



Who lives in a pear tree under the sea?

Tree-reefs increase trophic complexity for top-down predatory control of pests

Jon Dickson
Seagriculture 2025



**MARINE
TREES**

TREE REEF ECOLOGICAL
ENGINEERING STRUCTURES



Royal Netherlands
Institute for
Sea Research

My past life – forest fire fighting & “bush engineering”

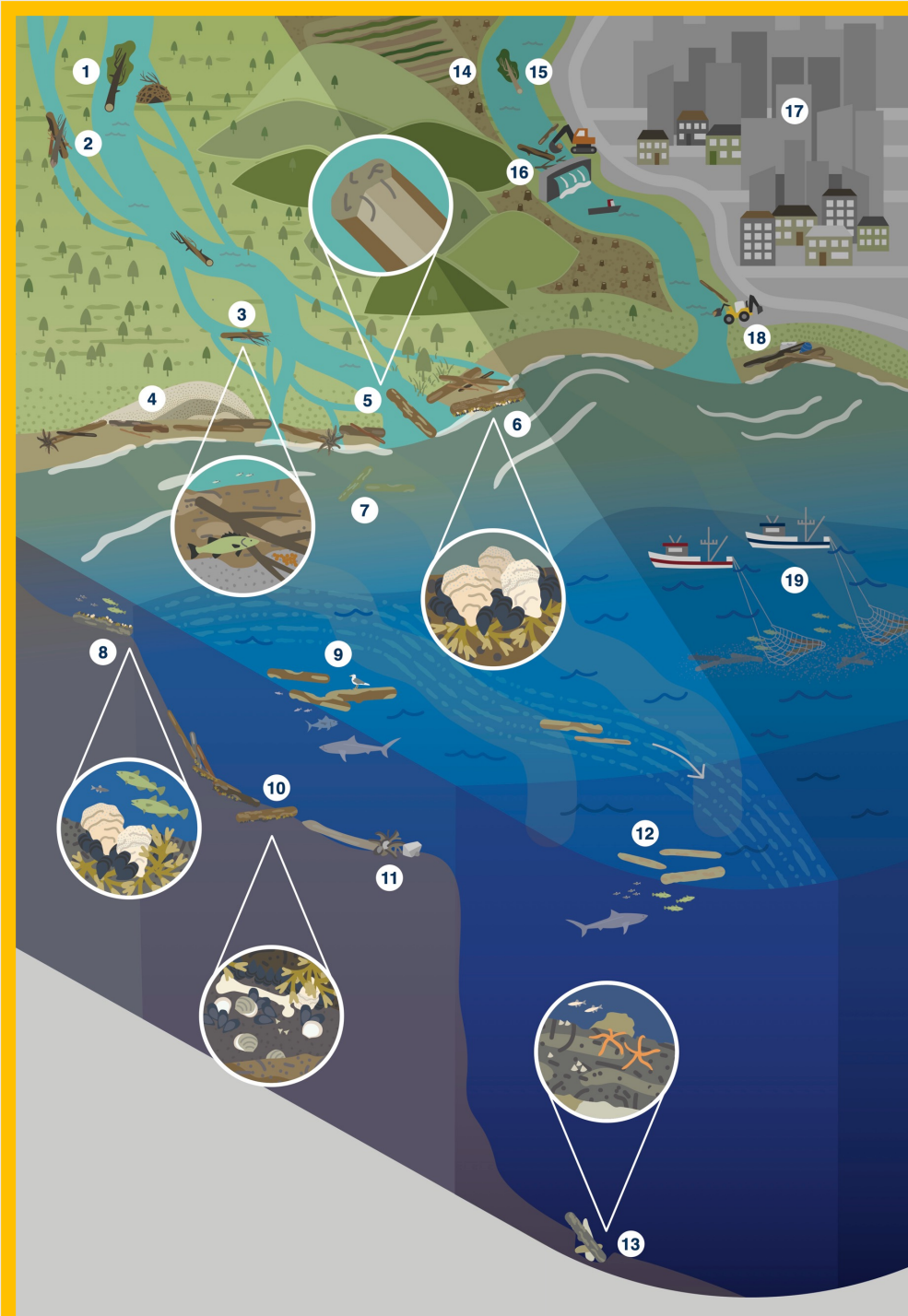
- Helipads (and other) need to stay structurally sound despite shifting heavy loads/stress
- Built with potentially sub-optimal material, conditions
- No “one-size-fits-all” approach – each tree is different
- Knowledge applied to marine restoration and tree reefs

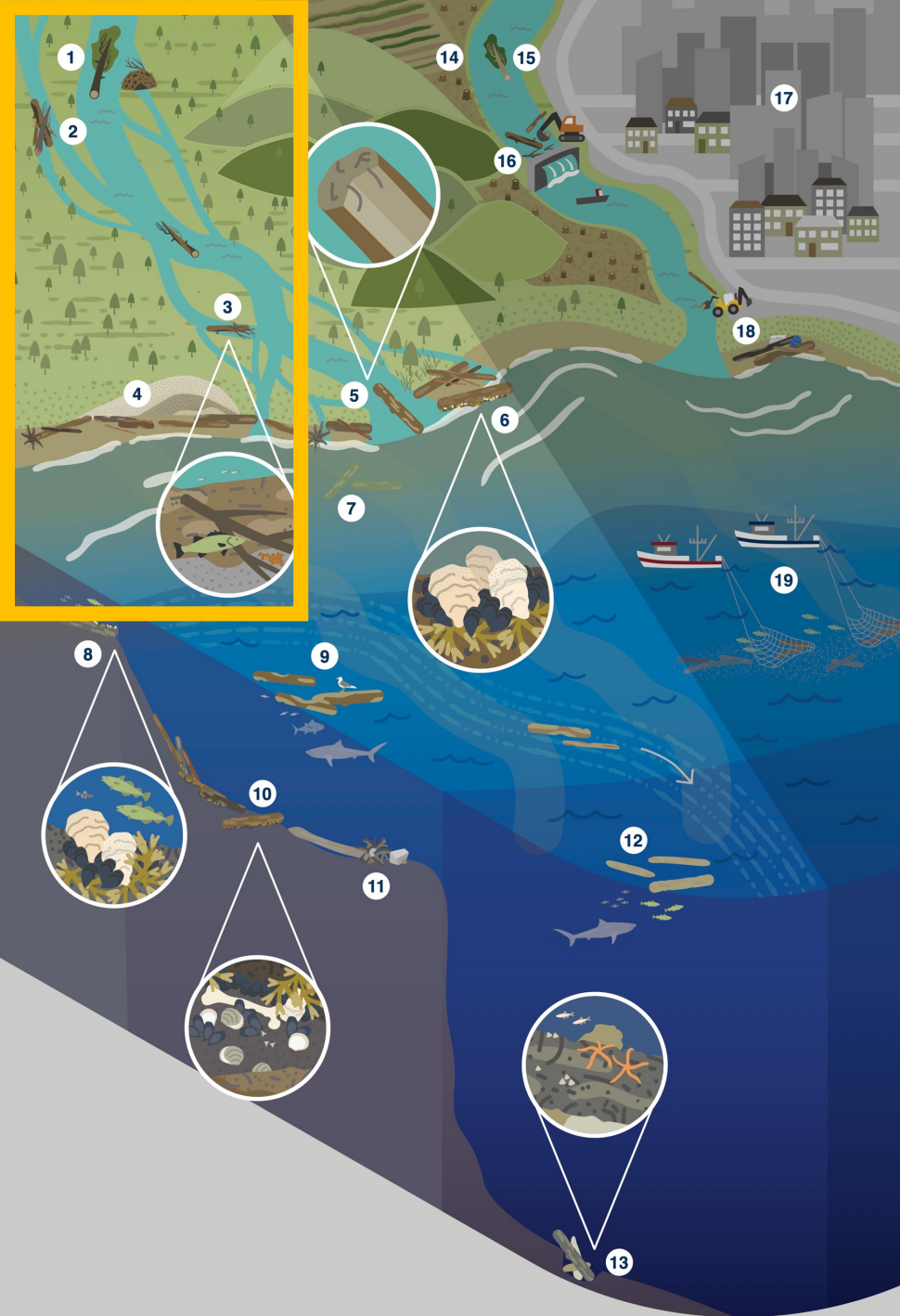


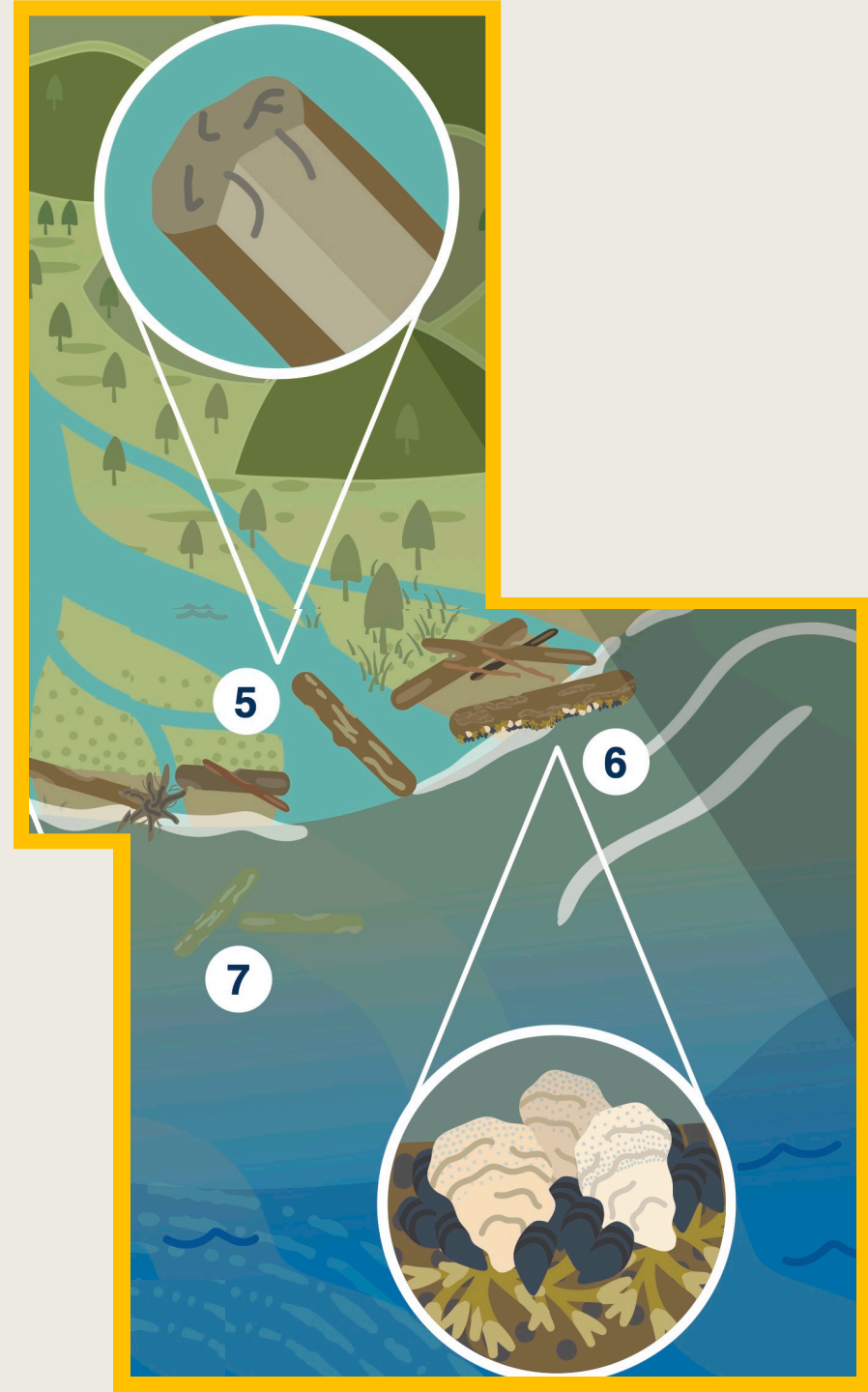
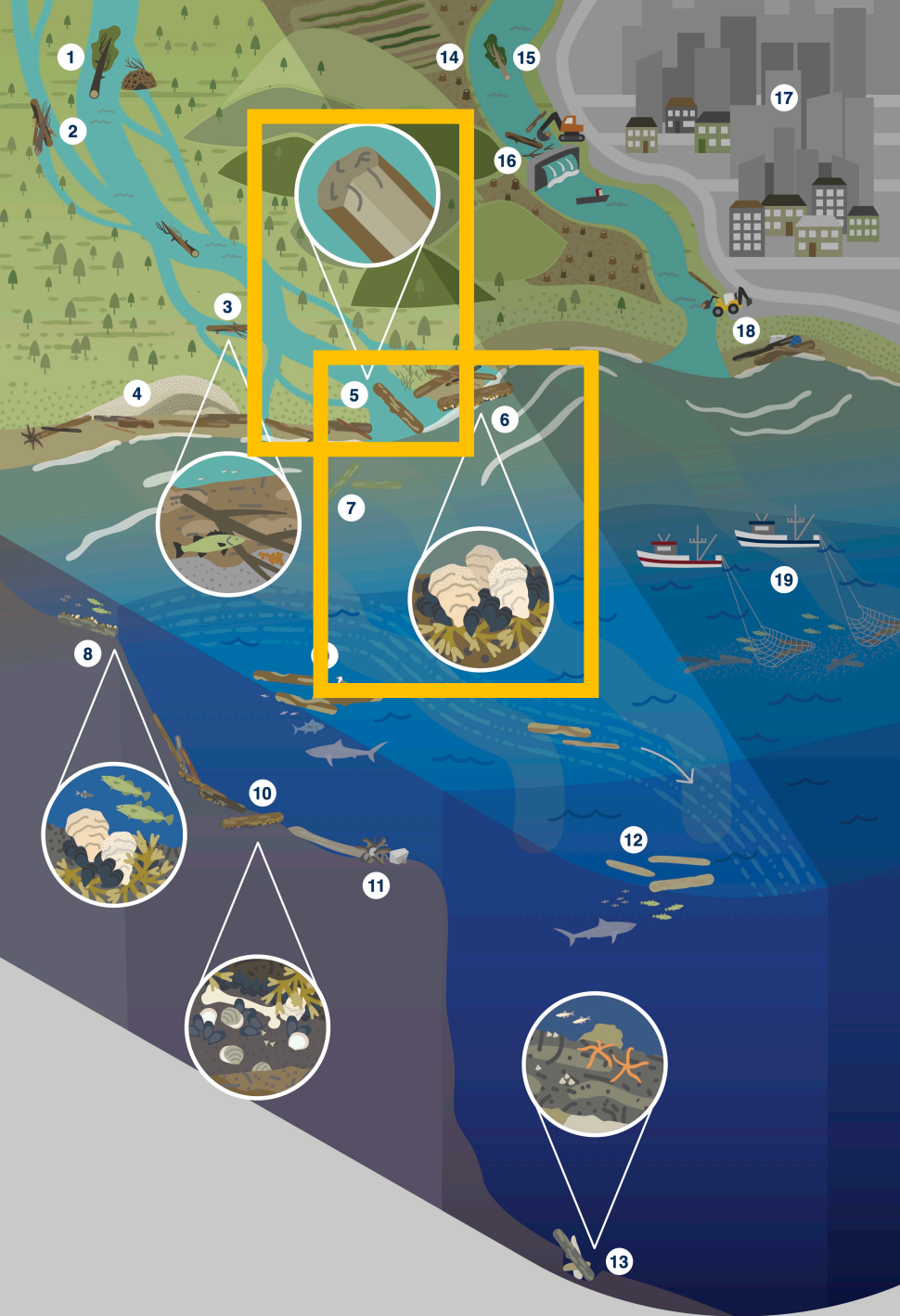
A photograph showing a 'tree-reef' structure in the foreground, made of bare, dark branches. A bright red flag is attached to one branch, and several yellow buoys are visible. A blue chain is draped over the branches. In the background, a calm body of water stretches to a distant island where a lighthouse with a glowing light stands. The sky is a pale, clear blue.

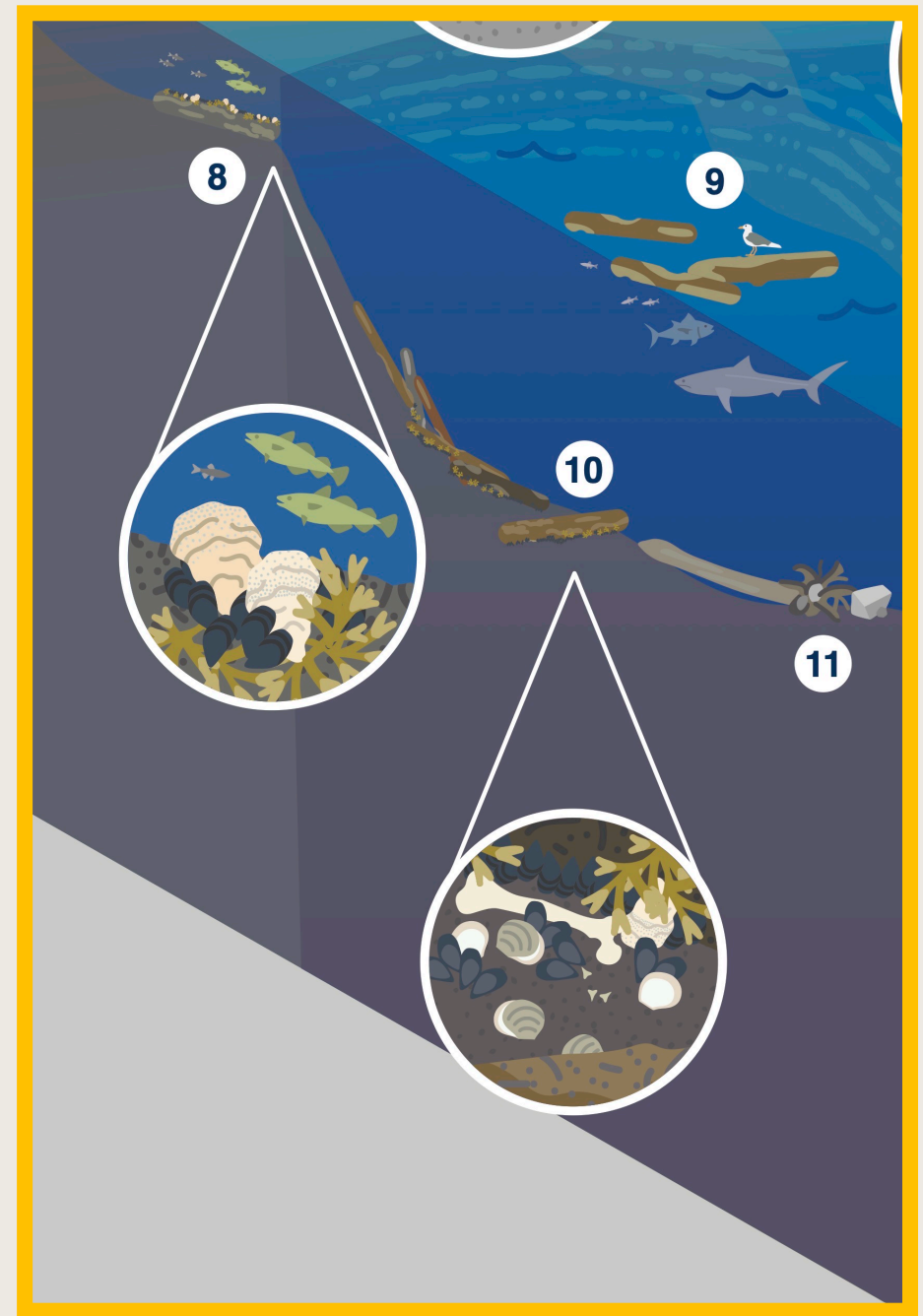
Tree-reefs: why?

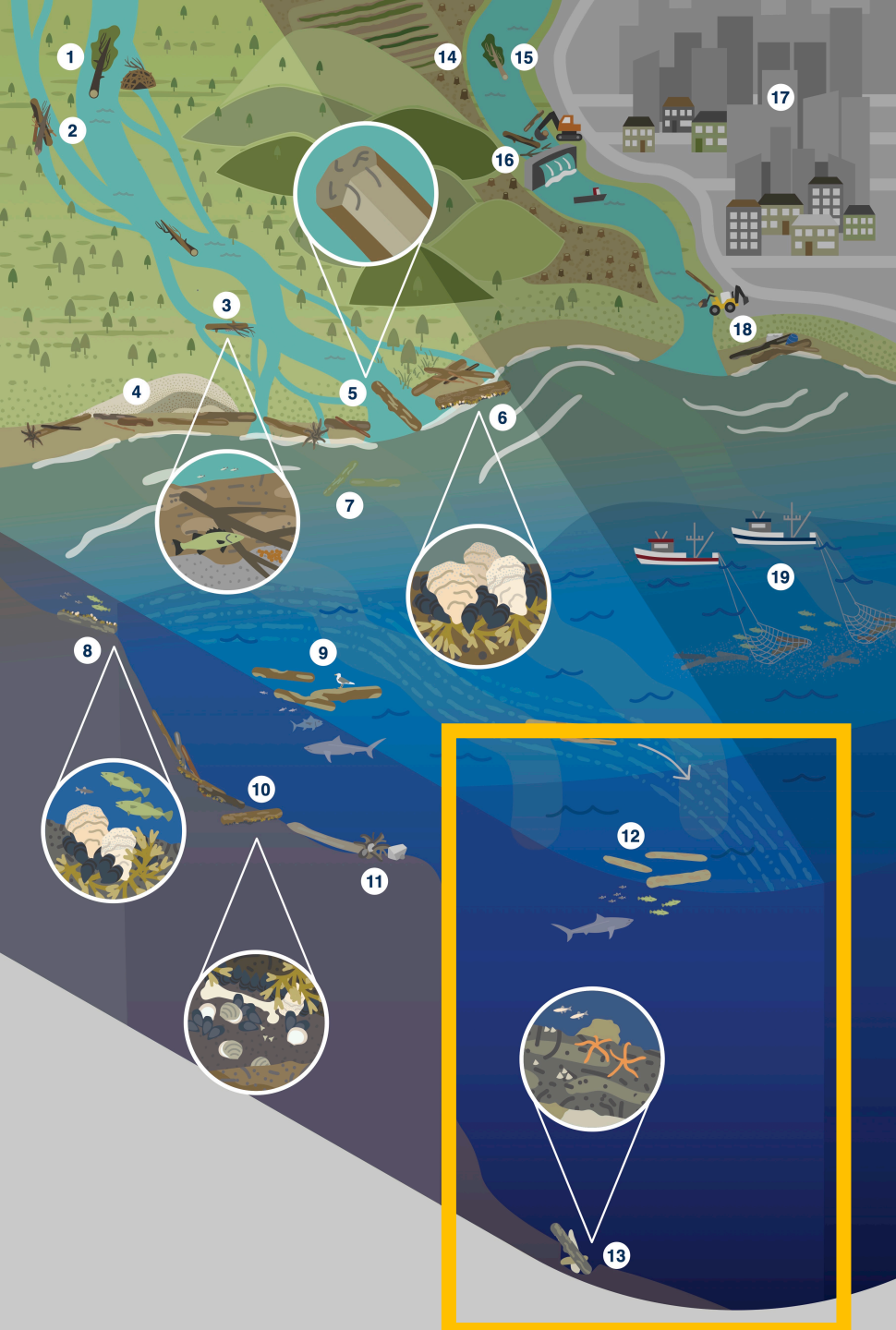
The Role of Wood: From River to Deep Sea

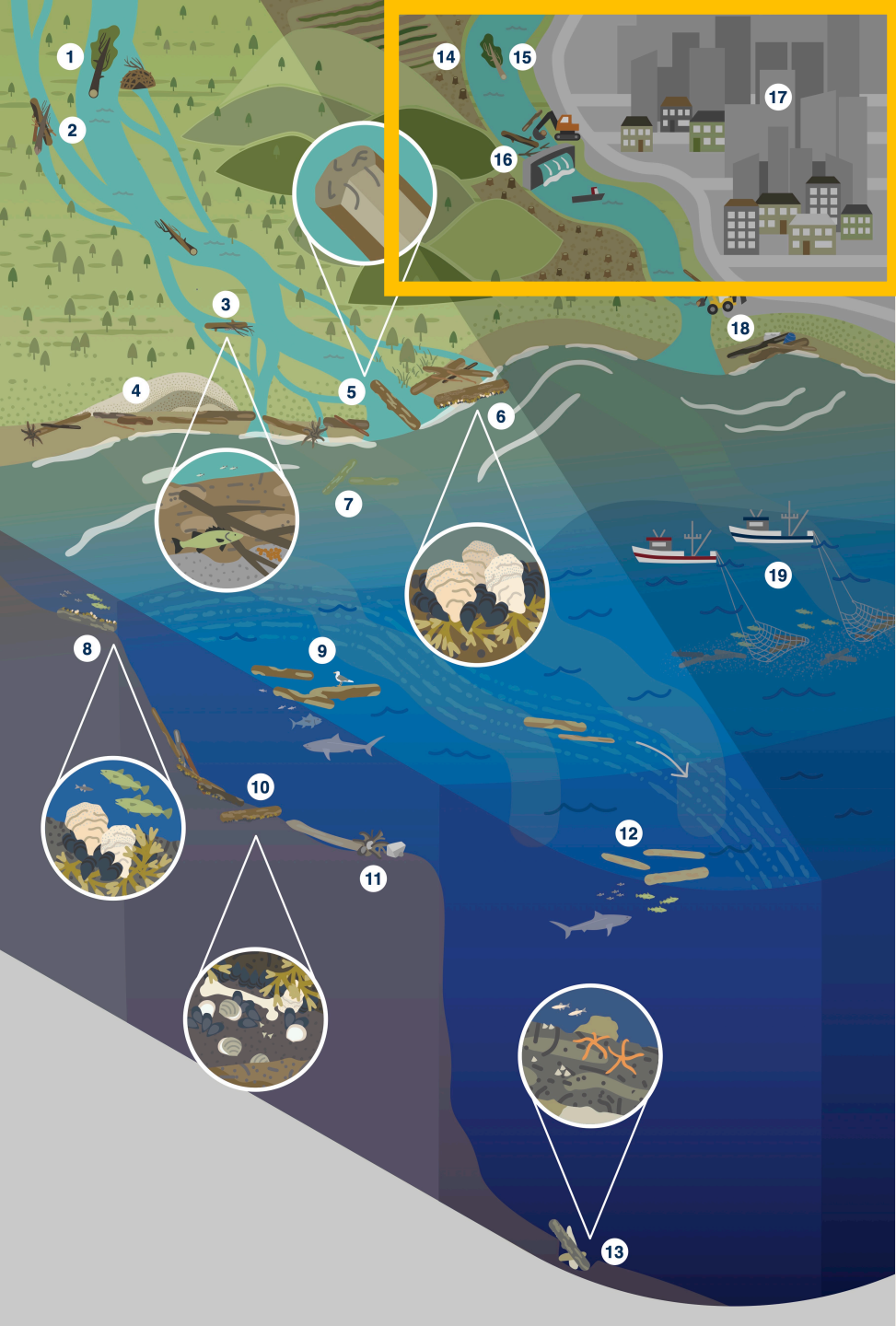


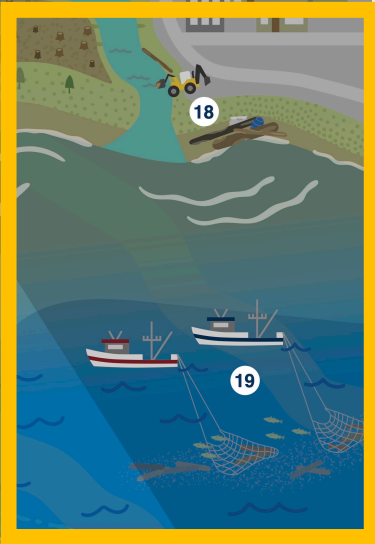
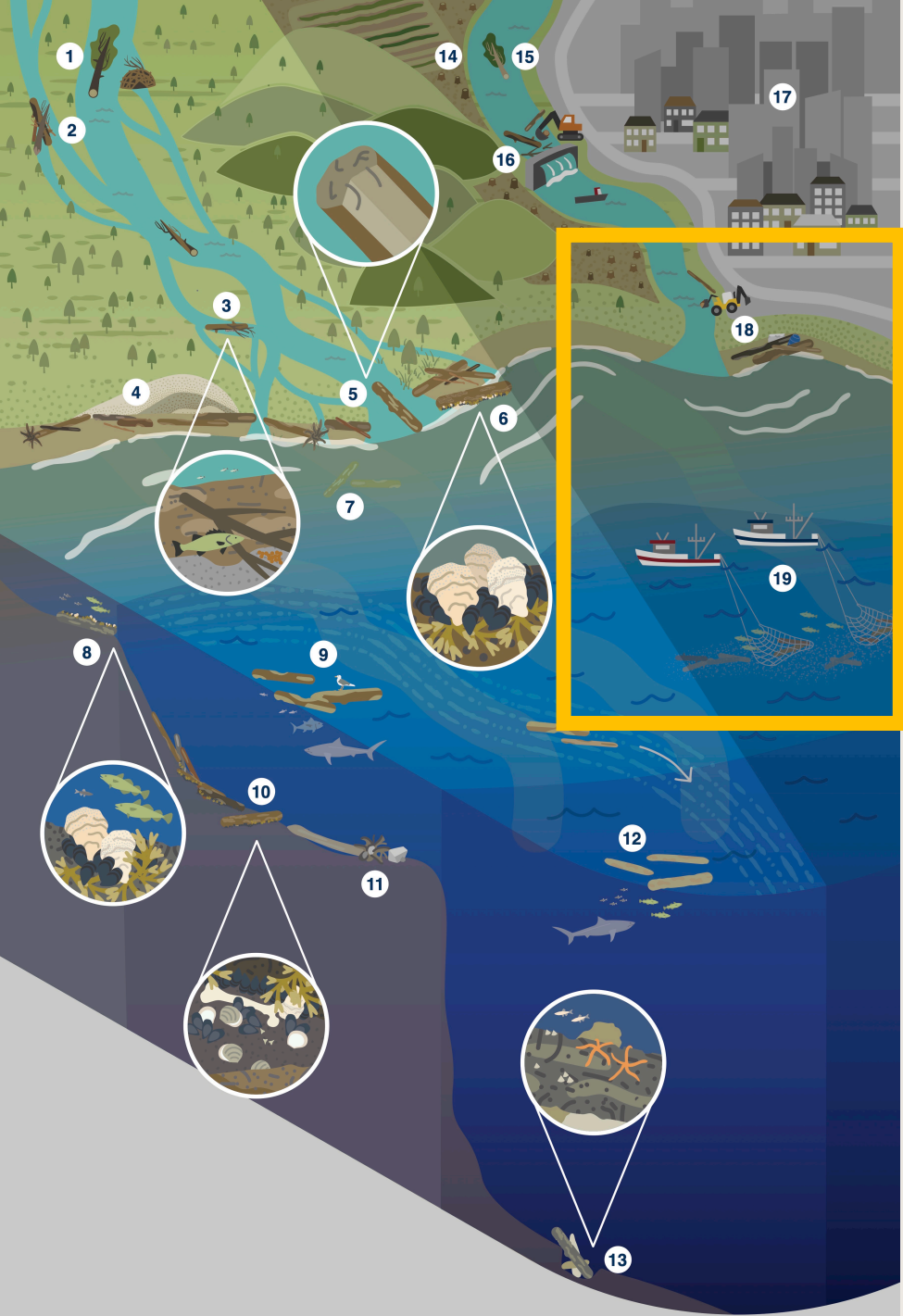






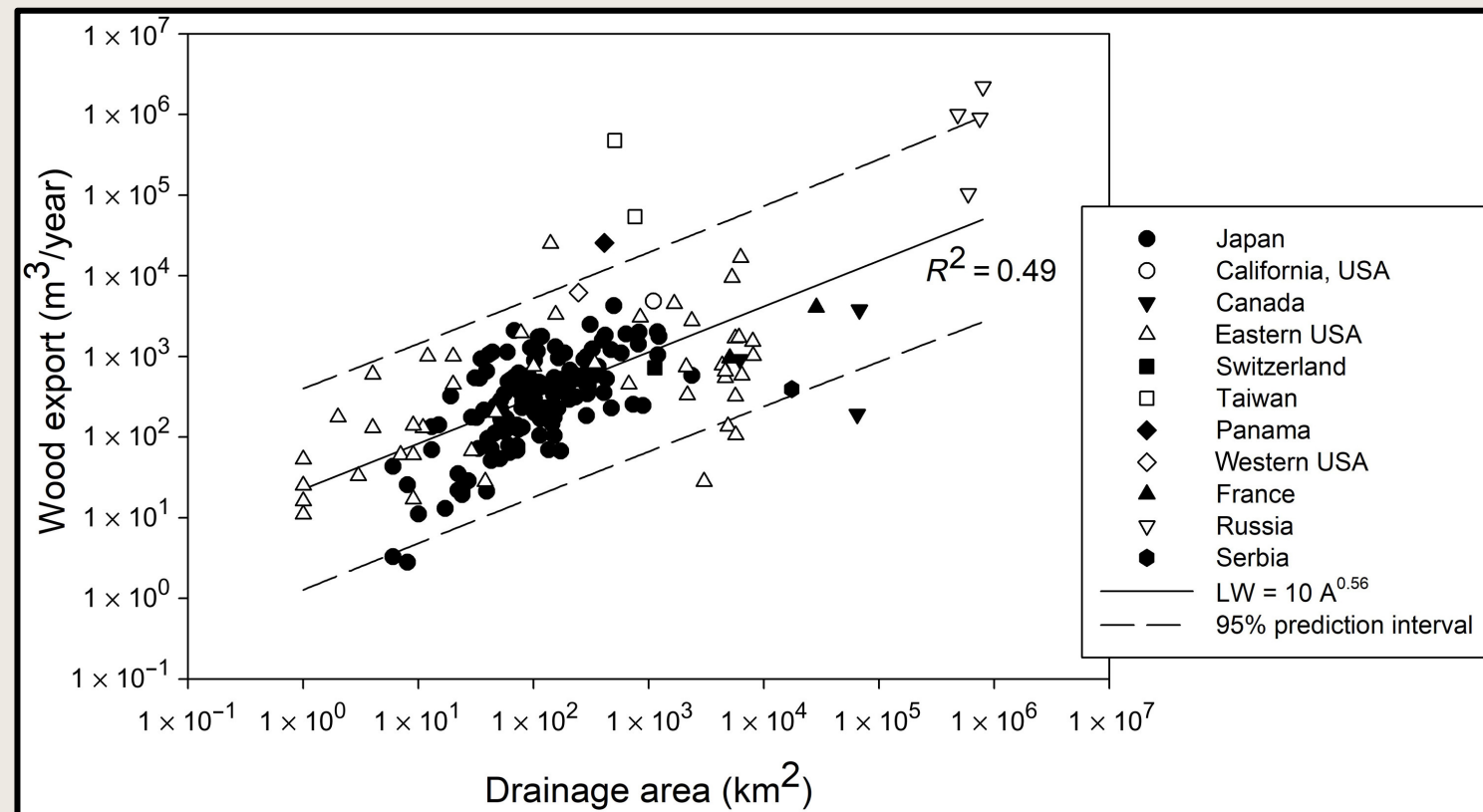






Historical wood export: rivers to sea

- Pre-landscape domestication, rivers exported vast quantities of driftwood to sea
- In the present day, rivers export **5 000 000m³ less** than in historic times
- Significantly less hard substrate for seaweeds, shellfish, and fish





Washington, USA



Fiordlands, New Zealand



Driftwood on Quadra Island

British Columbia, Canada



Westfjords, Iceland



Tree-reefs: why?



Tree-reefs: daarom!



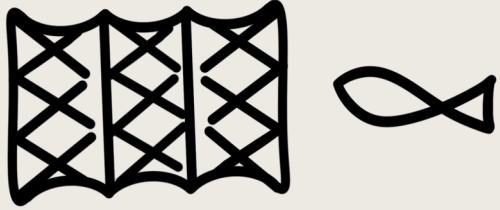
What *are* tree-reefs?

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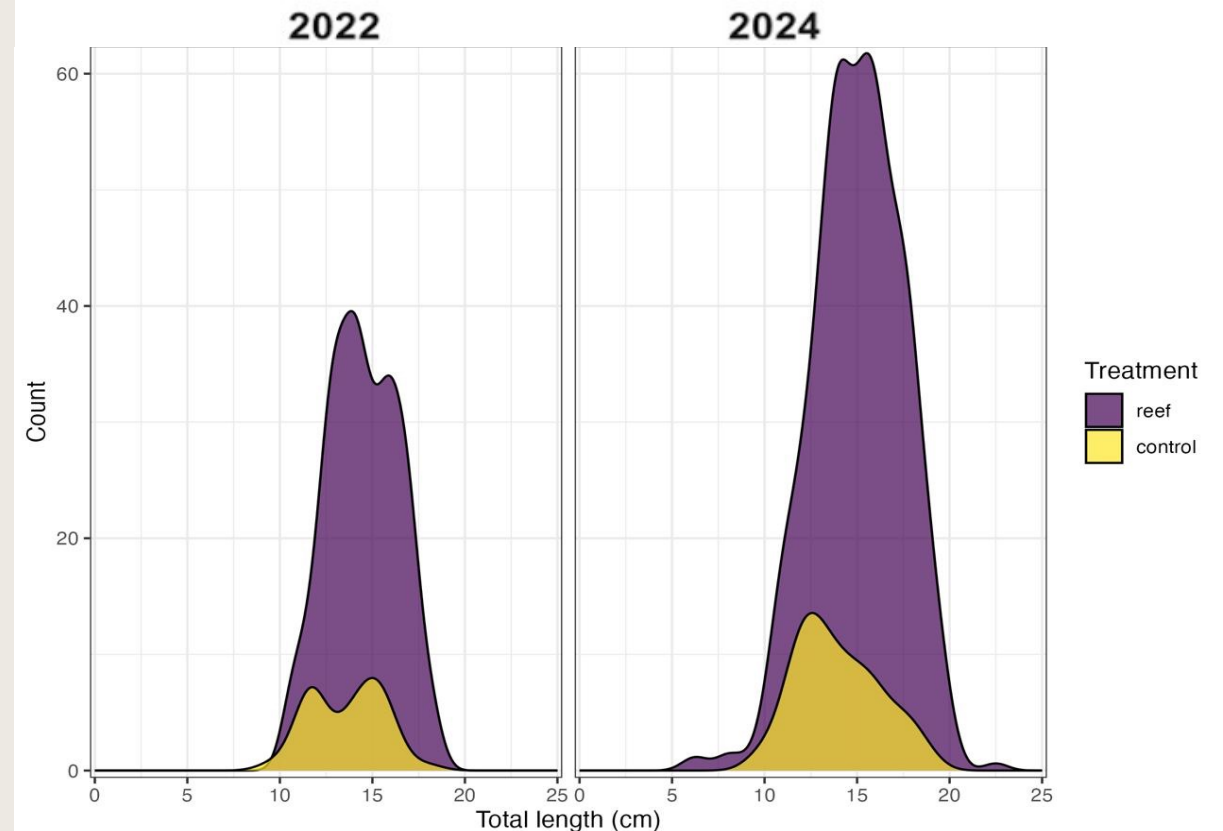
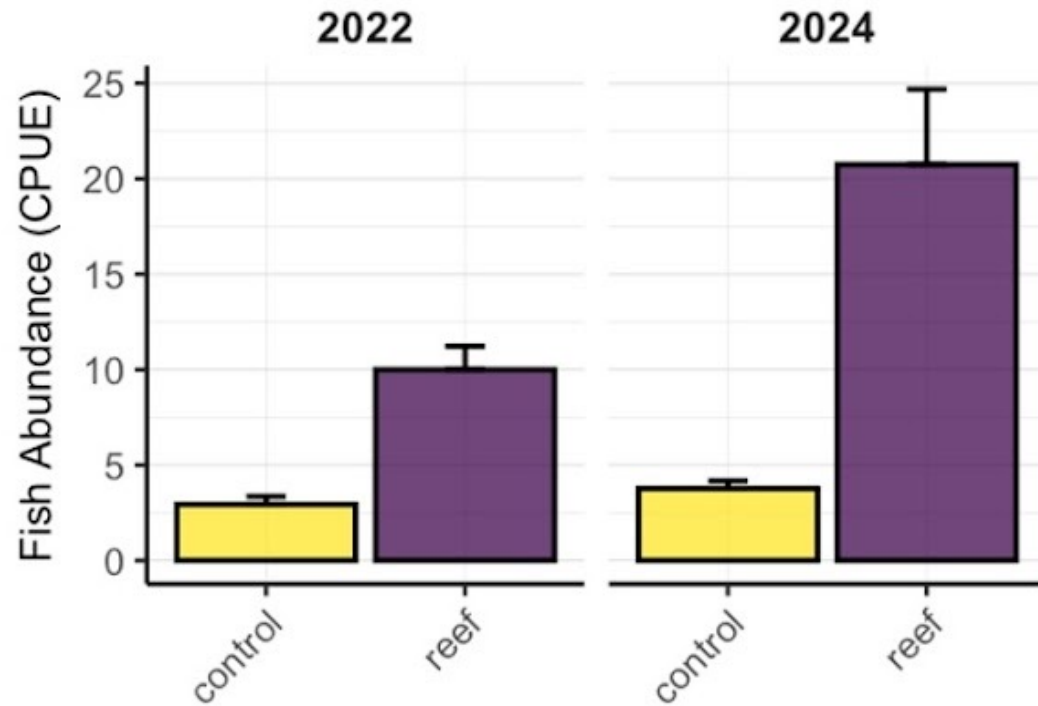
- Mimic of historically present substrate
- Natural, biodegradable material
- Readily available waste product
- Low/no carbon in construction material
- High levels of complexity
- Re-establish land-sea nutrient input



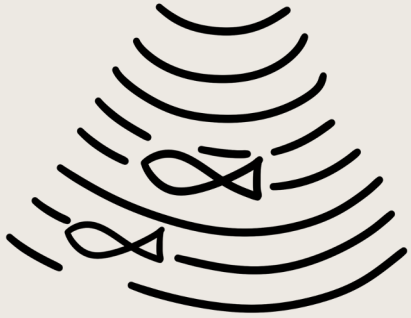
Within 2.5 years of deployment of tree-reefs:



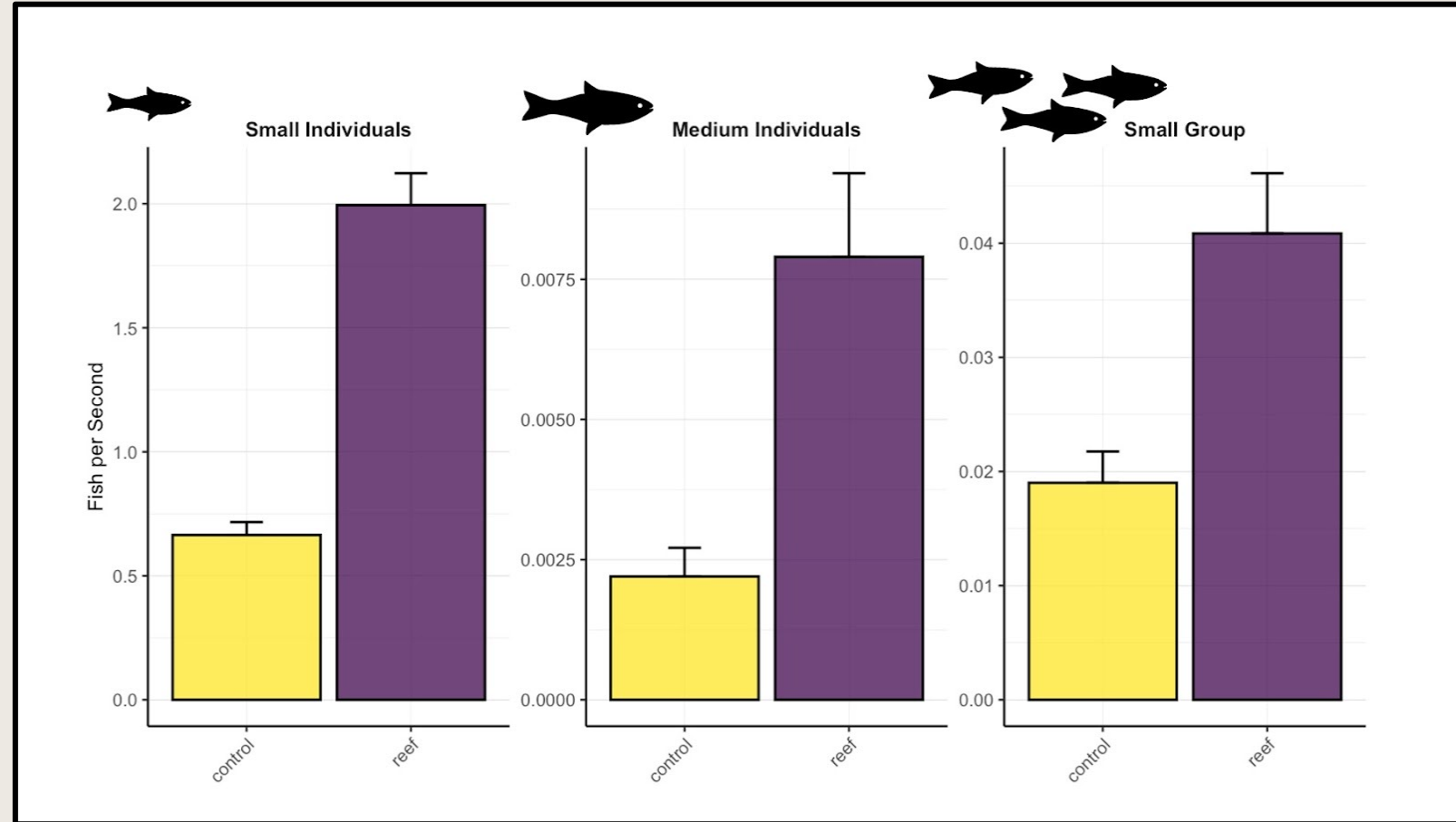
Trap fishing shows that at reef sites fish are 6x more abundant, 10% larger in size, and 7x more biodiverse



Within 2.5 years of deployment of tree-reefs:



- Sonar finds 215 – 359% greater fish abundance at reef sites across three size classes of fish.



“Natural” reefs and overpopulation of predators



- Subtidal oyster reef monitoring, Wadden Sea (~ 50x30m)
- Huge predation pressure on young shellfish establishment

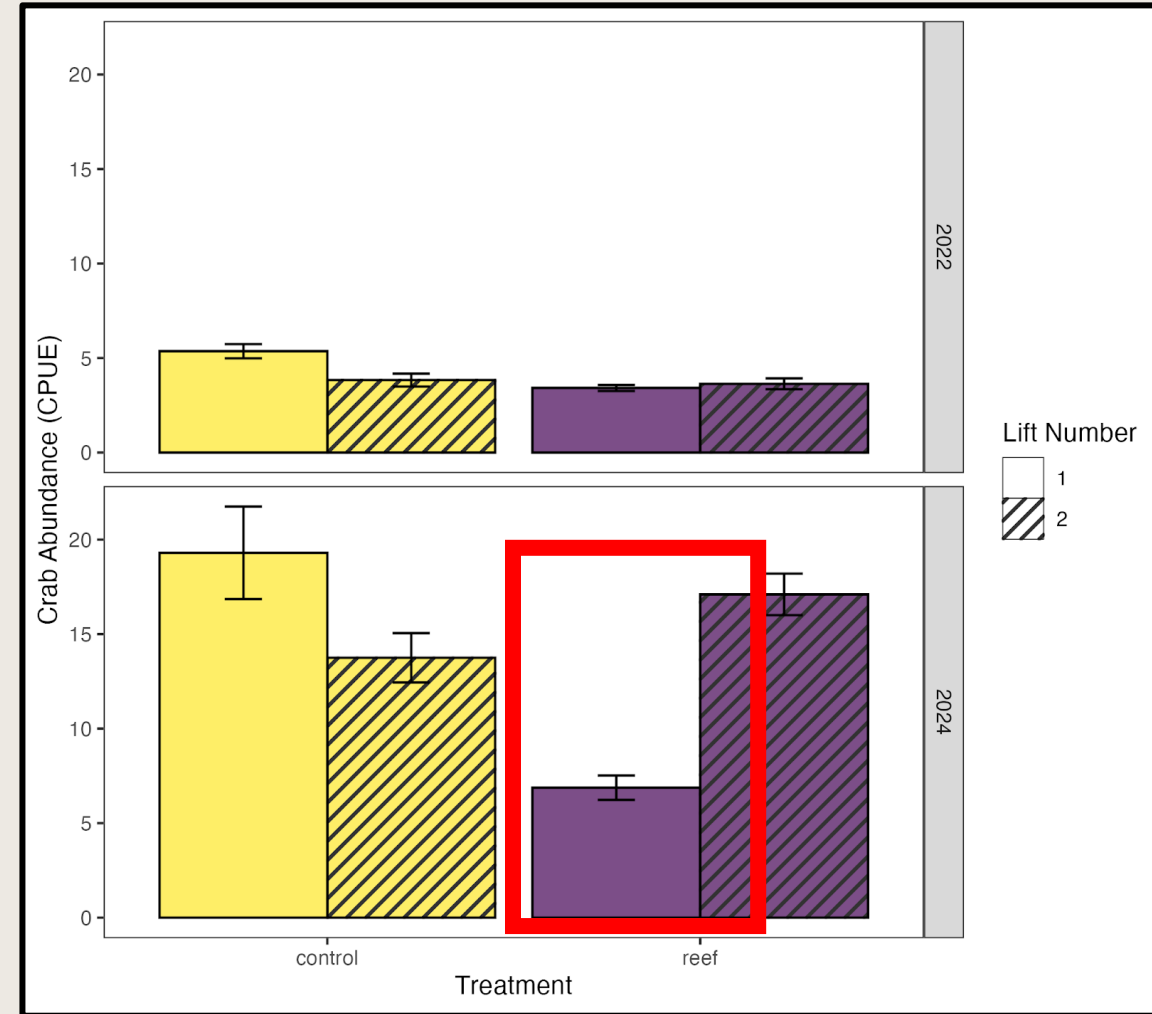
Tree-reefs, fish, and predators



- Tree-reefs mimic historic 3D substrate
- Historic flat oyster reefs = up to 7m tall*
- More physical niches for fish and shellfish

Crab catch: 2022 vs 2024

- Crab catch 77% less at reef sites in 2024
- Seascape of fear and direct predation effects created by reef-fish
- Crabs eat young shellfish
 - Too many predators prevents reef from establishing or growing
- This process also occurs with pests and seaweeds
 - i.e., urchins, sea otters, and kelp



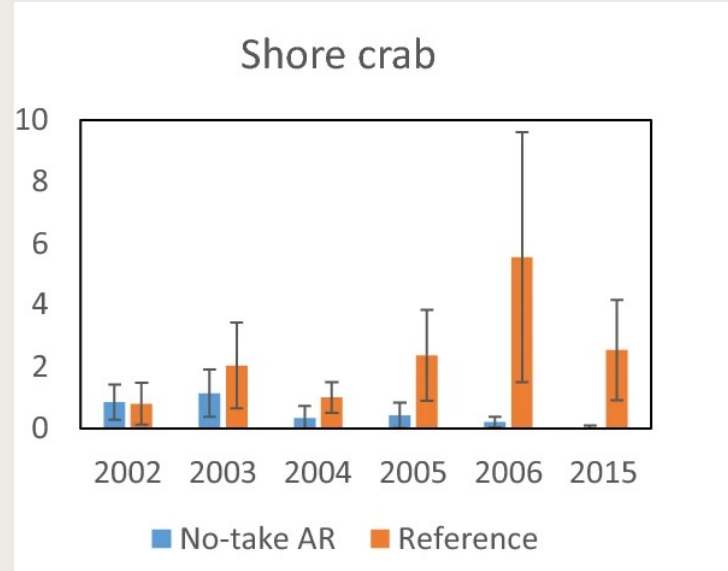
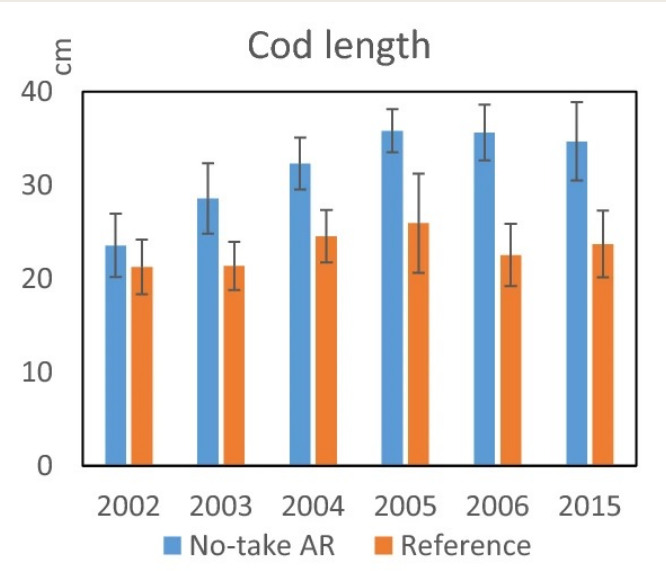
Crab catch: 2022 vs 2024



Sepia officinalis (cuttlefish) eggs

Provision of stable habitat structure

Re-establishment of top-down control

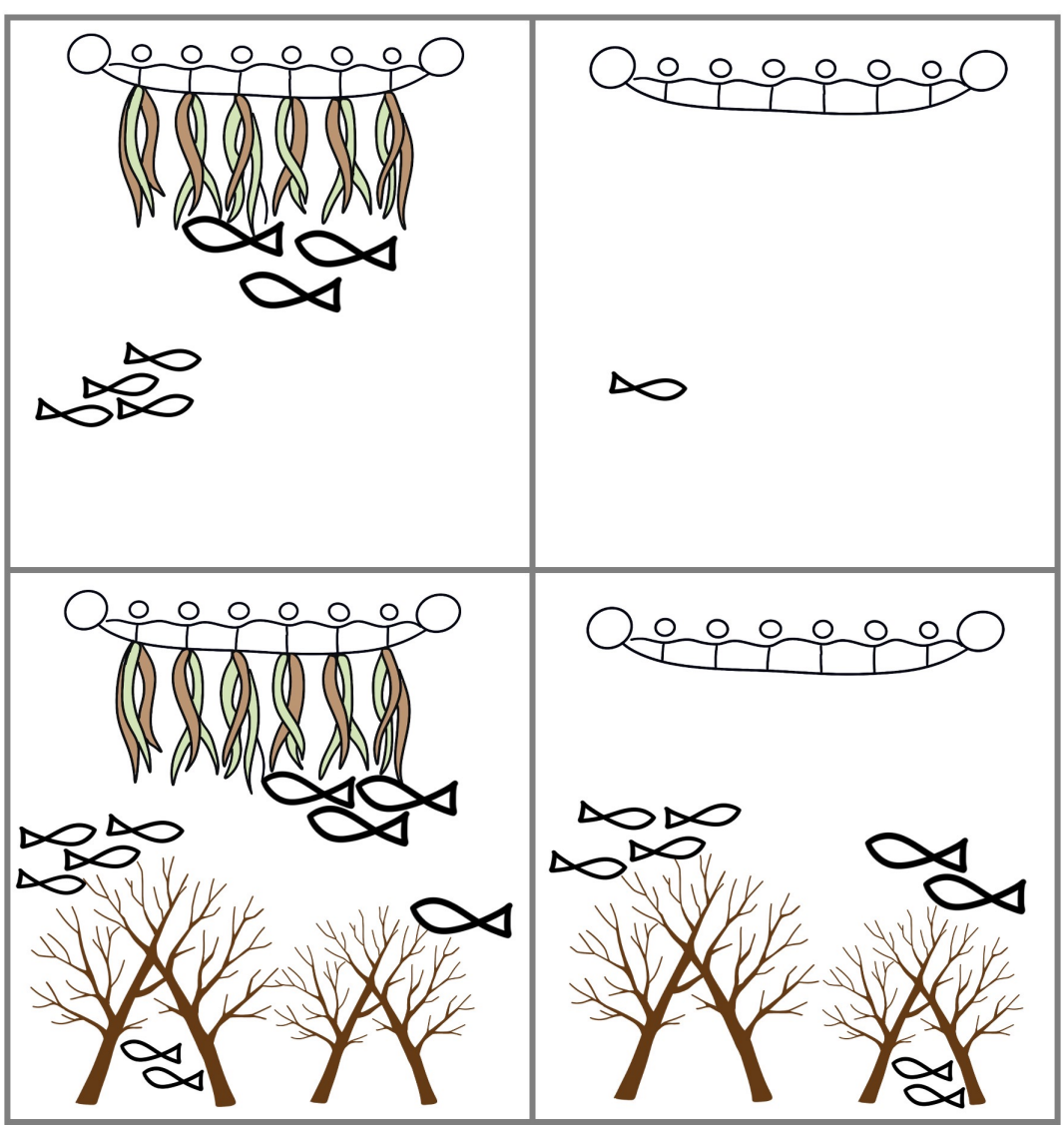


Similar patterns from a long term study in Sweden,
Krafvelin et al., 2023

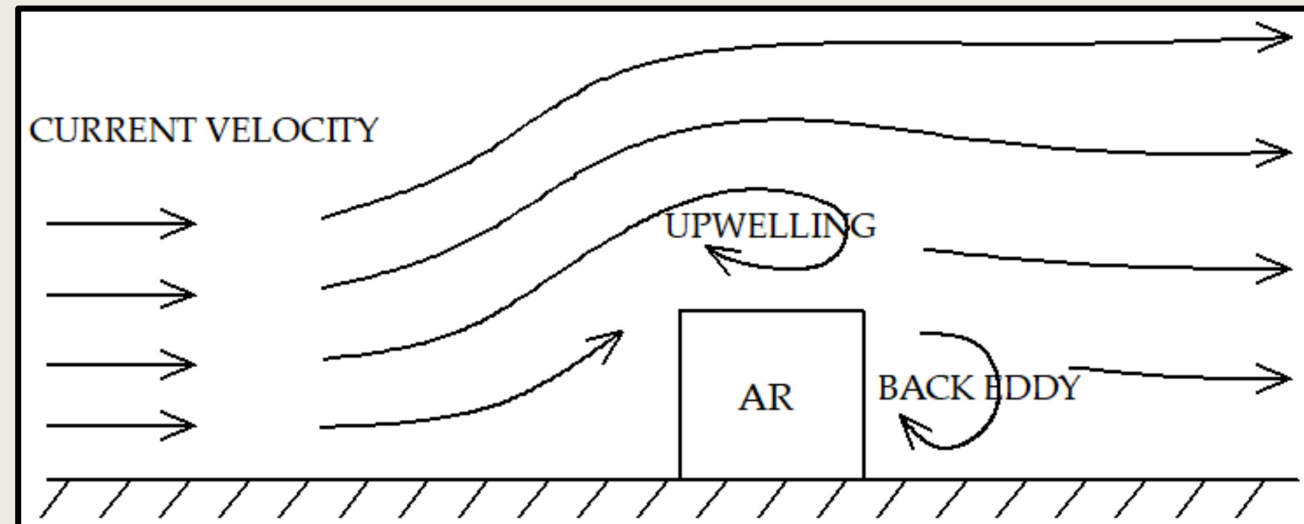
- Takes time for predators to become established
 - e.g., cod take >1 year to colonize wind turbine scour protection
- If habitat is ephemeral, predators have little reason to stick around
- If year-round refuge and food supply can be found locally, predators only need to move due to environmental effects – e.g., water temperature
- (Some) fish exhibit site fidelity – i.e., they are loyal to a single site if it works for them

Provision of stable habitat structure

Re-establishment of top-down control

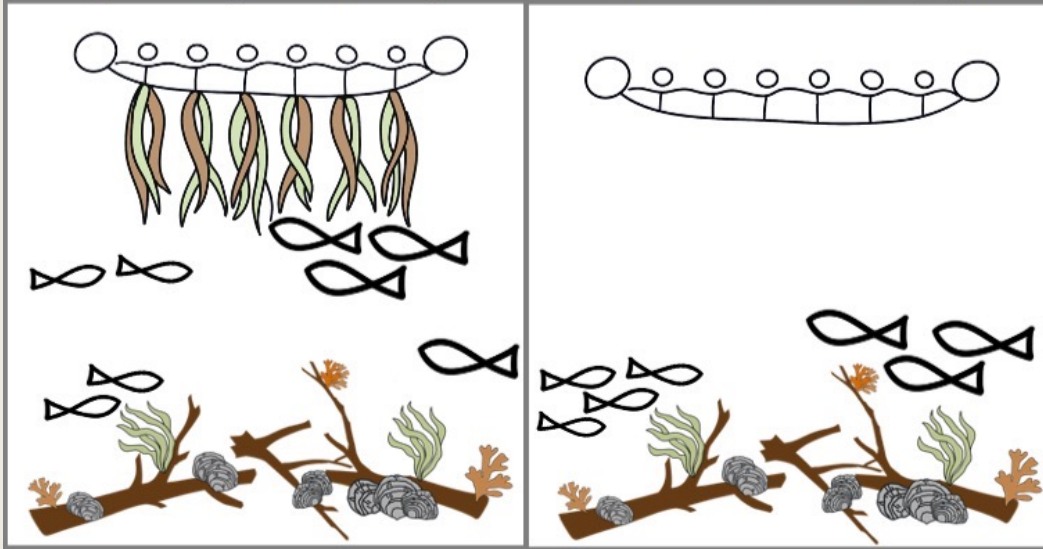


- Recruit long term population of higher level predators
- Can grow spawning populations of both fish and seaweeds
- Induced upwelling brings colder water and nutrients to upper water layers



Provision of stable habitat structure

Re-establishment of top-down control



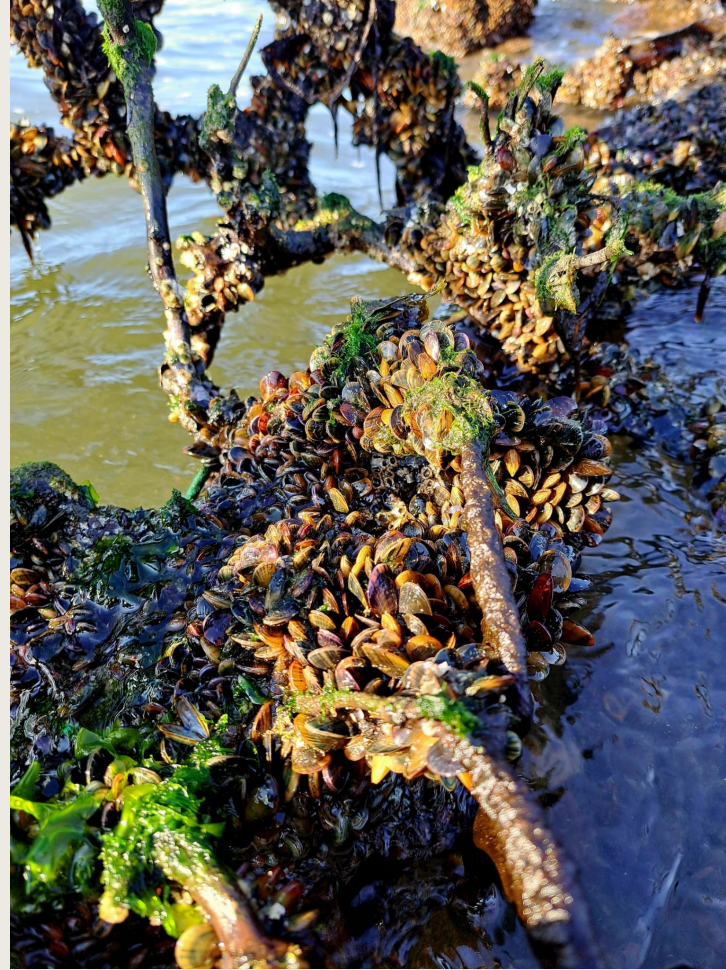
- Recruit long term population of higher level predators
- Can grow spawning populations of both fish and seaweeds
- Induced upwelling brings colder water and nutrients to upper water layers
- Self removing; no financial or regulatory considerations for removal
 - Permanent shellfish reef establish on degrading trees

Tree-reefs and shellfish

- One mussel / oyster can filter 2-8 litres per minute, also remove pathogens



Oyster and seaweeds



Mussels and seaweeds

Take-home messages

Tree-reefs:

- Attract and produce fish for long term predatory control of pests
- Induce upwelling
- Recruit shellfish for water filtration
- Transition from woody structure to long term shellfish reef
- Are cost-effective to scale in a meaningful way



Walcheren, Zeeland, 1946

“...when the floodwaters receded, instead of fruit in the branches of the dead trees, there were mussels...”



Questions?



info@marinetrees.com

Jon.Dickson@nioz.nl



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