

The Nature of Offshore Wind

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Renewable in the Anthropocene

- Upscaling wind energy contributes to the energy transition (climate neutrality)
- ...but affects the natural environment (biodiversity neutrality)
- Wind power potential is enormous, not least in Norwegian seas
- ...but can the sea withstand it on top of existing marine activities?



The risk propeller shows that risk emerges from the overlap of:

● Climate hazard(s)

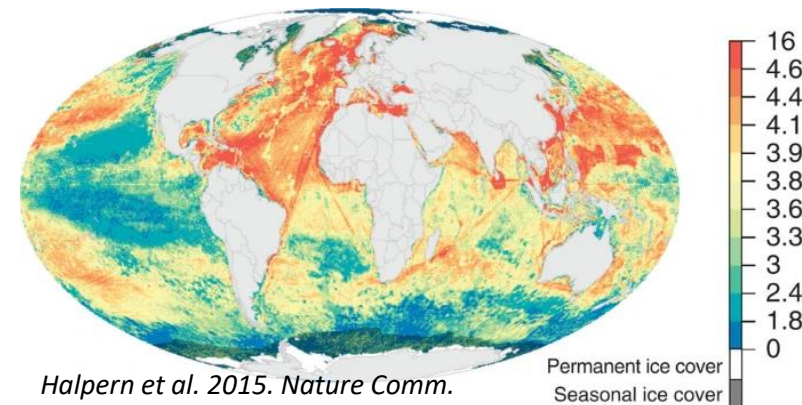
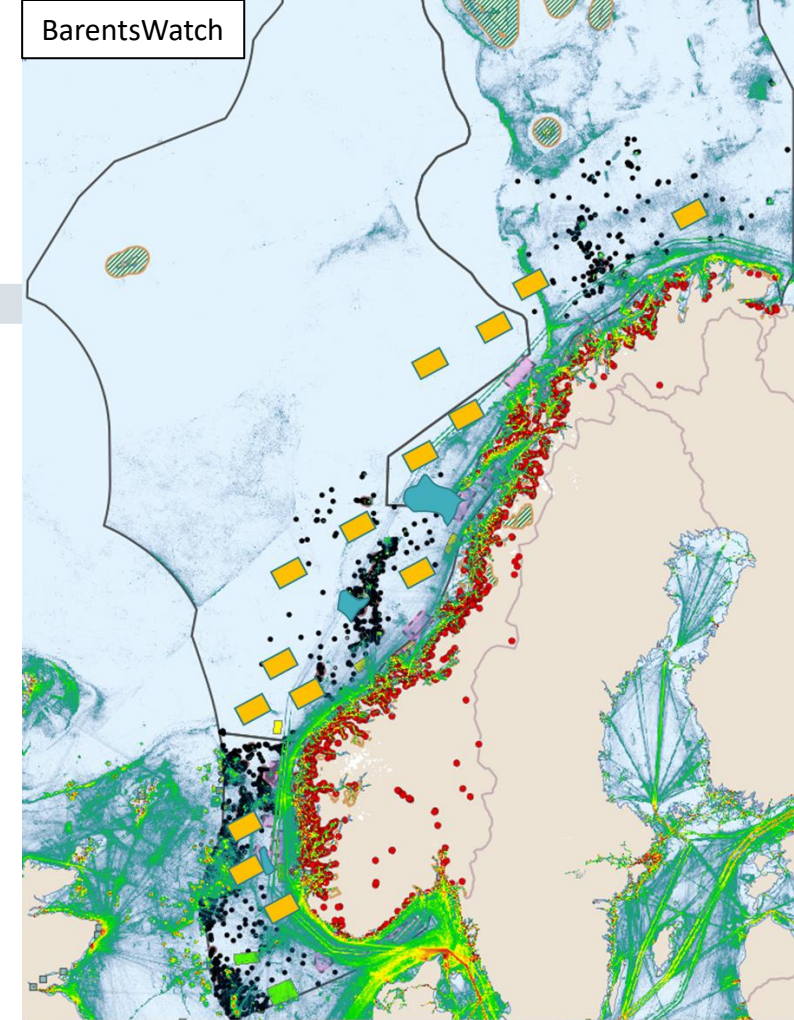
● Vulnerability

● Exposure

...of human systems, ecosystems and their biodiversity

Ocean of change

- Climate change
- Maritime shipping
- Army shooting ranges
- Oil and gas production
- Fisheries and aquaculture
- Coastal and runoff pollution
- Offshore wind energy (+30 GW)
- Marine protection (3.6% → 30% by 2030)



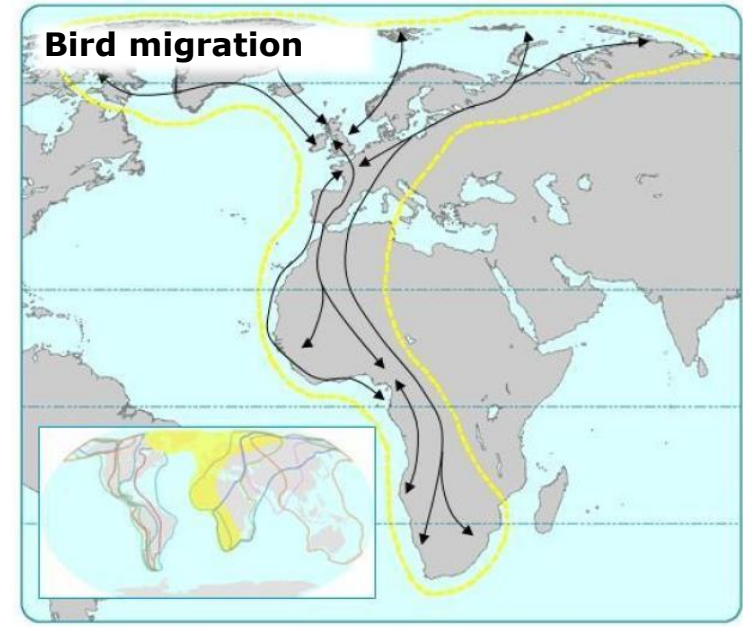
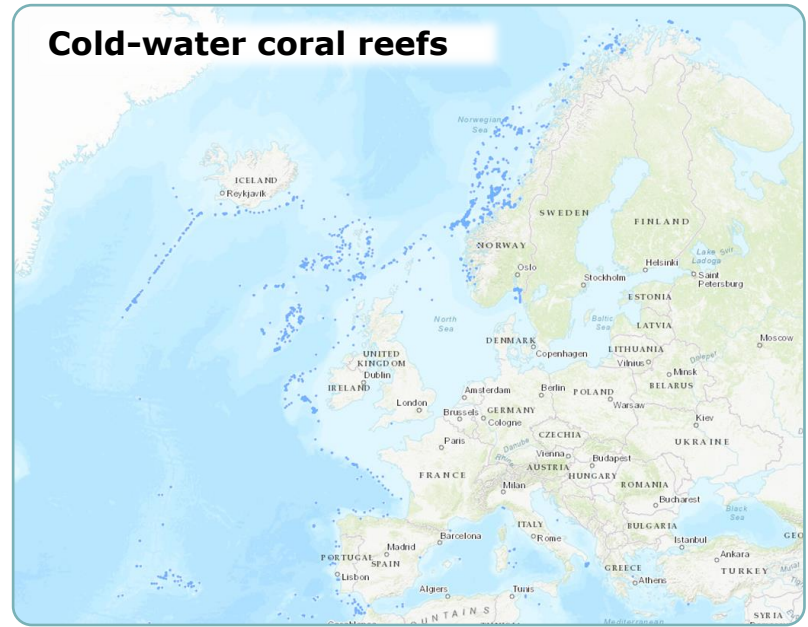
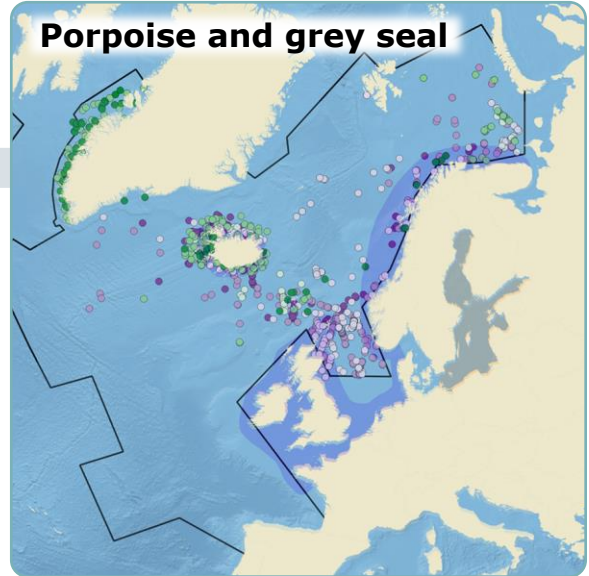
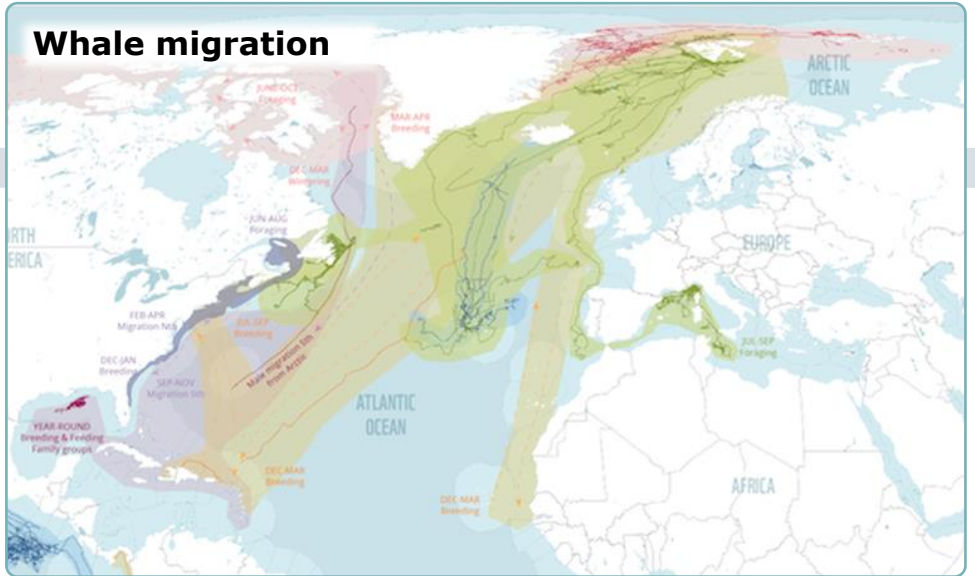
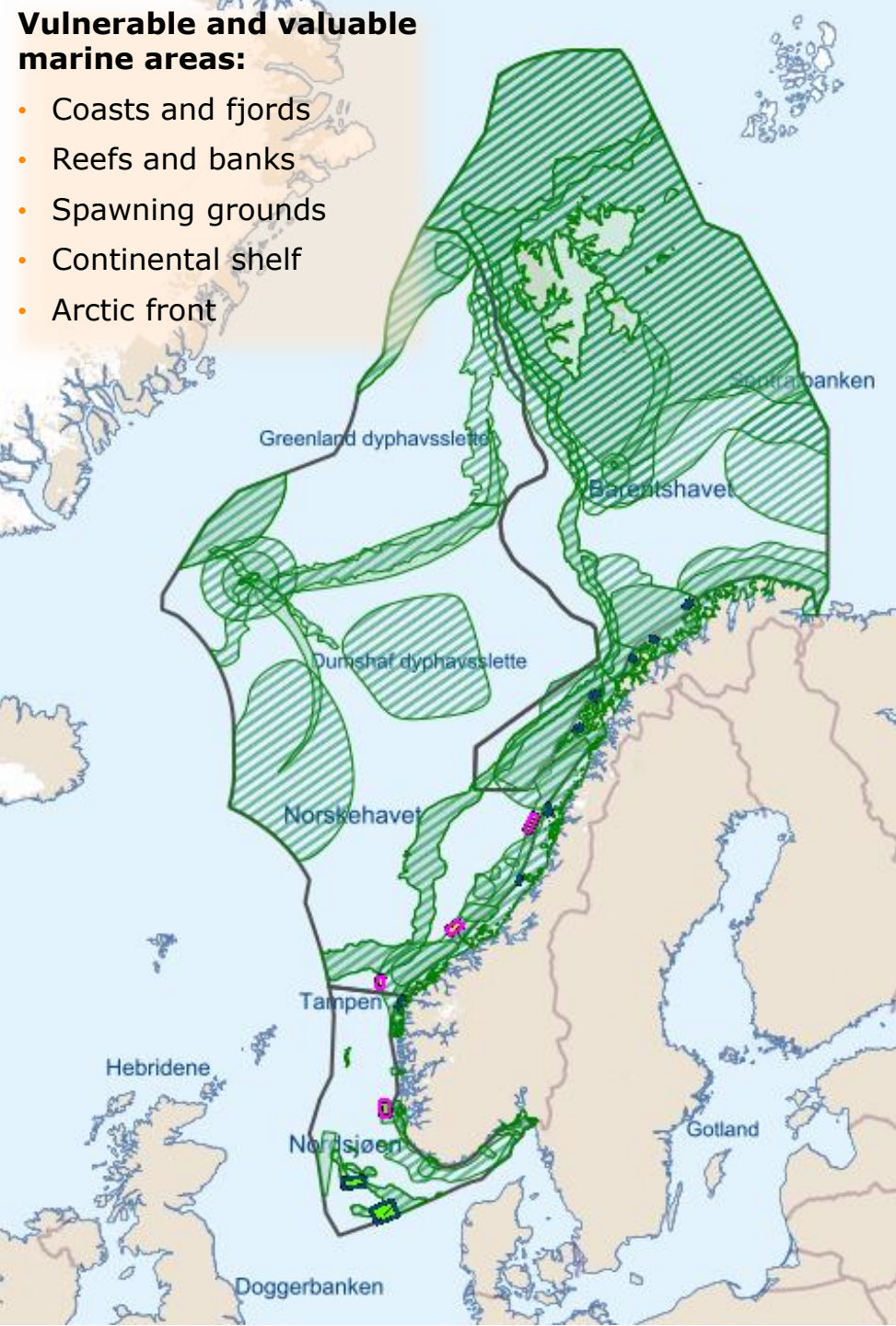
Change of oceans

- Cumulative effects
- Cascading effects
- Species use vast areas
- Transitions are important:
 - ▶ Coasts and fjords
 - ▶ Reefs and banks
 - ▶ Spawning grounds
 - ▶ Continental shelf
 - ▶ Arctic front



Vulnerable and valuable marine areas:

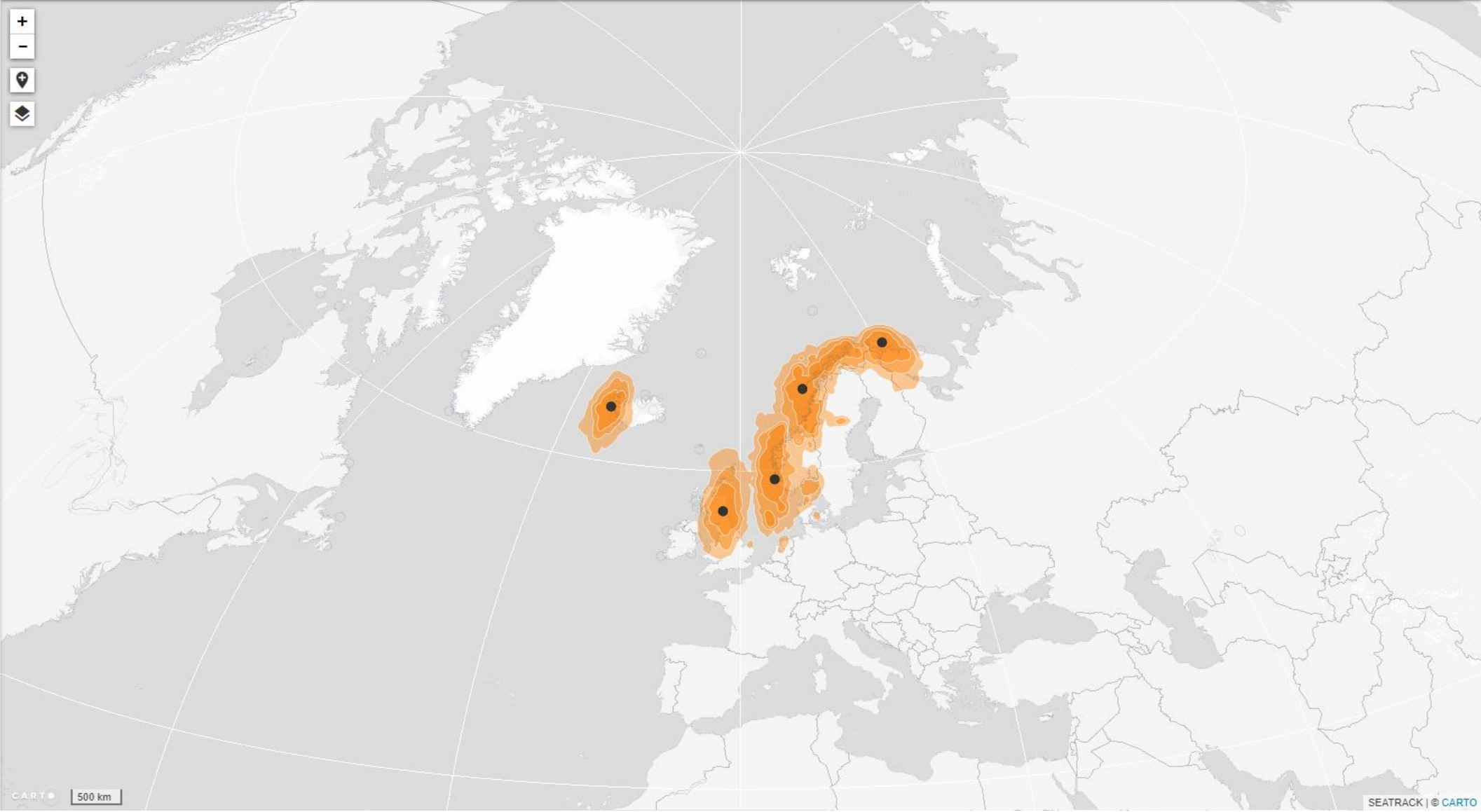
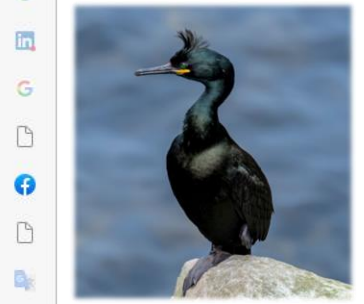
- Coasts and fjords
- Reefs and banks
- Spawning grounds
- Continental shelf
- Arctic front





European shag

- species: European shag
- season: All seasons
- period: All years 2014 to 2021
- colony: All colonies

Data used to produce map
Locations: 102324
Colonies: 5
Individuals: 169
Days: 190
Months: 8



		North-East Atlantic	Baltic Sea	Mediterranean Sea	Black Sea	European Seas			
		OSPAR	HELCOM	UNEP-MAP and GFCM	BSC and GFCM	Art. 17 Habitats Directive	IUCN Red List	Living Planet Index (LPI)	BEAT+ Worst case BQR
 Species groups	Seals								
	Cetaceans								
	Birds					N/A			
	Bony fish					N/A			
	Sharks and rays					N/A			
	Reptiles		N/A						
	Cephalopods		N/A		N/A	N/A			
	Other invertebrates								
 Habitats	Pelagic					N/A			
	Benthic								
Ecosystem	IPBES current and past trends								

State

Good	Moderate/mixed	Poor	Bad	Insufficient data
Limited data/ regional coverage				

Trend

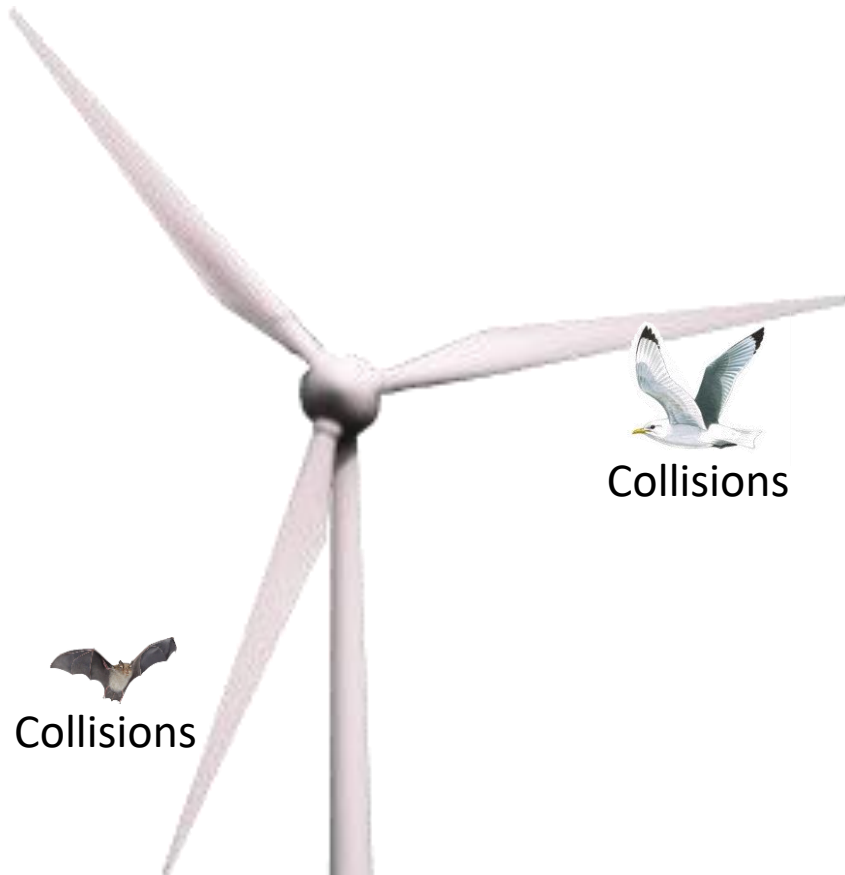
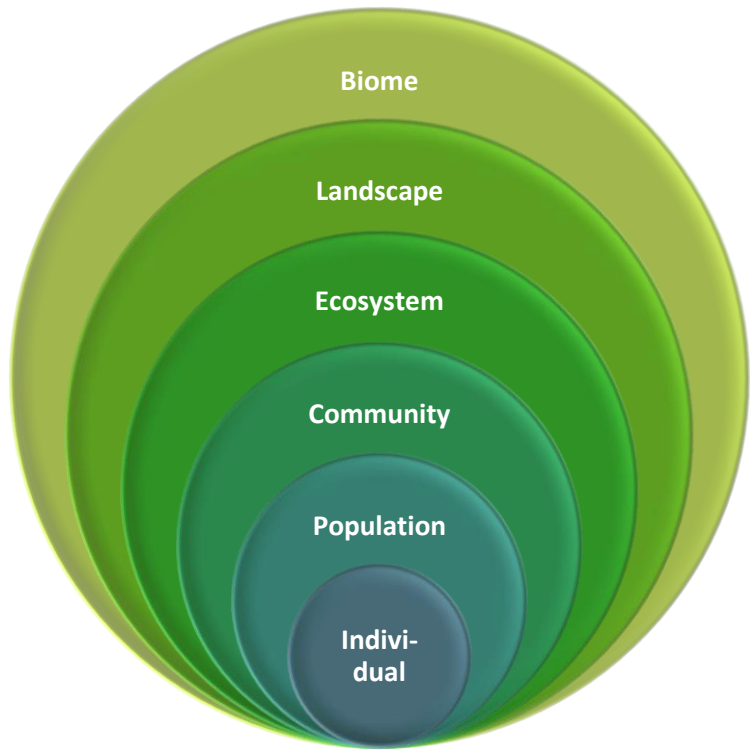
Improving	Stable/mixed	Moderate decline	Strong decline

N/A = Not applicable

Introducing offshore wind...



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Collisions

Collisions



Barrier effects



Displacement



Collisions



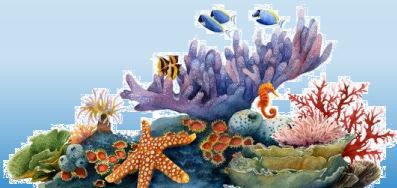
Underwater noise



Vibrations and EMF



Attraction effects



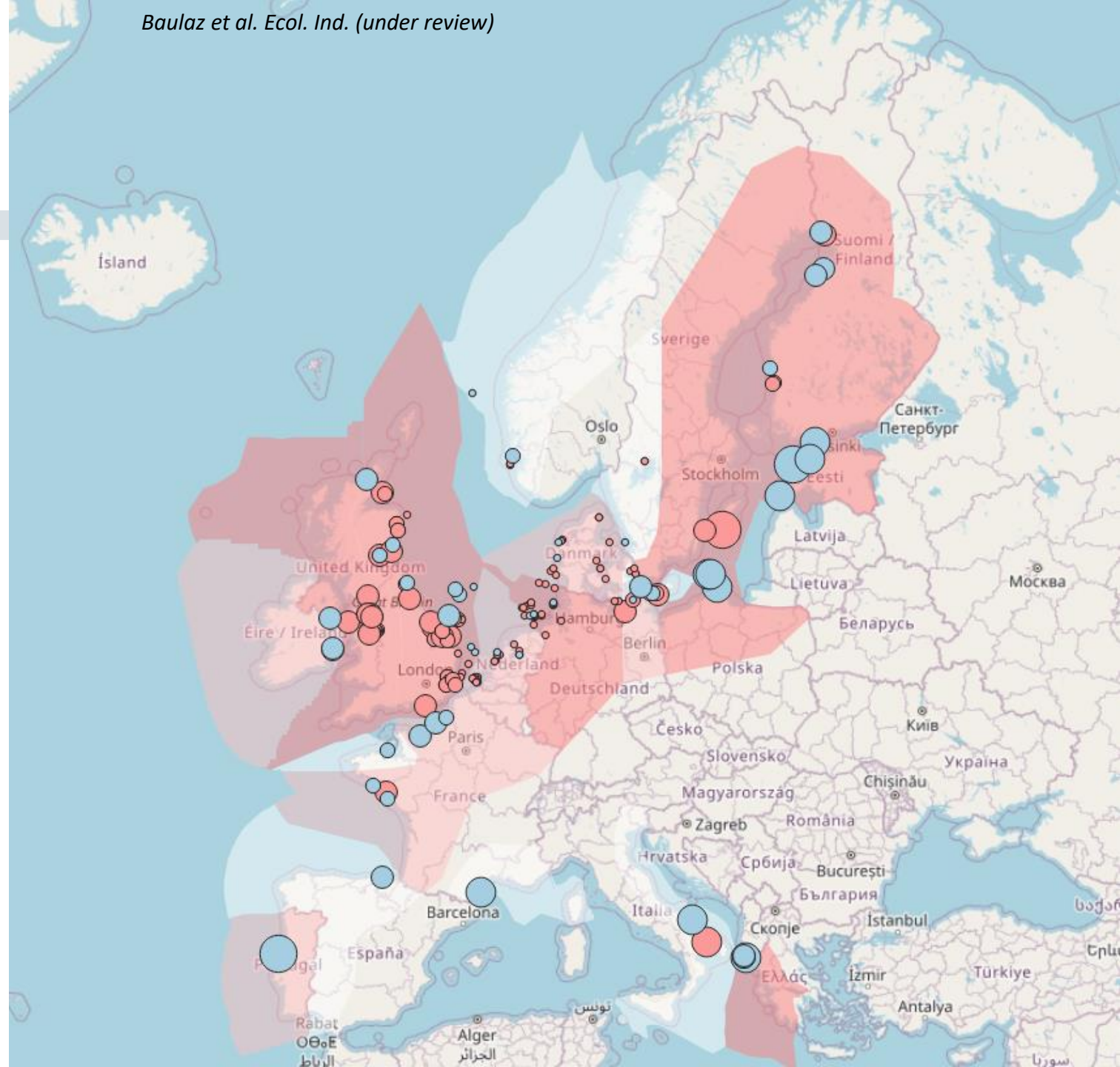
Habitat disturbance



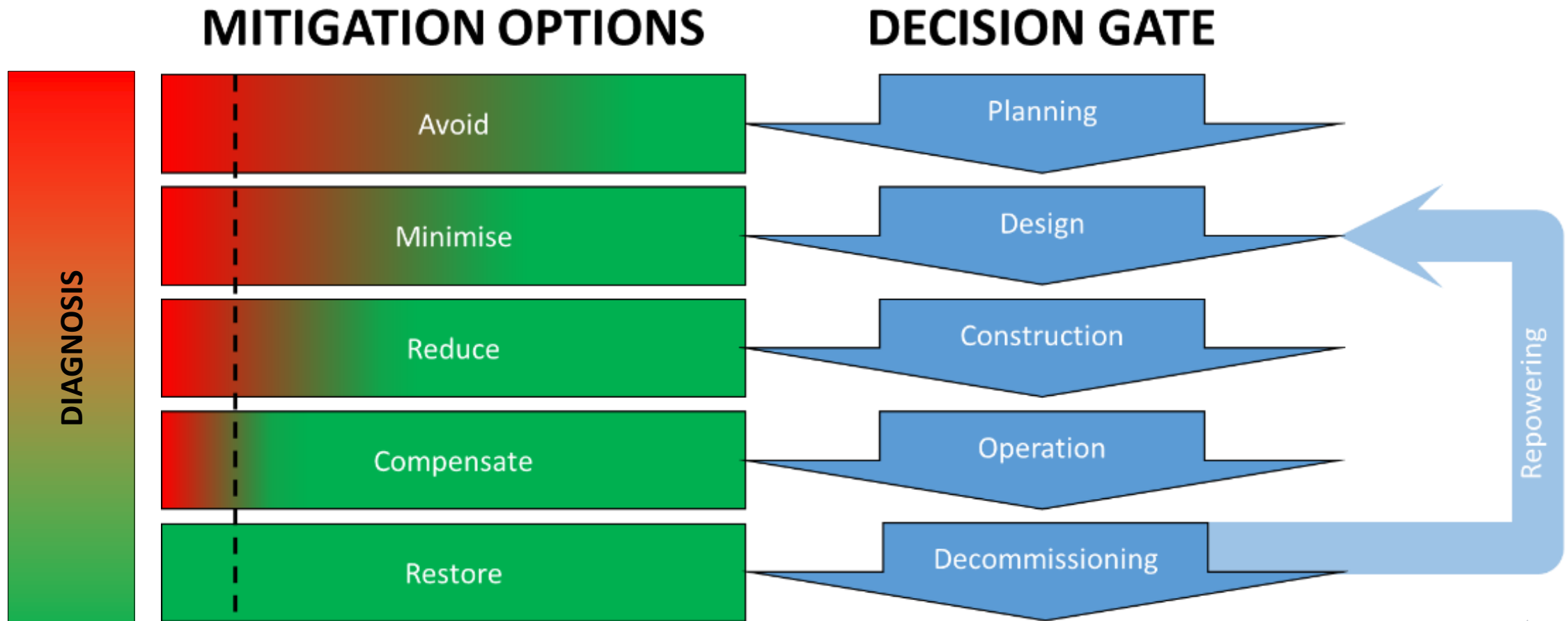
Displacement



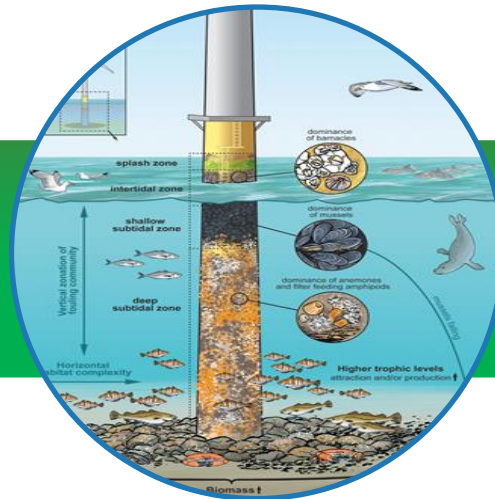
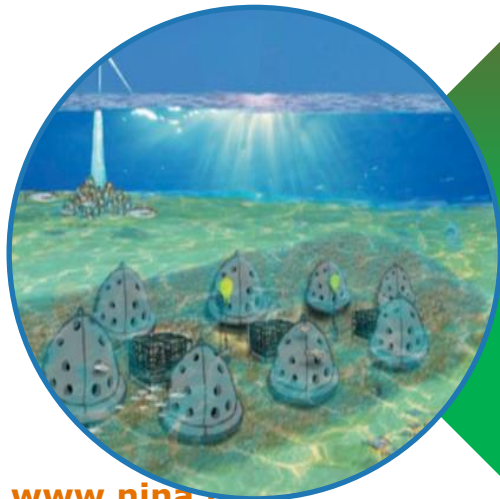
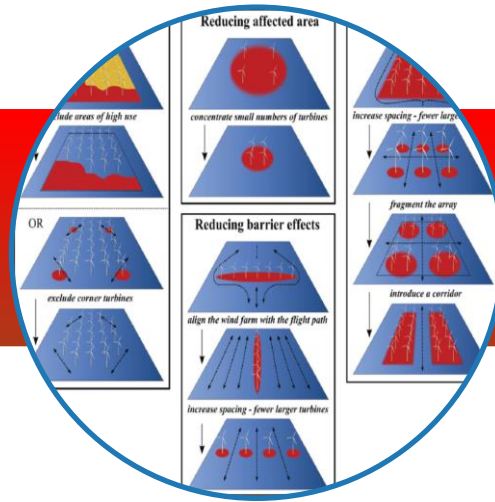
Lif-cycle assessment on collision impacts of **constructed/operational** and **planned/approved** offshore wind farms on seabird diversity in the marine Ecoregions of Europe



Mitigation of impact



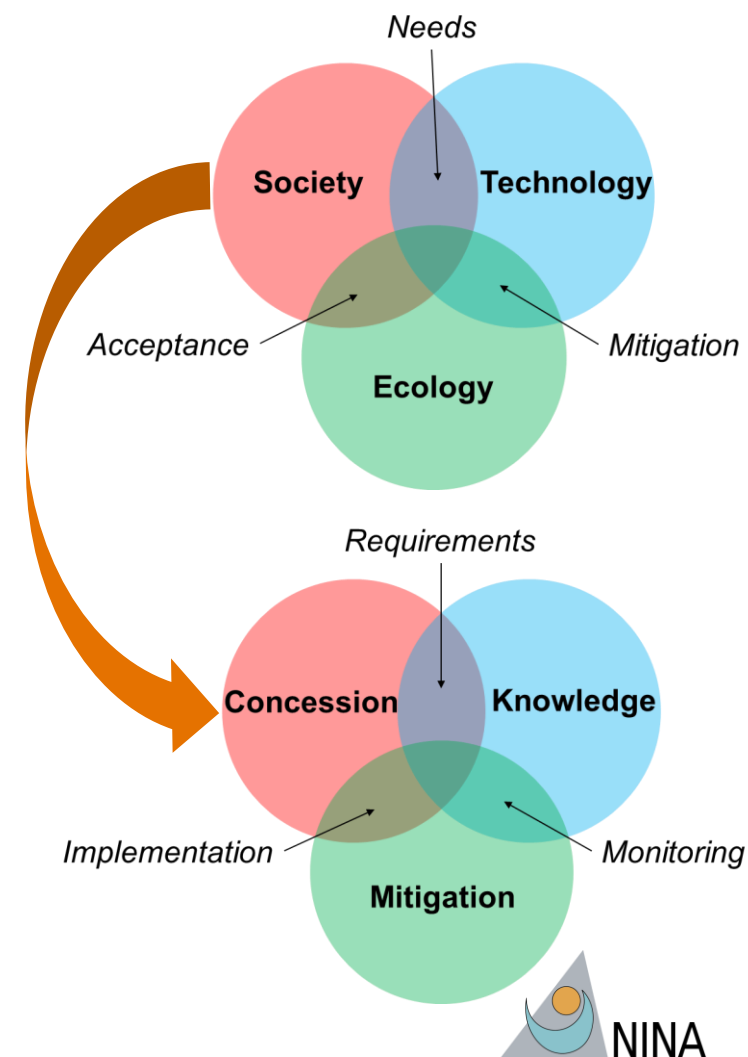
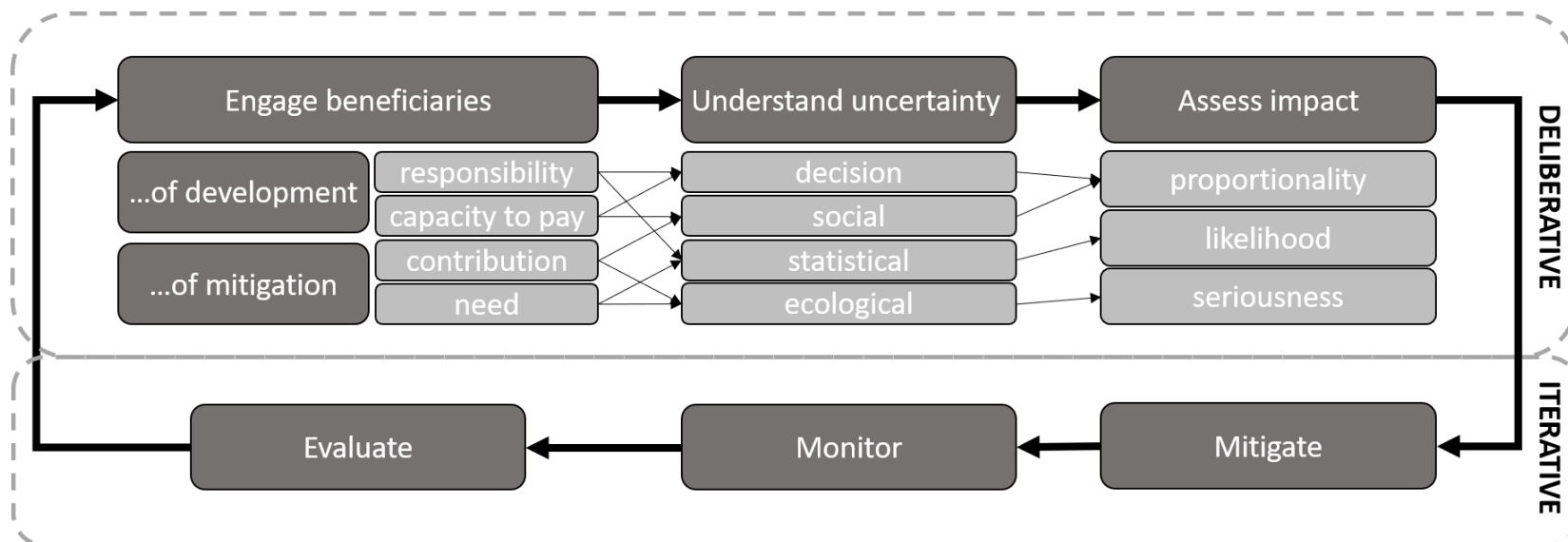
Mitigation of impact





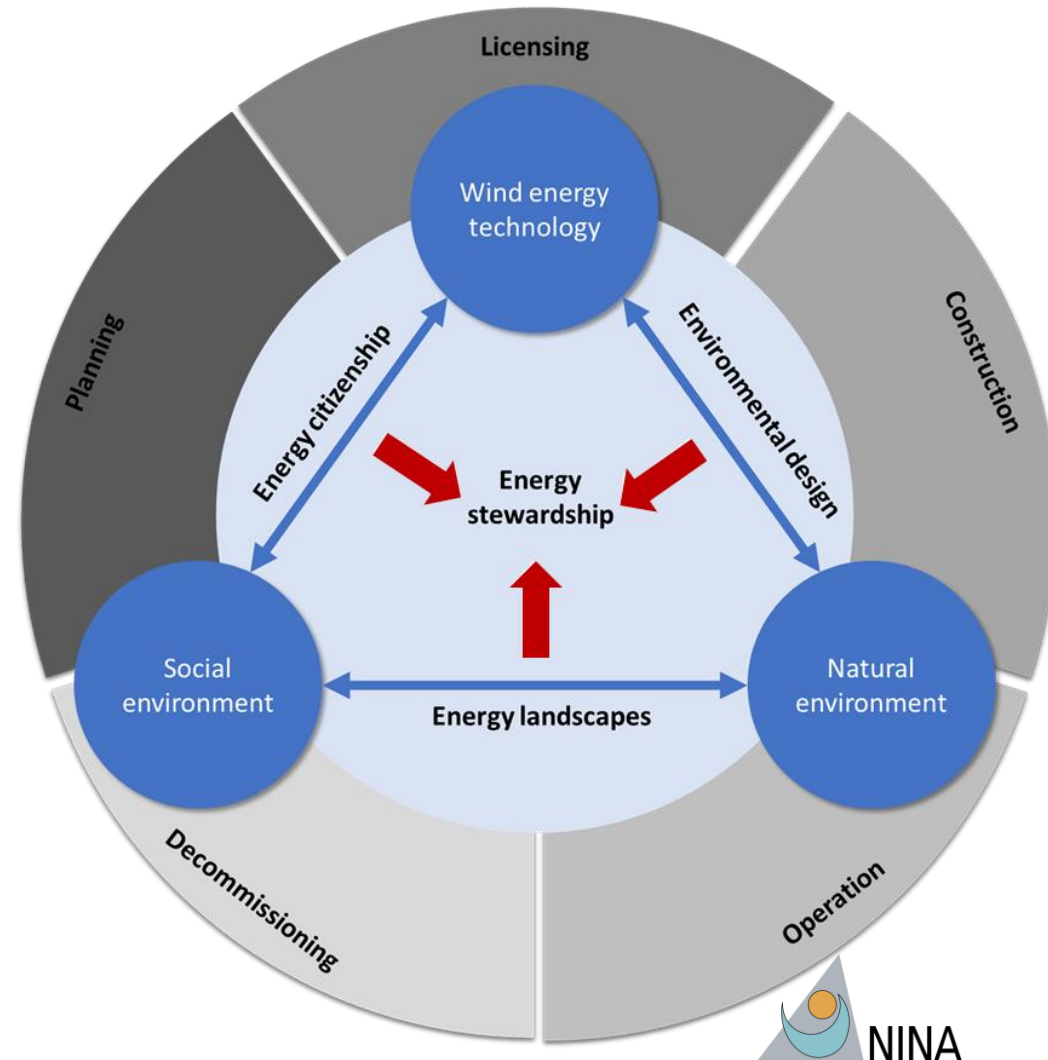
Impact of mitigation

- Wind energy with the least environmental impact per kWh requires balancing multiple interests throughout the entire life-cycle of a wind farm, and acting upon this adaptively

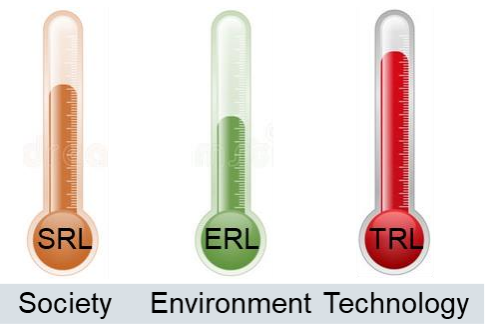


Towards energy stewardship

- Sustainable development of offshore wind can only be realized when people are willing to adapt and take responsibility
- A sector-wide and knowledge-based spatial policy for marine areas
- Apply the hierarchy of measures to mitigate unavoidable impacts



Are you ready for sustainability?



- Can R&D develop innovations for the construction and operation of nature-inclusive offshore wind?

“The Quest for the Perfect Turbine”

Efficient and powerful
Silent and invisible
Recyclable and green





Thank you for your attention!