

Ecosystem Responses to Offshore Wind Novel Structures

A large offshore wind turbine stands in the ocean under a sunset sky. The turbine is a monopile structure with three blades. The sky is a mix of light blue and orange, with some clouds. The water is calm and reflects the light from the sky.

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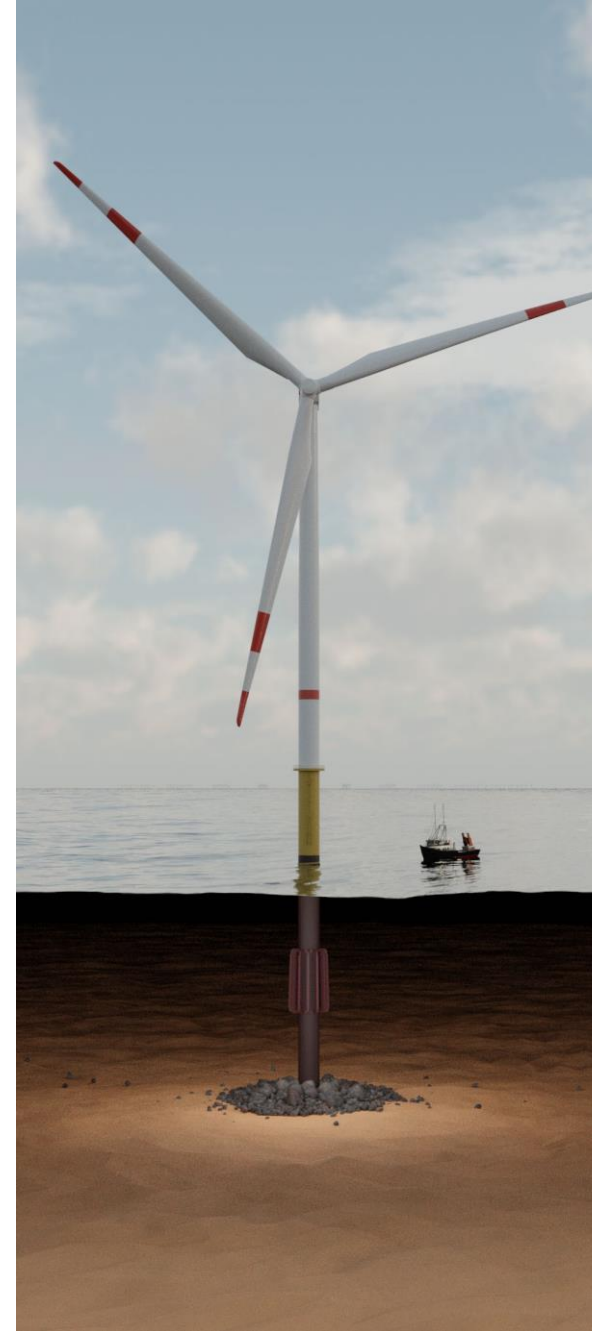
Artificial Reef Effect

Novel structures
lead to ecological shifts (connectivity) at multiple scales

Species Distributions

- Benthic species colonize structures
- Changes in community structure + diversity
- Facilitate poleward expansion of species
- Opportunistic non-indigenous colonization

Net Positive Impact on
Biodiversity



Artificial Reef Effect

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lead to ecological shifts (connectivity) at multiple scales

Species Distributions

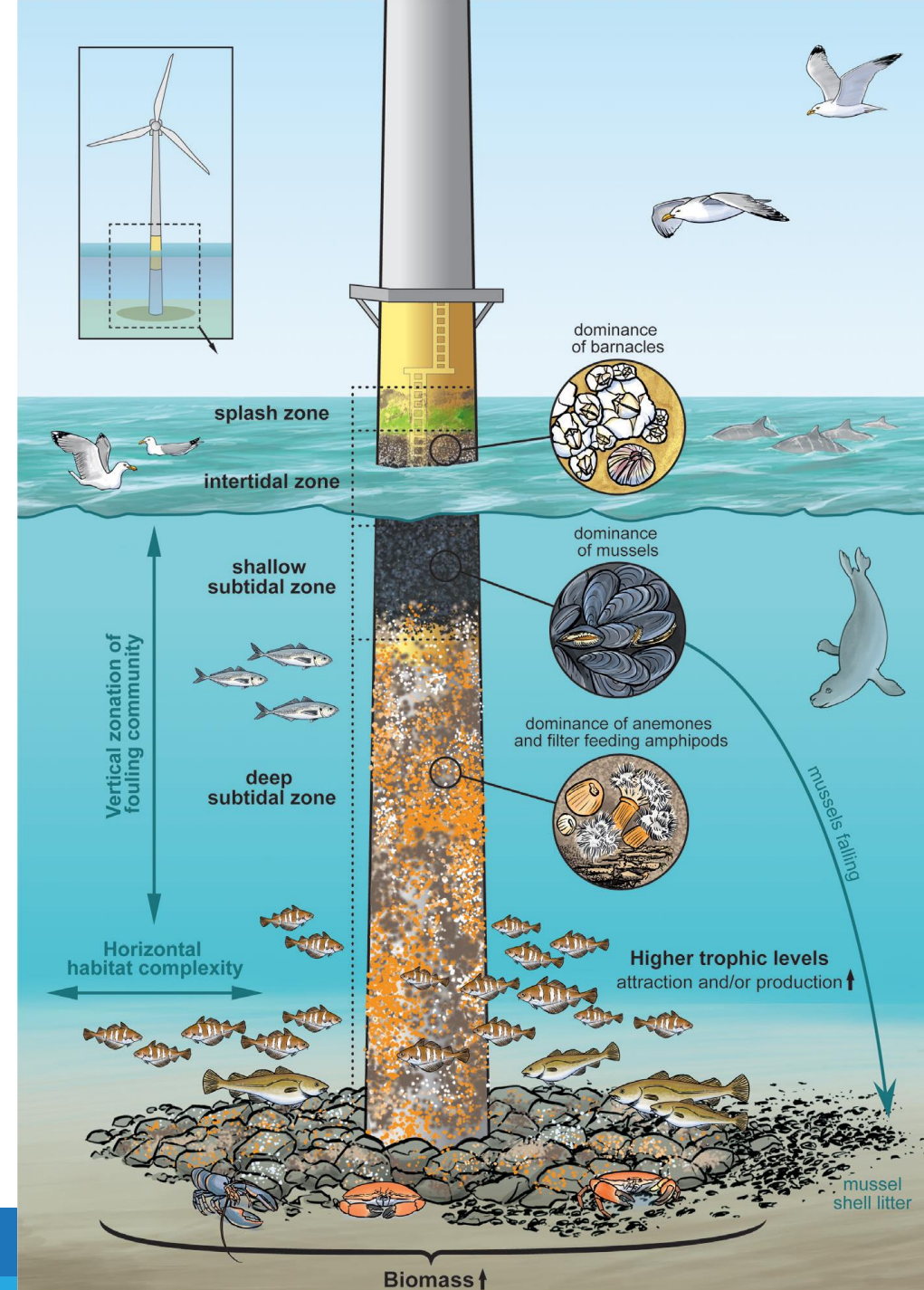
Benthic species colonize structures
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Facilitate poleward expansion of species
Opportunistic non-indigenous colonization



Net Positive Impact
associated with changes
in Ecosystem Function

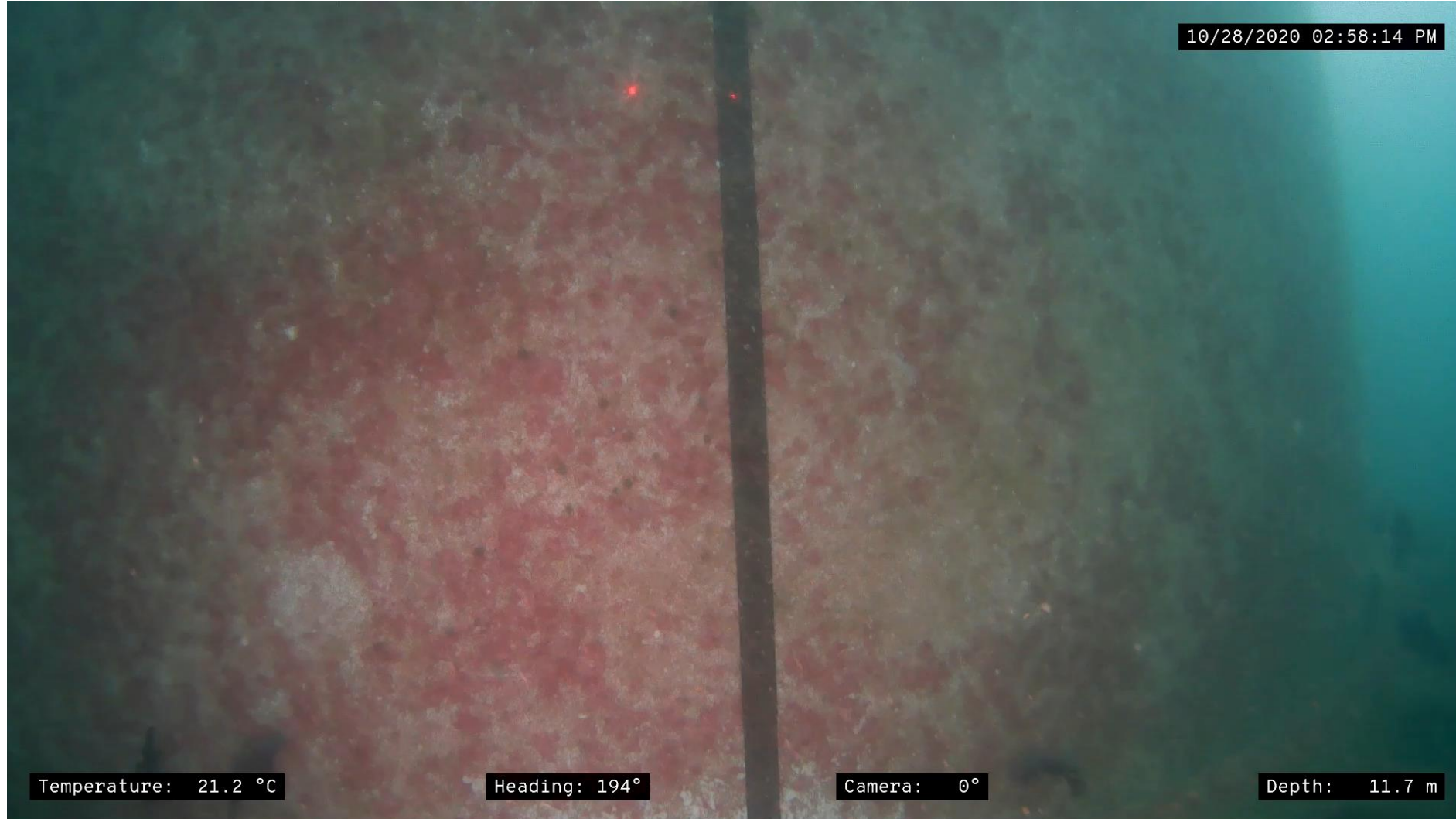
Energy Distributions

Redistribution of Carbon
Seafloor Enrichment
Foraging for Higher Trophic Levels



CVOW 2020 Anode Cage

Species Distribution
Energy Distribution



CVOW 2022 Anode Cage

Species Distribution
Energy Distribution



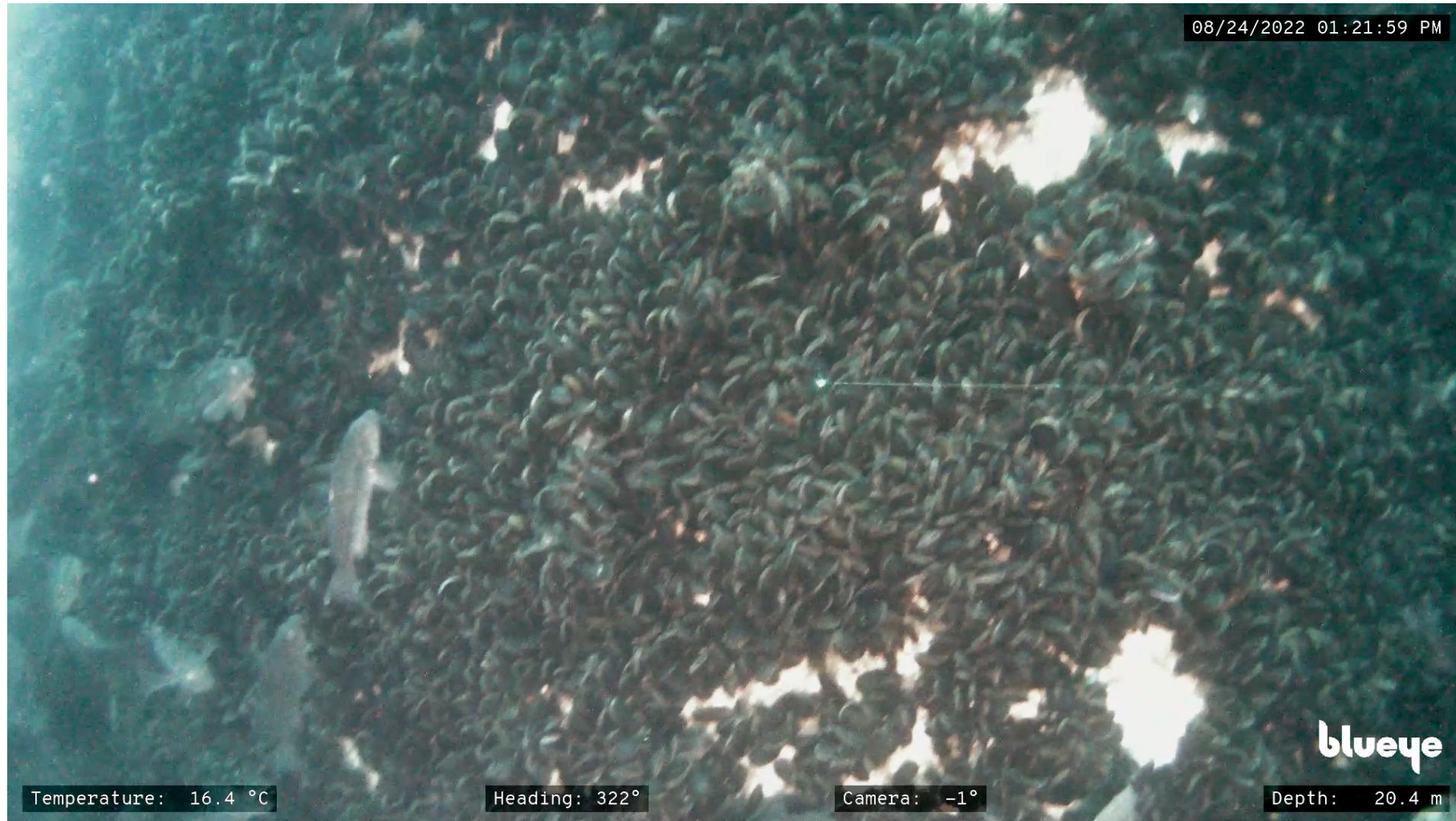
CVOW 2020 Scour Protection Layer

Species Distribution
Energy Distribution



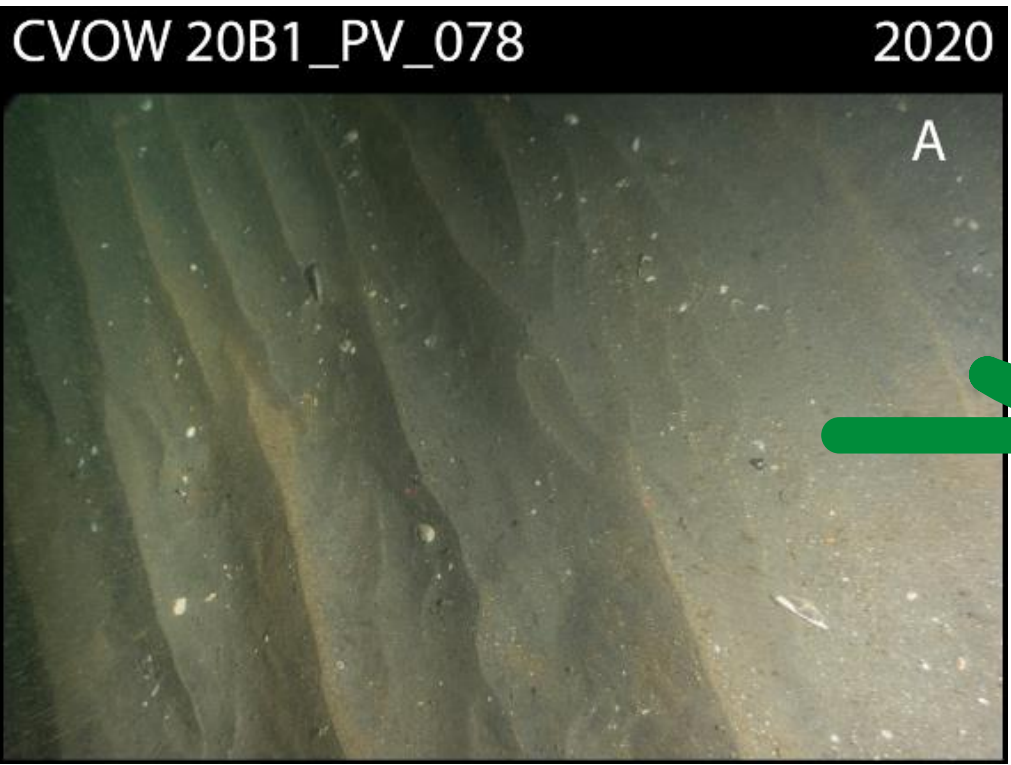
CVOW 2022 Scour Protection Layer

Species Distribution
Energy Distribution



CVOW 2020 and 2022 Surrounding Seafloor

Species Distribution
Energy Distribution



Deliberate Designs

Turbine Reefs

Nature Based Design of Offshore Wind Infrastructure

Nature-based Design includes options that can be integrated in or added to the design of offshore wind infrastructure to create, expand, enhance, or restore habitat for native species or communities.

Enhanced Scour Protection Layers

A combination of large and small structures with various sized holes and/or rocks with a range of shapes and sizes increases the surface area and habitat complexity of scour protection layers. This promotes biodiversity by providing adequate shelter for large, mobile species and suitable refuge for smaller species, juvenile life stages, and attached organisms.

Scour Protection

Mimicking Existing Complex Habitat

Habitats created by installation of offshore wind infrastructure can be optimized by mimicking naturally occurring complex habitat features.

Materials Designed to Promote Growth

Calcium carbonate (CaCO_3) or natural shell can be mixed into concrete structures to provide suitable chemical composition for larval settlement of calcareous organisms such as bivalves.

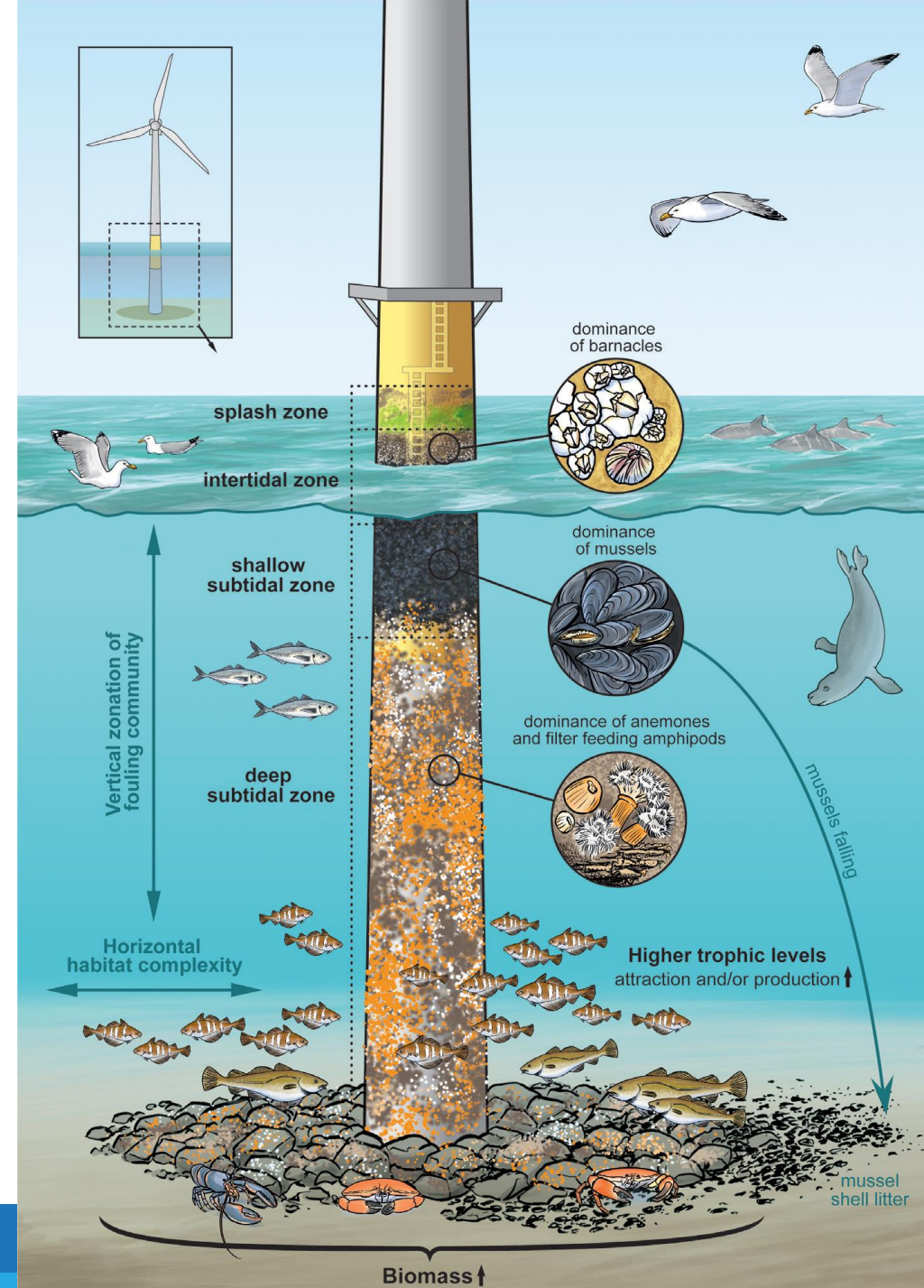
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Net Positive Impact Targets

- Enhance Benthic Biodiversity
- Promote Diverse Fish Assemblages
- Increase Fish Production
- Increase Sediment Carbon Storage

Hypothesis-Driven Monitoring

- Aim for Net Positive Impact, but ...
 - What is the specific goal?
 - What is being targeted?
 - What is expected ...hypothesis?
- Use this to design monitoring to test the hypothesis –
 - Was the goal accomplished?
 - Was the target met?
 - Was the hypothesis supported by the data?



Future Work

- Shift in Benthic Community Diversity/Structure
 - Continued monitoring with high resolution underwater imagery
- Shift in Benthic Functions –
 - Create photogrammetric models of structure (stereo imagery) to estimate biomass/volume of dominant species – to inform ecosystem models, decipher carbon cycling implications
 - Link with fisheries monitoring data to explore ecosystem connectivity shifts (trophic dynamics)



Pioneer stage
0-2 years

Intermediate stage
3-5 years

Climax stage
6+ years

