



Coastal Water Restoration Case Study:

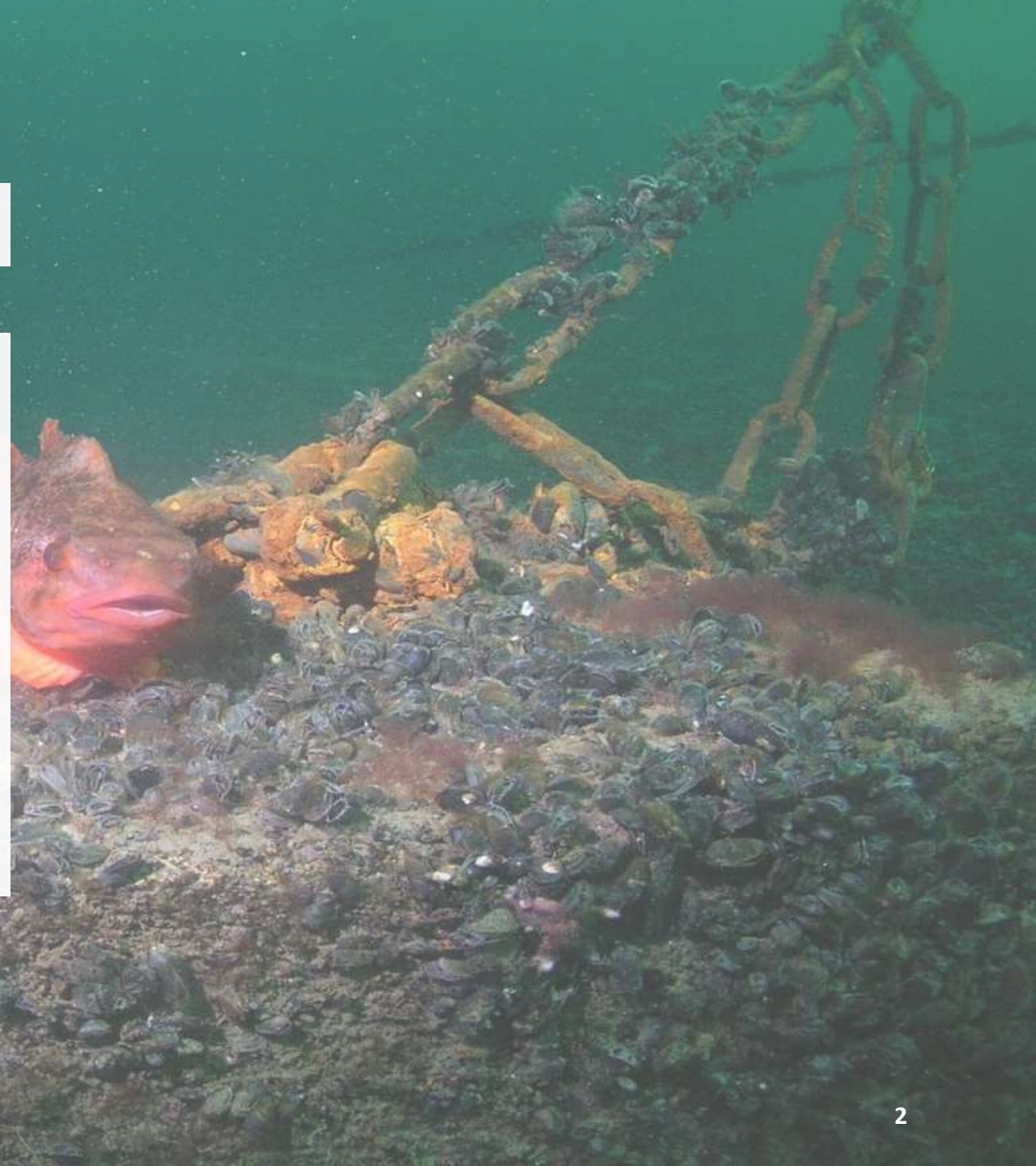
Baltic Sea – Temperate Reefs

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Overview

1. Introduction – What are temperate reefs
2. Need for reef restoration
3. Artificial reefs (AR)
4. Artificial reefs in Europe
5. Case study example: Nienhagen Reef
6. Summary



1. Introduction – *What are Temperate Rocky Reefs*

“Temperate Reefs are structurally complex habitats that provide shelter from predators, spawning and nursery areas, a feeding source for many species, and hard substrata for algae to grow” (Casabona et al., 2024)



Photo: Qui Nguyen



Photo: Wolf Wichmann

2. Need for reef restoration – *Ecological Needs*

Habitat restoration is “the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed”

(Seaman, 2007)

- Necessary for functions and services of marine ecosystems
- Anchorage of sessile biota (e.g., mussels, seaweed, anemones)
- Enhance food & shelter availability
- Attract invertebrates, fish, marine mammals
- Assist in carbon sequestration
- Enhance coastal protection
- Advance scientific research

2. Need for reef restoration – *Legal Needs*

Extreme degradation caused by “stone fishing”, banned in 1906

- Listed under the EU Habitats Directive (94/36 EU, 1999) → Requires restoration and maintenance of habitats & species
 1. Habitat is stable or expanding
 2. Ecological functions continue to exist
 3. Conservation status favourable
- Designated as part of the Natura 2000 network of protected areas
- The EU Nature Restoration Law (2024) legally binds member states to restore 20% of degraded ecosystems by 2030
- HOWEVER: No regulations on **rocky reef** restoration in EU

➔ Artificial reefs can be an active restoration tool

3. Artificial Reefs – *What are they?*

“A submerged structure deliberately placed on the seabed to mimic some functions of a natural reef such as protecting, regenerating, concentrating and/or enhancing population of living marine resources” (Fabi et al., 2011)



Intentional

(to serve as reefs)

Photo: Gerd Niedzwiedz



Unintentional

(Shipwrecks, offshore oil rigs, historic remnants)

Photo: Erik Stohr

3. Artificial Reefs (AR) – *Shape types*

Rings



<https://www.riff-nienhagen.de>

Cones



<https://www.riff-nienhagen.de/>

Tetrapods



<https://www.riff-nienhagen.de>

Algae Tables



<https://www.riff-nienhagen.de/>

4. Artificial Reefs in Europe – *Aims*

- Nature conservation and restoration
- Fish stock enhancement
- Fishery management and improvement
- Coastal protection and erosion control
- Prevention of illegal fishing practices
- Aquaculture
- Research
- Recreation

(Fabi et al., 2006; Muñoz-Pérez et al., 2000)



4. Artificial reefs in Europe – *International organisations*

No unified EU-wide regulation for artificial reef development but international (e.g., UNEP, IMO, OSPAR) and regional organisations (e.g., Barcelona Convention) developed guidelines to ensure artificial reefs are designed, constructed, and managed responsibly.

Organisations assist contracting parties in:

- Assessing proposal for artificial reef placement based on scientifically sound criteria
- Develop appropriate regulatory framework
- Implement regulations on artificial reef construction
- Prevent pollution/degradation of marine environment
- Subject to environmental impact assessment (EIA)
- Carefully monitored



4. Artificial reefs in Europe – *Problems with poor design and planning*

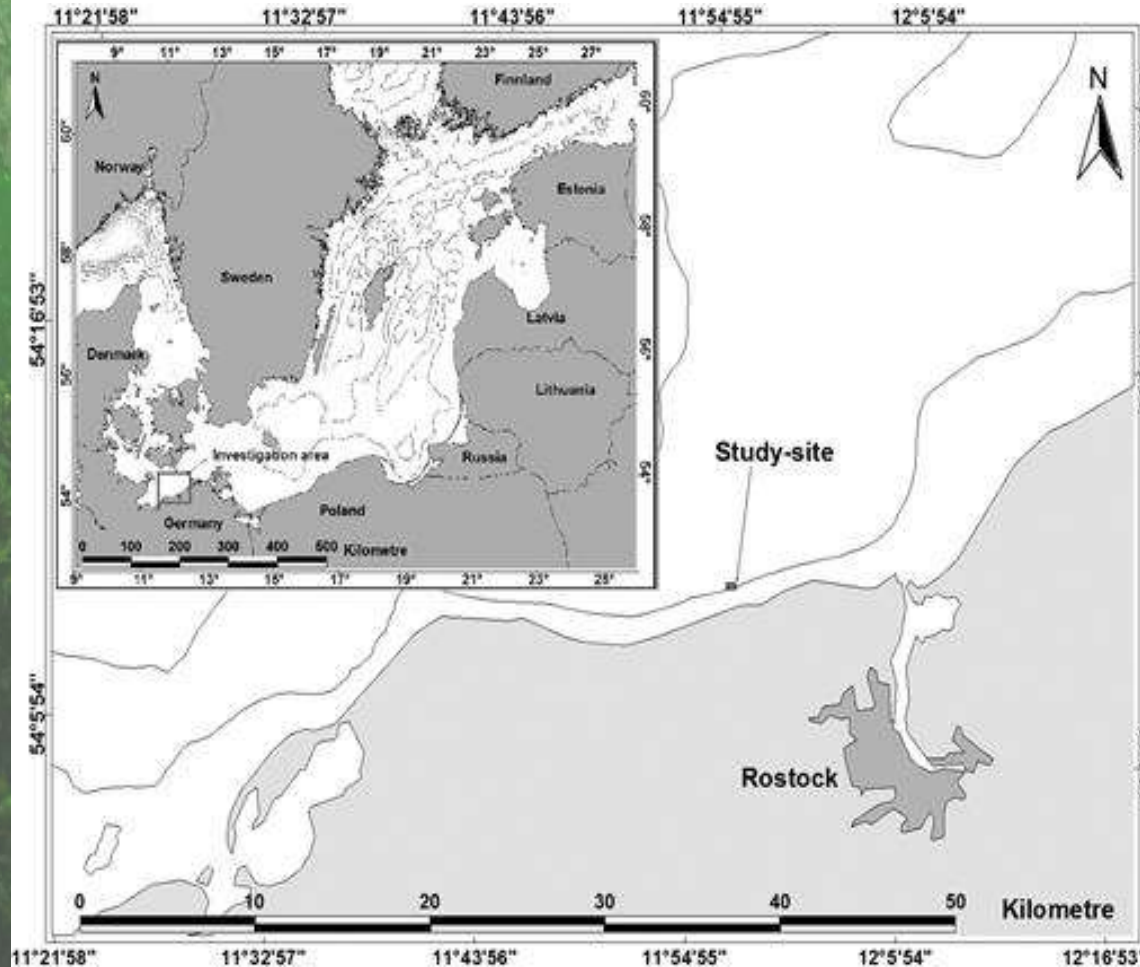
- Attraction and/or depletion of species stocks
- Pollution and toxicity
- Changes in species composition
- Invasive species dispersion
- Hydrodynamic changes

Should follow comprehensive design, planning, and deployment procedures and include stakeholder involvement

(Kristensen et al.,2013; Stottrup et al., 2017)

5. Nienhagen Reef

5. Nienhagen Reef - *Background*



Map: Schygulla & Peine, (2013)

- First artificial reef in Germany
- Influenced by the private sector
- Implemented in 2003 to increase biodiversity and biomass

Goals:

- 1) Increased biodiversity and fishery value by 2012
- 2) Feasibility study on artificial reef development

5. Nienhagen Reef - Structure



5. Nienhagen Reef - *Lessons learned*

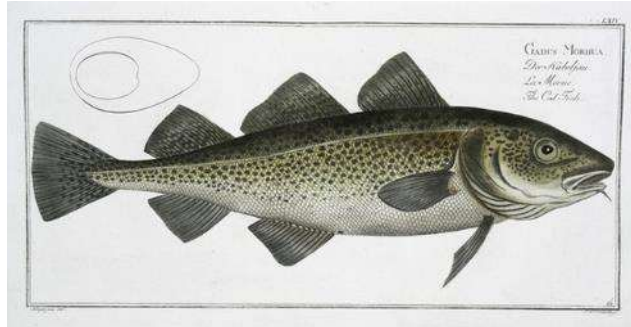
- Importance of long term data
- Higher recorded biodiversity
- Re-colonisation of macroflora, invertebrates, vertebrates
- High number of recorded fish fry (**juvenile cod twice as high**)
- Increase in filter feeders → increase in predators
- Settlement of Bladder wrack (kelp) → increase in invertebrate recruitment/survival
- Impact beyond its boundary
- Invasive species: Anellida; Asian shore crab; Sand gaper; Comb jelly; Bay barnacle

Nour et al. (2020); Sandrock et al. (2014); Wikstrom & Kautsky (2006)

Nienhagen reef species numbers

Group	Species encountered	Percentage biodiversity
Invertebrates	110	57%
Fish	43	22%
Macroalgae	39	20%
Total	192	

5. Nienhagen Reef - *Effect on Cod*



- New methodology using mark-recapture technique
- 6660 marked, 358 recaptured
- **High homing rates**
- Stock management measure accomplished

Mohr (2020)

Fish Trap



Photo: U. Friedrich

6. Summary



Photo: Gerd Niedzwiedz

- Temperate reefs are complex habitats
- Restoration through artificial reefs is necessary

BUT

- It requires much thinking at the development phase
- Post implementation monitoring is a must
- Nienhagen AR is successful but not perfect

Thank you for your attention!



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