



Learning from the Experts Webinar Series

A Panel on Nature Based Design Enhancements for Offshore Wind Farms



Carl Lobue
Ocean Program Director
The Nature Conservancy



Dr. Annie Murphy
Senior Scientist
INSPIRE Environmental Services

February 9, 2022



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A Panel on Nature Based Design Enhancements for Offshore Wind Farms



Ido Sella
Co-Founder & CEO
EConcrete Tech LTD



Captain Dave Monti
No Fluke Fishing LLC

February 9, 2022

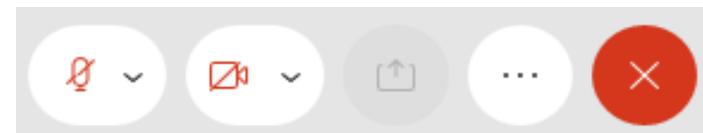
Meeting Procedures

Webinar recordings and presentations will be available at:

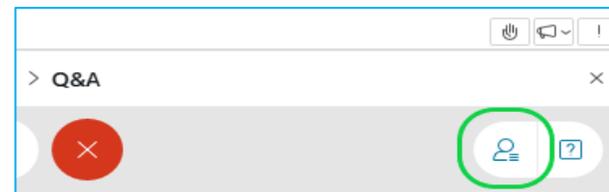
www.nyserda.ny.gov/osw-webinar-series

Participation for Members of the Public:

- > Members of the public will be muted upon entry.
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You'll see  when your microphone is muted



Learning from the Experts

This webinar series is hosted by NYSERDA's offshore wind team and features experts in offshore wind technologies, development practices, and related research.

DISCLAIMER:

The views and opinions expressed in this presentation are those of the presenter and do not represent the views or opinions of NYSERDA or New York State.



Nature Based Design Enhancements for Offshore Wind Farms

The Nature
Conservancy



Carl LoBue
NY Ocean Program Director
www.nature.org/turbinereefs



Nature-Based Design and Offshore Wind

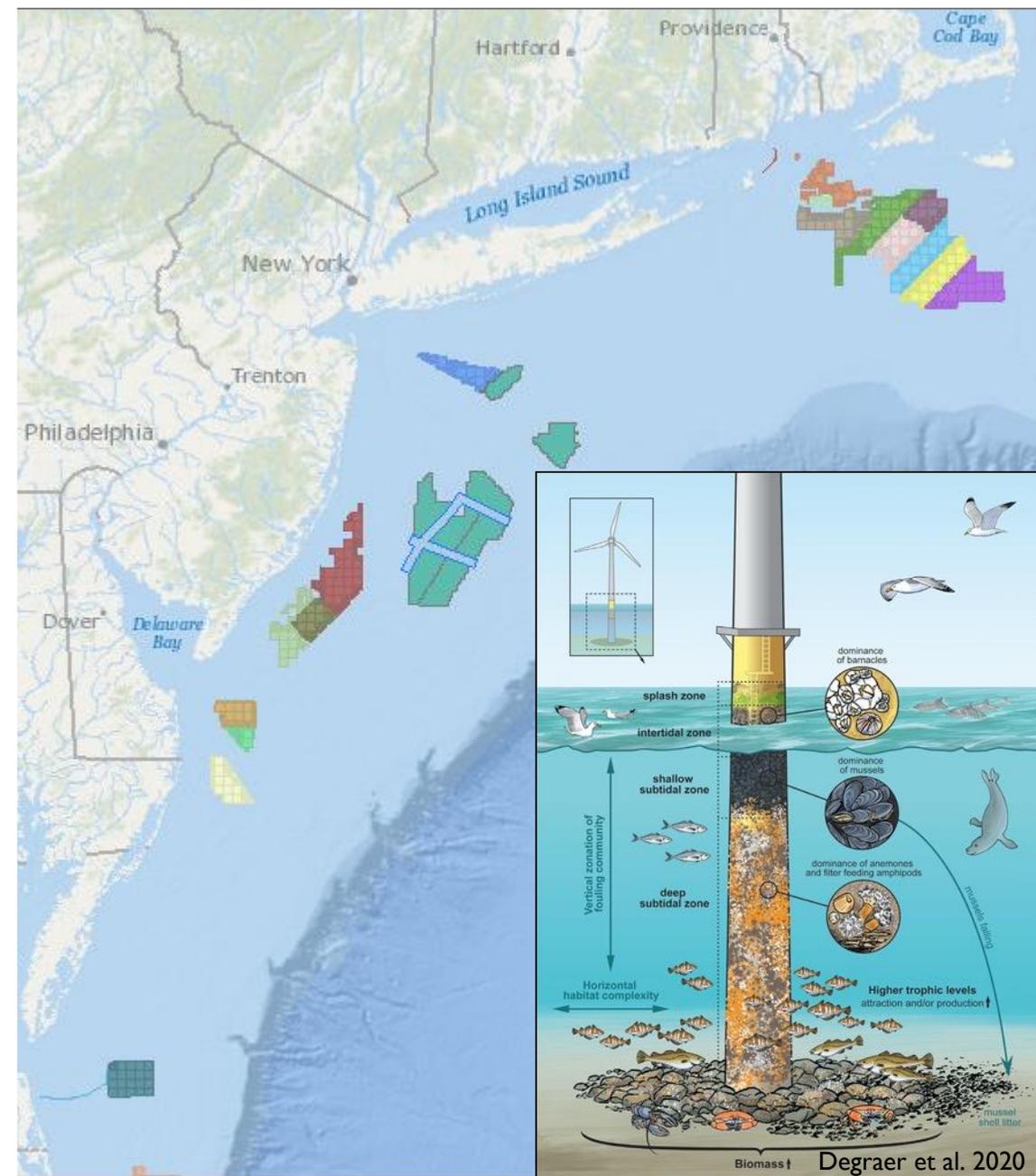
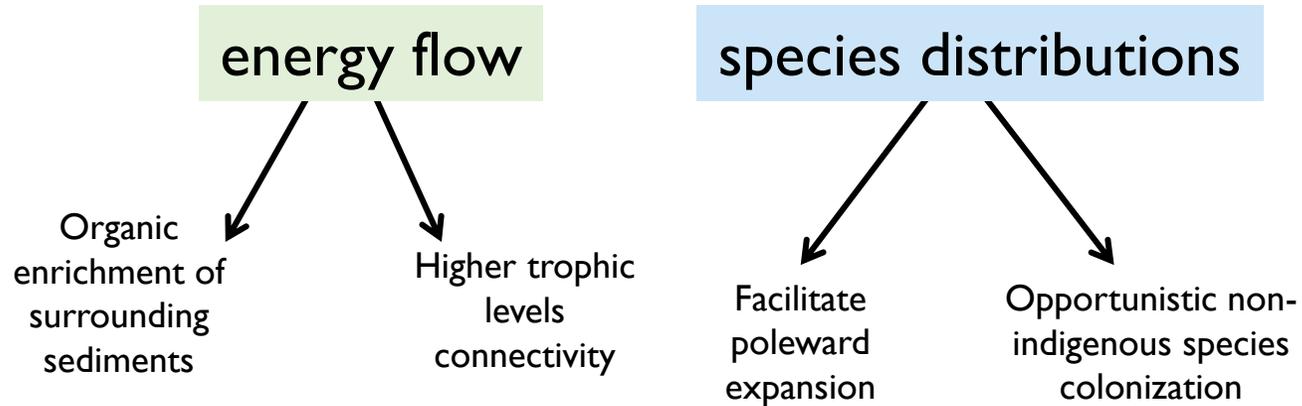
Annie Murphy, PhD
INSPIRE Environmental
NYSERDA Webinar
February 9, 2022

annie@inspireenvironmental.com

Artificial Reef Effect

Novel structures

may lead to shifts in connectivity at multiple scales





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.



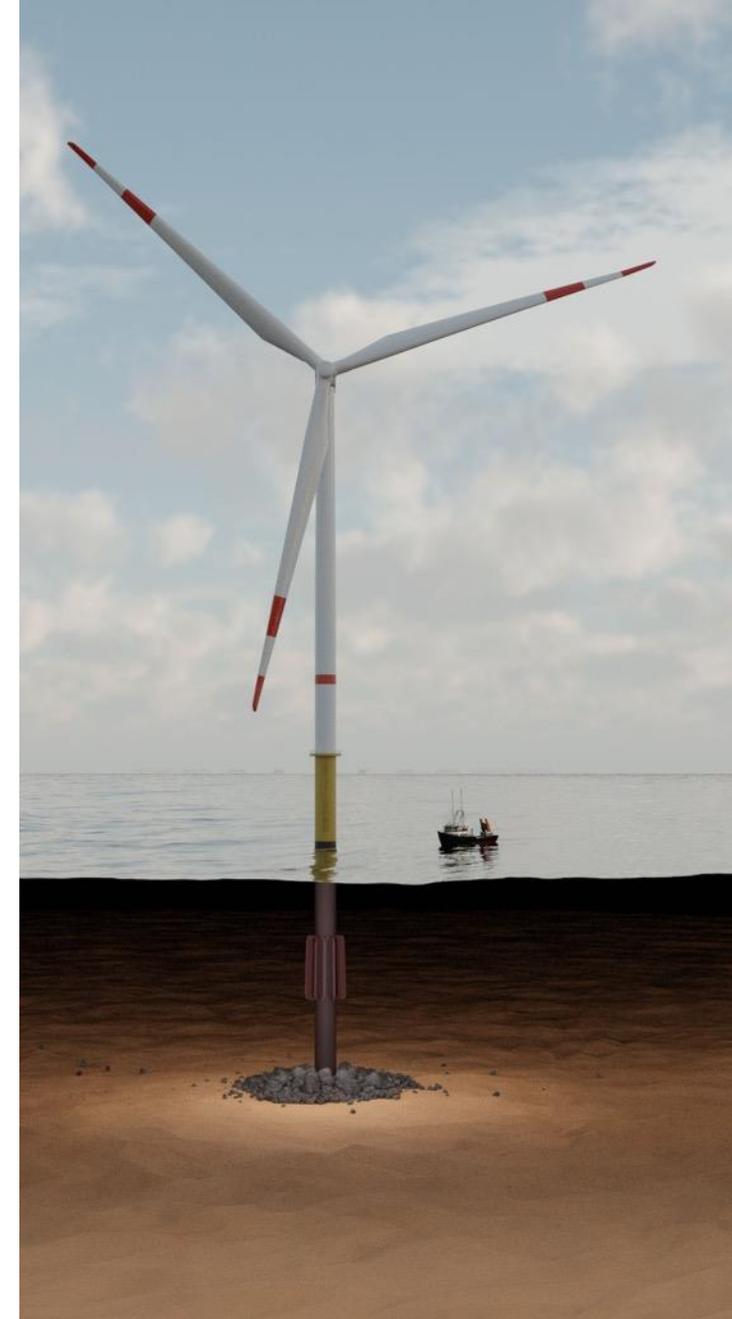
Materials Designed to Promote Growth

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.



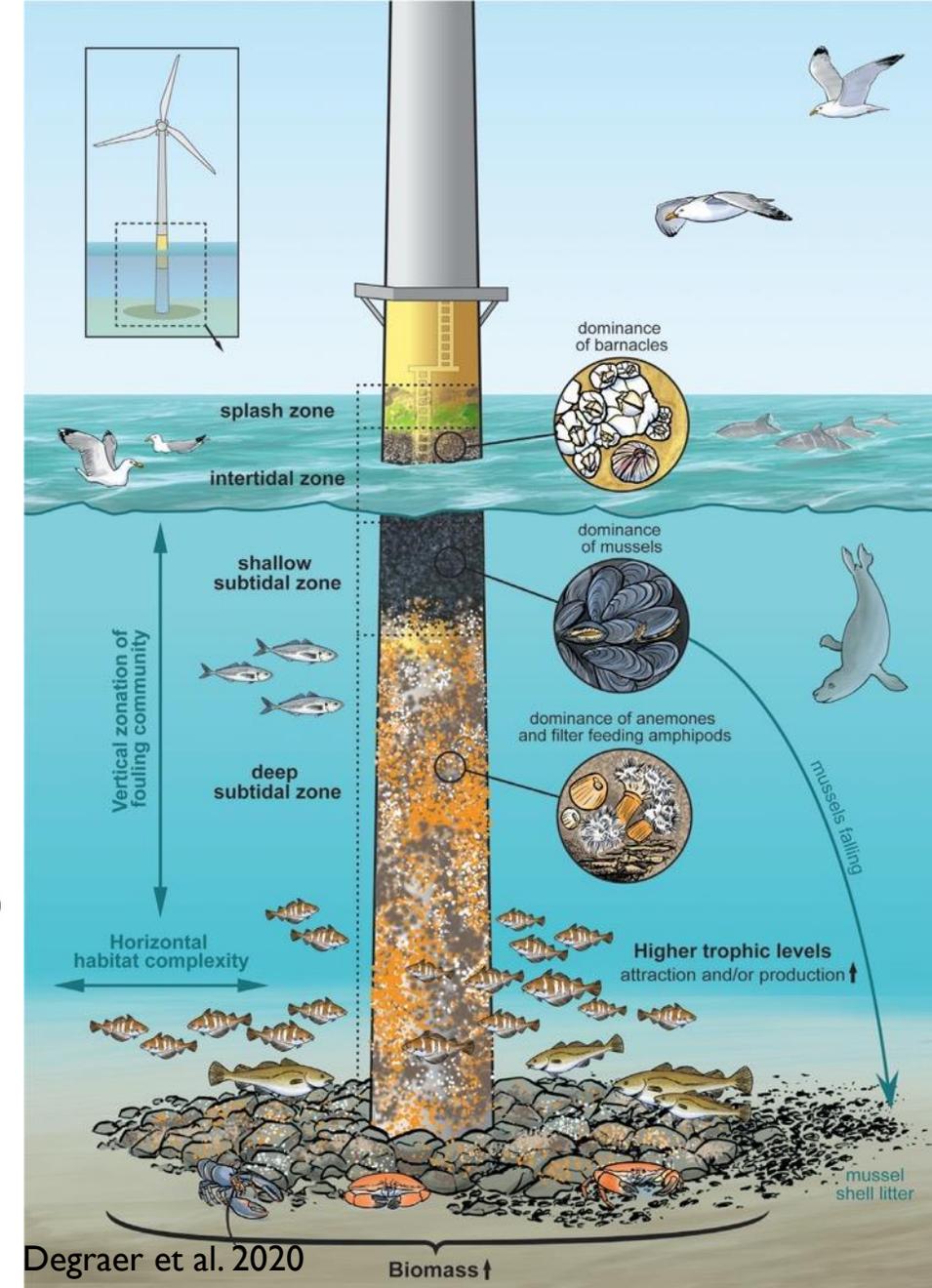
Nature-Based Design and Offshore Wind Knowledge Gaps

- Engineering: Can the novel structures (e.g., scour protection layers) be augmented to mimic natural habitat?
- Offshore setting: Does the use of NBD products for offshore wind structures facilitate colonization and use by mobile species (enhance ecological function)?
- Connectivity: How does local habitat distribution influence the colonization and use of NBD products at novel wind structures (e.g., vicinity of the nearest natural reef habitat)?



Considerations

- Goals: Identify measurable objectives that the NBD is aiming to achieve; align with permitting requirements, mitigation measures; targeted focal species
- Monitoring Programs: specifically designed to evaluate performance of the NBD based on the specific goals
- Technical – structure stability, durability, chemical composition
- Environmental – depth, current velocity, sediment dynamics
- Logistical – costs, fishing activities, decommissioning (Rigs-to-Reefs)
- Ecological – complexity of structure, local species, local recruitment
- Risks – structural failure, unforeseen costs, non-indigenous species, competition for resources



Catalog of Nature-Based Design Products

www.nature.org/content/dam/tnc/nature/en/documents/TurbineReefReport_Nature-BasedDesignsOffshoreWindStructures_Final2022.pdf

- NBD products currently available from US suppliers and have potential relevance to offshore wind designs
- Questionnaire to each supplier to collect information on available product designs, known ecological advantages, intended use, and estimated costs
- Focal species – current US northeast wind leases
 - EFH species
 - Habitat preferences and geographic range overlapping with current wind leases
 - Species with high economic or ecological importance
 - Species considered sensitive to offshore wind development

Table 1. Focal Species with Potential to Utilize NBD Options Around Offshore Wind Structures

Common Name	Scientific Name	Life Stage Associated with Structured Habitat	Primary Function of Hard Substrate
Finfish			
Atlantic Cod	<i>Gadus morhua</i>	J, A	N / F / S / R
Atlantic Herring	<i>Clupea harengus</i>	E	A
Black Sea Bass	<i>Centropristis striata</i>	J, A	N / F / S
Gag Grouper	<i>Mycteroperca microlepis</i>	J, A	F / S / N / R
Gray Triggerfish	<i>Balistes capricus</i>	E, J, A	F / S / N / R
Haddock	<i>Melanogrammus aeglefinus</i>	J, A	N / F / S
Ocean Pout	<i>Macrozoarces americanus</i>	E, J, A	N / F / S / R
Red Hake	<i>Urophycis chuss</i>	J, A	N / S
Scup	<i>Stenotomus chrysops</i>	J, A	N / F / S
Summer Flounder	<i>Paralichthys dentatus</i>	J, A	F
Tautog	<i>Tautoga onitis</i>	J, A	N / F / S
Crustaceans			
American Lobster	<i>Homarus americanus</i>	L, J, A	N / S
Jonah Crab	<i>Cancer borealis</i>	J, A	F / S
Rock Crab	<i>Cancer irroratus</i>		F / S
Mollusks			
Blue Mussels	<i>Mytilus edulis</i>	J, A	A
Eastern Oyster	<i>Crassostrea virginica</i>	J, A	A
Anthozoa			
Frilled Anemone	<i>Metridium senile</i>	J, A	A
Northern Star Coral	<i>Astrangia poculata</i>	J, A	A
Sea Whip	<i>Leptogorgia virgulata</i>	J, A	A
Sponges			
Boring Sponge	<i>Cliona celata</i>	J, A	A
Red Beard Sponge	<i>Microciona prolifera</i>	J, A	A

A - Adult
 E - Egg
 J - Juvenile
 L - Post-larvae
 A - Attachment
 F - Foraging
 N - Nursery
 R - Reproduction
 S - Shelter

NBD Catalog

Potential application to offshore wind infrastructure

Product Description

Ecological Advantage

Specification

Estimated Product Costs

Publications

Enhanced Scour Protection Layer

Reef Balls®

Product Description
Reef Balls® can be added on top of, placed next to, or integrated into a scour protection layer. They can be customized to meet specific project needs and designed to attract use by specific local species. Reef Balls® are designed to withstand movement and damage in storms and can be installed using a variety of methods. Reef Balls® can be outfitted with various add-on options that include base units to add height and surface area.

Ecological Advantages
Products are made from marine grade pH-neutralized concrete resulting in a pH similar to seawater. Reef Balls® can be customized to more closely resemble natural habitats by altering the placement, size, and number of holes in the structure. They are constructed with a rough textured surface to promote colonization of marine epifauna. Internal Juvenile Habitat units can be added to provide shelter for juvenile fish.

Specifications
Size: Individual Reef Ball® units come in a range of sizes 12 to 56 in. high and 12 to 78 in. wide
Footprint: 18 to 28.2 m² (varies by product)
Surface area available for colonization: 7.25 to 230 ft² (varies by product)
Weight of a single unit: 55-5000 lbs. (varies by product)
Max depth previously deployed: 400+ ft
Estimated life of product: 500 years

Estimated Product Costs
Per unit: \$45 to \$490
Product to cover 2000 m²: \$334,000 to \$460,000
Lead time for production: 5 months

Authorized U.S. Reef Ball® Suppliers:
Reef Innovations (FL), reefinnovations.com
Roman Stone Construction Co. (NY), romanstoneco.com
Designed by: Reef Ball® Foundation, ReefBall.org

Publications*
Del Vita, L. 2016. Hydraulic response of submerged breakwaters in Reef Ball modules. Ph.D. Thesis, University of Naples Federico II, Naples, Italy.
Harris, L.E. 2009. Artificial reefs for ecosystem restoration and coastal erosion protection with aquaculture and recreational amenities. *Reef Journal*, 1: 235-246.
Lowry, M., H. Follop, M. Gregson, and R. McKenzie. 2010. Assessment of artificial reefs in Lake Macquarie NSW. Fisheries Final Report Series No. 125. Industry & Investment NSW, Fort Stephens Fisheries Institute.
Sherman, R.L., D.S. Gilliam, and R.E. Spieler. 2002. Artificial reef design: void space, complexity, and attractants. *ICES Journal of Marine Science*, 59: 3196-3200.

*Additional publications can be found at <https://reefballfoundation.org/knowledge-base-and-research/>



Layer Reef Ball, reefinnovations.com

Turbine Reefs 27

Enhanced Scour Protection Layer

Layer Cakes

Product Description
Layer Cakes are designed to provide increased horizontal surface area for colonization of benthic epifauna (when compared to Reef Balls®). Layer Cakes come in a variety of sizes ranging from the 17 x 9-inch Oyster Layer Cakes to the 72 x 46-inch Goliath Layer Cake. They can be added on top of, placed next to, or integrated into a scour protection layer and are installed using a crane. Layer Cakes can be customized to meet specific project needs and designed to attract use by specific local species by customizing the number, shape, and size of layers.

Ecological Advantages
Layer Cakes are made from marine grade pH-neutralized concrete and are constructed with multiple shell layers. They are constructed with a rough textured surface to promote colonization of marine epifauna. Additional layers increase available surface area for colonization. Various natural materials can be added to increase structural complexity such as rocks and shells.

Specifications
Size: Individual Layer Cake units range from 9 to 60 inches in height and 17 to 72 inches in width
Footprint: varies by product size
Surface area available for colonization: varies by product size
Weight of a single unit: 42 to 5,200 lbs. (varies by product size)
Max depth previously deployed: 400+ ft
Estimated life of product: 500 years

Estimated Product Costs
Per unit: \$65 to \$1400
Product to cover 2000 m²: \$501,000 to \$700,000
Lead time for production: up to 12 months

Authorized U.S. Layer Cake Supplier
Reef Innovations (FL), reefinnovations.com
Designed by: Reef Ball® Foundation, ReefBall.org

Publications
See Reef Ball® publications



Layer Cake, reefinnovations.com

Turbine Reefs 28

Cable Protection Layer

ECOcrete® ECO Mats

Product Description
These articulated concrete mattresses are designed to provide flexible, stable protection for offshore cables while promoting colonization and use by benthic organisms. Mattresses are composed of interlocking concrete blocks connected with a polyester cable. The concrete mix design includes ECOcrete® Admix and is coupled with complex surface textures to encourage colonization and attachment by marine epifauna. ECO Mat dimensions are tailored and pre-assembled to fit project needs and can be lowered into place by crane and standard lifting equipment.

Ecological Advantages
ECOcrete® units have been shown to enhance growth of ecosystem engineering species such as oysters, serpulid worms, bryozoans, and coralline algae, compared with Portland cement units. These species (oysters, serpulid worms, barnacles, and corals) deposit their CaCO₃ skeletons onto hard surfaces, thus creating valuable habitat for other benthic organisms as well as generating an active carbon sink over the lifespan of the structure.

Specifications
Size/Footprint/Surface area for Colonization: according to project requirements
Weight of a single unit: variable
Max depth previously deployed: 20 ft
Estimated life of product: 30+ years

Estimated Product Costs
Per unit: \$12 to \$18 per m²
Product to cover 2000 m²: N/A
Lead time for production: 3 months

Supplier(s)
ECOcrete, ecoconcrete.com

Publications
Perkol-Finkel, S., and I. Sella. 2014. Ecologically active concrete for coastal and marine infrastructure: innovative matrices and designs. In: Allopp, W., Burgess, K. (Eds.), *From Sea to Shore – Meeting the Challenges of the Sea*. ICE Publishing, pp. 1120-1169.
Perkol-Finkel, S., and I. Sella. 2015. Harnessing urban coastal infrastructure for ecological enhancement. *Maritime Engineering*, 168 (M3): 102-110.
Sella, I., and S. Perkol-Finkel. 2015. Blue is the new green – Ecological enhancement of concrete based coastal and marine infrastructure. *Ecological Engineering*, 84: 260-272. ISSN 0925-8574.
Sella, I., T. Hadary, A. Rolla, B. Ringel, D. Swack, and S. Perkol-Finkel. 2021. Design, production, and validation of the biological and structural performance of an ecologically engineered concrete block mattress: A Nature-Inclusive Design for shoreline and offshore construction. *Integr. Environ. Assess. Manag.*, 2021:00-1-15.



ECOcrete® ECO Mat, www.ecoconcrete.com



ECOcrete® ECO Mat block

Turbine Reefs 29

Enhanced Scour Protection Layer

Cube Reefs

Product Description
Cube Reefs can be added on top of, placed next to, or integrated into a scour protection layer and are lowered to the seafloor using a crane. Concrete cube structures can be placed as a single unit or stacked up to five units high. Each cube structure contains a center hole with a diameter of 10 to 12 inches and 4 horizontal holes with 6-to-8-inch openings. Reef cubes can be combined with Reef Balls® for added structural complexity.

Ecological Advantages
Products are made from marine grade pH-neutralized concrete and are constructed with holes on each side of the structure, including one in the center, and can be customized to meet specific project needs and designed to attract use by specific local species by customizing the size. They are constructed with a rough textured surface to promote colonization of marine epifauna, and the addition of multiple product layers increase available surface area.

Specifications
Size: Individual Cube Reef units range from 9 to 13 inches in height and 22 to 36 inches in width (customizable)
Footprint: 4 ft² (varies by product size)
Surface area available for colonization: varies by product size
Weight of a single unit: 100 to 500 lbs.
Max depth previously deployed: 70 ft
Estimated life of product: 500 years

Estimated Product Costs
Per unit: \$275
Product to cover 2000 m²: \$336,400
Lead time for production: 5-10 months

Authorized U.S. Cube Reef Supplier
Reef Innovations (FL), reefinnovations.com
Designed by: Reef Ball® Foundation, ReefBall.org

Publications
See Reef Ball® publications



Cube Reef, reefinnovations.com

Turbine Reefs 29

Enhanced Scour Protection Layer

Reef Cells

Product Description
Reef Cell Modules are designed to mimic natural reefs and provide a large amount of surface area with a plethora of interconnected spaces of various size. Units can be added on top of, placed next to, or integrated into a scour protection layer and are installed using a crane. The base of each module provides ballast weight to increase anchoring stability post-deployment.

Ecological Advantages
Units contain holes in the module surface that allow for interior exchange of seawater and nutrients, sunlight penetration, and egress by mobile organisms. The surface holes also increase module stability by reducing hydraulic drag and lifting forces. Units include large habitat cells on the outer layer. Smaller inner chambers provide shelter for small and juvenile fish. The modules are built utilizing a pH-neutral concrete mix and the exterior surface of each module is impregnated with 30-50 grit calcium carbonate aggregate, which encourages rapid attachment by calcareous organisms.

Specifications
Size: Individual units range from -5 to 8 feet in height and are -7 feet in width
Footprint: 12.5 ft²
Surface area available for colonization: variable
Weight of a single unit: 2,976 to 6,772 lbs.
Max depth previously deployed: 60 ft
Estimated life of product: 50+ years

Estimated Product Costs
Per unit: \$2,800
Product to cover 2000 m²: \$100,000
Lead time for production: 4 months

Supplier:
Reef Cells (FL), reefcells.com



Reef Cell Module, reefcells.com

Turbine Reefs 30

Cable Protection Layer

Fleximats®

Product Description
This is a cable protection option that provides a high degree of flexibility, allowing it to closely follow the contours of a pipeline/umbilical cable and seabed. The mat is constructed using high-strength concrete profiled blocks and ultraviolet-stabilized polypropylene rope. Once installed, the Fleximat® may scour into the seabed to increase the stability and be compatible with trawling. Mats can be constructed to meet project-specific size requirements.

Ecological Advantages
Concrete can be made with admixtures that reduce the pH of the concrete and can be textured (see image) to encourage faster colonization of benthic epifauna.

Specifications
Size: 20 x 8 x 1 ft
Footprint: 160 ft²
Surface area available for colonization: 320+ ft²
Weight of a single unit: 18,298.4 lbs.
Max depth previously deployed: -6,500 ft
Estimated life of product: 50+ years

Estimated Product Costs
Per unit: \$800 to \$1,200
Product to cover 2000 m²: N/A
Lead time for production: 6 to 9 months

Supplier(s)
Roman Stone Construction Co. (NY), romanstone.com
(Under license from Subsea Protection Services)

Publications
International Marine Contractors Association (IMCA). 2011. Guidelines for Diver and ROV Based Concrete Mattress Handling, Deployment, Installation, Repositioning and Decommissioning. IMCA D042 Rev 1 / IMCA 8016.



Fleximat®, subseaprotection.com



Fleximat®, romanstone.com

Turbine Reefs 31



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

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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.



Bring concrete **to life**

Dr. Ido Sella

www.econcretetech.com



ECOncrete® is an environmental concrete technology that complies with Marine construction standards and provides biological, and structural benefits.

Concrete Problem

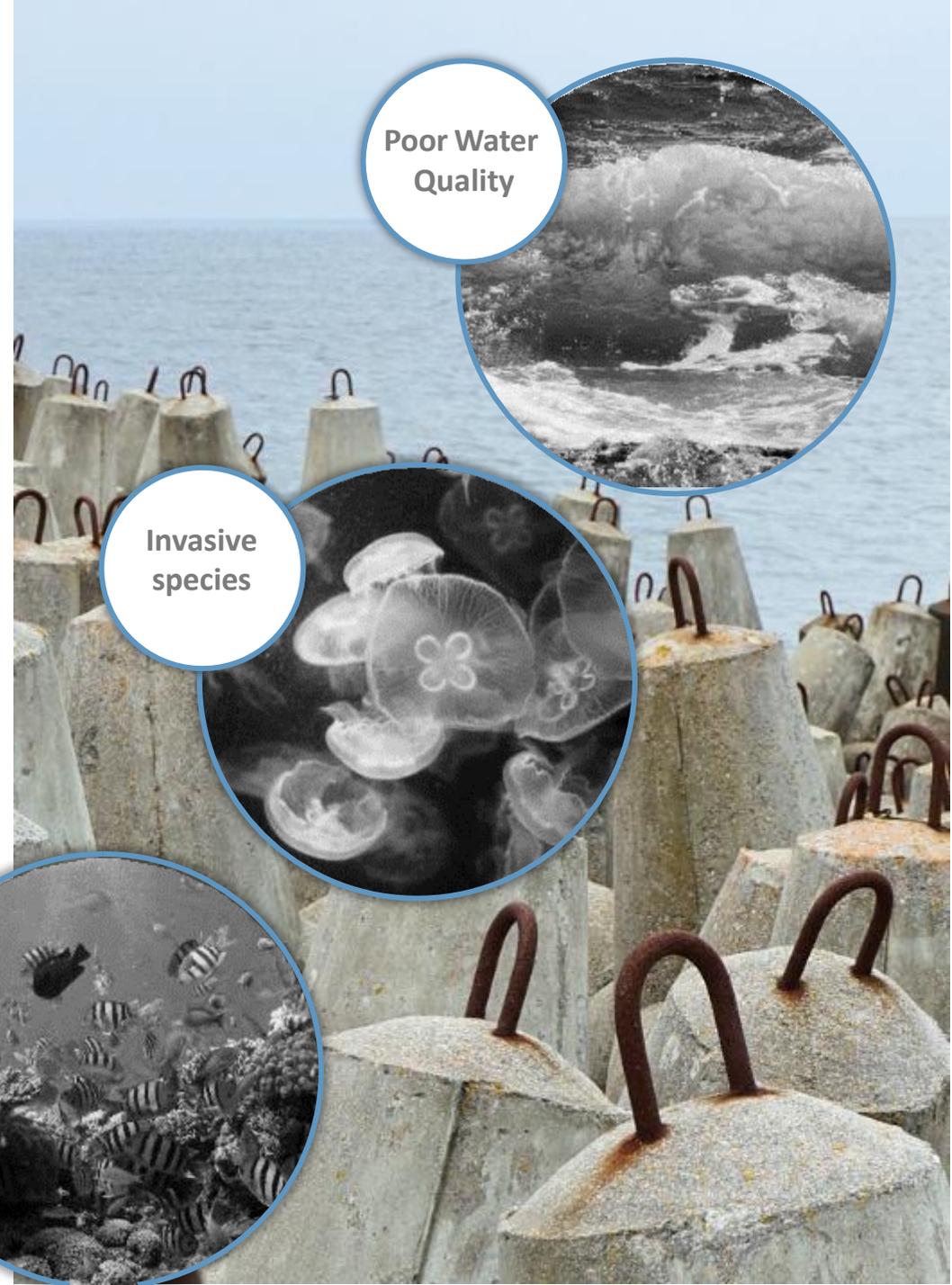
70%

of coastal and marine structures
are concrete based

Poor Water
Quality

Invasive
species

Low
Biodiversity

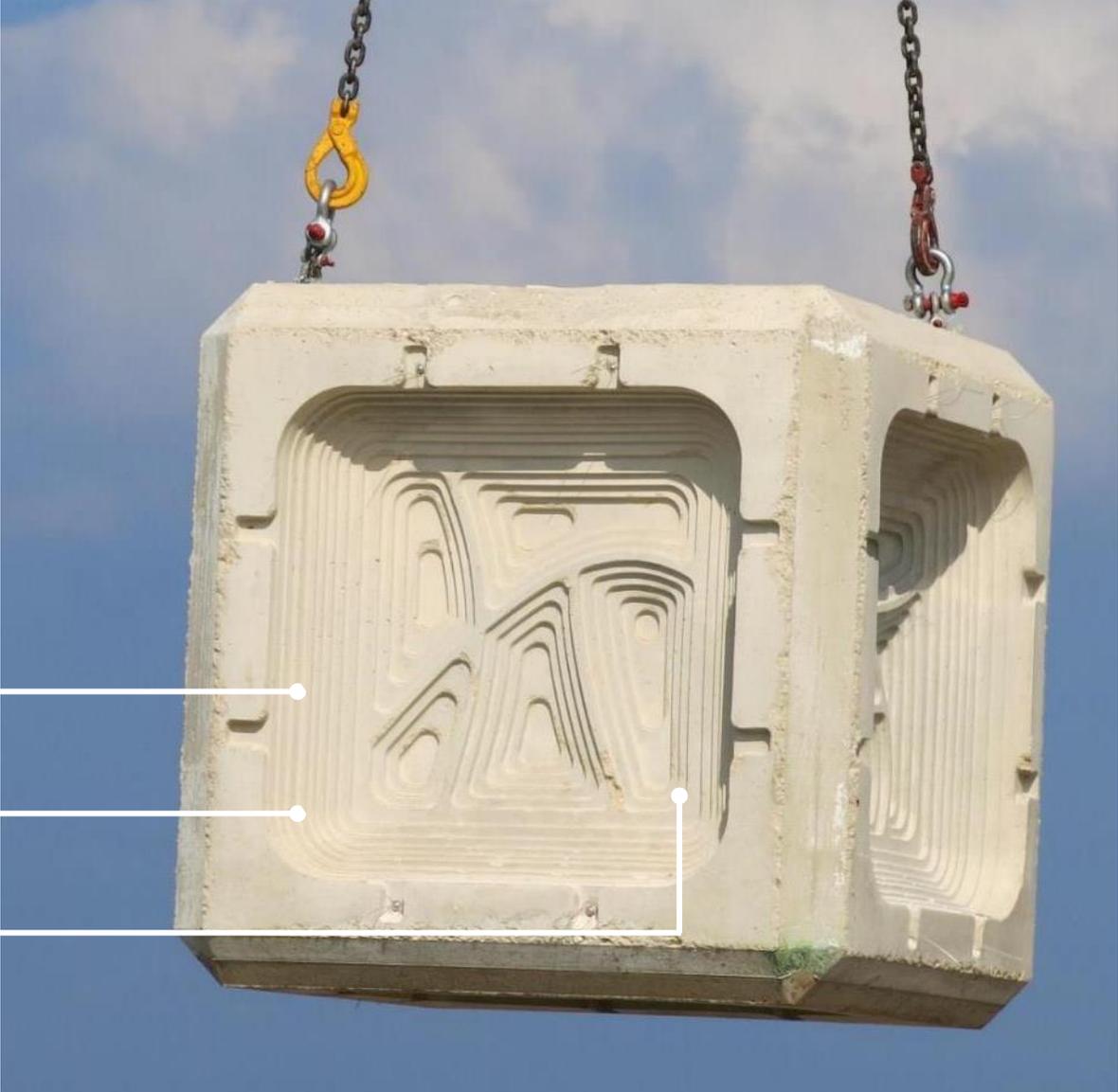


ECOncrete® Patented Solution

Material composition

Surface complexity

Macro design



+



+

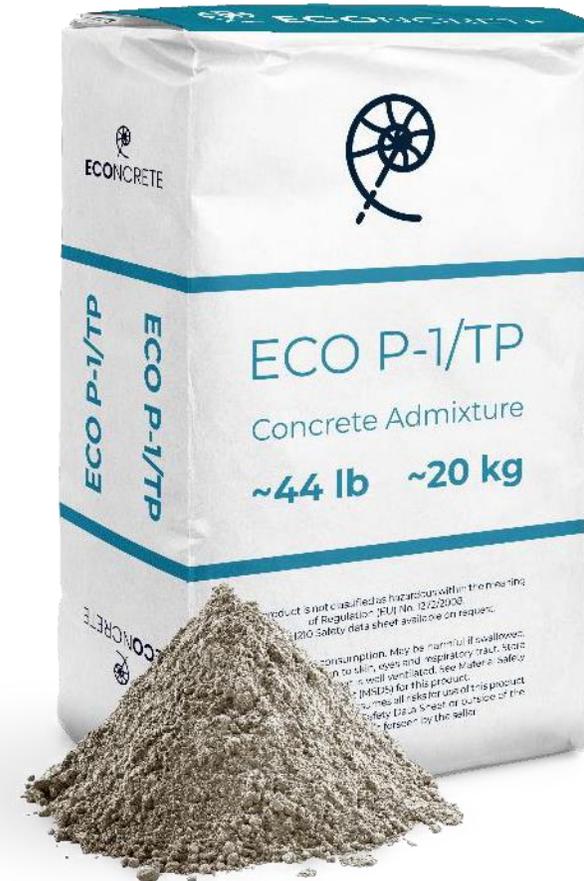


Patented Solution

ECONcrete® Admix complies with US, UK, EU, & Australian standards for general and workability concrete admixture



- ASTM C494, Standard Specification for Chemical Admixtures for Concrete.
- EU/UK/IS: Improve workability of concrete admixture (SI 89 and the EN 934-1 2008 and EN 934-2: 2009 + A1: 2012).
- Australia: Special purpose admixture, Section 3 and 4 of AS 1478.1-2000 (R2018).



BRINGING CONCRETE TO LIFE

Biodiversity

2 X

Water Quality

16 X

Carbon Sink

7 X

Native : invasive
species ratio

3 : 1

Species Richness

2 X

Habitat Creation

INCREASED



BRINGING CONCRETE TO LIFE

Biodiversity

2 X

Water Quality

16 X

Carbon Sink

7 X

Native : invasive
species ratio

3 : 1

Species Richness

2 X

Habitat Creation

INCREASED





40+ Locations | 7 Seas | 10 Countries



Shoreline Protect



Wet cast Marine Mattress



ECO Seawall



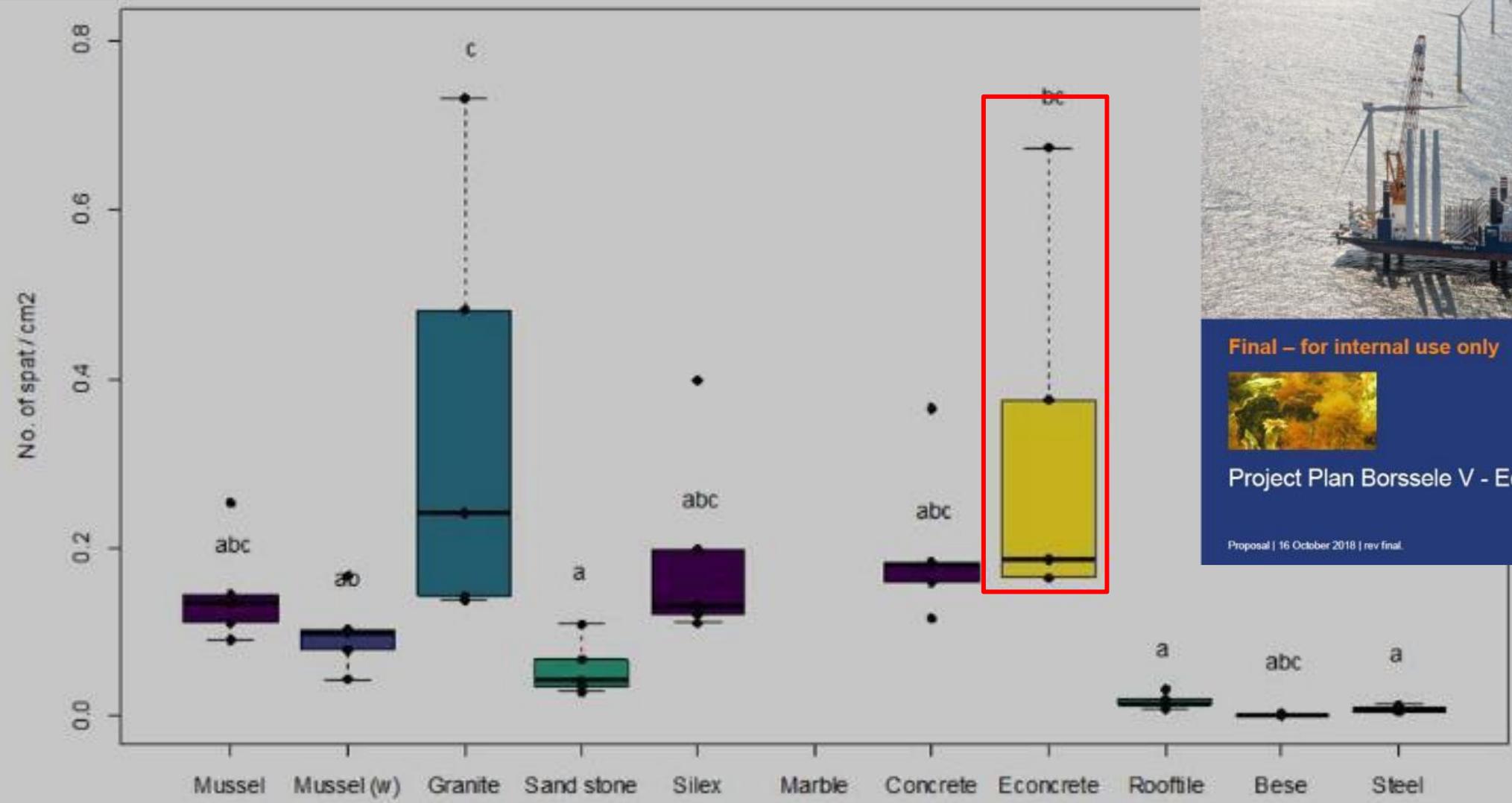
Tide Pool Armor



ECO Armor Block



Drycast ECO Mat



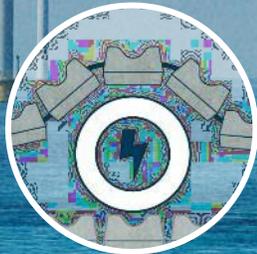
Final – for internal use only



Project Plan Borssele V - EcoScour

Proposal | 16 October 2018 | rev final.

Offshore Applications



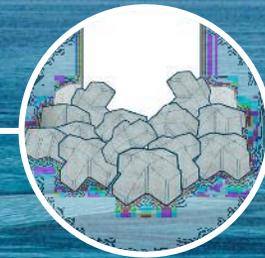
Turbine Reefs: Nature-Based Designs for Augmenting Offshore Wind Structures in the United States

Technical Report

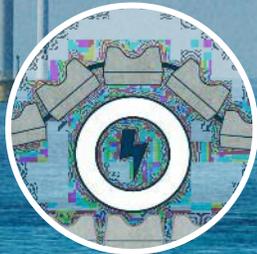
November 2021

The Nature
Conservancy 

INSPIRE
ENVIRONMENTAL



Offshore Applications



Witteveen + Bos

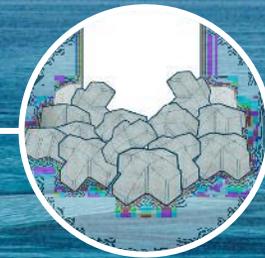
WAGENINGEN
UNIVERSITY & RESEARCH



Nature-Inclusive Design: a catalogue
for offshore wind infrastructure
Technical report

The Ministry of Agriculture, Nature and Food Quality

17 March 2020



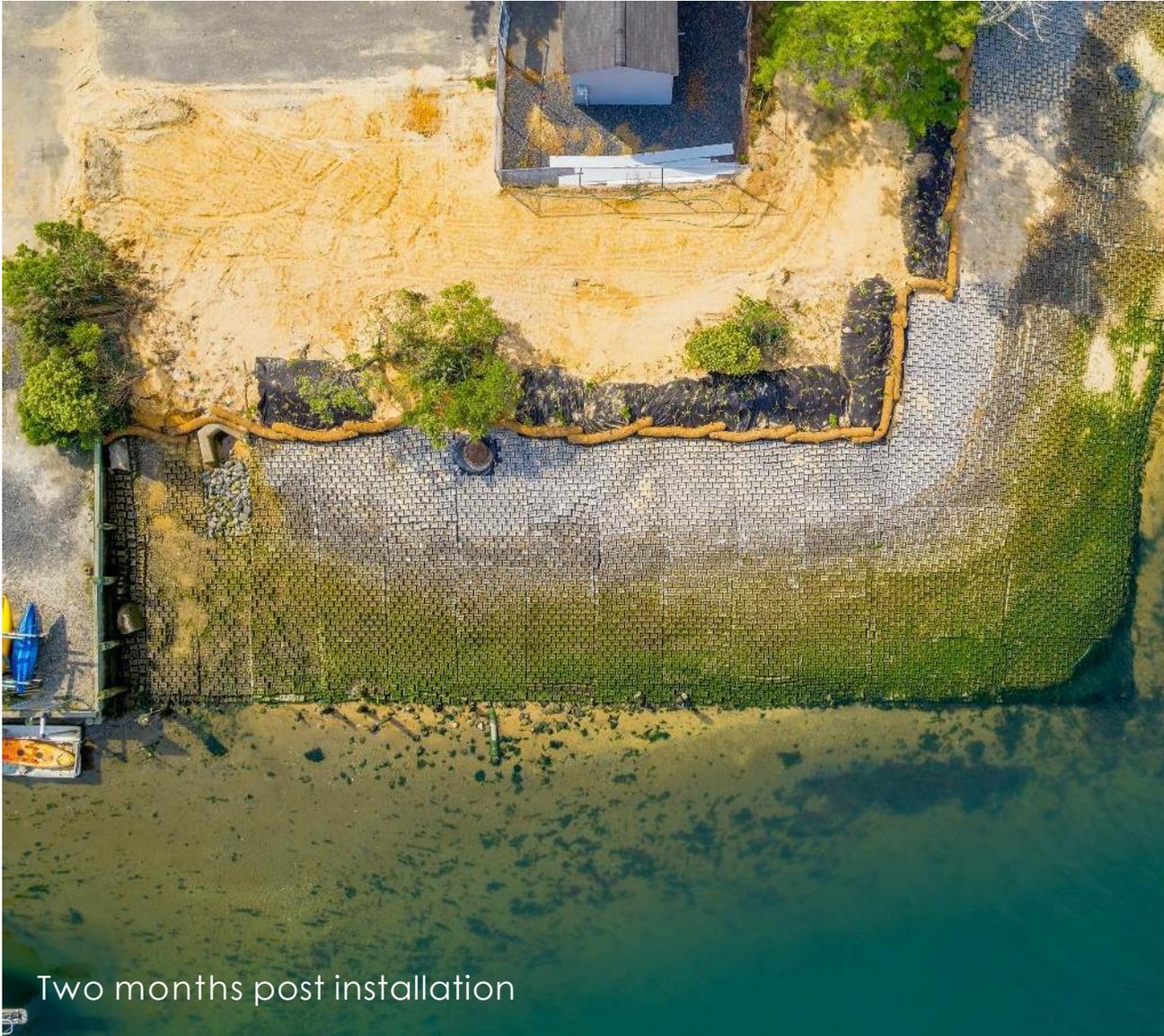
Shark River Island, Neptune City, NJ

Stabilizing a highly eroded shoreline along a Community Waterfront

📅 Jun. 2018, Jun 2021

📍 Shark River Island, Neptune City, NJ, USA





Two months post installation

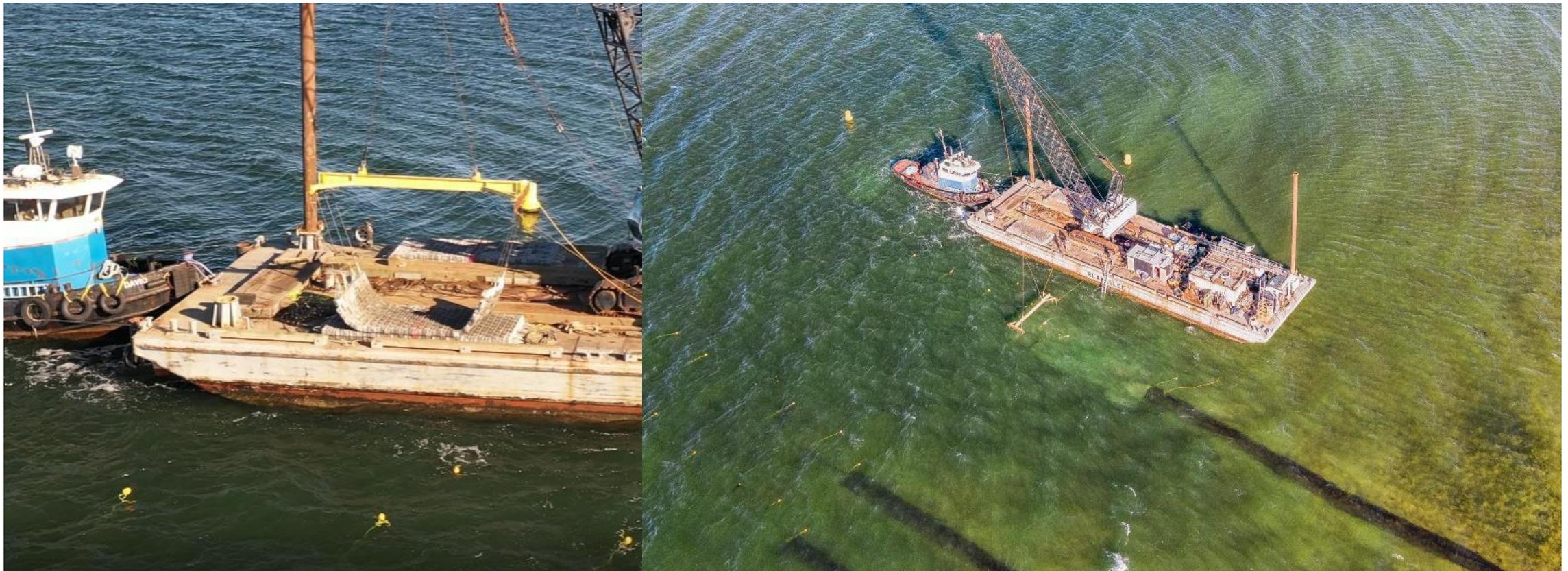


Fort Salonga, Long Island, USA

Protecting Underwater Energy Cables

📅 Dec. 2020

📍 Fort Salonga, Long Island, USA



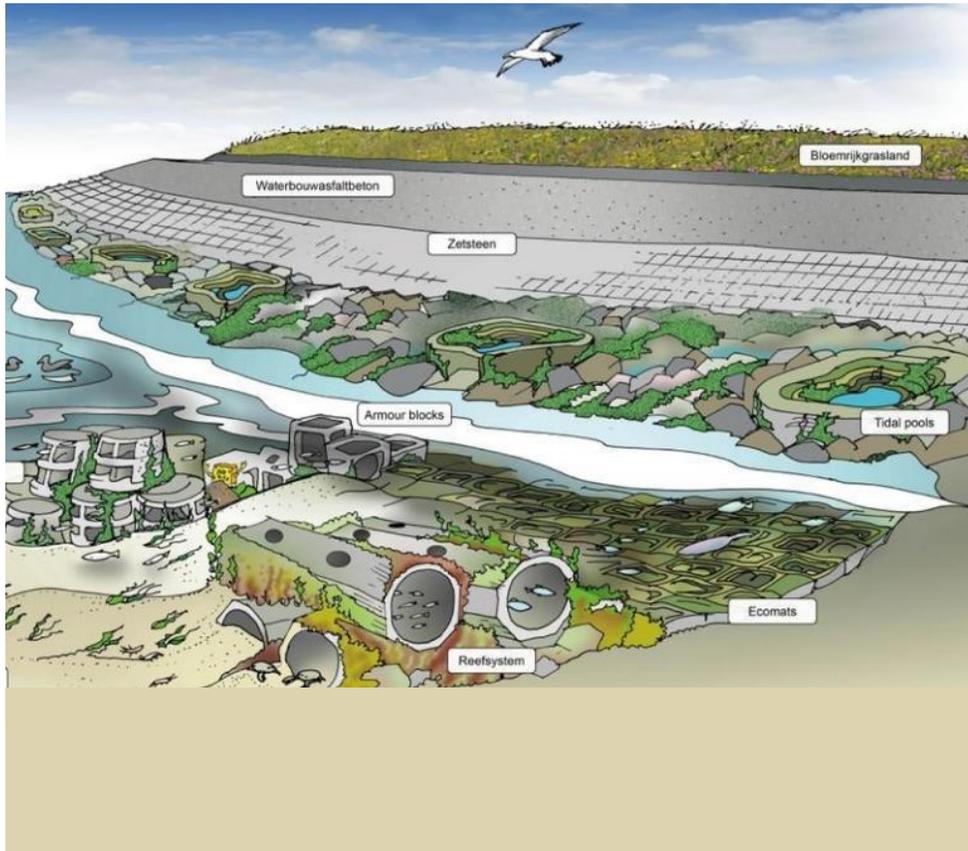


The Netherlands – Lauwersmeer Dike

Dike reinforcement pilot with Underwater Marine Life Enhancement

Nov. 2021

Wadden Sea, Groningse
Lauwersmeerdijk, Netherlands



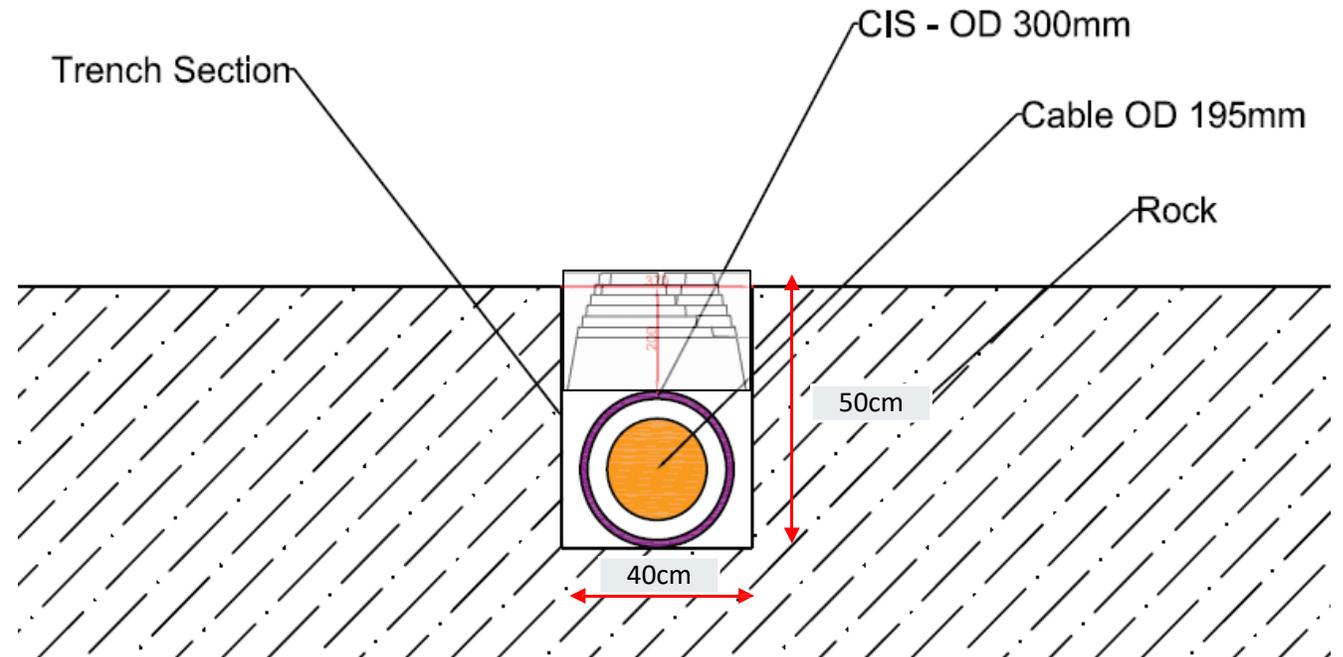
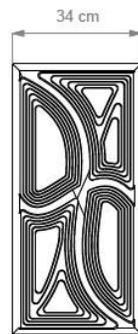
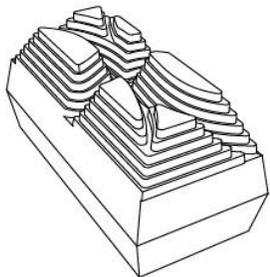
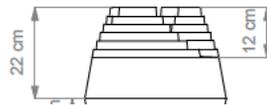
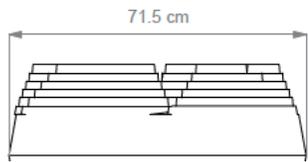
Cable protection, Fuerteventura, Spain

UNDER CONSTRUCTION

Submarine electrical cable protection. Fuerteventura-Lanzarote, Canary Islands.
Bioenhancing Offshore facilities

Dec 2021-March 2022

Fuerteventura-Lanzarote,
Canary Islands, Spain



Anti-trawling blocks, Melendugno, Italy UNDER CONSTRUCTION

Submarine gas pipeline protection. Albania-Italy. Bioenhancing-protecting Offshore facilities

📅 July 2021-April 2022

📍 Melendugno, Italy

200 units of 8m³





Department of Energy

Department of Energy Announces Eight New Projects Through BIRD Energy Partnership with Israel

DECEMBER 21, 2020



EConcrete Tech Ltd. and **LafargeHolcim (US) Inc.** developing an **eco-engineered** concrete product for scour protection and ecological uplift of offshore wind energy infrastructure.

ECOscour protection. BIRD Grant.

Analysis of the biological enhancement, production and Offshore placement

📅 Jan 2021-Aug 2022 📍 East Coast, USA

R & D

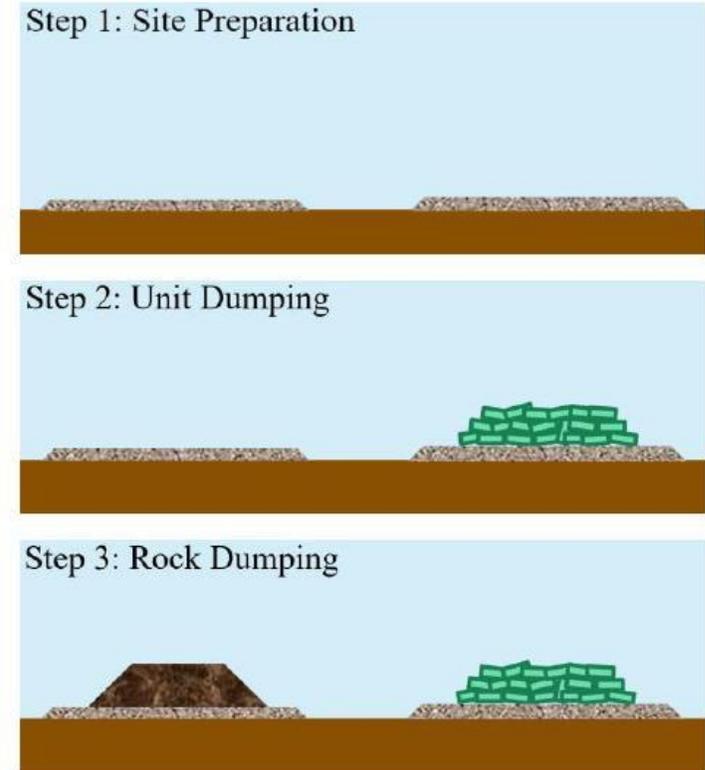
UPCOMING CONSTRUCTION



ECOscour protection. BIRD Grant.

Analysis of the biological enhancement, production and Offshore placement

Jan 2021-Aug 2022 East Coast, USA



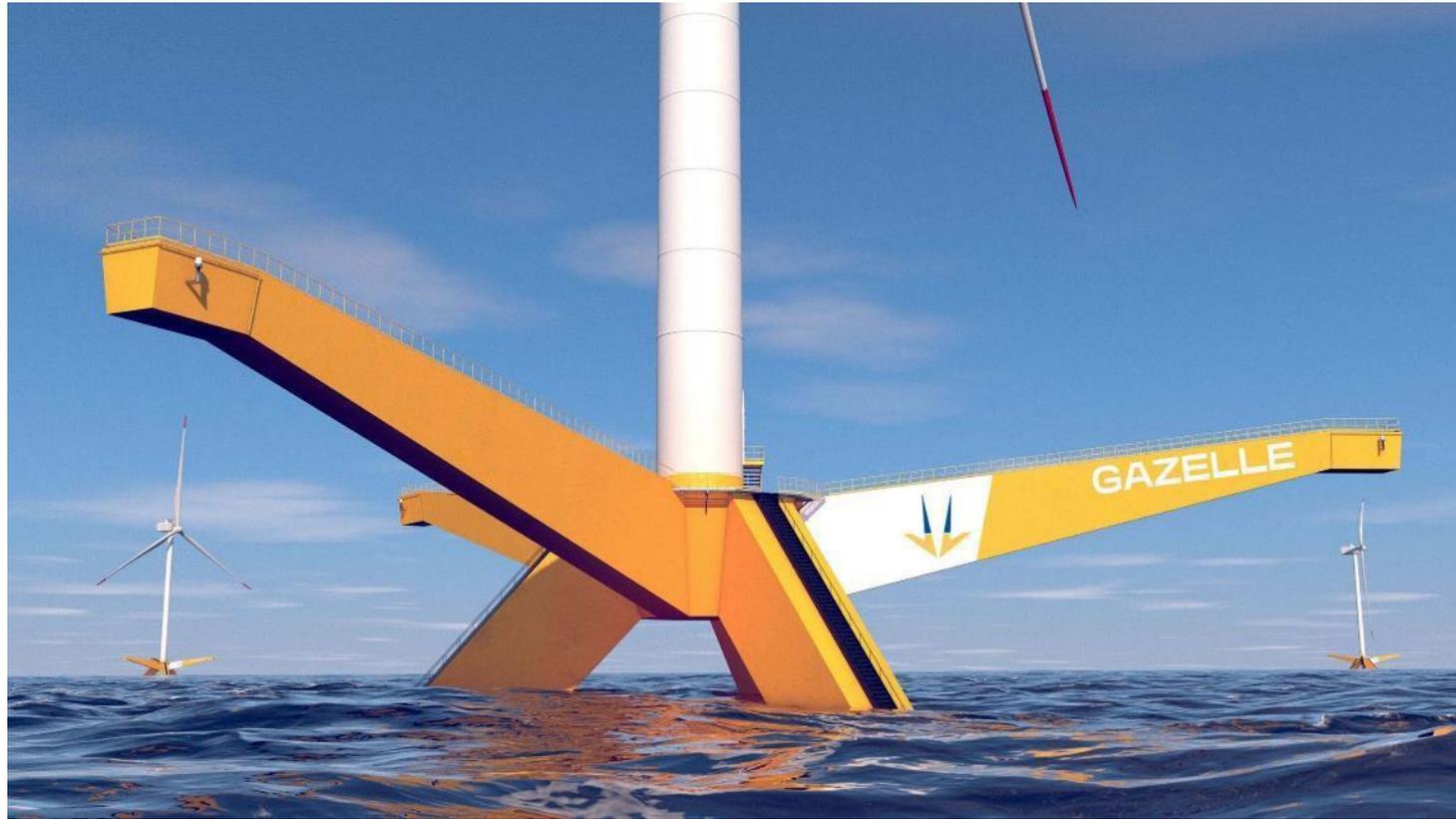
Mooring units for Floating Offshore Wind

ECONcrete mooring units for Floating Offshore Wind Parks.

R & D

UPCOMING CONSTRUCTION

F Jan 2022-Dec 2022 📍 Canary Islands, Spain





Let's build responsibly, **together**

www.econcretetech.com



Fishing Among Giants



Capt. Dave Monti

- Recreational fisherman
- Charter captain/fishing guide
- Fishing journalist... Providence Journal and 15 others
- Fish advocate, conservation & offshore wind
- Saltwater Anglers Association Board
and RI Charter & Party Boat Association
- RI Marine Fisheries Council, vice chair
- Am. Saltwater Guides Association board











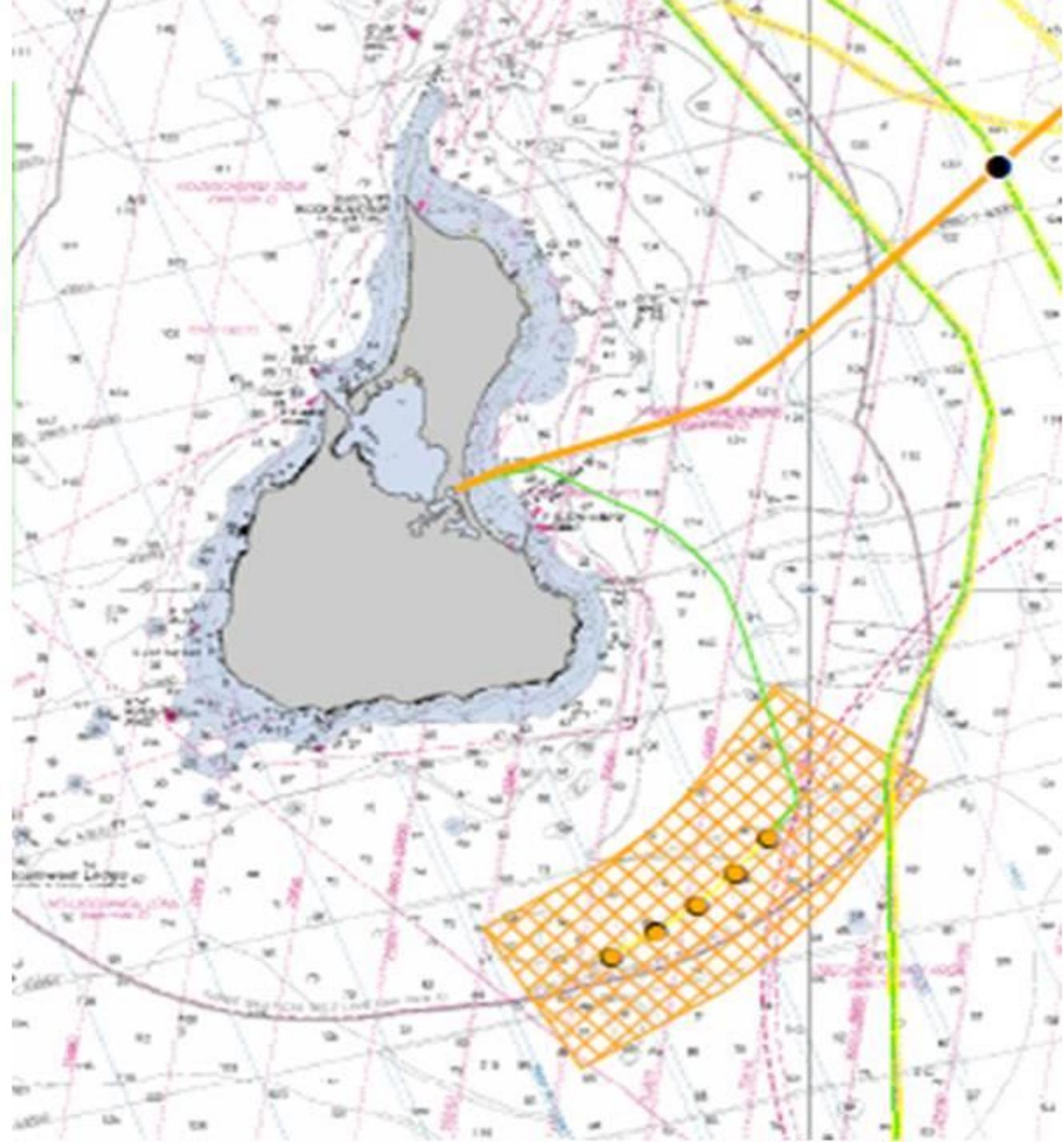
Structure and Fishing

- As a charter captain and fishermen I spend most of my fishing days seeking out structure... natural structure like ledges, channel breaks, deep holes, rock clusters, banks or man made like, bridge abutments, jetties, ocean platforms, artificial reefs, etc.
- Know of no structure that has been bad for fishing... natural or man made

Fishing in the BIWF





















Enhanced fishing and pressure



Block Island Wind Farm

- Southern New England Offshore Wind Energy Science Forum (12/17)... 50 scientists present research findings.
- BIWF has had no remarkable adverse effects on the environment, fish, mammals, birds and people.

Block Island Wind Farm

- Scientists at the Forum also said that the cumulative effects of hundreds of turbines in the same area are unknown, based on European/BIWF experiences believe we will have a positive cumulative impact
- Seven years: enhanced/complemented habitat, created life, attacking fish of all sizes we like to catch, eat and/or release

Moving forward

Offshore wind and fishing can coexist and thrive

- Block Island Wind Farm is the proof
- Enhance structure at base of pylons
- Conduct fish and habitat research before, during and after wind farm construction
- We have a proven research protocol via the BIWF, let's follow it, learn as we go and improve our fisheries and ability to offset negative climate impacts

Fishing among giants



Coming Next:

March 2, 1:30 p.m. ET
Research Priorities
for Offshore Wind
Carrie Cullen Hitt,
NOWRDC

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