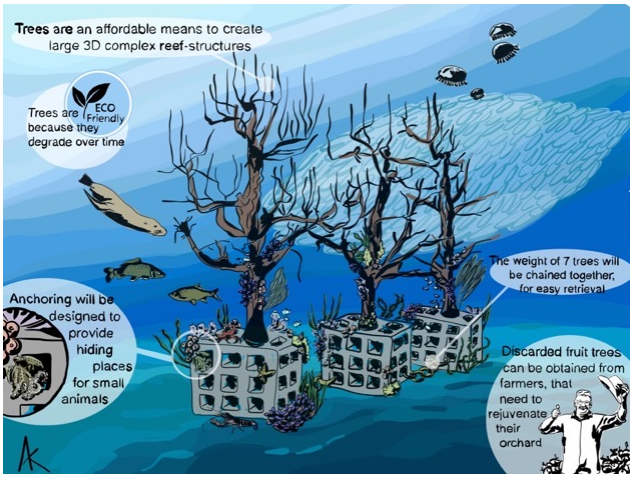
Active reef restoration for biodiversity
→ by creating temporary WoO



Tree-Reefs as example

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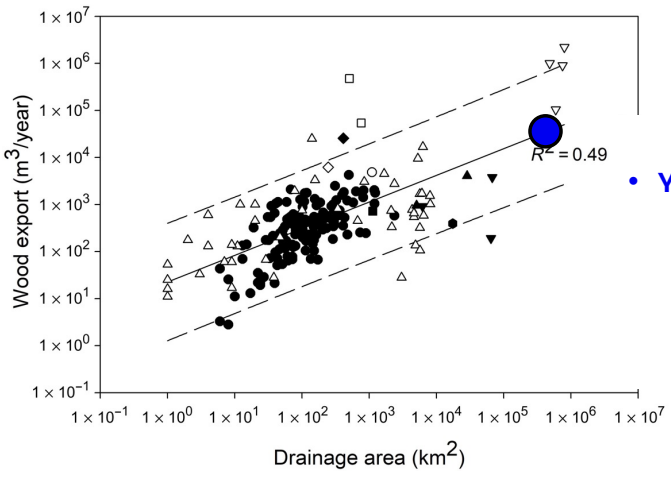
In the past → Massive wood export to estuaries & seas



Rhine, 185 000km2

Jon Dickson

- **Yearly export**
  - **~100 000m3 of large wood (>3m)**
  - **25 Olympic swimming pools**

Damming the Wood Falls - Wohl & Iskin (2021)

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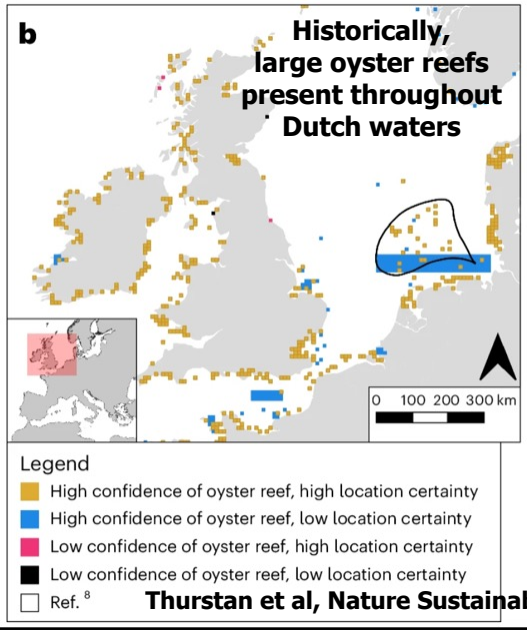
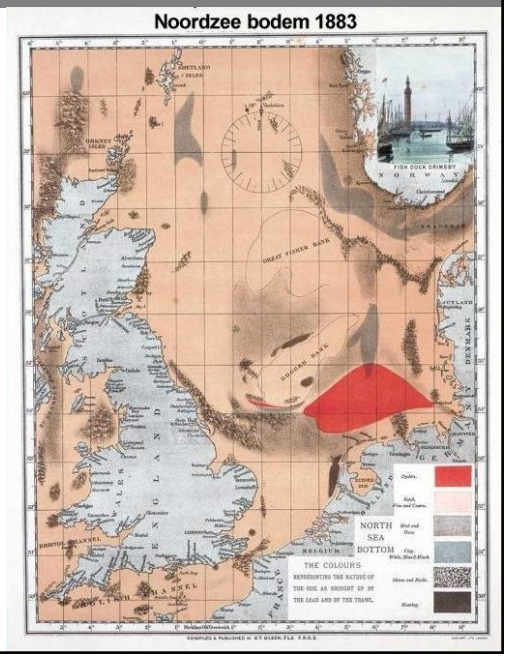
In the past → Oyster Reefs & other structures → incl. moorlogs



Thurstan et al, Nature Sustainability 2024.



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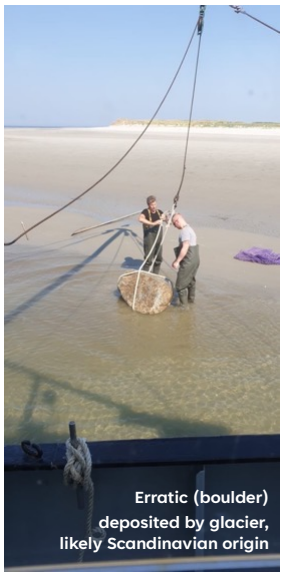
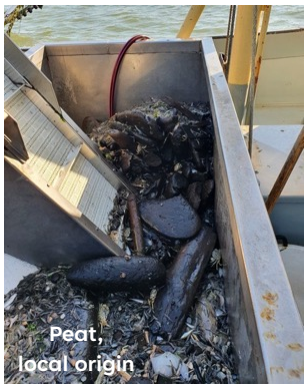
Structures → mostly lost & loss is still ongoing





Wadden Sea

Anthropocene

- **Ongoing removal large stones, natural wood and peat**
- **Loss of 'Islands of structure' in soft bottomed system**

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Fish → Massively declined over time ! (Waddensea)

1965

2013

Movie shows massive fish loss from 1965 to 2013, which is much later than loss of structures. Fish decline is most likely due to combination of past fishing pressures & loss of structures

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What makes good reefs for restoring biodiversity ?

- *Hiding places*
  - → spatial complexity
- *Height*
  - → escape bottom-dwelling predators
  - → escape sand burial
- *Self-sustainable*
  - → biodegradable establishment substrate
  - → fragments become new reefs

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TreeReefs (Fruits de Mer) – pilot study Waddenzee

Jon Dickson

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Who lives in a pear tree under the sea?

Jon Dickson

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Fish "residents"

- **5 x more fish on reef**
  - as nearby sand, 2022
- ***Preliminary – 2024**
- **10–25 x more fish on reef**
- **reef-fish are much larger**
- **3 to 5 x as many species**
  - Including endangered

Jon Dickson et al. in prep

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Height is life

- **increased Biodiversity & Richness**
  - escape bottom Predation
  - escape bottom burial
- **positive for REEF formers**
  - Altered foodweb
    - → less predators of juveniles
  - Tree-fragmentation over time
    - → reef expansion
- **fish effect might be height effect**

Jon Dickson et al. in prep

Jon Dickson

NIOZ

Mytilus edulis
mussel

Magallana gigas
Pacific oysters

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What is next ???

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NL km² marine > NL km² land

How to get to reef restoration @ XXL-scale ???

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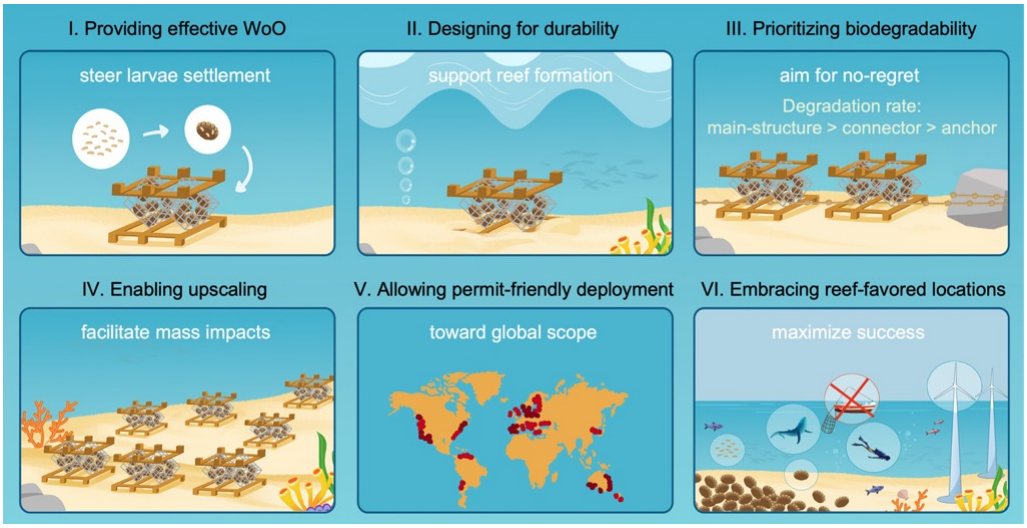
How to get to reef restoration @ XXL-scale ???

- SeaD-Bombs concept ⇔ no-regret option



Zhiyuan Zhao

- ✓ kick-start recovery while minimizing subsequent intervention
- ✓ allowing nature to do what nature does

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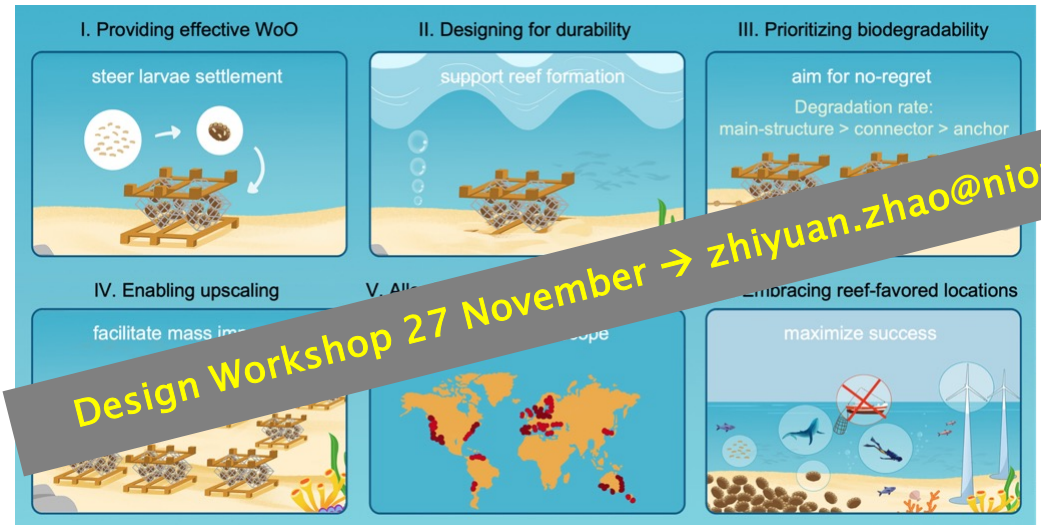
How to get to reef restoration @ XXL-scale ???

NIOZ

Zhiyuan Zhao

- SeaD-Bombs concept ⇔ no-regret option



Design Workshop 27 November → zhiyuan.zhao@nioz.nl

- art
  overy while minimizing subsequent intervention
- ✓ allowing nature to do what nature does

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