



Cumulative Effects of Offshore Wind on Benthic Habitats



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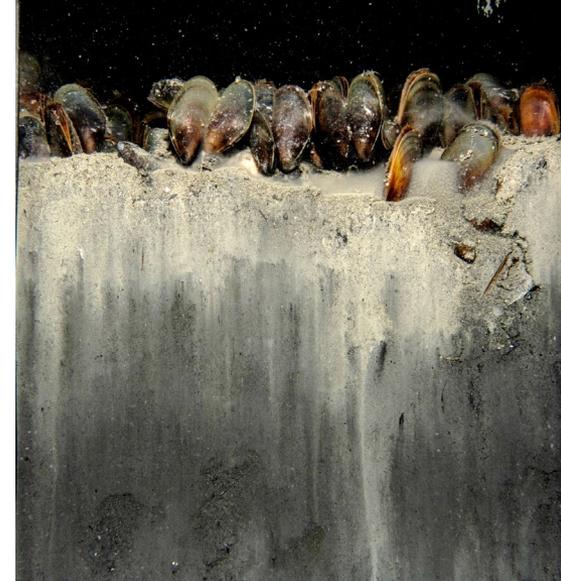
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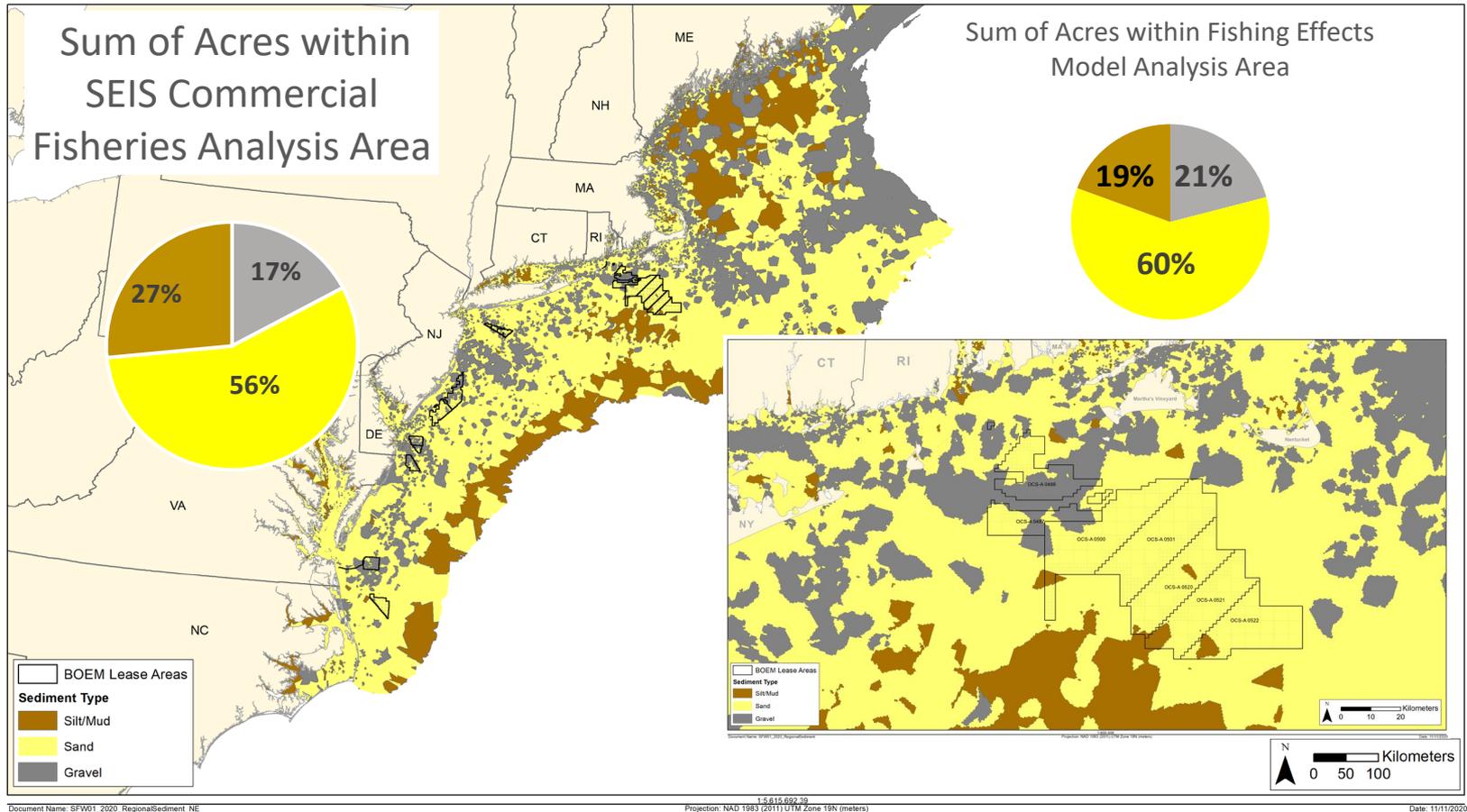
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Benthic Habitats

- Benthic Habitat Modification
 - Soft sediments
 - Hard sediments
- Enrichment: Benthic-Pelagic Coupling
 - Energy flow
 - Fate of energy
 - Food webs
- Connectivity / Habitat Expansion
 - Islands of complexity
- Habitat Suitability
 - Changing trophic structure



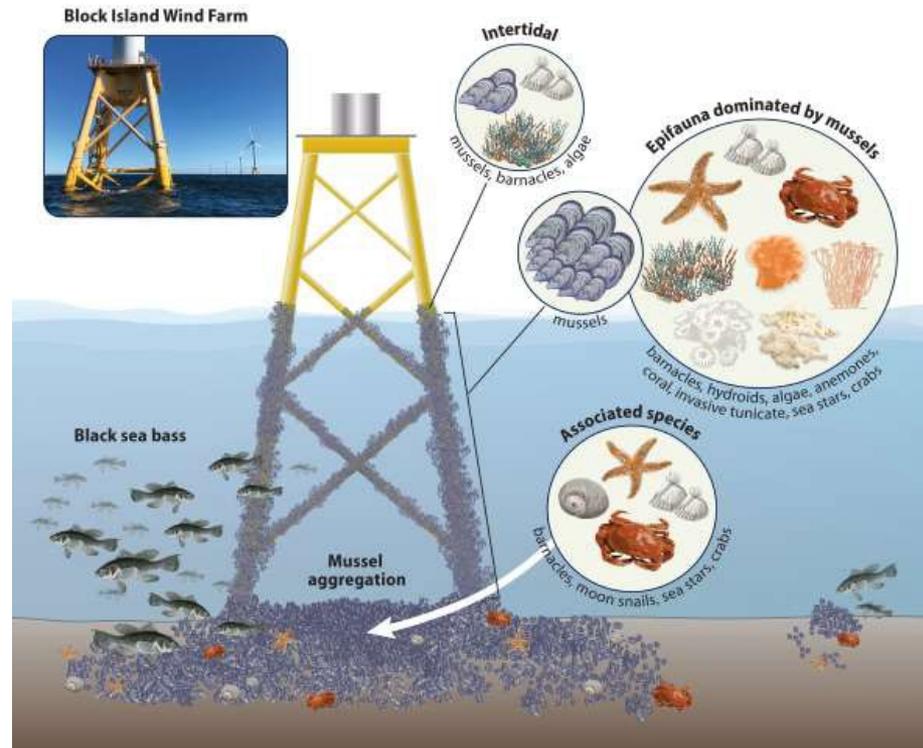
Fishing Effects Model Percent Sediment Type



Michelle Bachman, 2020

Benthic Habitat Modification

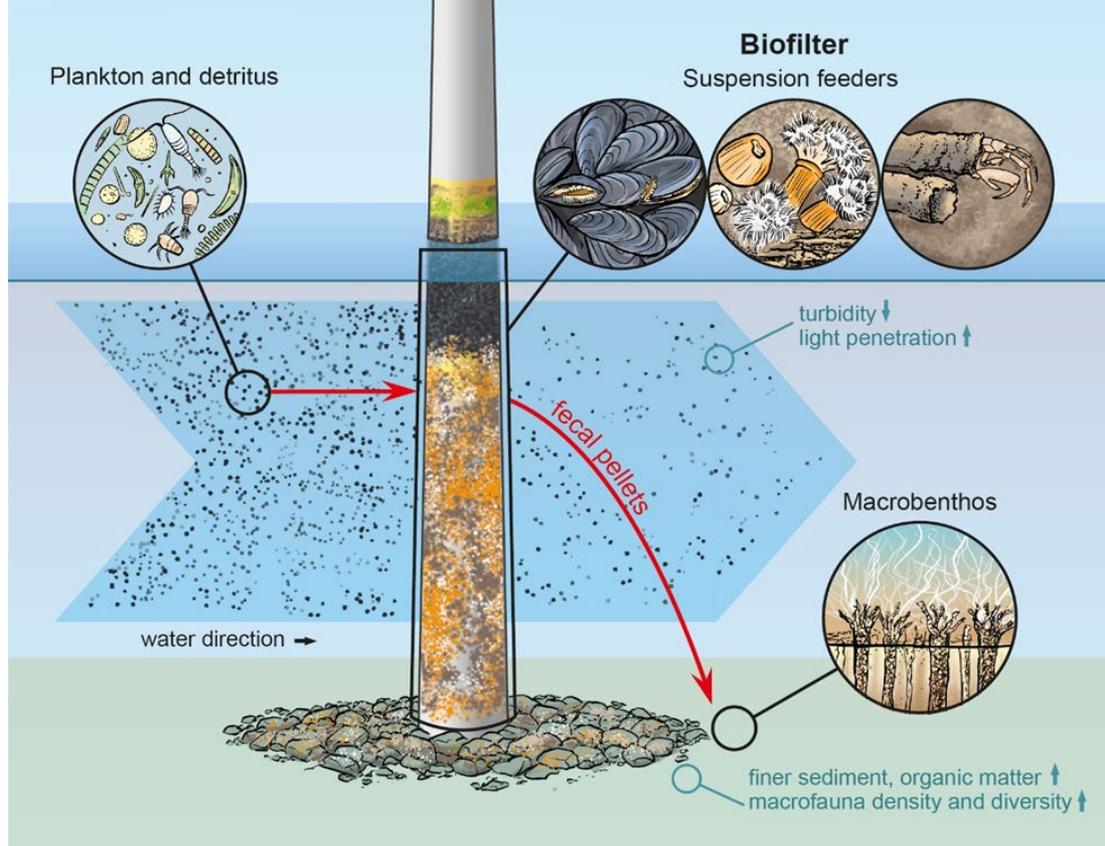
- Introduction of intertidal-subtidal surface
- Bottom sediment modification
- Changes to benthic-pelagic coupling
- Key cumulative effects: export of energy and changes in local food webs



HDR. 2020. Benthic and Epifaunal Monitoring During Wind Turbine Installation and Operation—OCS Study BOEM 2020-044.

Bottom Sediment Modification

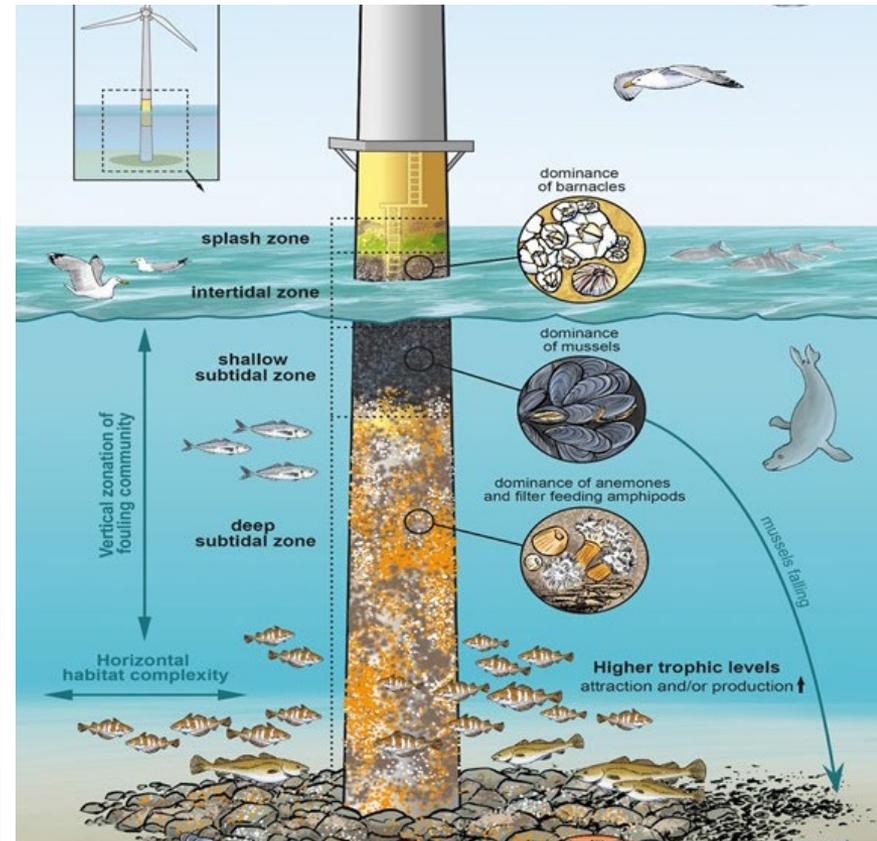
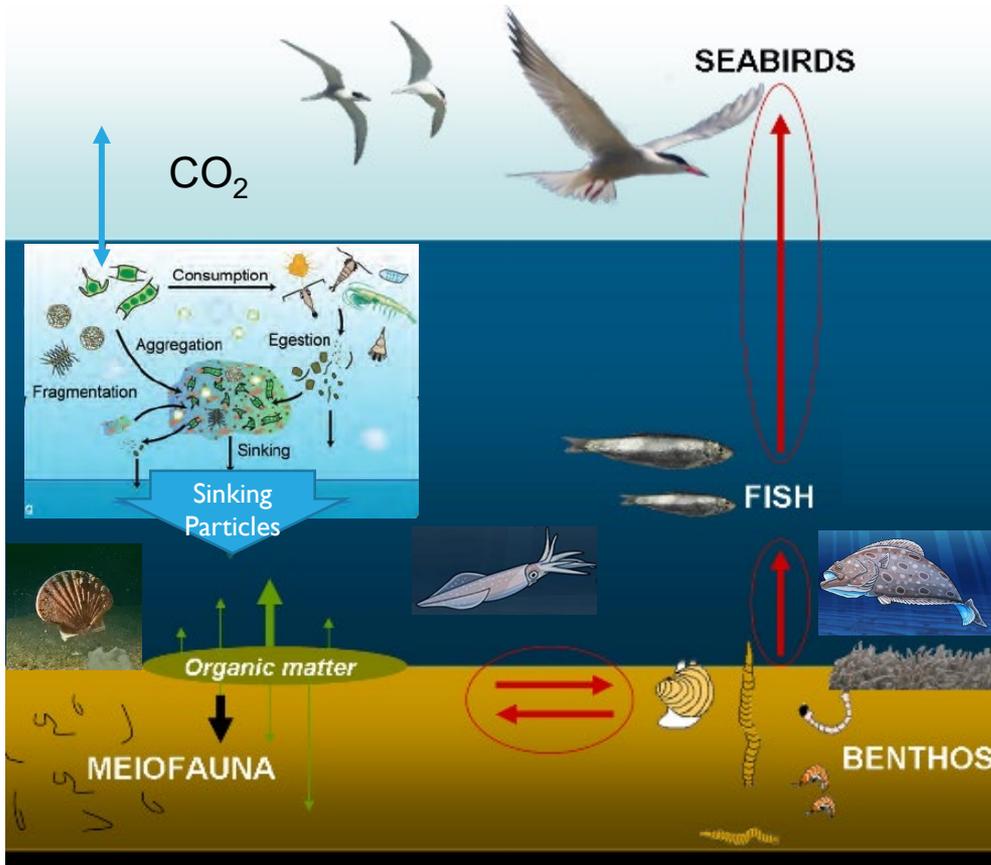
- Organic enrichment
- Energy flow
- What we know
 - Changes in particle size
 - Changes in organic content
 - Changes to flora and fauna
- What we need to know
 - What is the fate of the energy?
 - What is the appropriate spatial scale?



Degraer et al., 2020, Oceanography Special Issue Vol. 33, 4



Benthic-Pelagic Processes in shallow shelf (0-100m) before and after WTGs



From WestBanks vliz.be, Buessler et al., 2007, Pew Trust

Degraer et al., 2020, Oceanography Special Issue Vol. 33, 4

After Gill et al., 2019, Wildlife and Wind farms

Enrichment: Benthic-Pelagic Coupling

Biomass growth on foundation

Predation increased

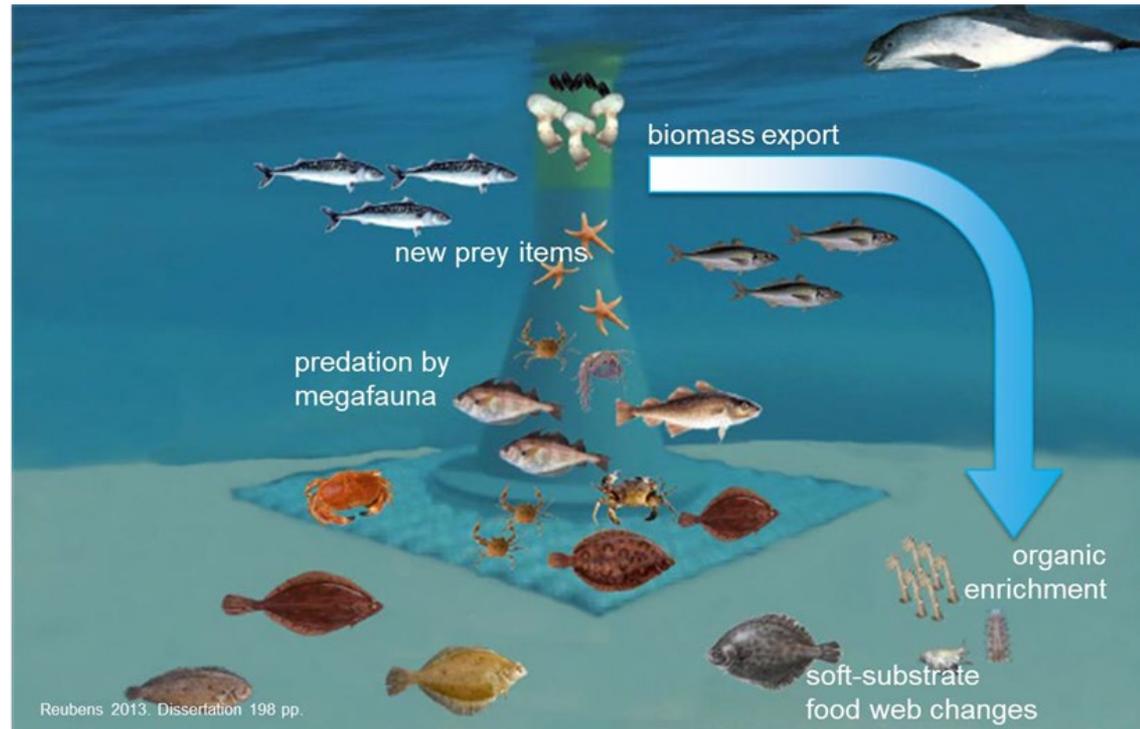
Biomass exported

How much reaches Benthos?

Does benthic production increase?

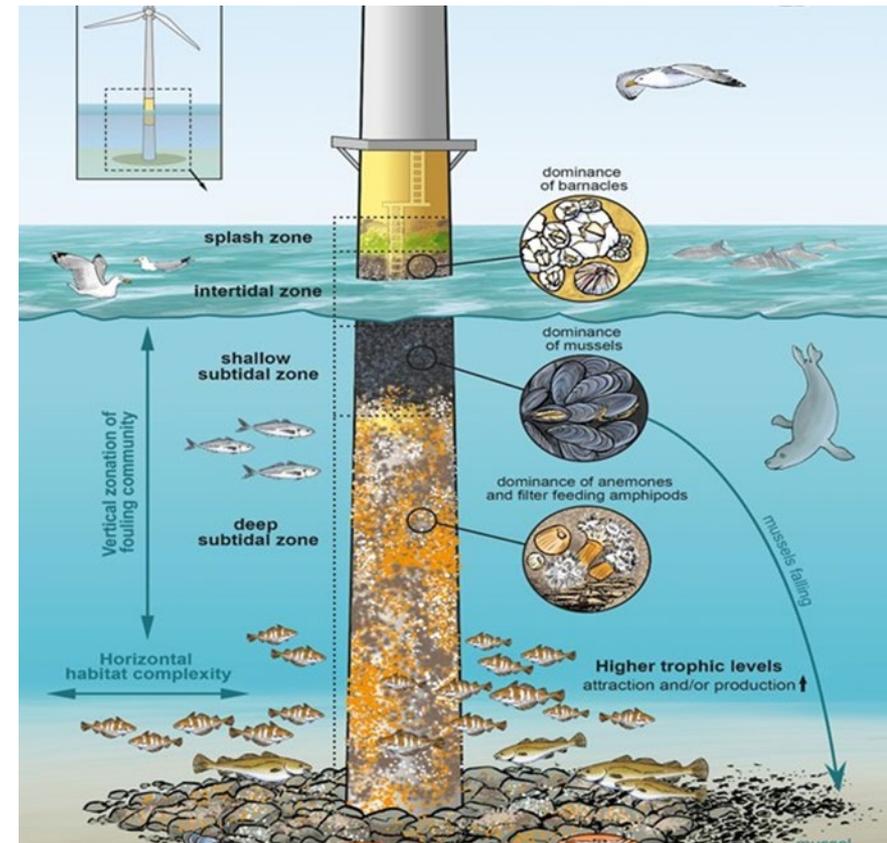
Does food web change?

How far does this go?



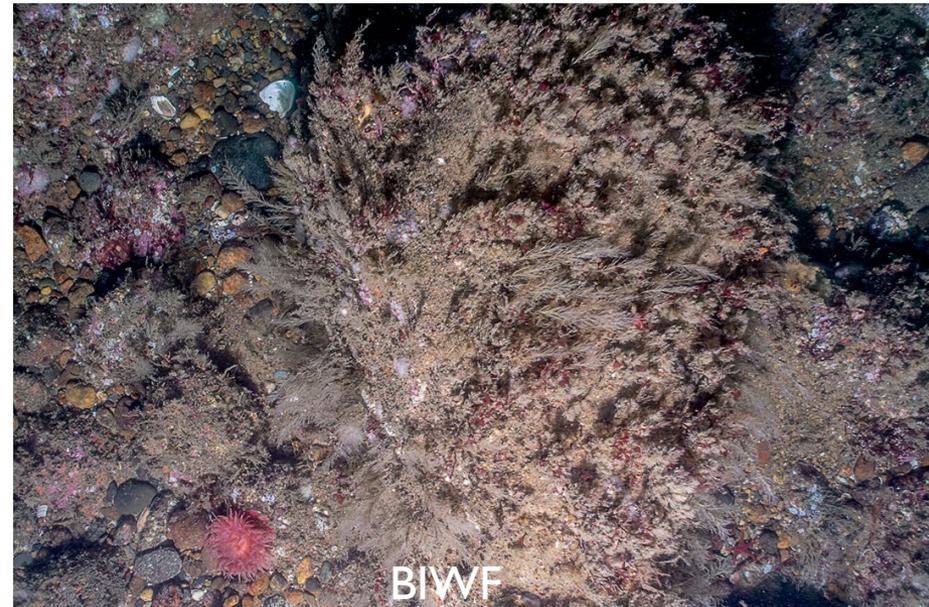
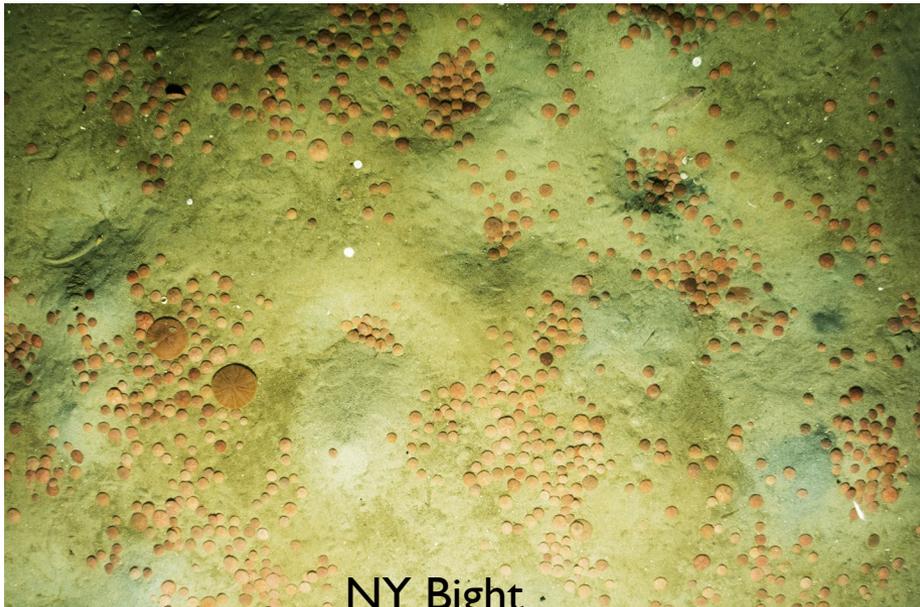
Enrichment

- Predation and increase in prey species
- Brings demersal species into water column
 - Starfish
 - Demersal-pelagic finfish (structure loving)
 - Crabs
- Top trophic species attracted to predators
 - Marine mammals
 - Highly migratory species
- Benthic food web responds to energy and complexity



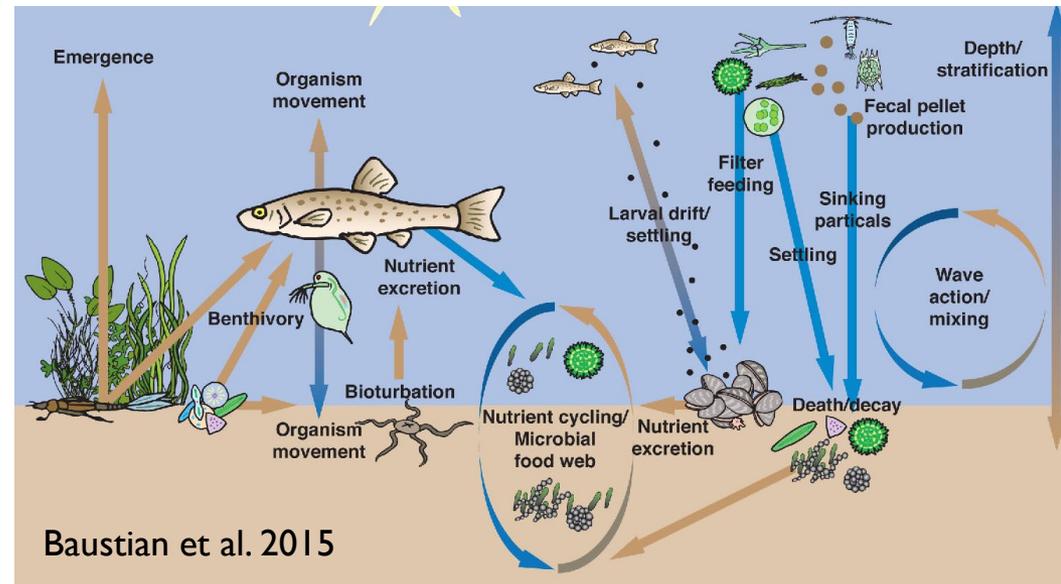
Energy flow to Benthos

- Primary production captured locally (energy in phytoplankton or epiflora)
- Energy turned into biomass of epifauna (gC or kJ)
- Energy exported to benthos (soft and hard)
- Energy exported to demersal-pelagic fish and invertebrates
- Increased secondary production in benthos and water column
- Alter food web to support scavengers, surface deposit feeders



Biomass exported

- Mobile predators move away from site – energy export
- Mobile predators stay at site – energy to benthos
- Suspension feeders feed on waste – energy to benthos
- Detritus and shell litter – energy to benthos (some refractory)
- Remineralization of detritus in benthos
- Release of energy back to water column



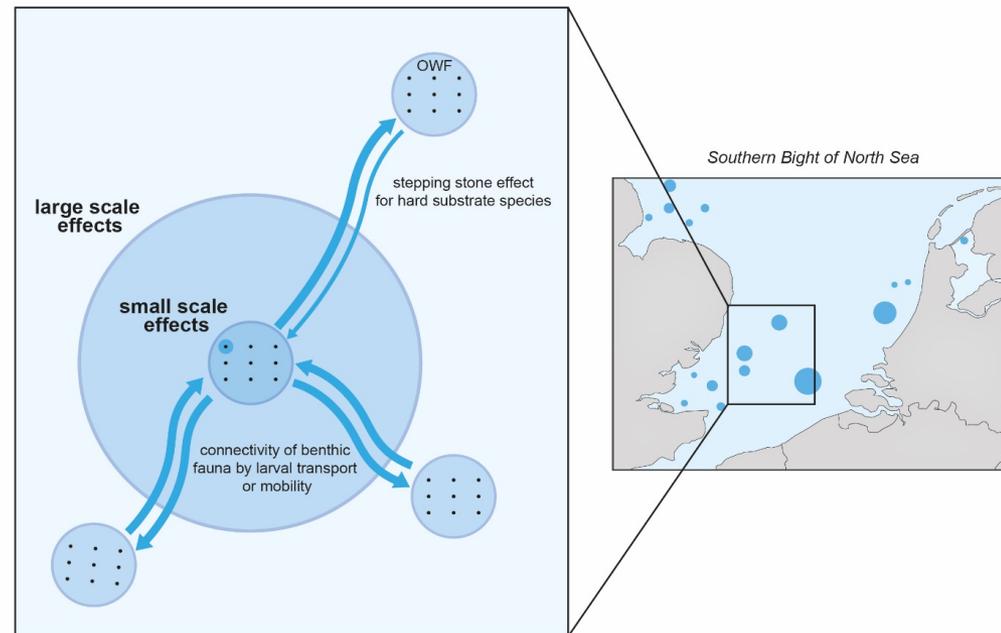


Spatial and temporal scale of energy flows

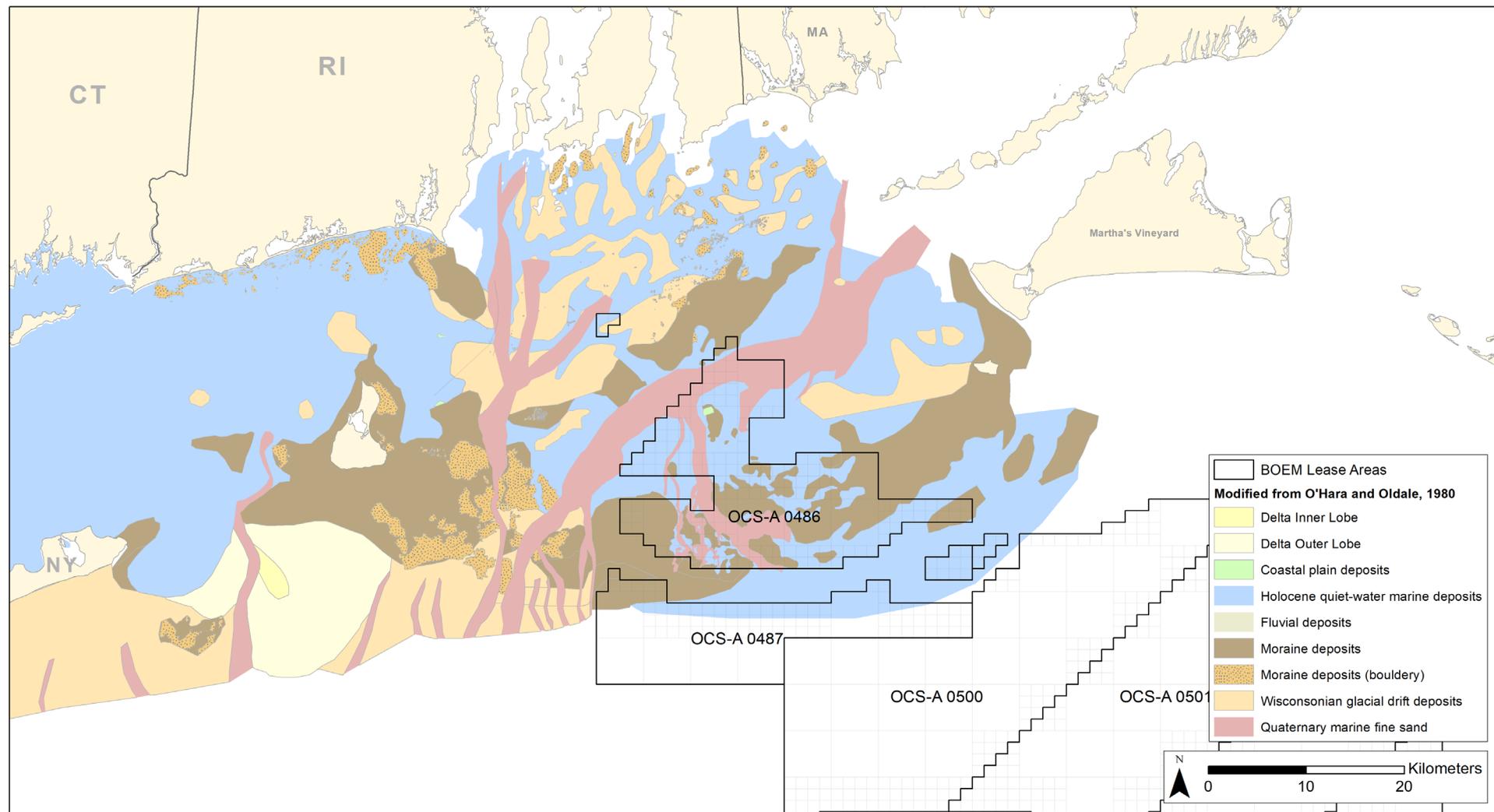
- Most studies = 1, 3, 5 years
 - Result in localized effects 5-50 m and initial food web
- Belgian studies = 10 + years
 - Result in wider effects (>200 m) and changes in food web
- Unknown effects on benthos beyond 10 years and 200 m
 - Does the system stabilize or continue to change?
 - Does a measurable amount of energy export have a wider ecosystem effect?
- Connectivity
 - May be affected by the nature of benthic habitats near projects (Wilhelmsson and Malm, 2008) – hard substratum vs. soft substratum

Connectivity

- Introduction of inter-tidal habitat in deeper water
- Potential habitat expansion for both desirable and undesirable species.
- May be affected by the nature of benthic habitats near projects (Wilhelmsson and Malm, 2008)
- What we know
 - Inter-tidal species colonize offshore structures
- What we need to know
 - At what scale does this connectivity move from small-scale effect to large scale effect?



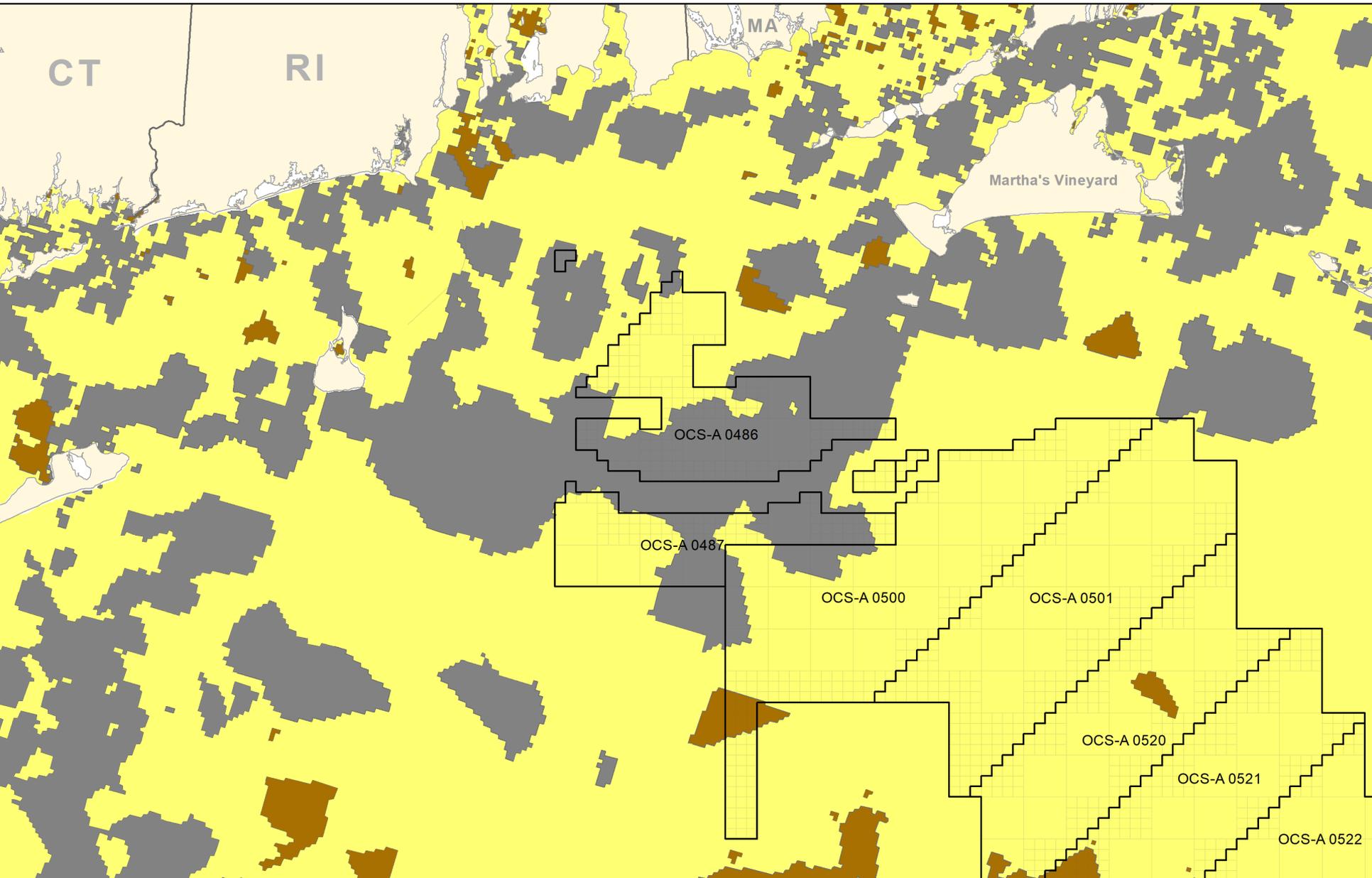
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Document Name: SFW01_2020_RegionalSediment

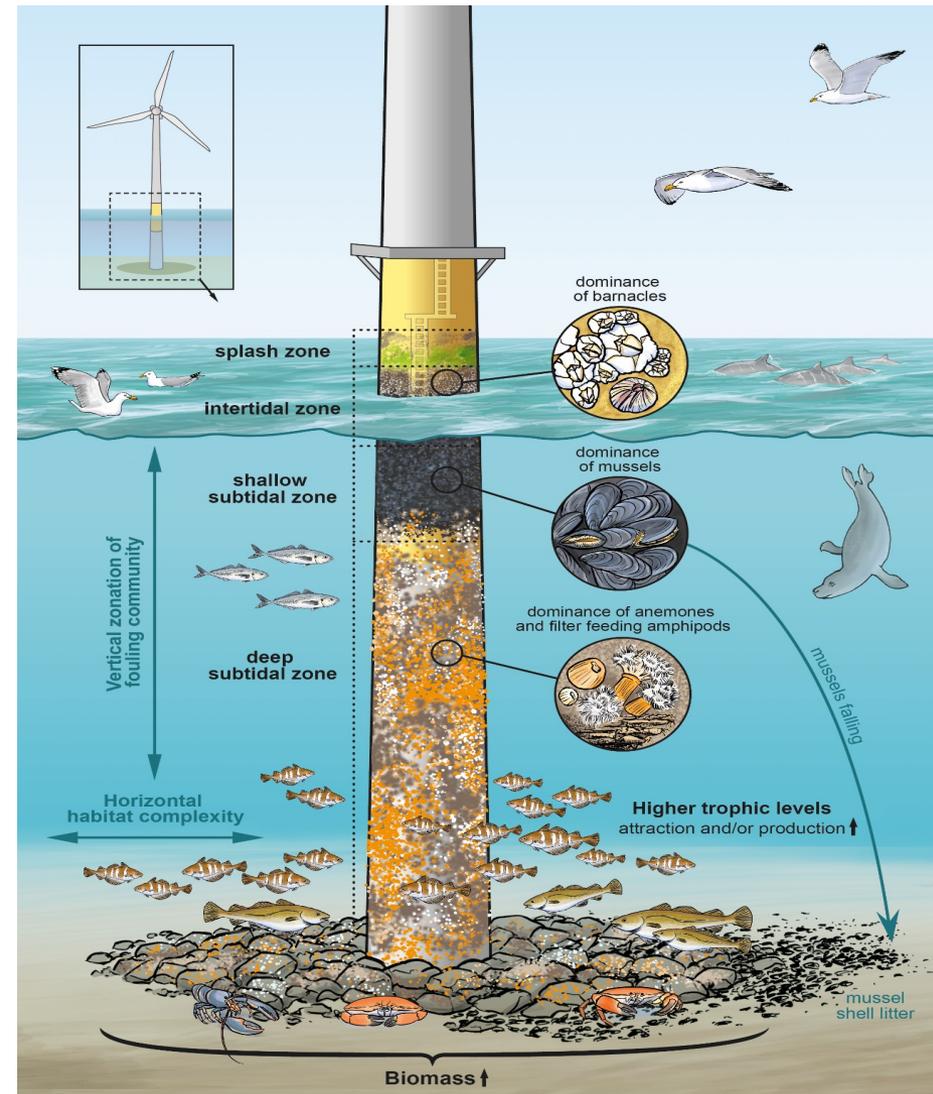
Projection: NAD 1983 (2011) UTM Zone 18N (meters)

Date: 11/12/2020



Habitat Suitability

- Food web dynamics
 - Primary productivity
 - Predator-prey relationships
- What we know
 - Documentation of species presence/absence
 - Spatial/temporal resolution
- What we need to know
 - How does this affect habitat function?
 - How is it functioning at an ecosystem scale?
 - Is effect positive or negative? Functionally equivalent?



Degraer et al., 2020, Oceanography Special Issue Vol. 33, 4

Acknowledgements

Many colleagues in Europe and
United States

Jan Vanaverbeke

Joop Coolen

Michelle Bachman

Monique LaFrance Bartley

Lena Bergström

Silvana Birchenough

Arjen Boon

Ulrike Braeckman

Jean-Claude Dauvin

Andrew Gill

Marion Harrald

Brian Hooker

Zoë Hutchison

Angus Jackson

Urszula Janas

Francis Kerkhof

Roland Krone

Nene Lefaible

Ninon Mavraki

Ilse de Mesel

Francis O'Beirn

Jan Reubens

Bob Rumes

Emma Sheehan

Tom Wilding

Dan Wilhelmsson