



Ôde à la mer

A4 Presentation | Prune Wassenaar | 5499933

Master of Architecture

Geert Coumans | Marcel Bilow

16.06.2026

Architecture is
the creation and organization of **spaces**
to support **human needs**.

Spatial
human needs

Architecture is
about functionality, efficiency, and
practicality of spatial use.

Spatial
human needs

Functional and efficient
spatial design

Architecture is
an artistic practice that shapes
experiences and evokes **emotions**.

Architecture is
the technical design of **safe**,
comfortable, and **resilient** structures
that **protect** and **support** their users.

Spatial
human needs

Functional and efficient
spatial design

Spatial experiences evoking
emotions

Architecture is
a translation of **cultural traditions**
and **values.**

Spatial
human needs

Functional and efficient
spatial design

Spatial experiences evoking
emotions

Engineering safe and
comfortable environments

Architecture is
an interpretation of the **unique**
characteristics of a place into
spatial and material form.

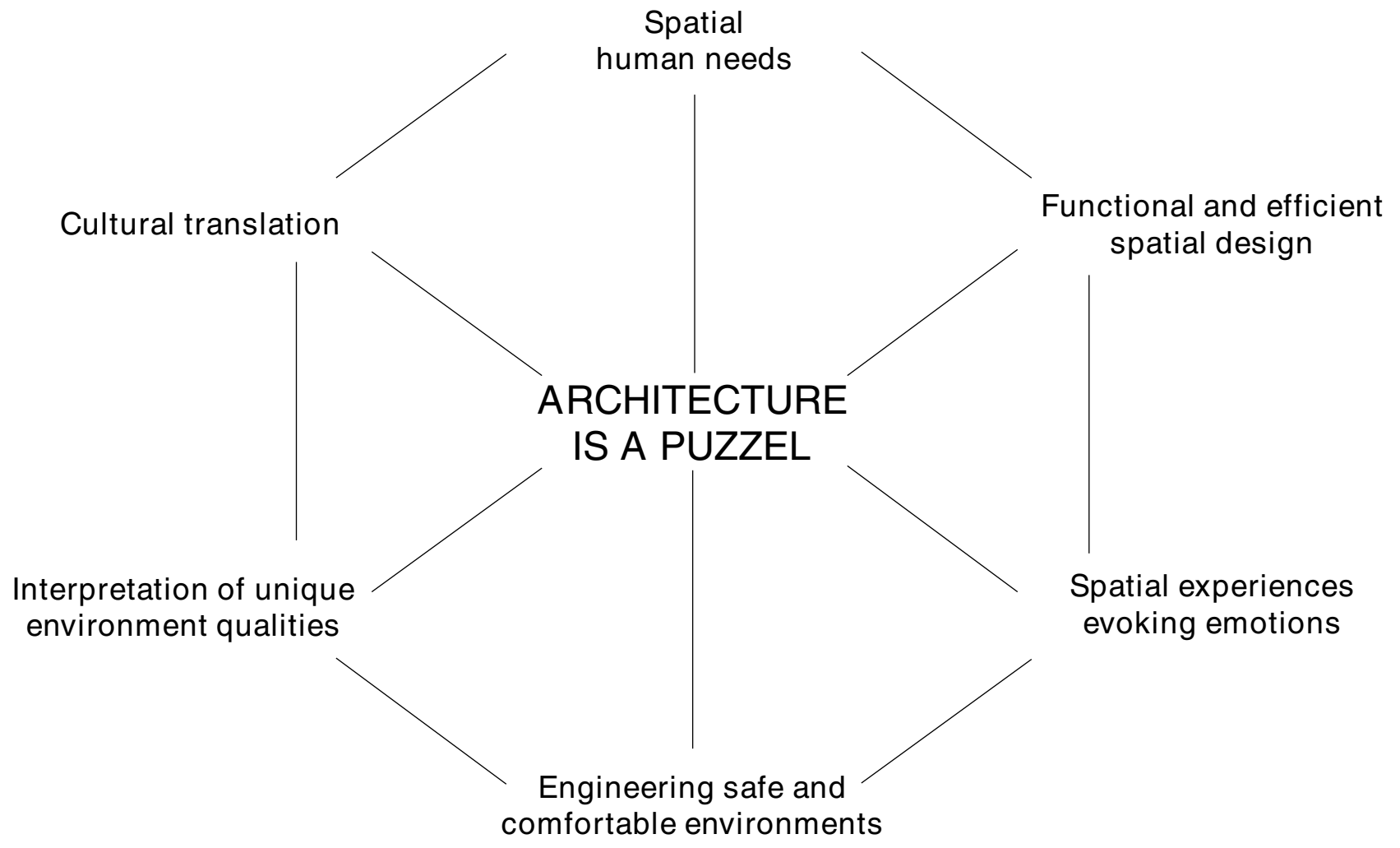
Spatial
human needs

Functional and efficient
spatial design

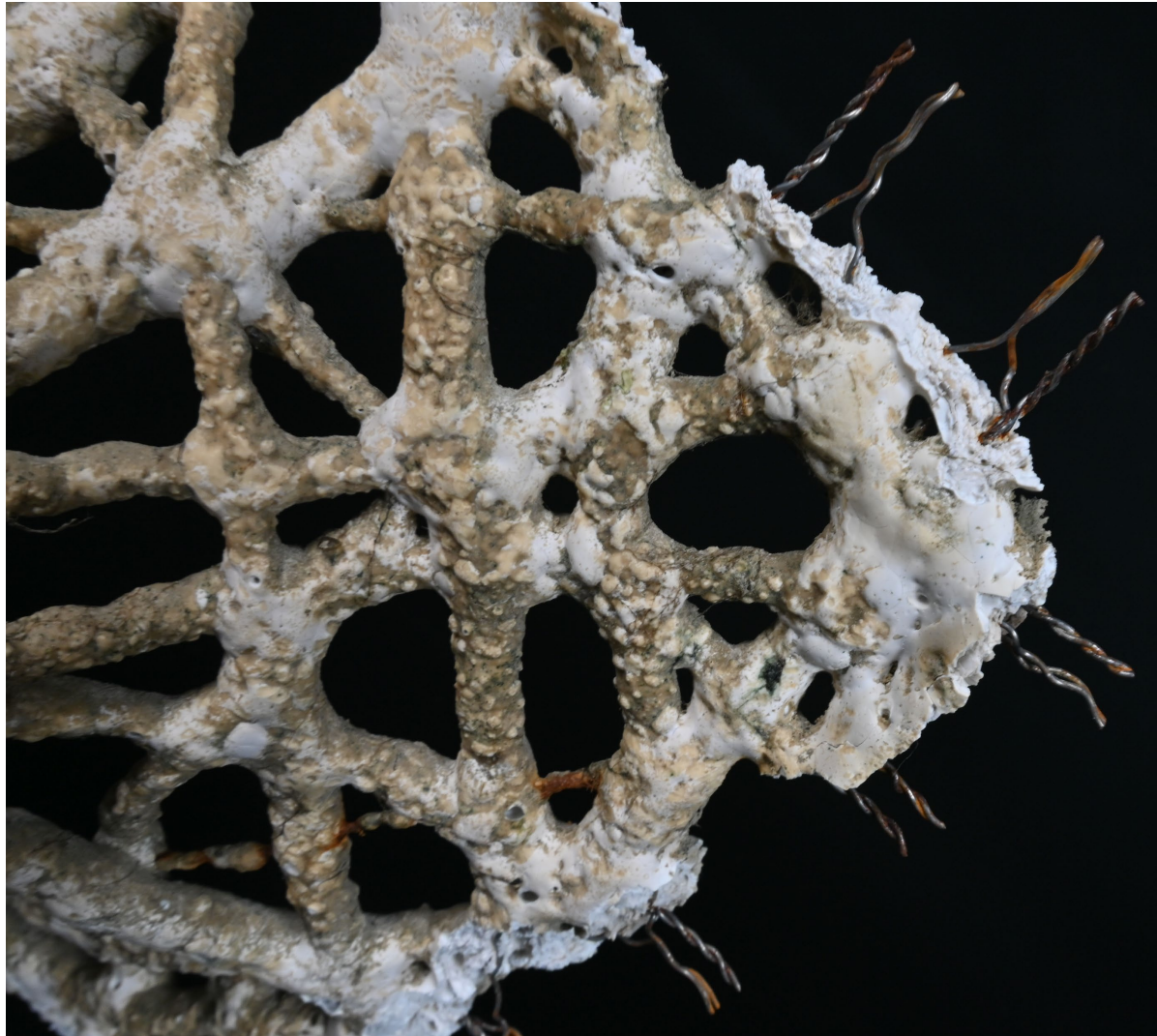
Spatial experiences evoking
emotions

Engineering safe and
comfortable environments

Cultural translation

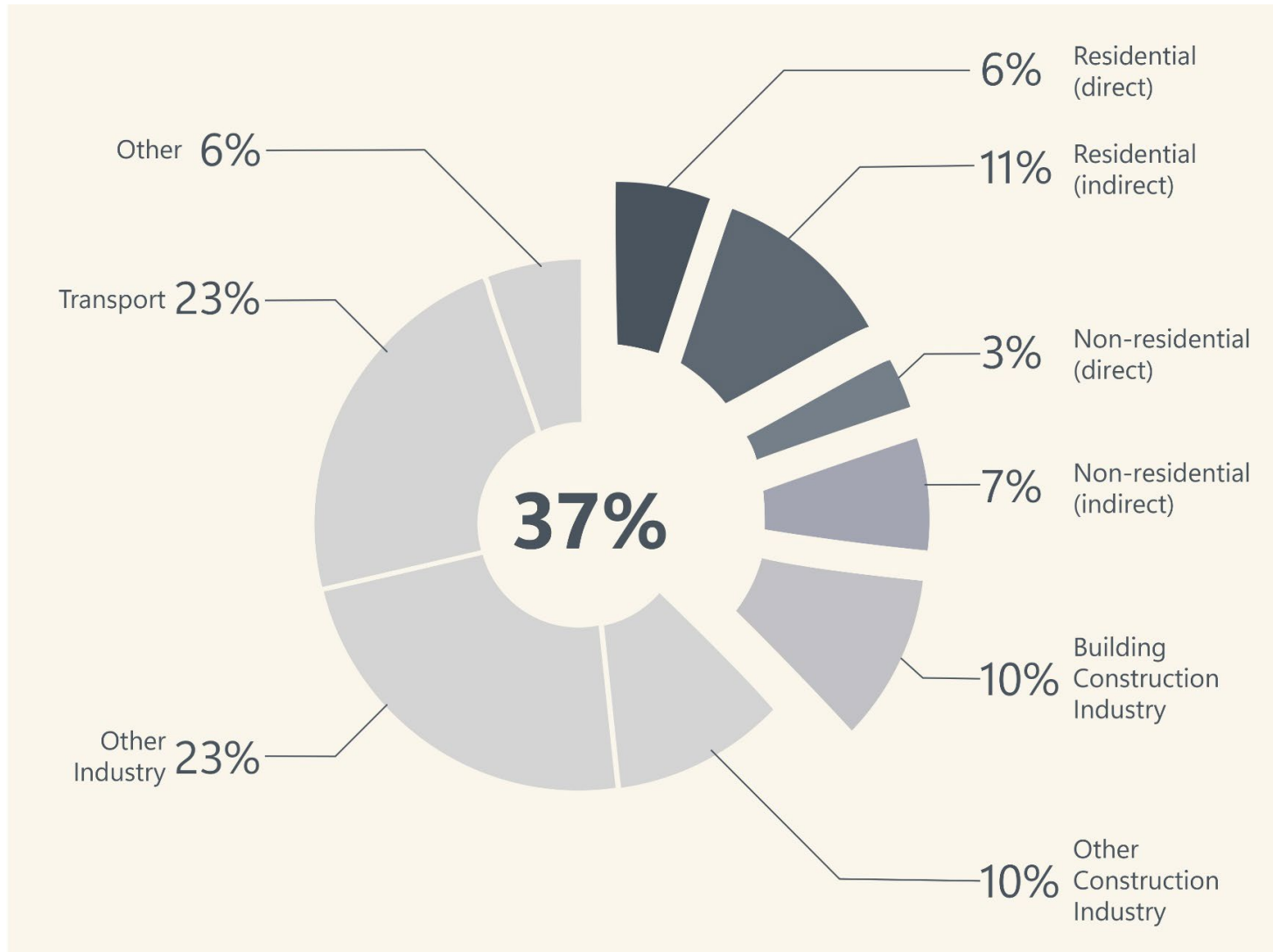






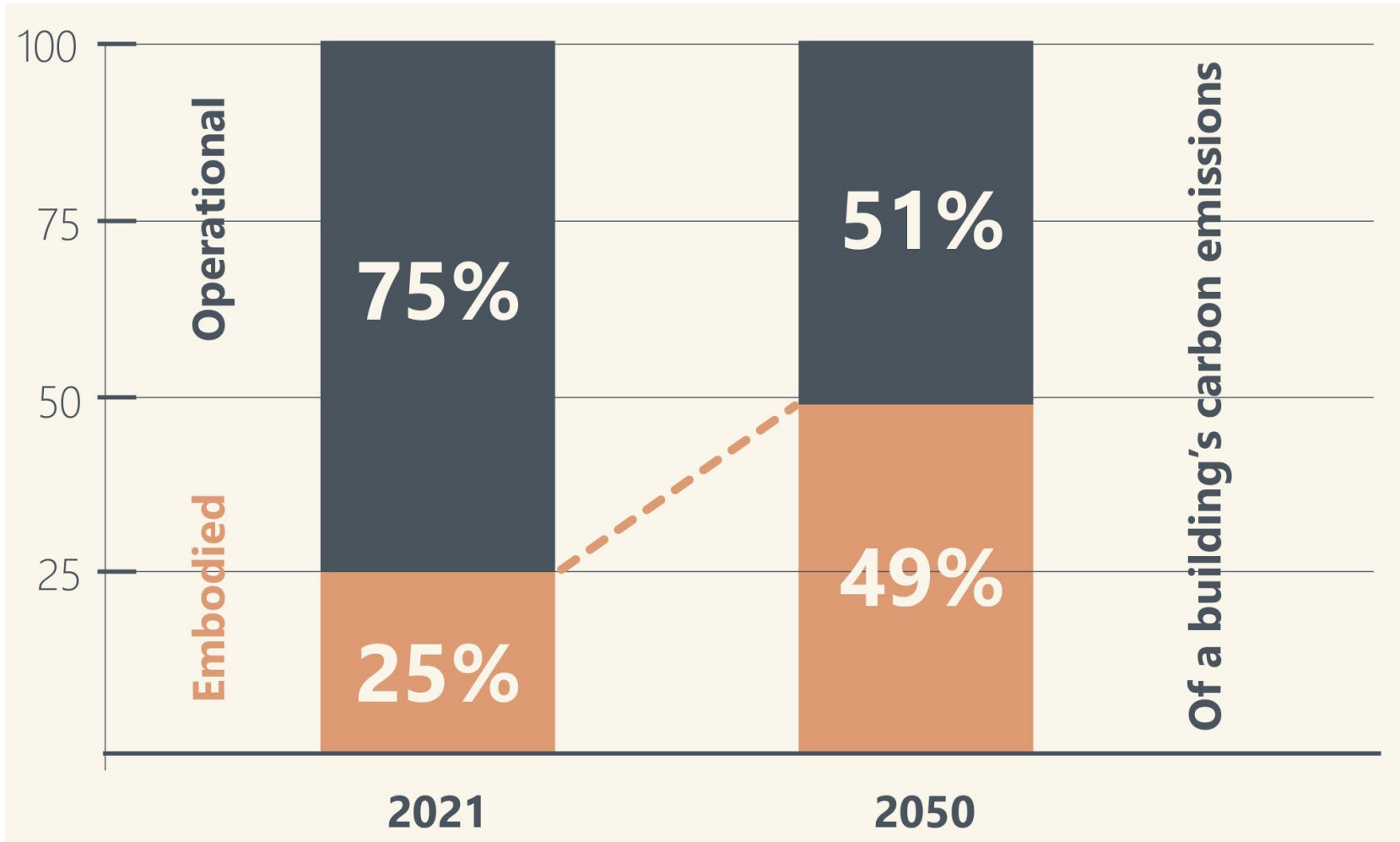
BIOROCK AS CENTER PIECE
OF THE PUZZEL

Global energy related carbon emissions from the construction sector



Global energy related carbon emissions from the construction sector (own diagram based on Dyson et al. 2023)

Expected evolution of the embodied and operational carbon emissions in the construction sector



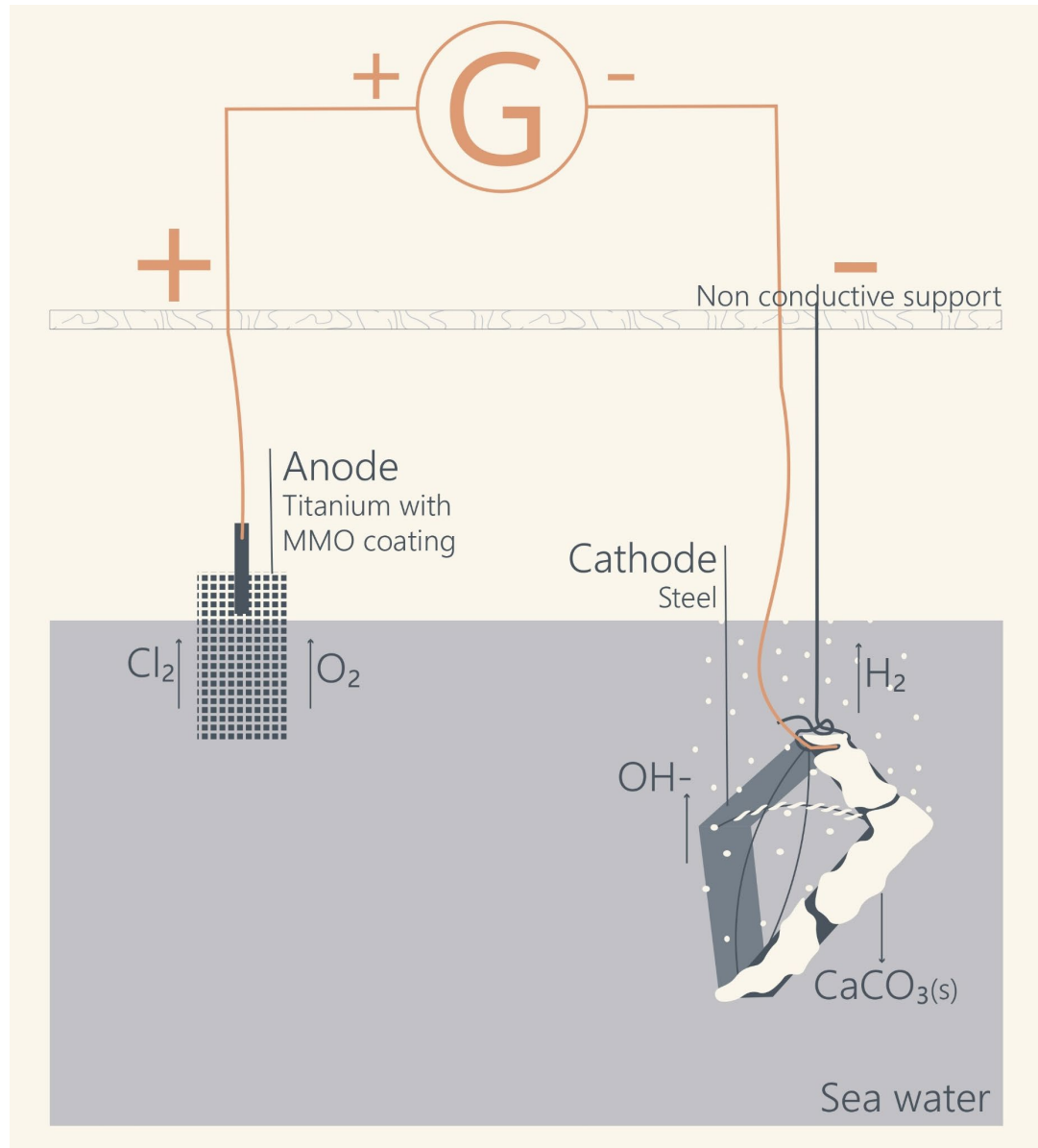
Expected evolution of embodied and operational carbon emissions (own diagram based on UN Environment programme, n.d.)



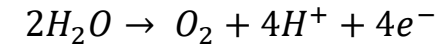
How can Biorock technology be translated into an **architectural design tool** to reduce **embodied carbon** ...

Property	LV Biorock	HV Biorock	Concrete
Density (kg/m^3)	2499.2	1771.1	1800-2400
Compression Strength (MPa)	Not measured	16.8	24.2
Puncture resistance (kN)	3.9	1.4	3.4
Specific heat capacity (J/kg.K)	811	9108.2	900
Thermal diffusivity (mm^2/s)	0.69	0.45	0.99-0.67
Thermal conductivity (W/m.K)	1.398	0.654	1.95-1.33

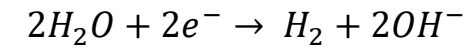
Summurize resulted mechanical propertie of Biorock (Johra, et al. 2021)



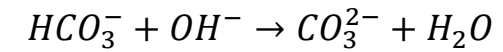
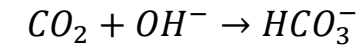
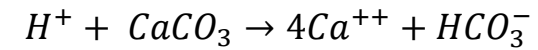
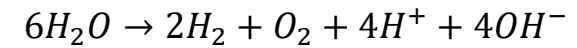
Anode reaction



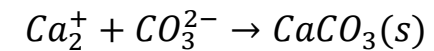
Cathode reaction

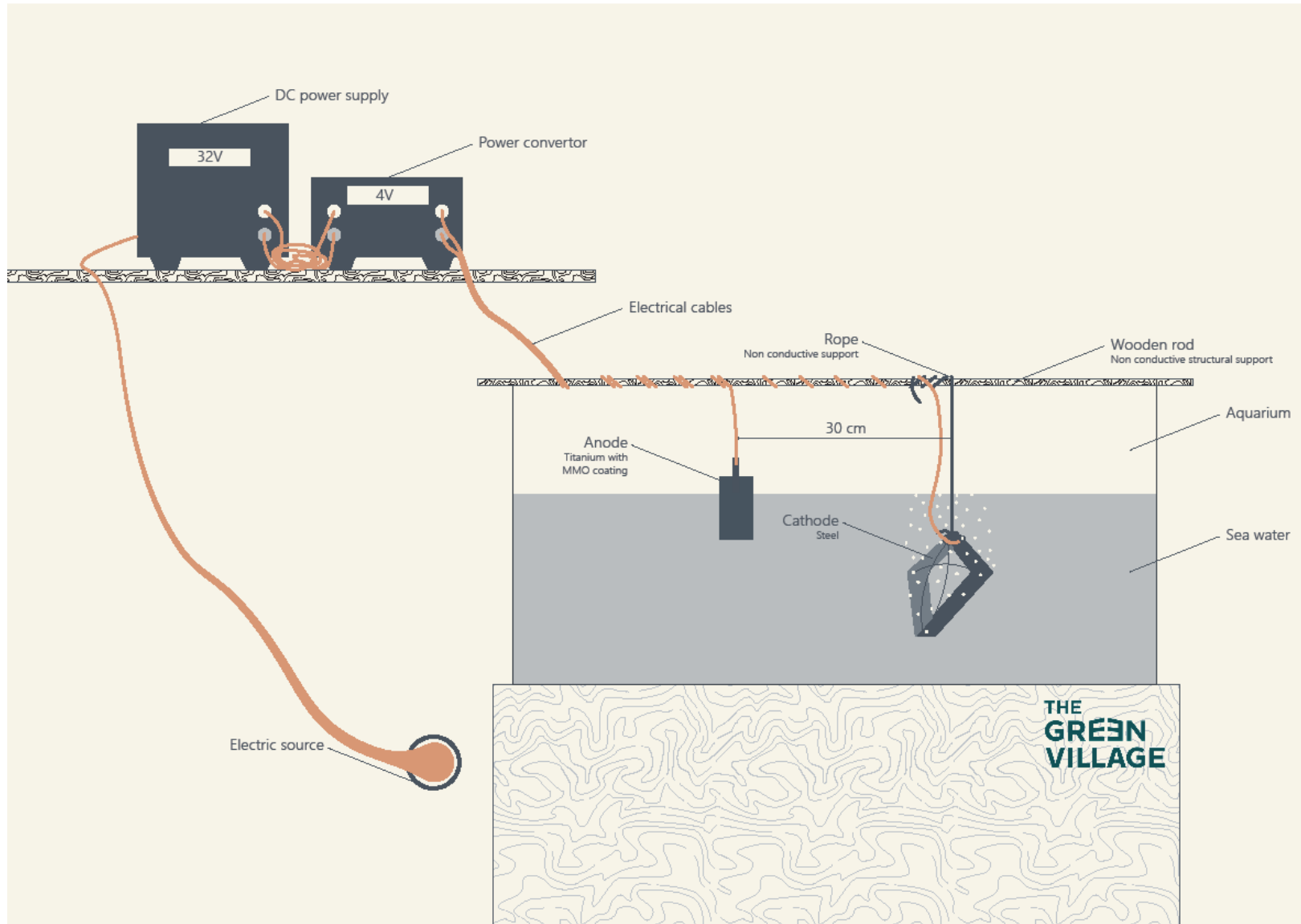


Net reaction

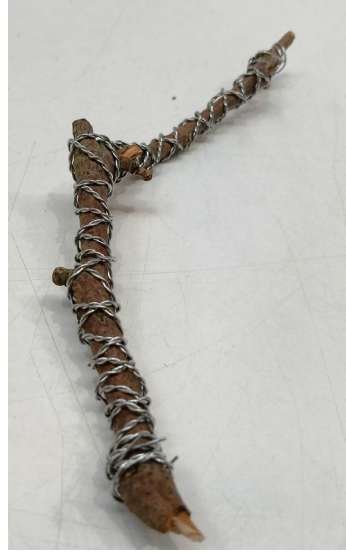


Solid Calcium
Carbonate formation

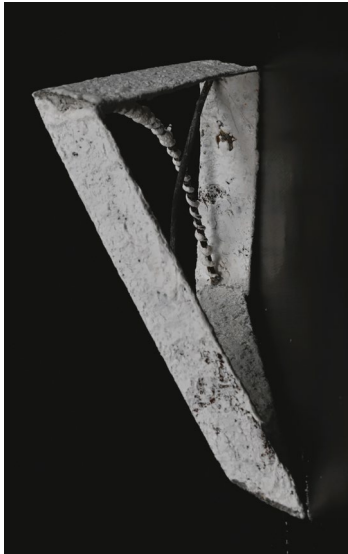




Experimental Set-up



Starting structures



Final results



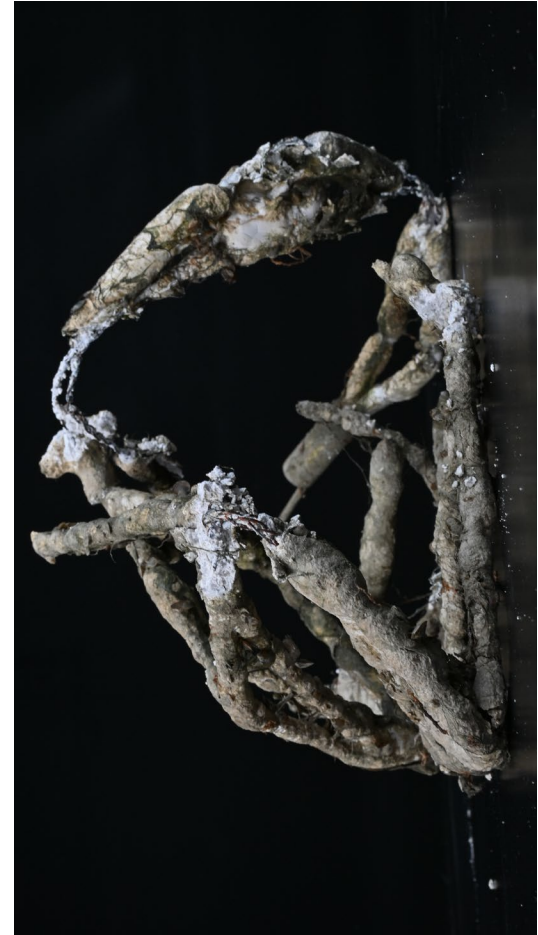
Marine Experimentation



Starting structures



Growing structures



Final structures



CONCLUSIONS

To maximize efficient growth the aimed Biorock structure should be designed as a **framework** with a **rough** steel surface.

Biorock is therefor not to be seen and designed with as a massive building block but rather as an **interconnection of thin structural networks**.

The **framework's joints** are key growth zones, as mineral accretion is most efficient at these locations.

Growth occurs unevenly across one same structure, producing **unique forms** even when composed of identical **mass-produced** elements.



A material developed for
architectural use and
spread in tropical seas as
support for reef
ecosystems



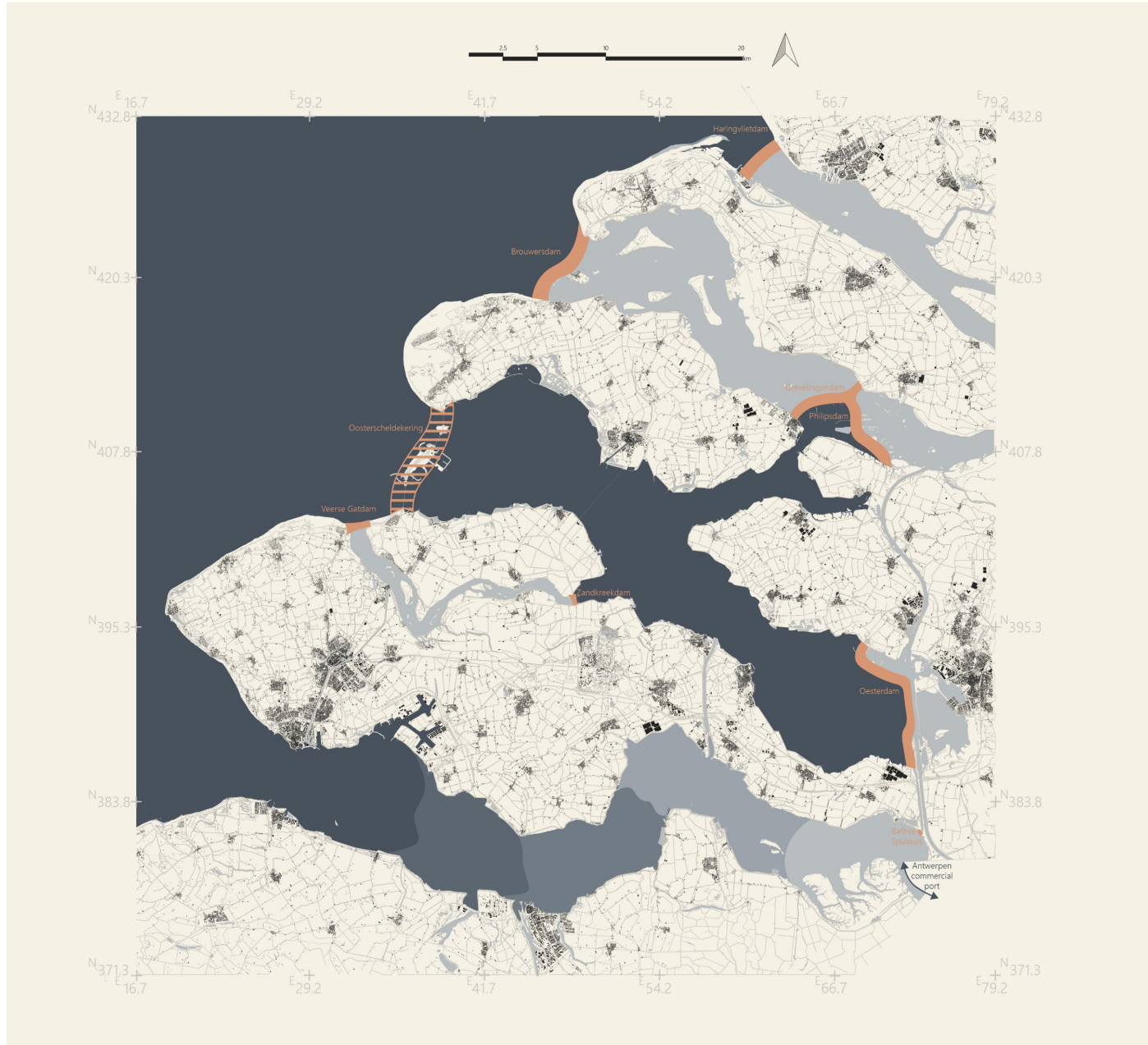
Current research start
looking into the effect of
Biorock on marine
ecosystems in the **Dutch**
context



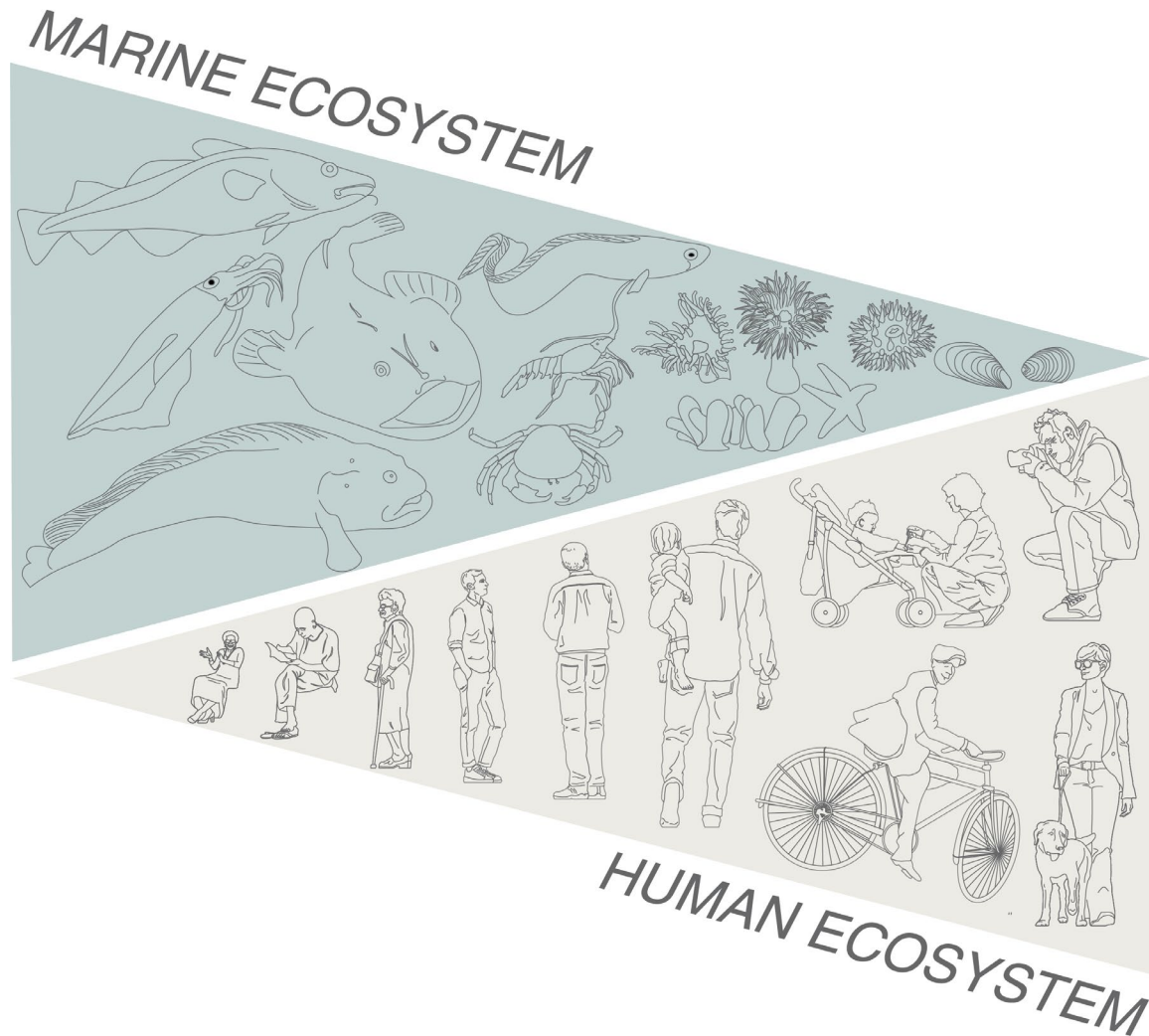
How can Biorock technology be translated into an **architectural design tool** to reduce **embodied carbon** while integrating it as part of the **natural marine ecosystem...**



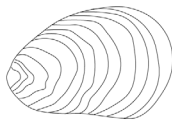
Protected natural environments correlated to marine educational and research centers in the Netherlands



An educational and research center for marine ecosystems of the Oosterschelde

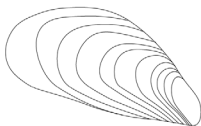


How can Biorock technology be translated into an **architectural design tool** to reduce **embodied carbon** while integrating it as part of the **natural marine ecosystem** of the Oosterschelde?



Hard Substrate

Flat Oyster

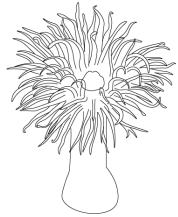


1-10m deep

Can be combined with oysters to combat predators

Blue Mussel

Reef building species



Plumose Anemone

Adheres to rocks, boulders, man-made structures, peddles and shells

Favours places where the current is strong

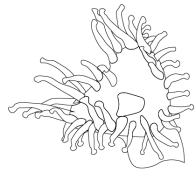
Under stones, beneath underhangs and shaded places



Dead men's finger

Bed rocks, boulders and stones

Favors strong currents and shaded areas



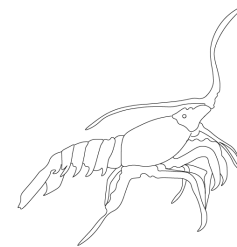
Jewel Anemone

Needs a hard substrate



Dahlia Anemone

Rock pools, crevices and gullies, caves and partly buried

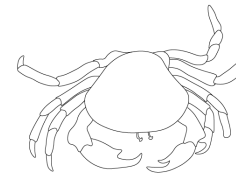


Lobster

Horizontal surfaces

size: 28-38 cm

Favors caves



Crab

Reef associated species

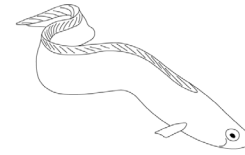


Atlantic Cod

Diet: Other fish

Size: 9-75 cm

Habitat: - Juvenils in complex shallow waters
- Adults in large crevices seeking for shelter

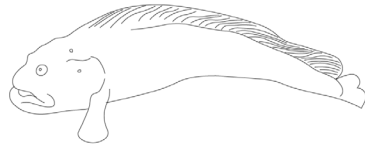


Rock gunnel

Size: 30 cm

Habitat: Under rocky substrate

Takes shelter from predators under rocks under and above the waterline



Atlantic Wolffish

Size: 20-150 cm

Habitat: Rocks and small caves

Primarily stationary fish, rarely moves from their rocky homes



Sea Star

Size: up to 50 cm, usually 30 cm

Habitat: Shallow environment, on rocks around the reef



Monk fish

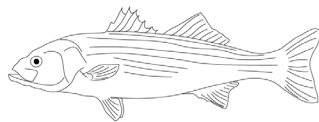
Habitat: Passage holes and layers

Relies on camouflage for hunting



Octopus

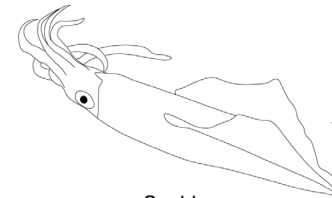
Size: up to 50 cm



Seabass

Size: 35-42 cm

Habitat: Juvenile stays 4-5 years at the shore in shallow water seeking for protection from predators



Squid

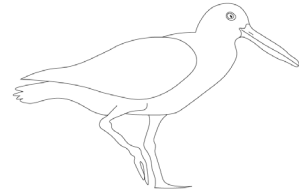
Size: up to 40 cm

Habitat: Sandy to muddy bottoms

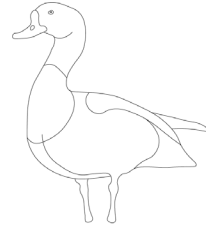
Reef benefitting species



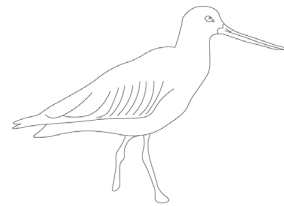
Modular Biorock reef element



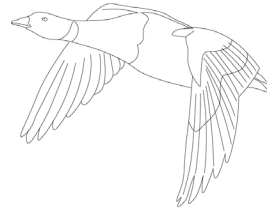
Oystercatcher



Shelduck



Bar tailed Godwit

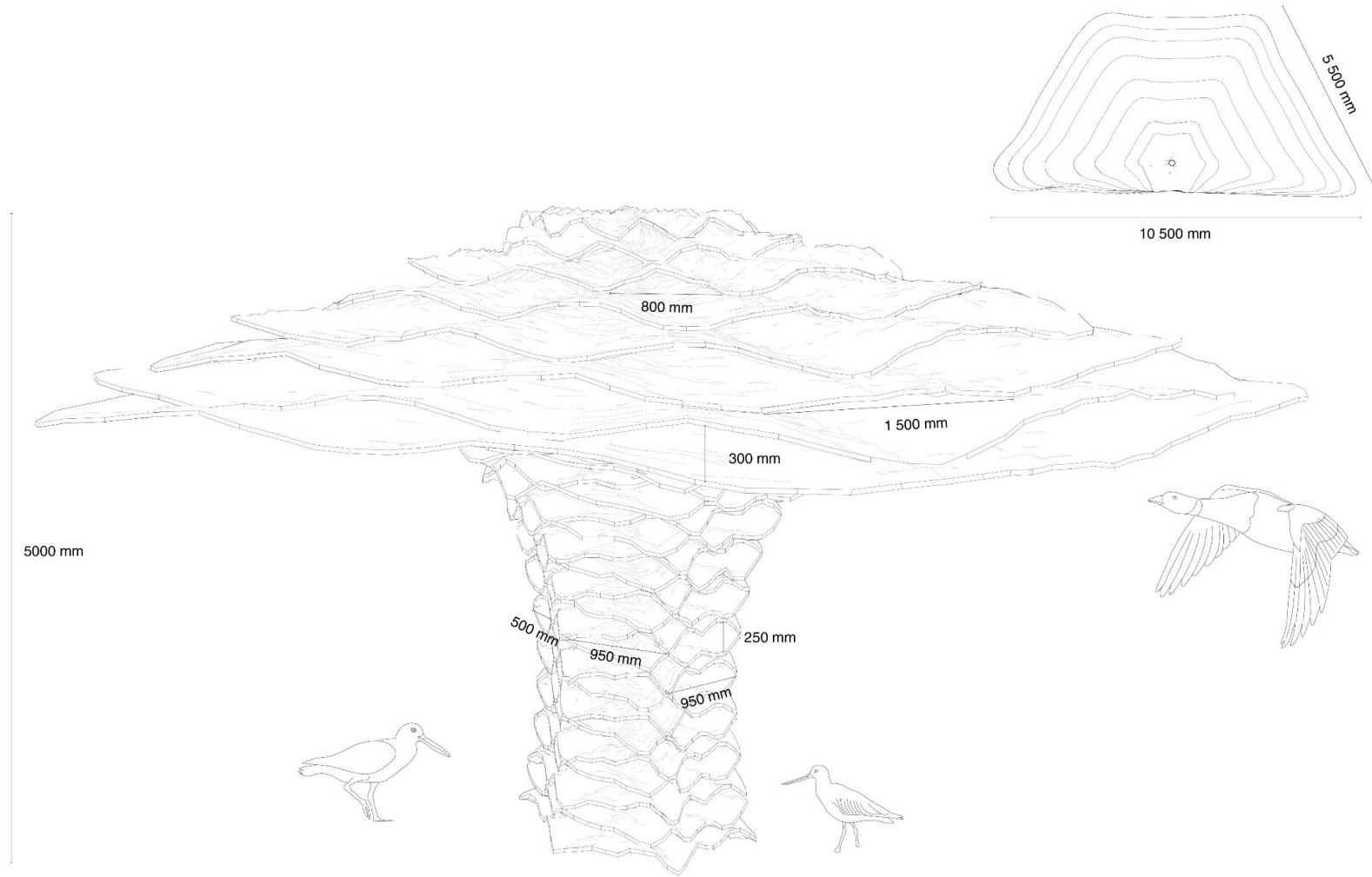


Brent Goose

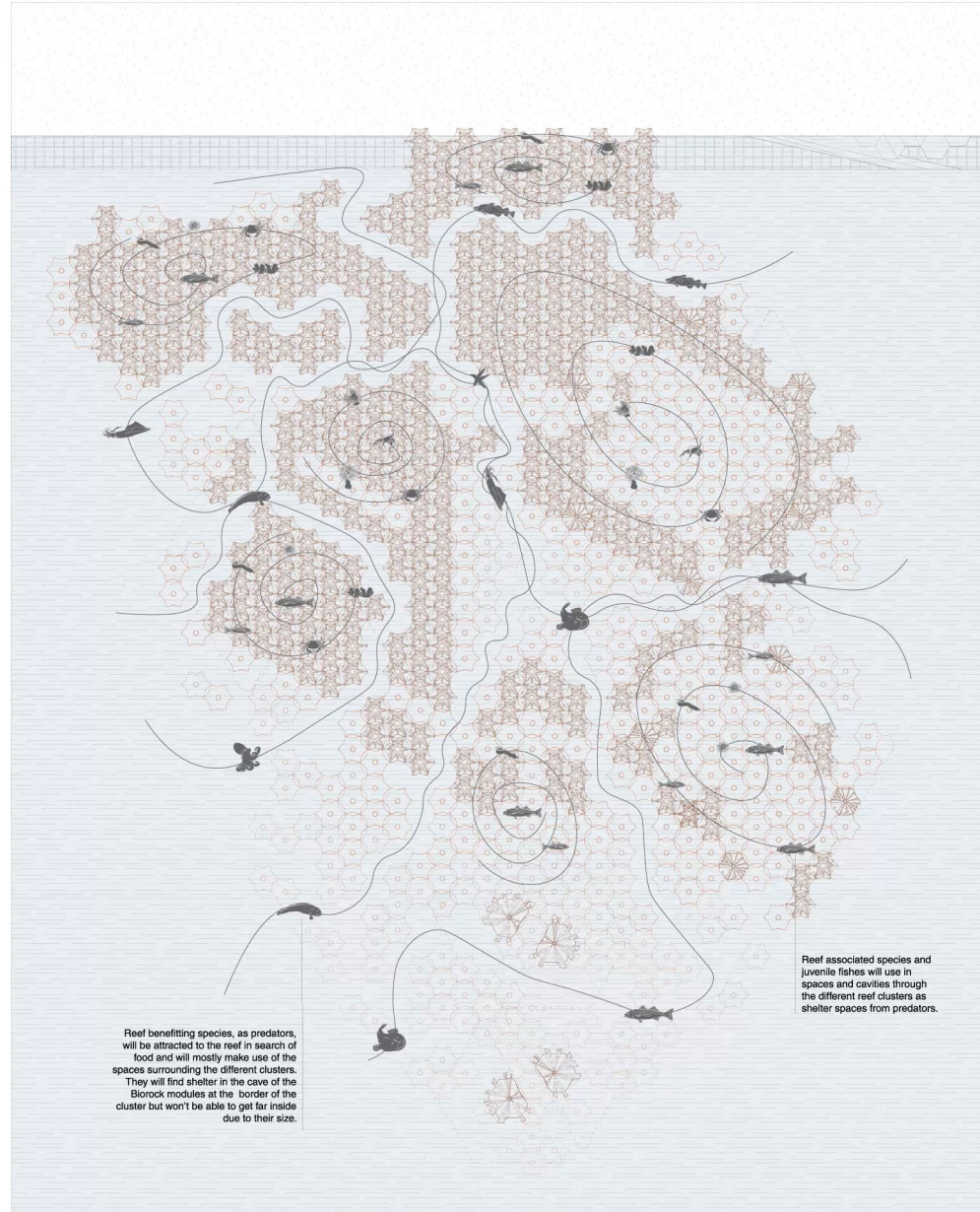
Food resources are diminishing
due to sand starvation in the Oosterschelde

Most reproduction fails are due to predators.
Birds are therefor seeking for a safe area to nest

Coastal bird species



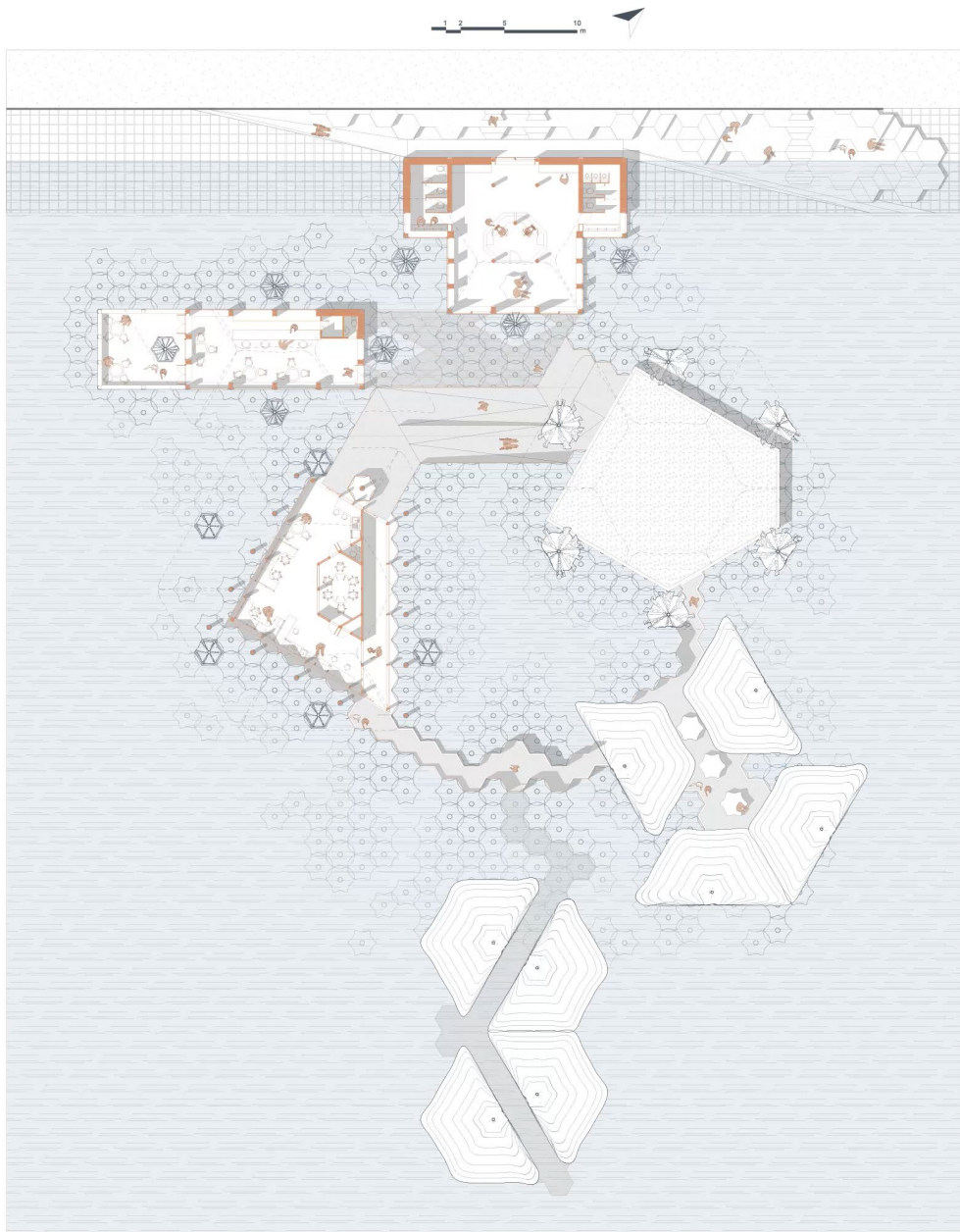
Modular Biorock ecological column element



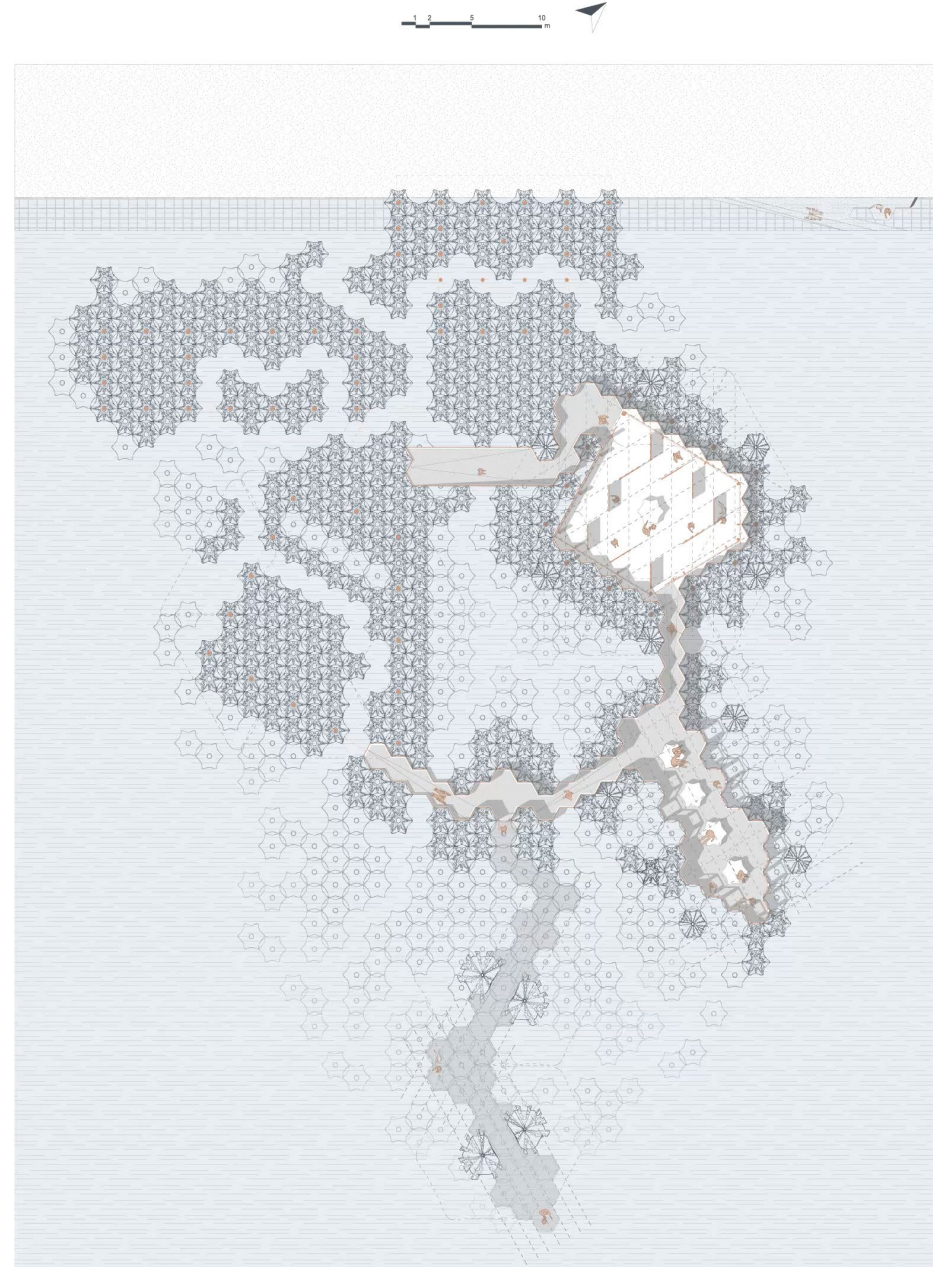
Reef benefiting species, as predators, will be attracted to the reef in search of food and will mostly make use of the spaces surrounding the different clusters. They will find shelter in the cave of the Siercock modules at the border of the cluster but won't be able to get far inside due to their size.

Reef associated species and juvenile fishes will use in spaces and cavities through the different reef clusters as shelter spaces from predators.

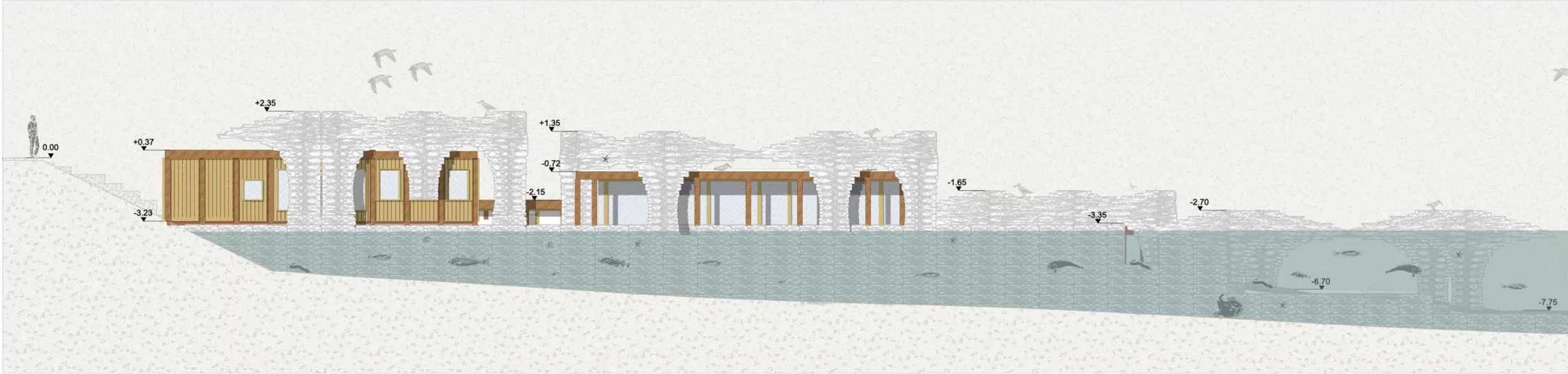
Reef design floorplan



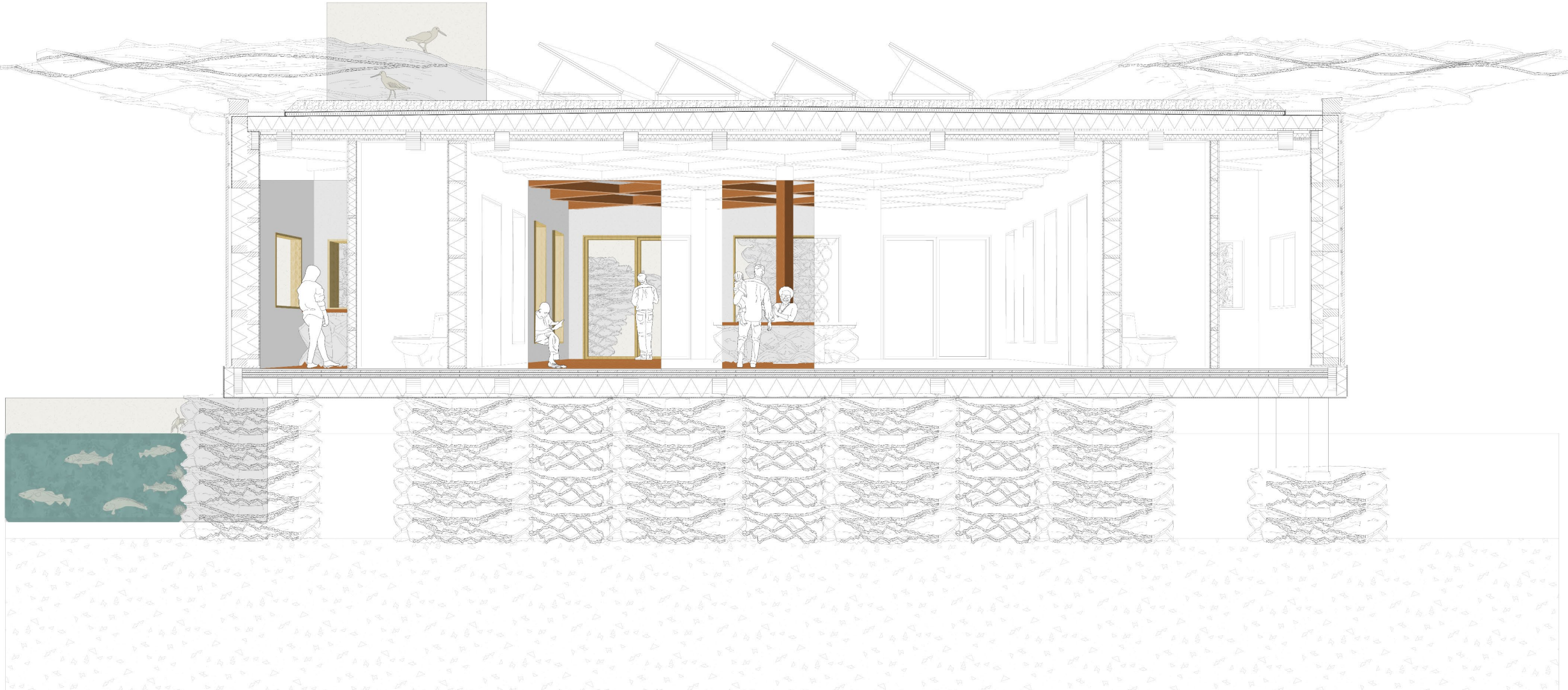
Architectural design upper pavilions

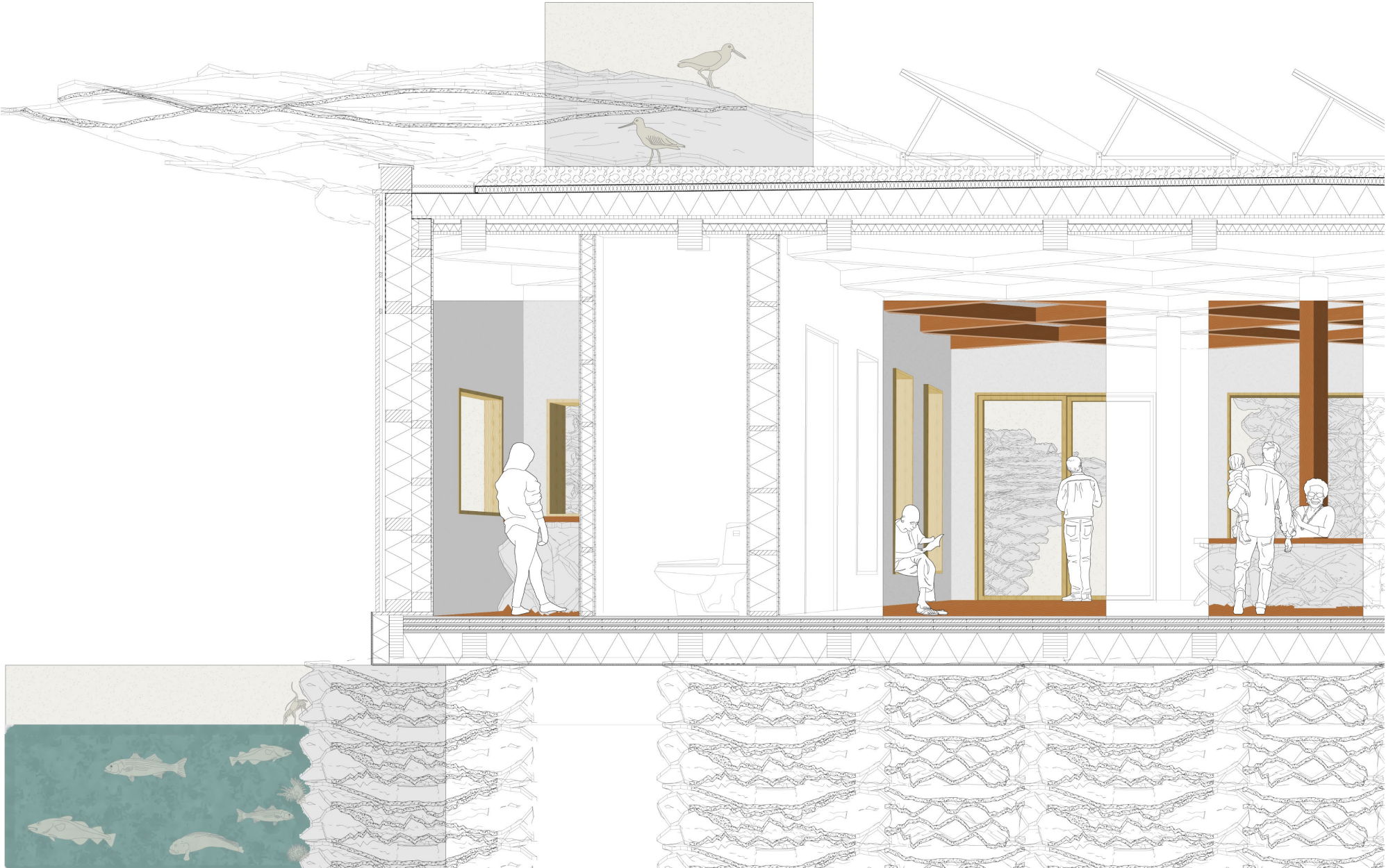


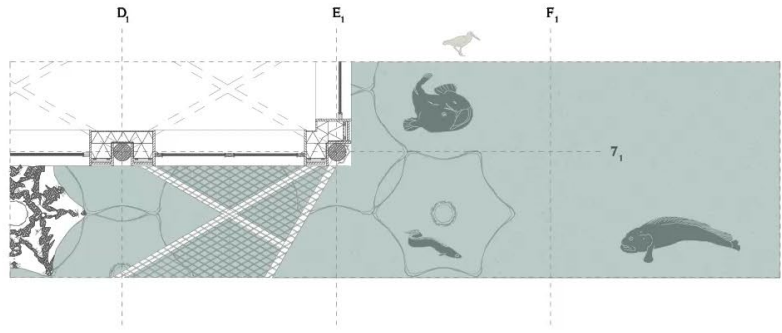
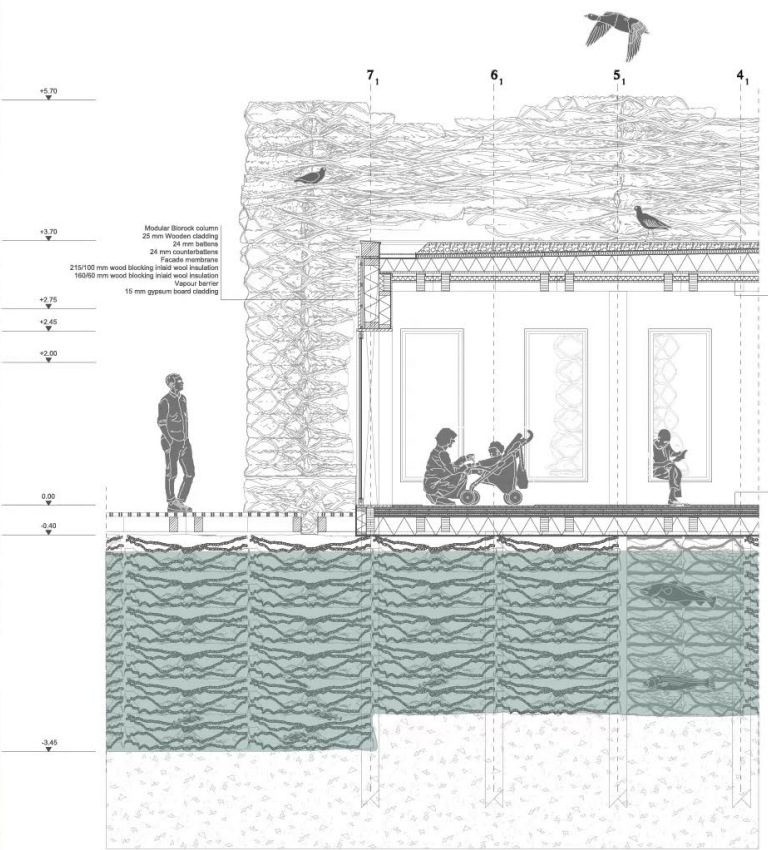
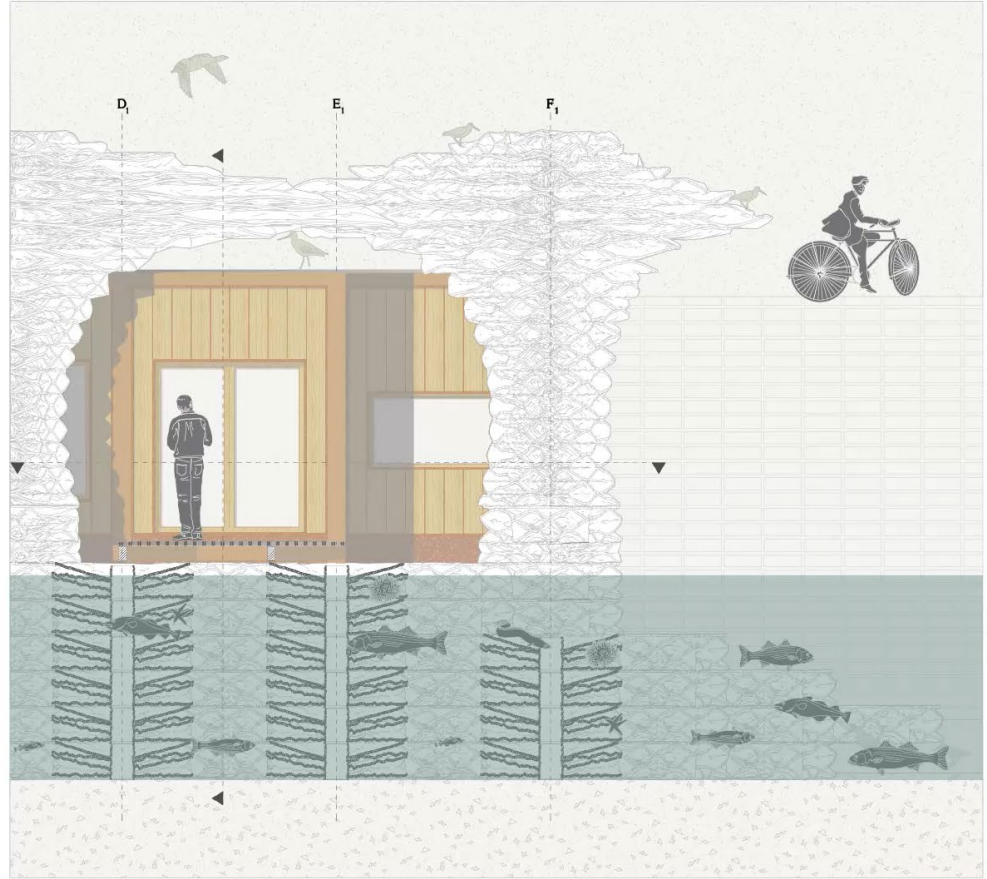
Architectural design lower pavilions



South-West Elevation

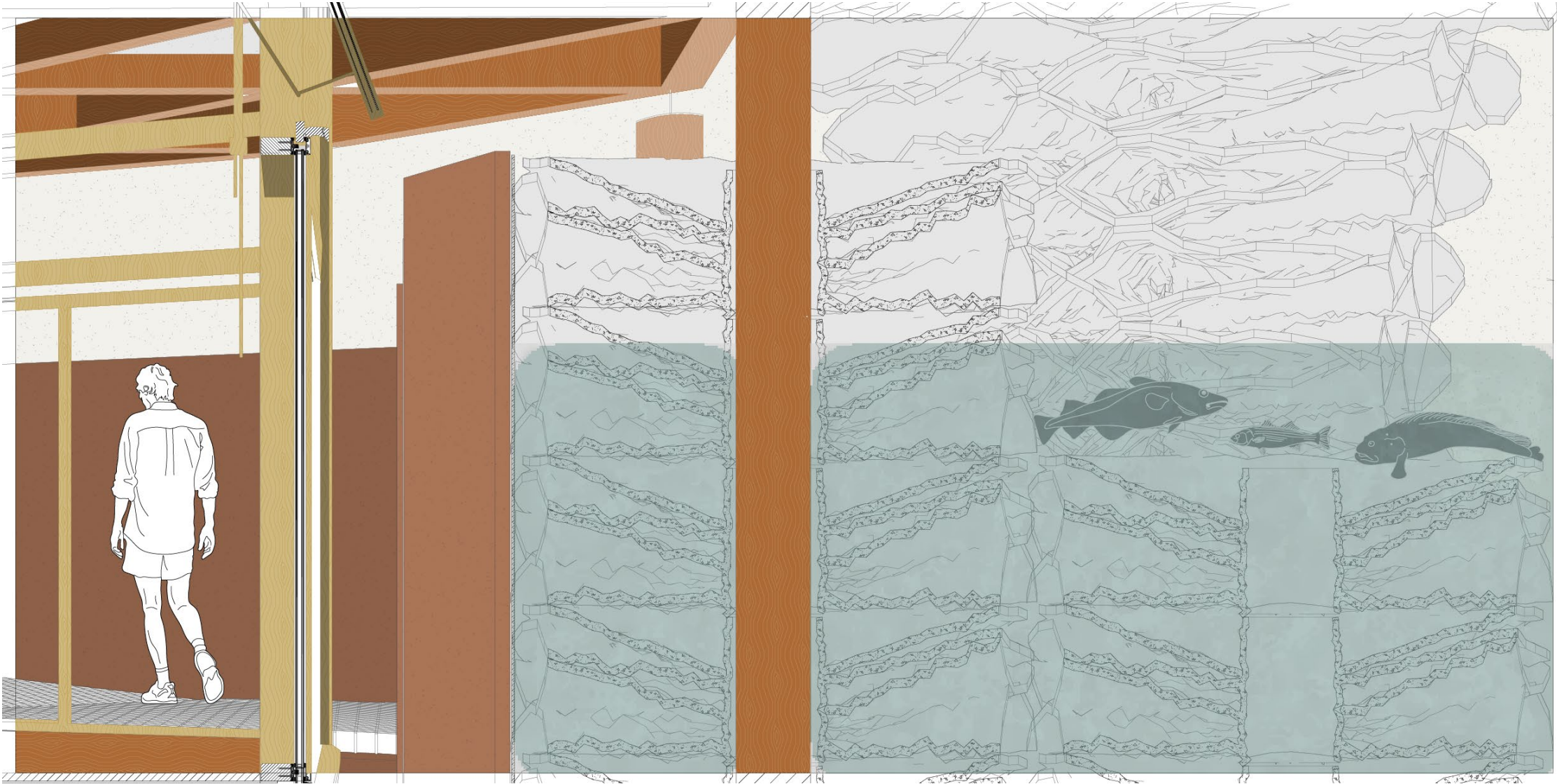


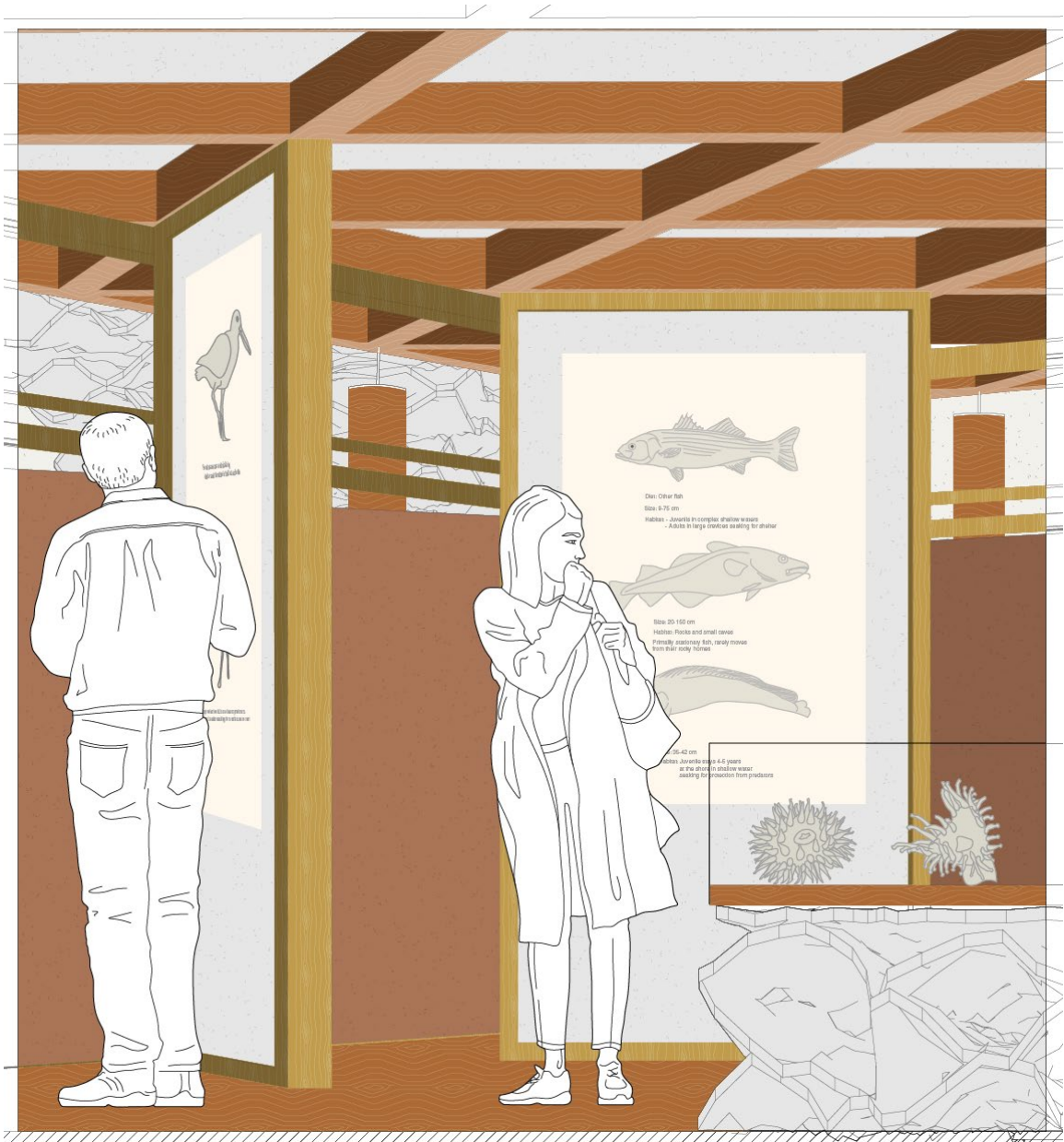


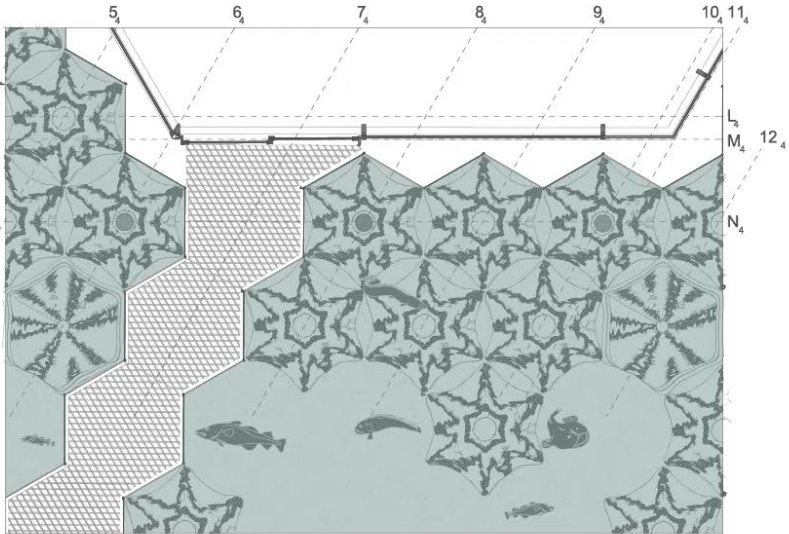
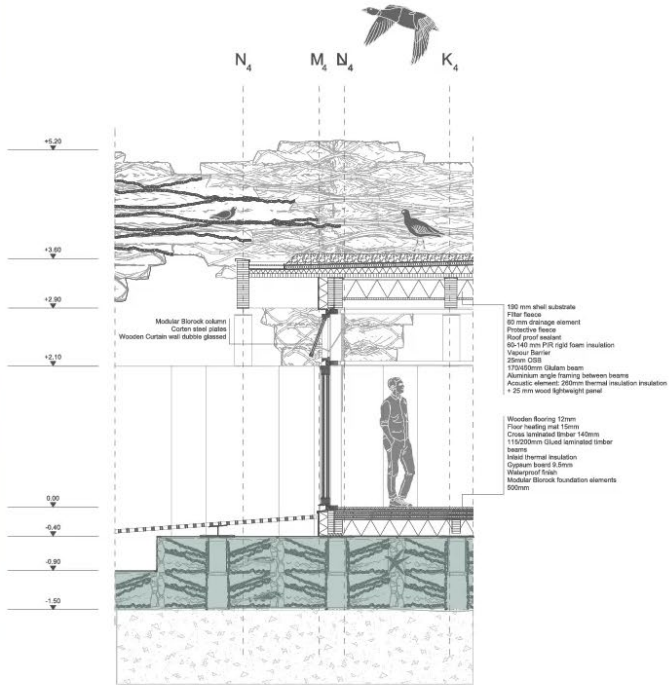
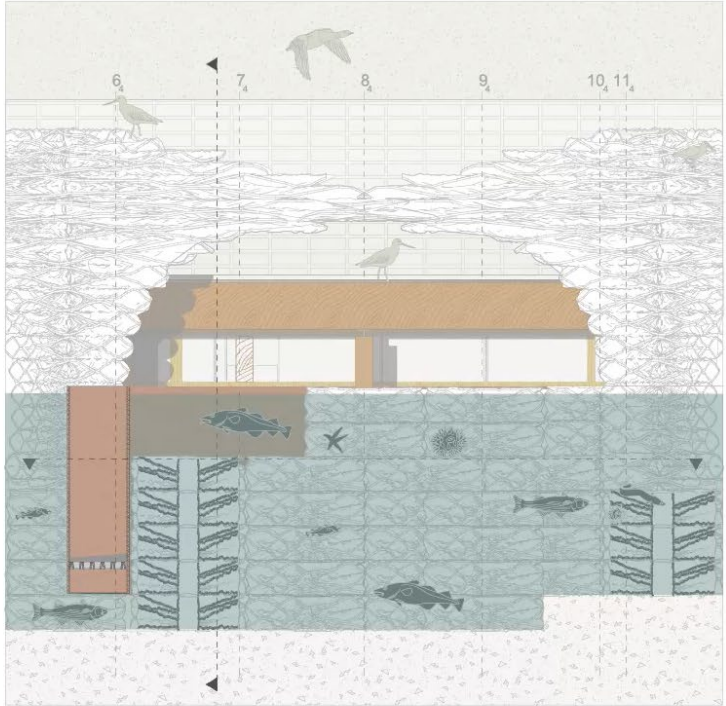


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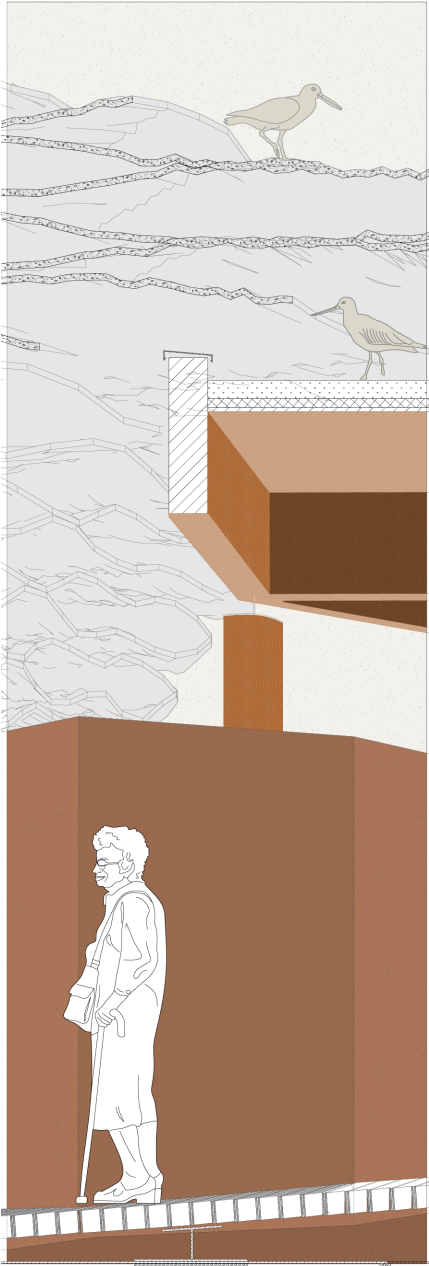


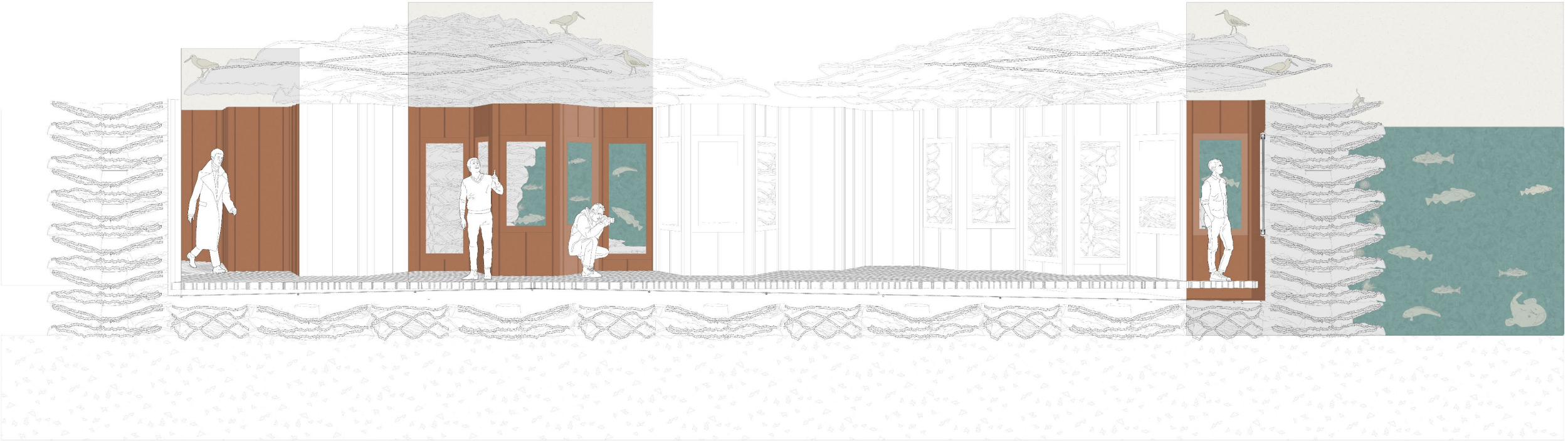


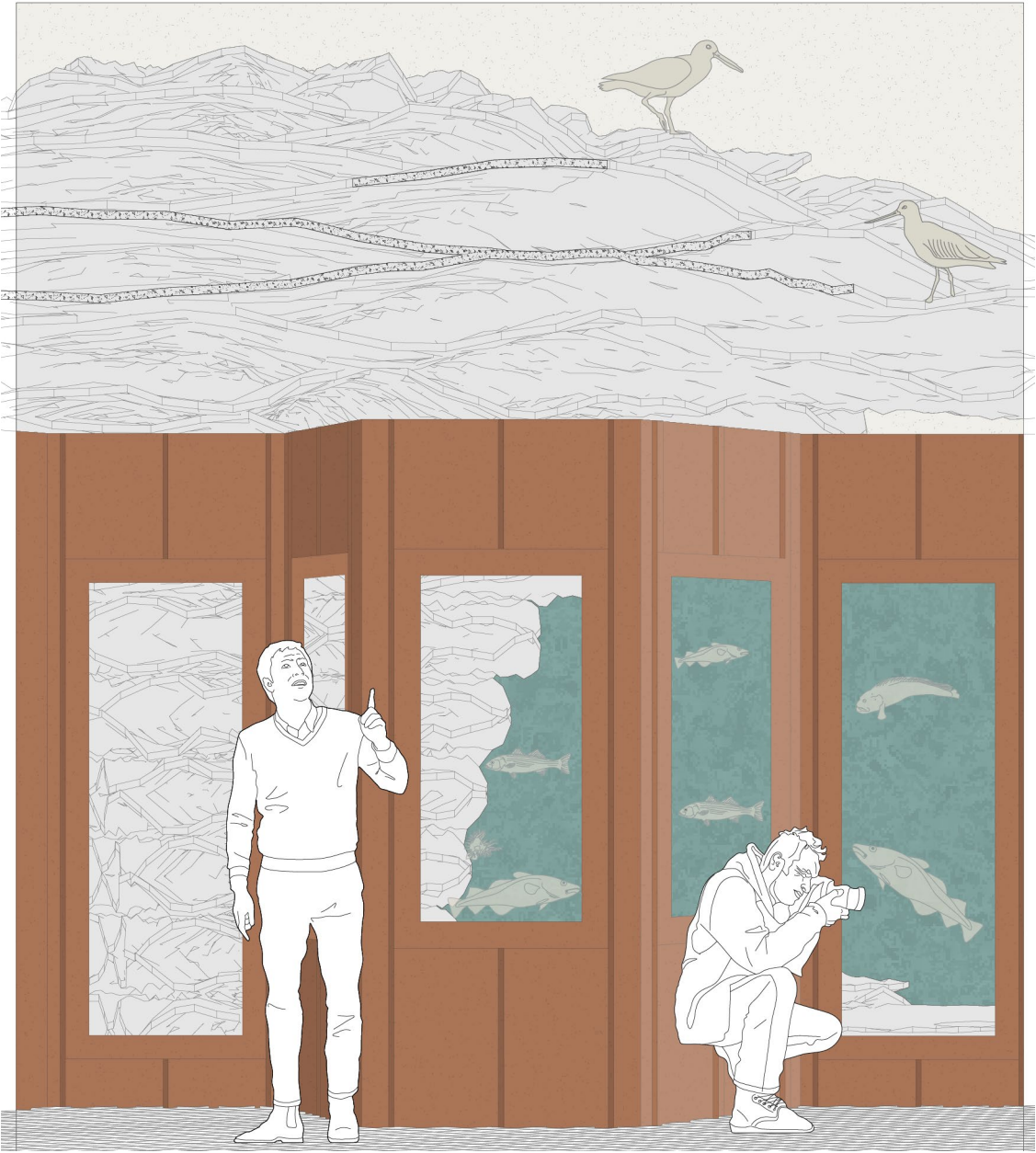


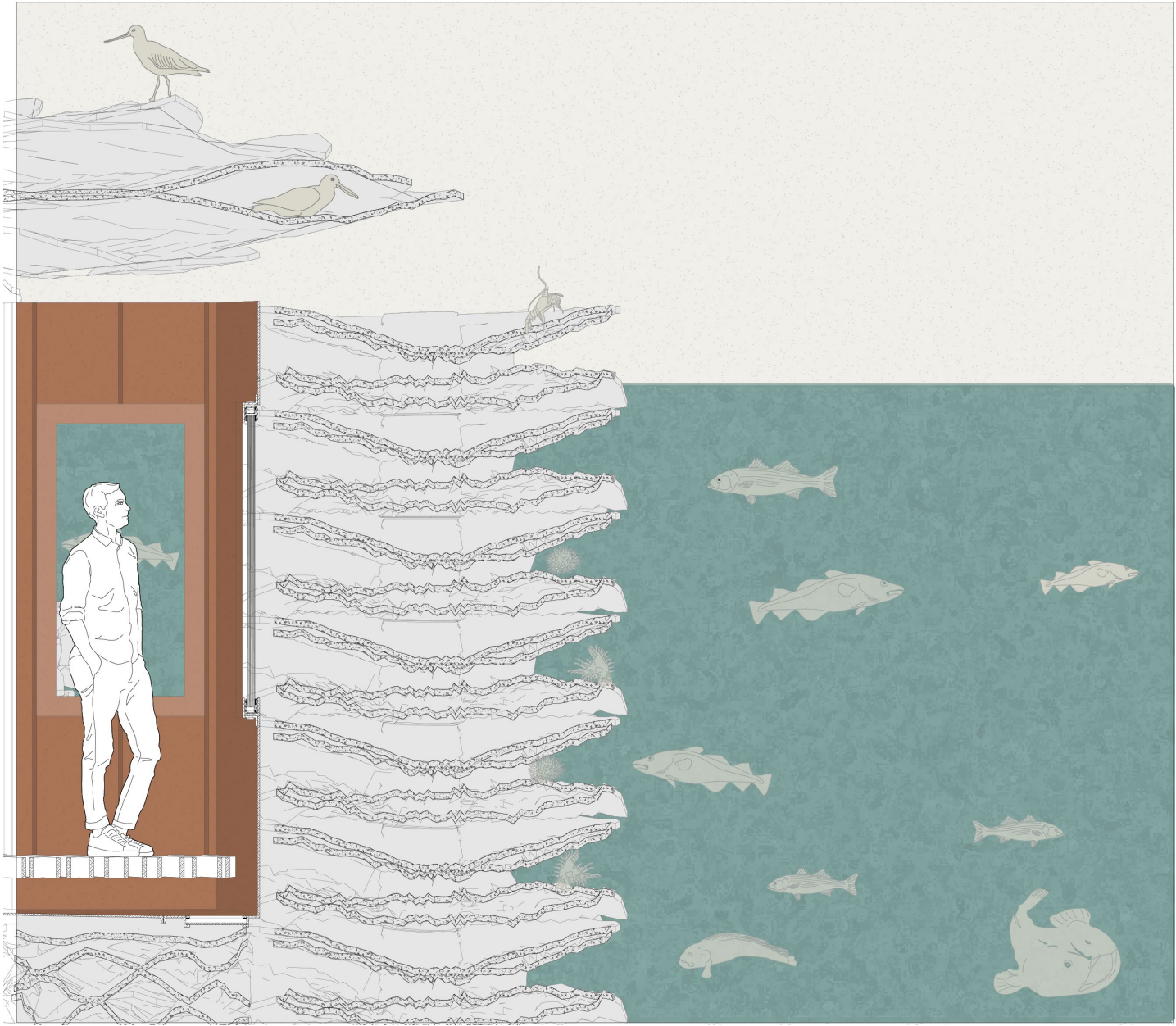


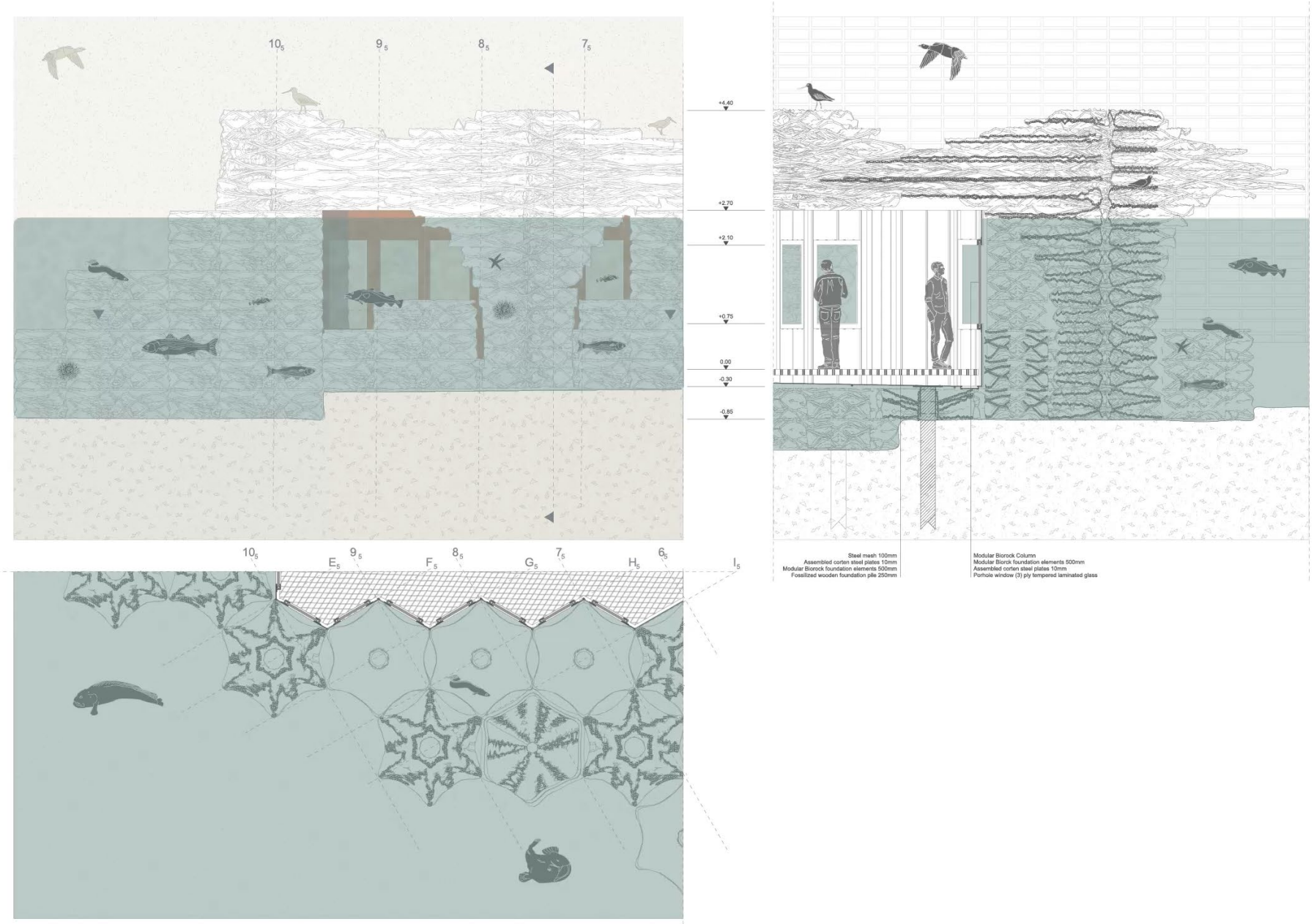
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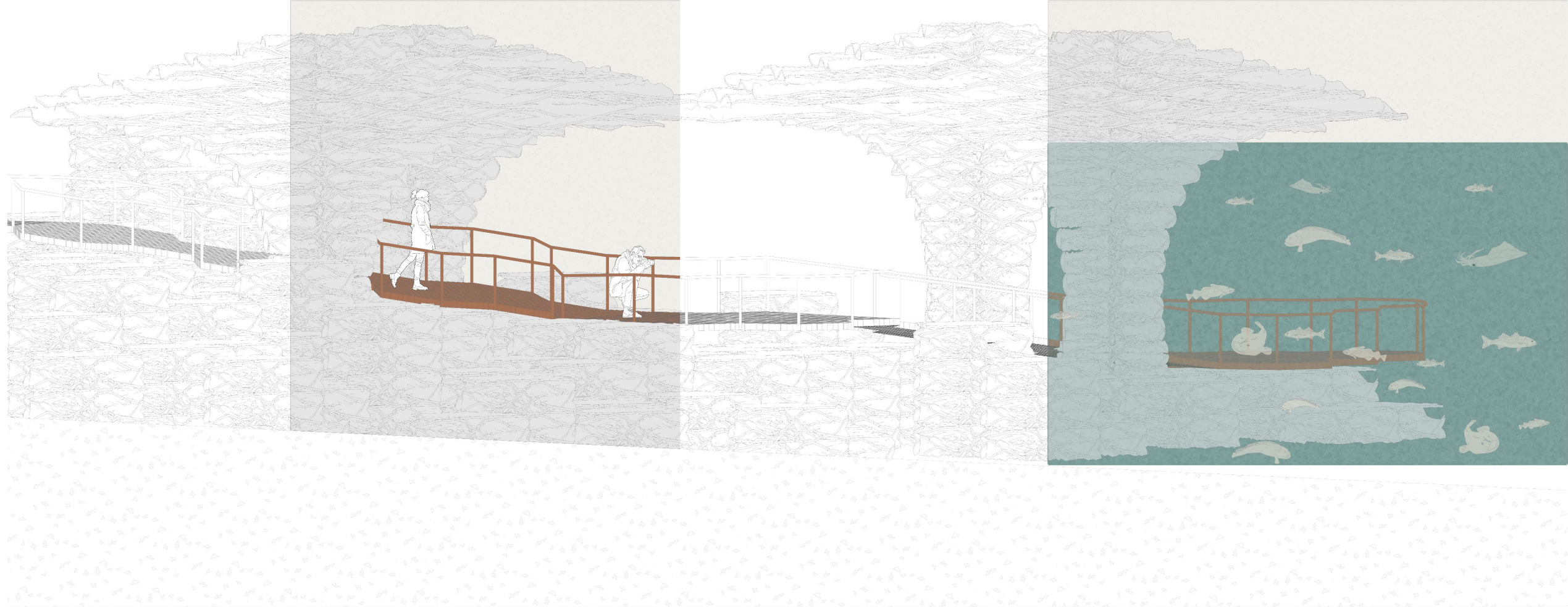




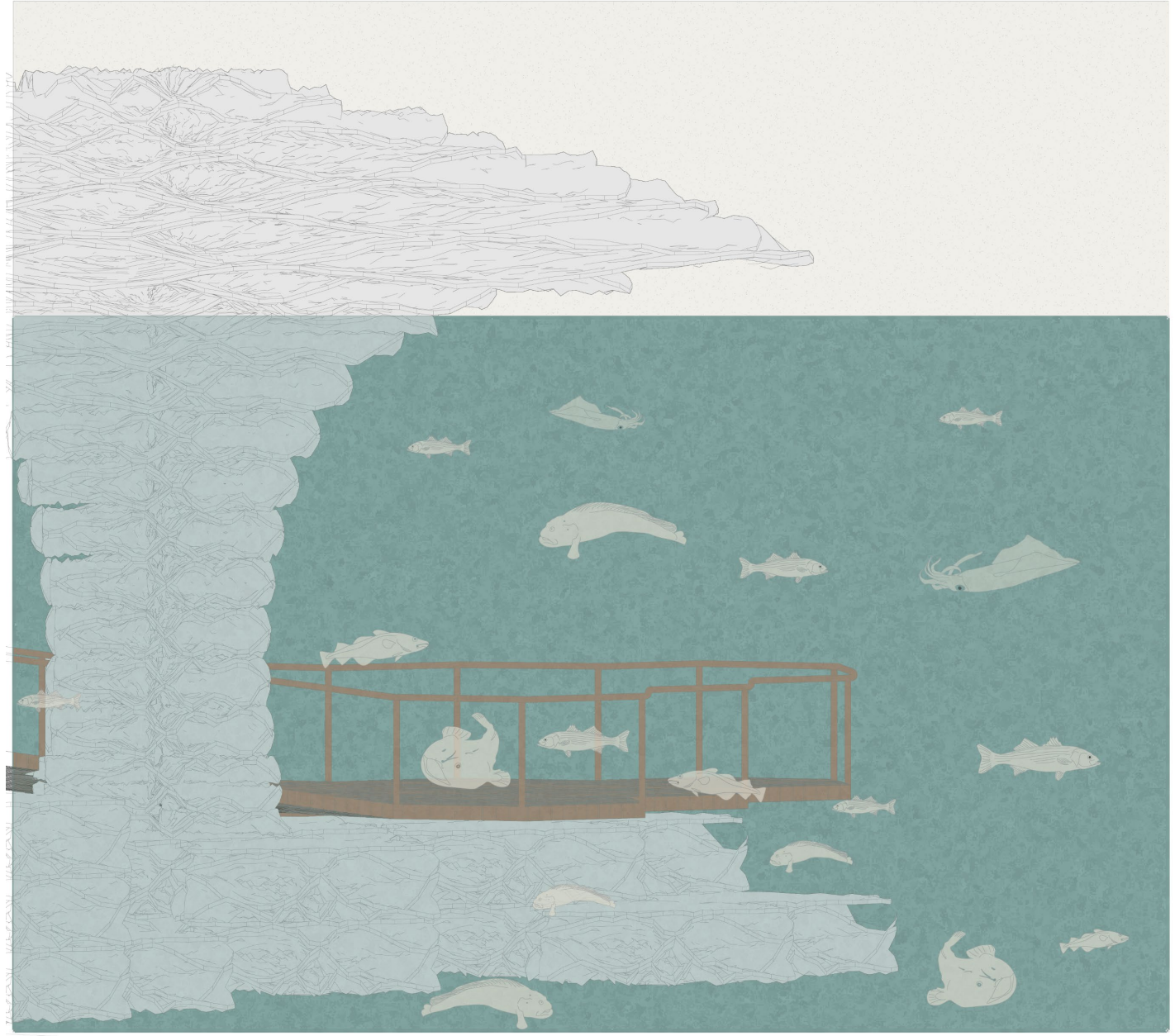


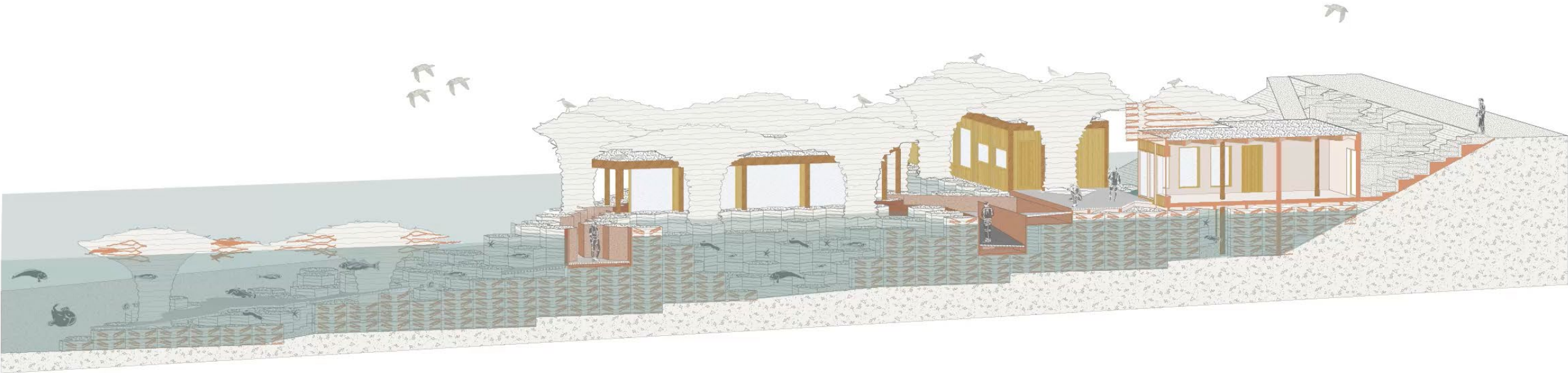


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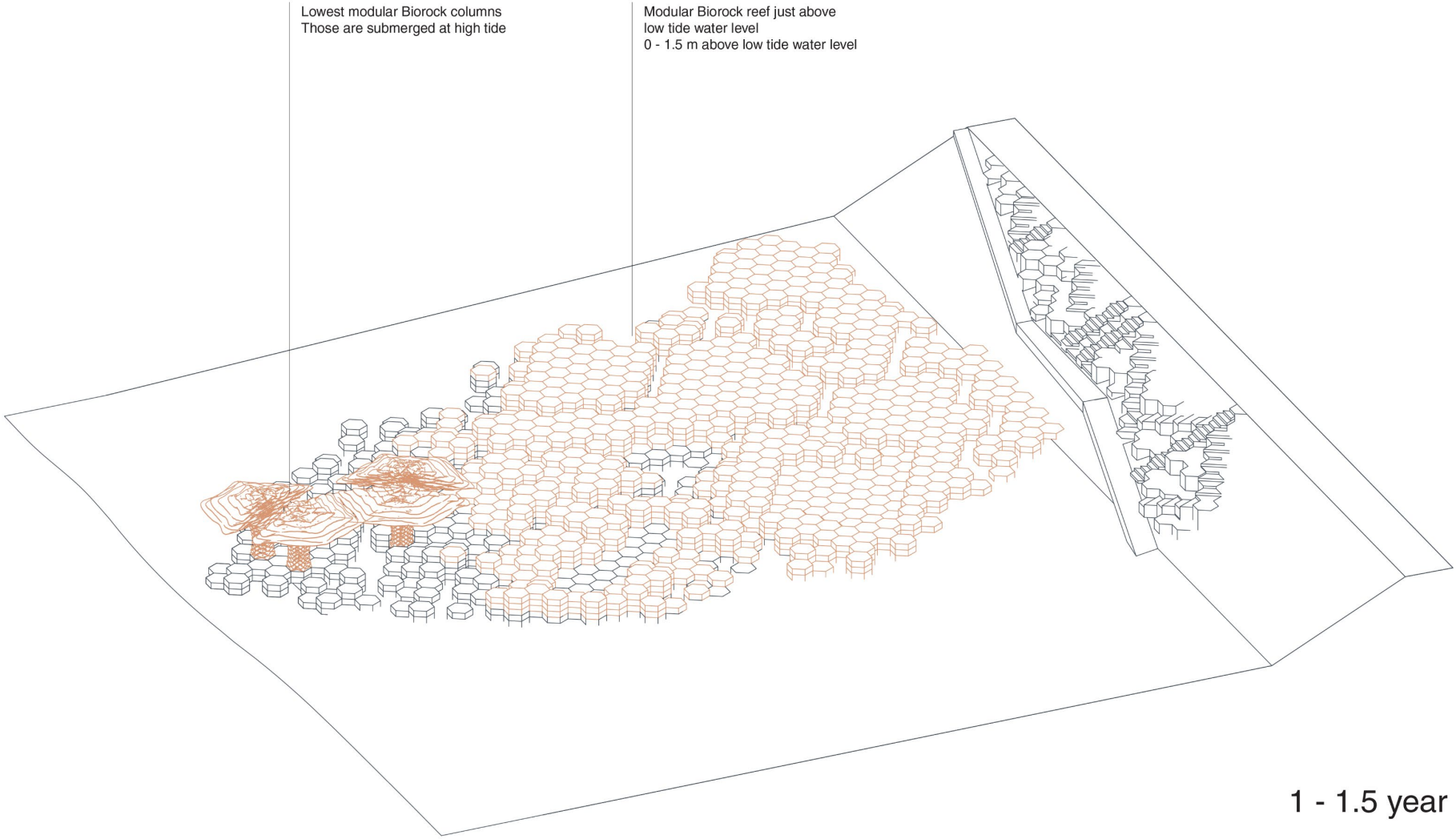


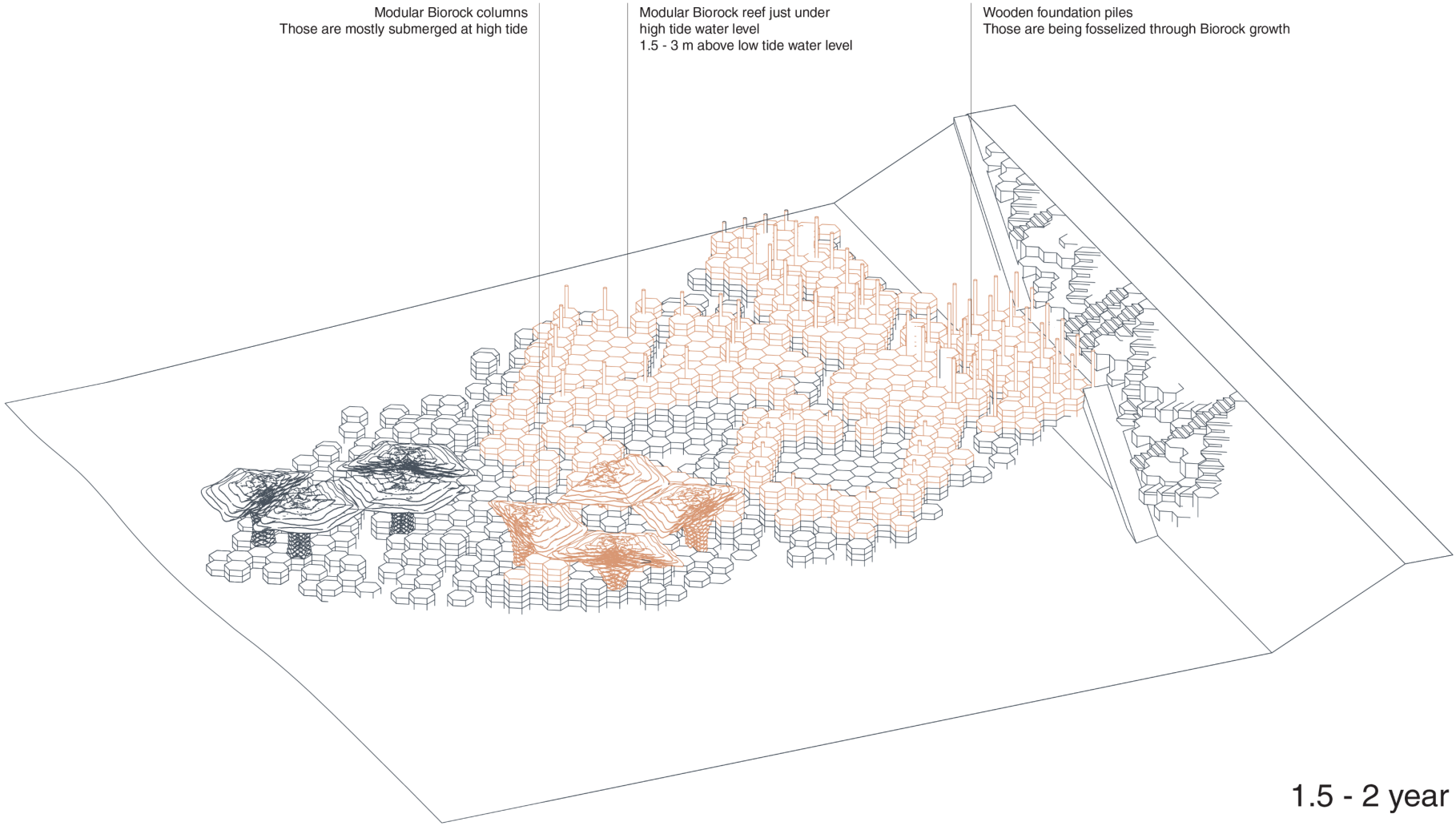


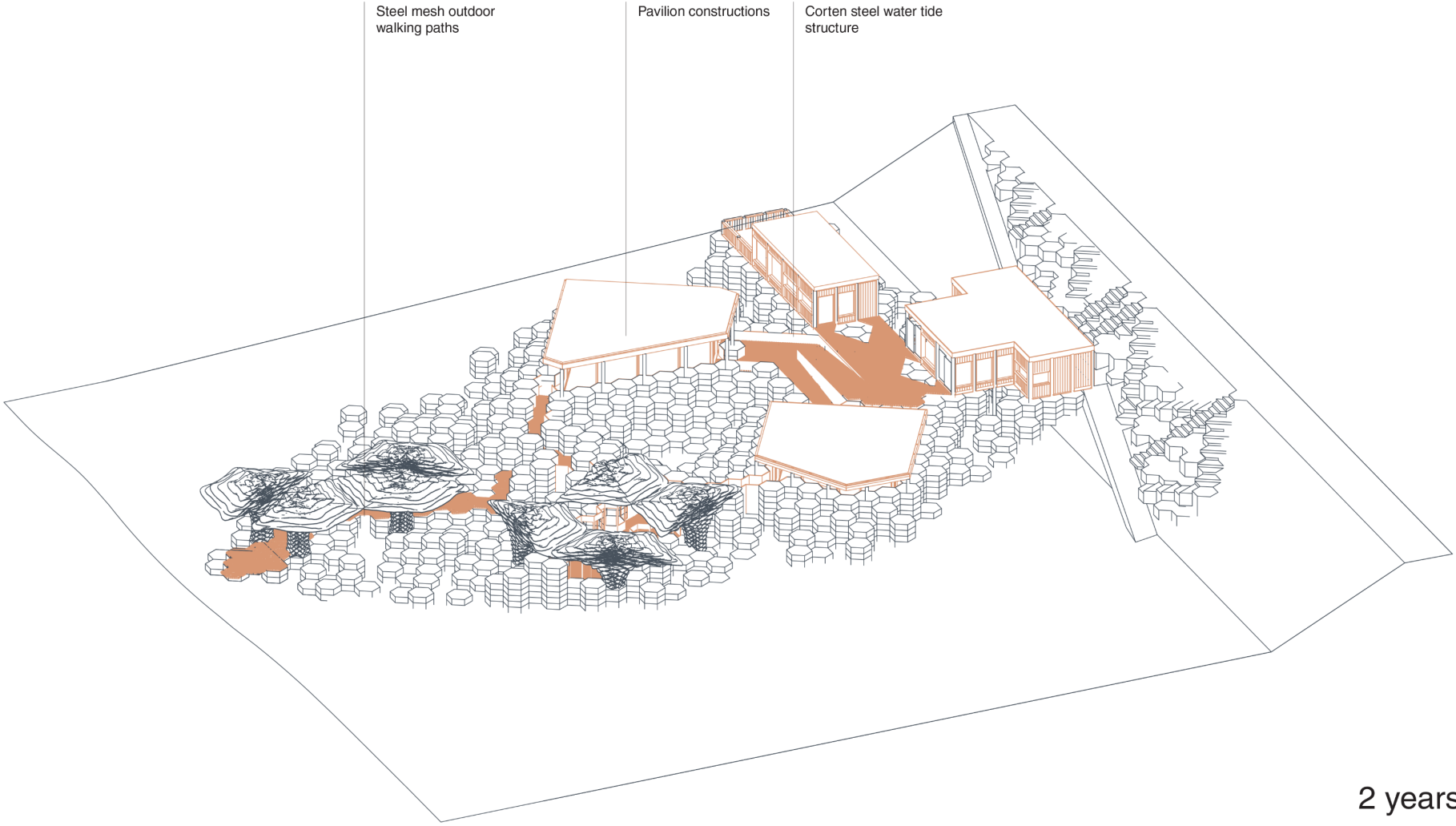


Section

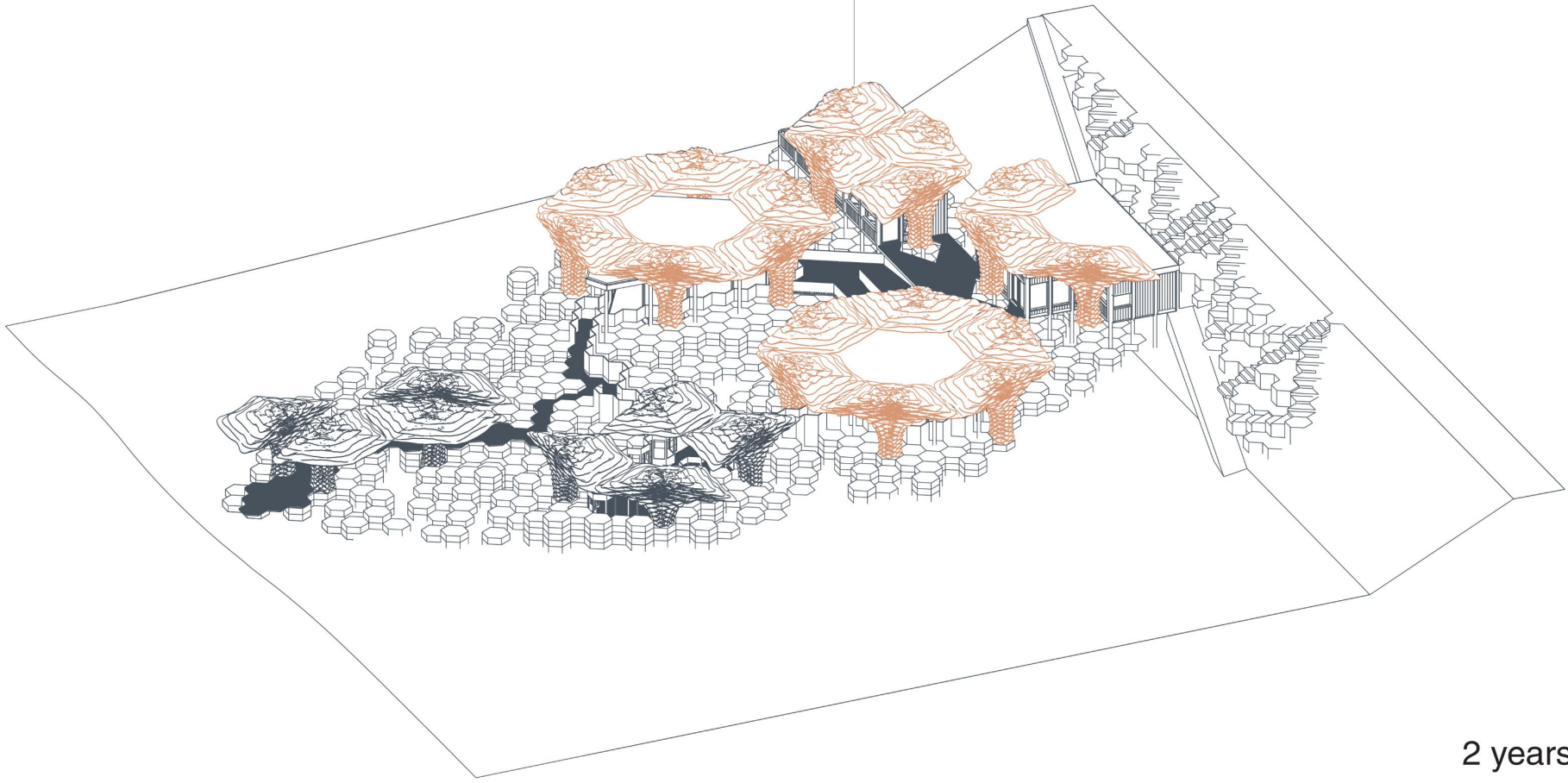






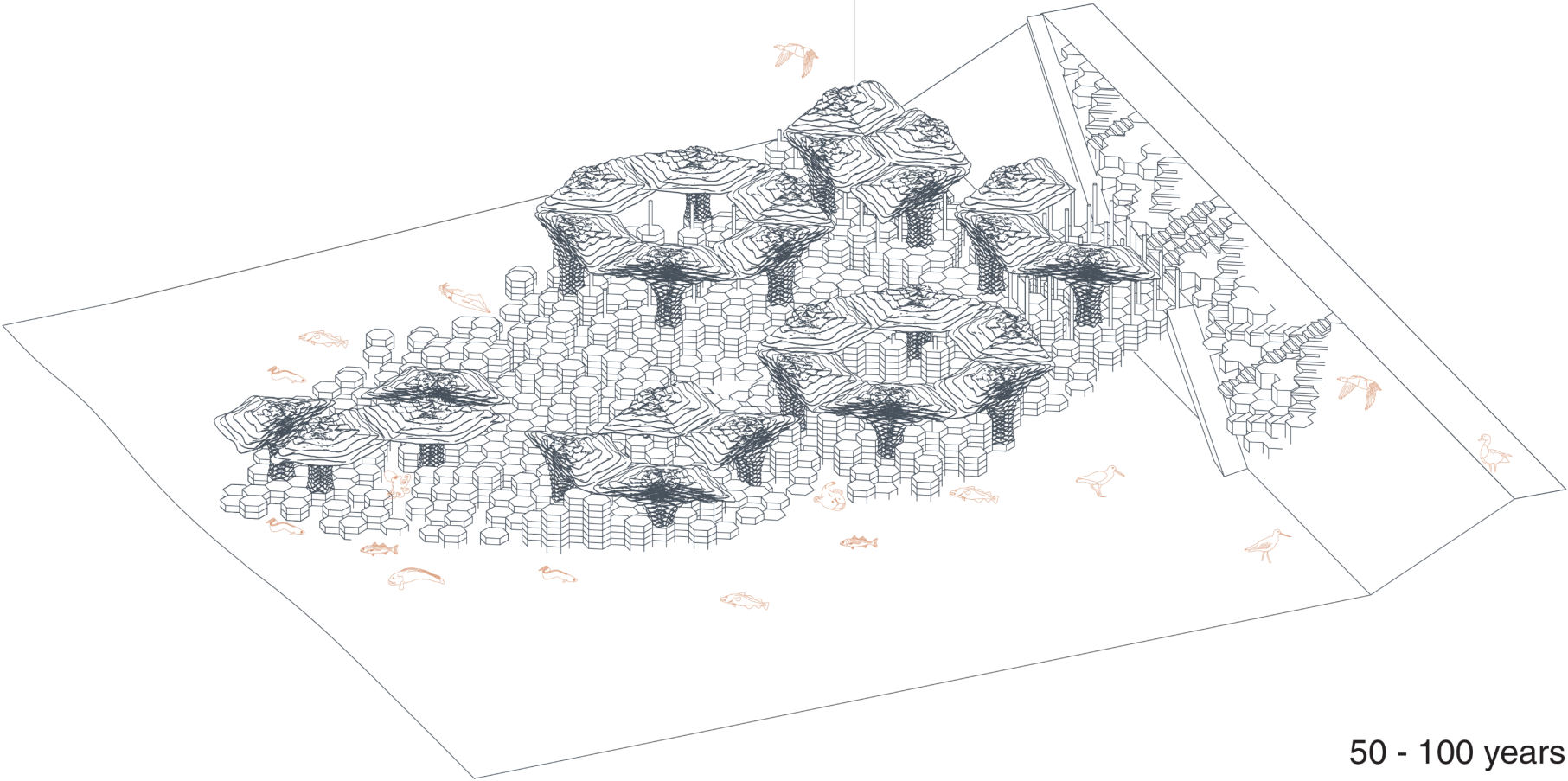


Modular Birock columns
Placed around the constructive pavilions
Those are partially or fully above high tide water level

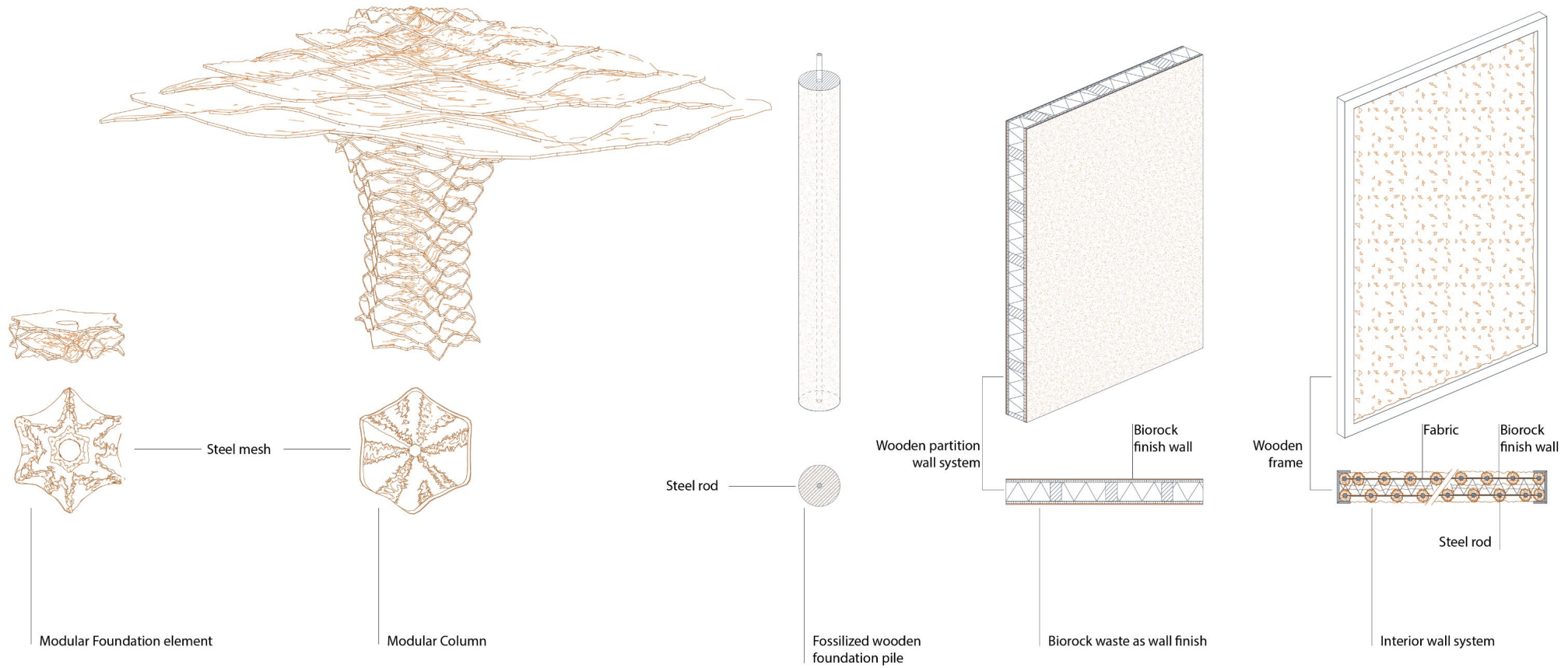


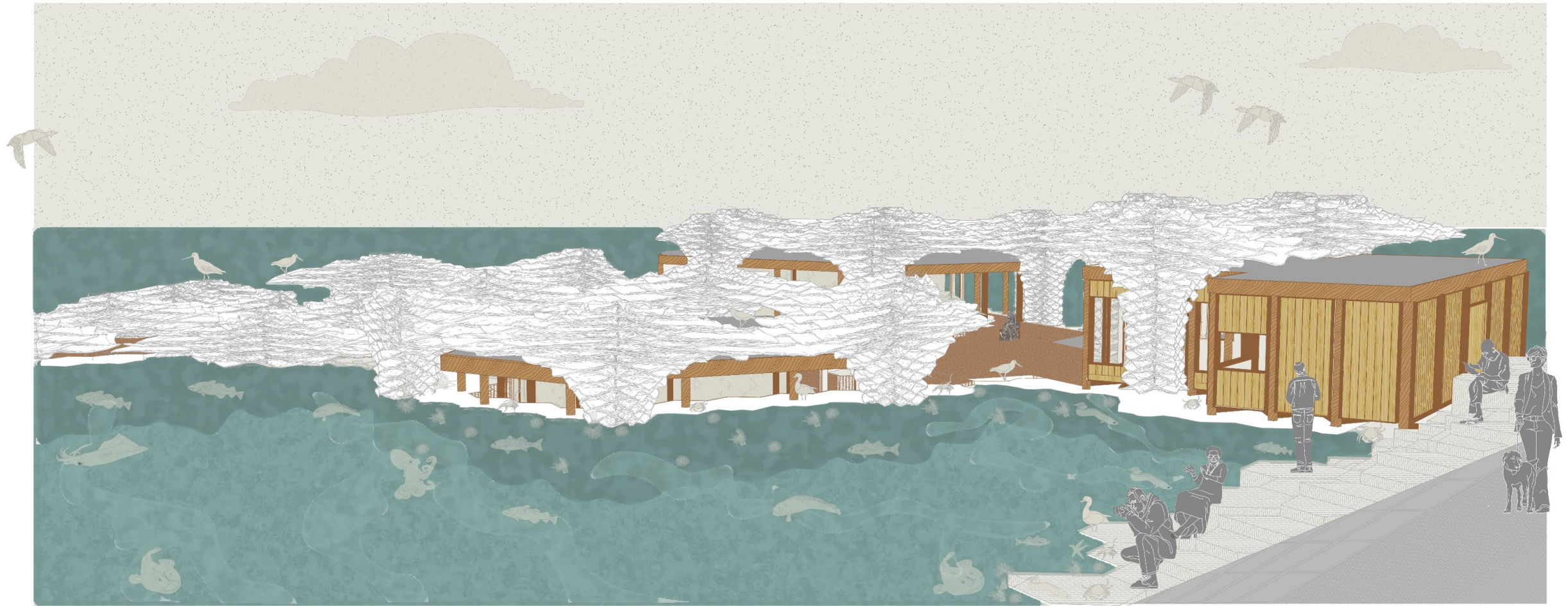
2 years

All constructions for human use are removed
The project is fully used as a reef by coastal ecosystems



50 - 100 years





Ôde à la mer

A project where Biorock creates a living interface, blurring the boundary between human and marine ecosystems.



Ôde à la mer

A4 Presentation | Prune Wassenaar | 5499933

Master of Architecture

Geert Coumans | Marcel Bilow

16.06.2025

Ôde à Patrick Mouton