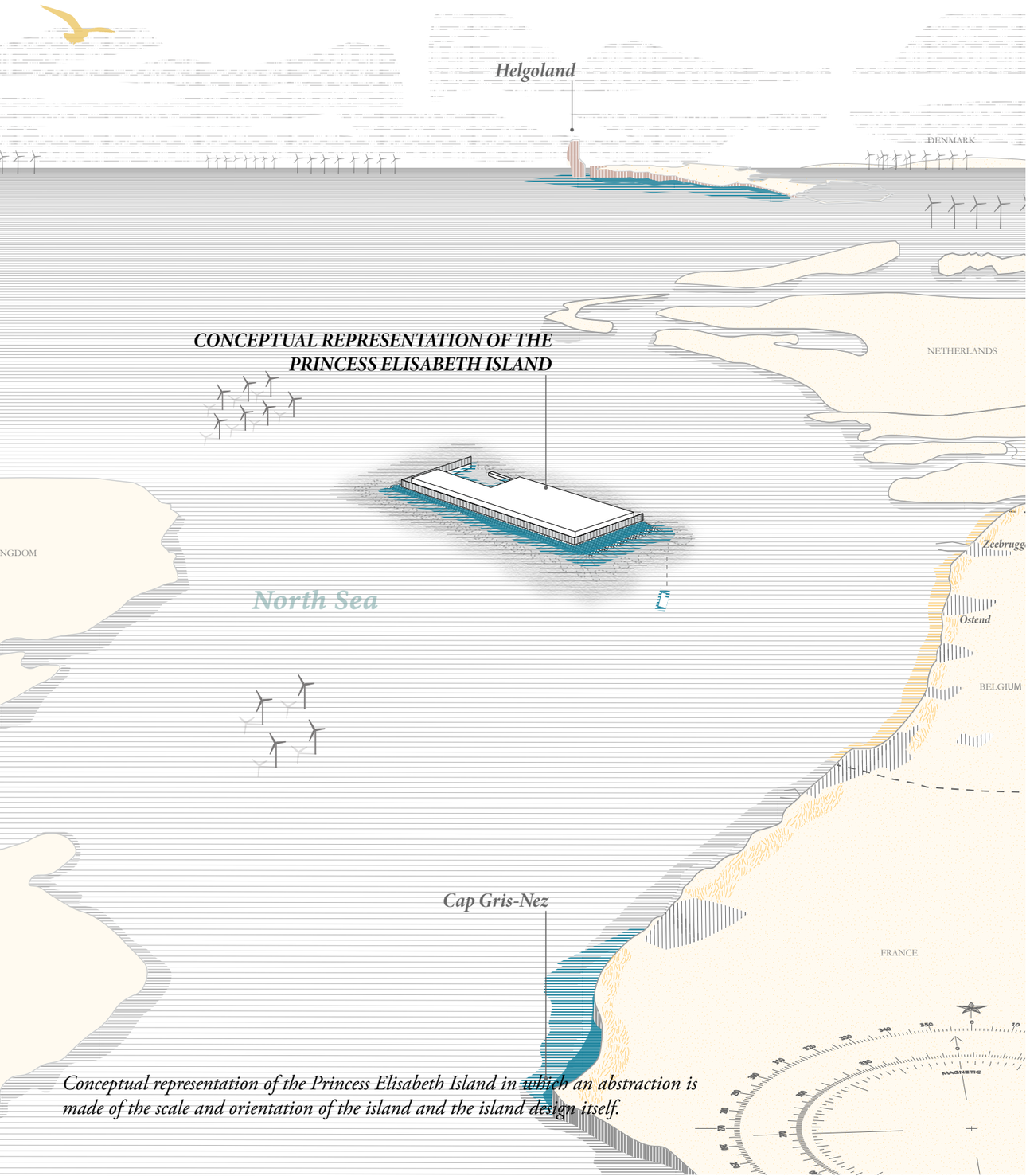

elia
Elia Group
CO-CREATION PROJECT
NATURE INCLUSIVE DESIGN
Princess Elisabeth Island



Conceptual representation of the Princess Elisabeth Island in which an abstraction is made of the scale and orientation of the island and the island design itself.

CO-CREATION PROJECT

NATURE INCLUSIVE DESIGN

Princess Elisabeth Island

The Princess Elisabeth Island is subsidised by the European Union

Funded by
the European Union

The Princess Elisabeth Island presents an excellent opportunity to put Belgium on the international map, both in the field of energy infrastructure and in the field of Nature Inclusive Design (NID) of such energy infrastructures.

Particularly characterised by a sandy coast and seabed with accompanying ecology, the island's petrified basic infrastructure can represent a special enrichment of the ecological pallet of the Belgian North Sea - provided that it has an ambitious NID.

Like a Helgoland off the Belgian coast.

In this way, the Princess Elisabeth Island will not only form a node in a European energy network, it will also have the potential to form a node within an ecological network that spreads across the North Sea.

elia Elia Group ORG MANTIS CONSULTING

Helgoland

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"For an 'island made of hard substrate', the intertidal area of Helgoland is the inspiration."

"The more gradual the slope in the intertidal zone and the more intertidal pools, the better."

INTRODUCTION

Spread over six workshops - from March to October 2022 - experts were invited to contribute to a Nature Inclusive Design (NID) strategy for the future Princess Elisabeth Island. This resulted in ten recommendations, three models and a wide range of options. These recommendations focus explicitly on the ecological added value of NID. Ideas about mitigating any negative effects during the construction of the island are part of the Environmental Impact Assessment procedure. In the context of this NID co-creation project, experts mainly expressed their views about nature. The starting point was the island design proposed by Elia. During the later 'Detailed Design Phase' - in the course of 2023 - the technical and economic feasibility of the proposed NID measures will be explored in more detail.

During the co-creation process, the Framework of Ambitions and Preconditions were first detailed together. Taking maximum account of these frameworks, three NID models - with increasingly higher NID ambition - were examined in a co-creative spatial manner and ecologically refined. Finally, the three models were evaluated for their relative ecological added value. The ten recommendations are based on the research carried out during the six workshops. This paper concludes with the various NID elements that make up the models.

"Achieving sufficient scale in combination with a diversity of habitats and long-term stability are guiding principles in the NID design."

DEFINITION OF NATURE INCLUSIVE DESIGN

"Options that can be integrated in, or added to, the design of an anthropogenic structure with the aim to enhance ecological functioning" (source: Renewables Grid Initiative)

Co-creation Princess Elisabeth Island

“The intertidal area is particularly attractive to young fish as a nursery and shelter.”

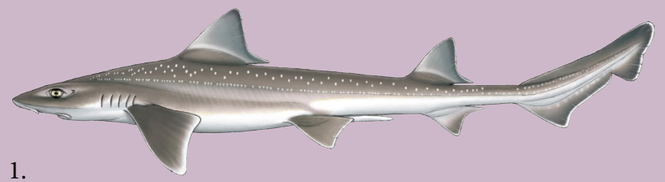
RECOMMENDATIONS

1. The Princess Elisabeth Island has the potential to be nature-enhancing. The expert group recommends that maximum efforts should be made to strengthen nature and it recognises that particular elements can contribute to the federal government’s North Sea nature restoration plan.
2. The expert group recommends that maximum use is made of ‘Nature Inclusive Design’ (NID) on the seabed, in the subtidal, intertidal and supratidal areas, with attention always paid to the functions of reproduction, shelter and foraging. The group therefore defined a basis scenario to guarantee ecological relevance (NID+). Starting from there, two other scenarios were developed with more mature ecological benefits (NID++ and NID+++). Based on these scenarios, mixed scenarios are possible; the ecological relevance of NID+ is the starting point here.
3. Interaction effects between different ecosystem components must be pursued as much as possible.
4. For the intertidal area, it is strongly recommended to aim for a nature-inspired design and to avoid smooth vertical walls as much as possible because they are ecologically less interesting. In order for a complex ecosystem with large predators to function, there is a need for sufficient surface area; here the experts speak in terms of hectares. On the basis of the best available knowledge, it is strongly recommended that the surface area of the intertidal area should be maximised.
5. For the seabed, NIDs focus on increasing complexity, preferably habitats inspired by gravel beds (without using genuine marine gravel) and aiming at creating oyster beds (for European flat oyster). The long-term stability of the rock revetment is crucial for creating a stable habitat; overdimensioning of the rocks can help in this respect.

6. The Princess Elisabeth Island can become very attractive to birds. Design for birds must focus on breeding and resting opportunities. Intertidal zones for foraging are also important here. A sufficiently large approach route without obstructions (the cable corridors) and sufficient distance between the wind turbine blades and the sea surface (the new generation of wind turbines meets this requirement) are important preconditions.
7. For the development of a positive public narrative, 'sufficiently large surface areas in combination with visible effects of NID' and 'making these effects visible' are important. This must always be based on scientific knowledge and this calls for a high level of ambition.
8. There is a need for accompanying scientific research with continuous scientific monitoring of the NIDs on and around the Princess Elisabeth Island in order to achieve a continuous knowledge build up. This must enable Belgium to claim intellectual and economic market leadership with regard to the NID of (energy) islands.
9. The expert group is of the opinion that the knowledge gathered can contribute to NID development in various infrastructure projects in the North Sea and it calls for this knowledge to be made available to the public as much as possible.
10. The various NIDs postulated will be applied as much as possible at the start. Since, on and around the Princess Elisabeth Island, preference will be given to long-lived species – for which the disturbance must be minimal – it is only useful for several NID elements to install them in a later project phase. A smart, zoned phasing of the implementation of the various NID elements must be elaborated.

"The attraction of (top) predators is necessary in order to structure the ecosystem and keep it dynamic."

1.



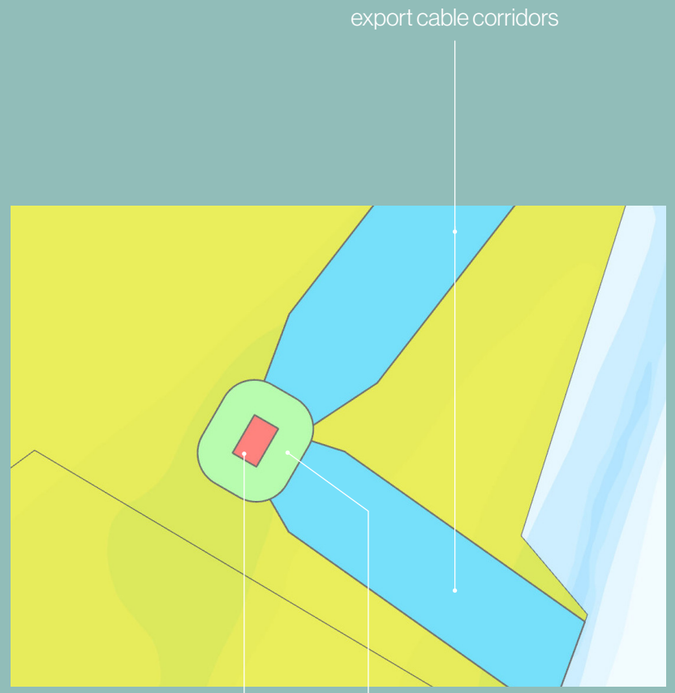
2.

3.

4.

5.

1. Mustelus asterias (Starry Smooth-hound Shark) - 2. Scyliorhinus canicula (Lesser-spotted Dogfish) - 3. Scyliorhinus stellaris (Greater-spotted Dogfish) - 4. Squatina squatina (Monkfish) - 5. Raja brachyura (Blonde Ray)



FRAMEWORK OF AMBITIONS

Overall ambition

We aim to maximally facilitate rich habitats in the subtidal and intertidal zones; within these habitats we aim to facilitate rich micro habitats as much as possible.

Subambition Nature creation/extension in the subtidal zone

The NID proposals in the subtidal zone focus on nature creation and extension; gravel beds and flat oyster reefs are a source of inspiration.

Subambition Nature creation in the intertidal zone

Through NID, we also create new nature and new habitats in the intertidal zone; here we have in mind a habitat-rich intertidal landscape.

Subambition Design

In order to maximise opportunities for subtidal and intertidal habitats with associated micro-habitats, NID proposals look for heterogeneity and complexity in their design.

Subambition Birds

By providing suitable breeding, resting and foraging habitats, we have in mind the maximum utilisation by birds of the energy island - provided that there is a sufficiently broad approach route without obstructions and provided that a minimum distance between the bottom of the blade and the sea surface is respected in the choice of the wind turbines to be installed.

“The intention is to focus on rich and diverse habitats rather than species.”

PRECONDITIONS

Precondition NID surface area & Natura 2000

Maximising habitat richness on and around the energy island remains within the boundaries of the domain concession zone.

The various NID designs may not lead to additional significant negative impacts on the nearby Natura 2000 site and on other nature values in the vicinity.

In the event of the island's footprint being exceeded, the relevant authorities must be consulted.

Precondition Mitigating construction risk (timing)

The NID proposals are designed in such a way that they fit within the predetermined timing. Structural NID solutions must fit within the timing imposed by the European subsidy process; this aims at a realisation of the island structure by August 2026. NID solutions can also be added as add-ons afterwards - in function of construction phases and in order not to damage NID elements.

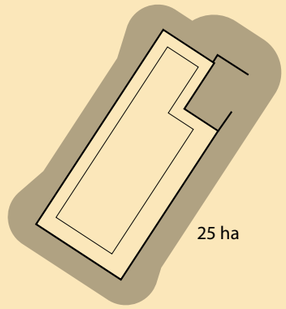
Precondition Feasibility (construction costs)

The NID proposals seek a healthy balance between the benefits for the marine ecosystem and the associated construction costs.

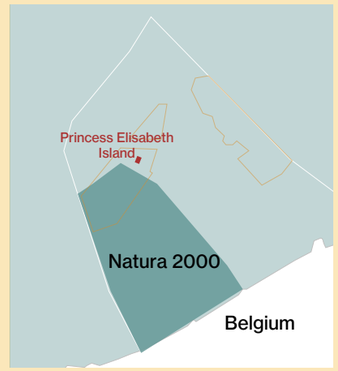
Precondition Realisation

The NID proposals are technically feasible, safely realisable and low-maintenance (preferably maintenance-free). The structure of the island is stable at all times.

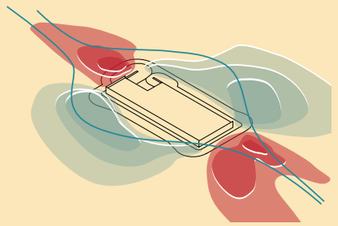
"The focus does not lie on marine mammals such as the grey seal. They will probably already be present by themselves and moreover there is no need for additional resting places."



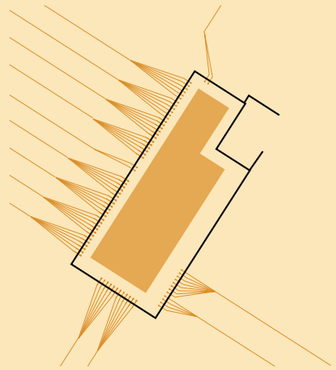
Footprint of 25 ha



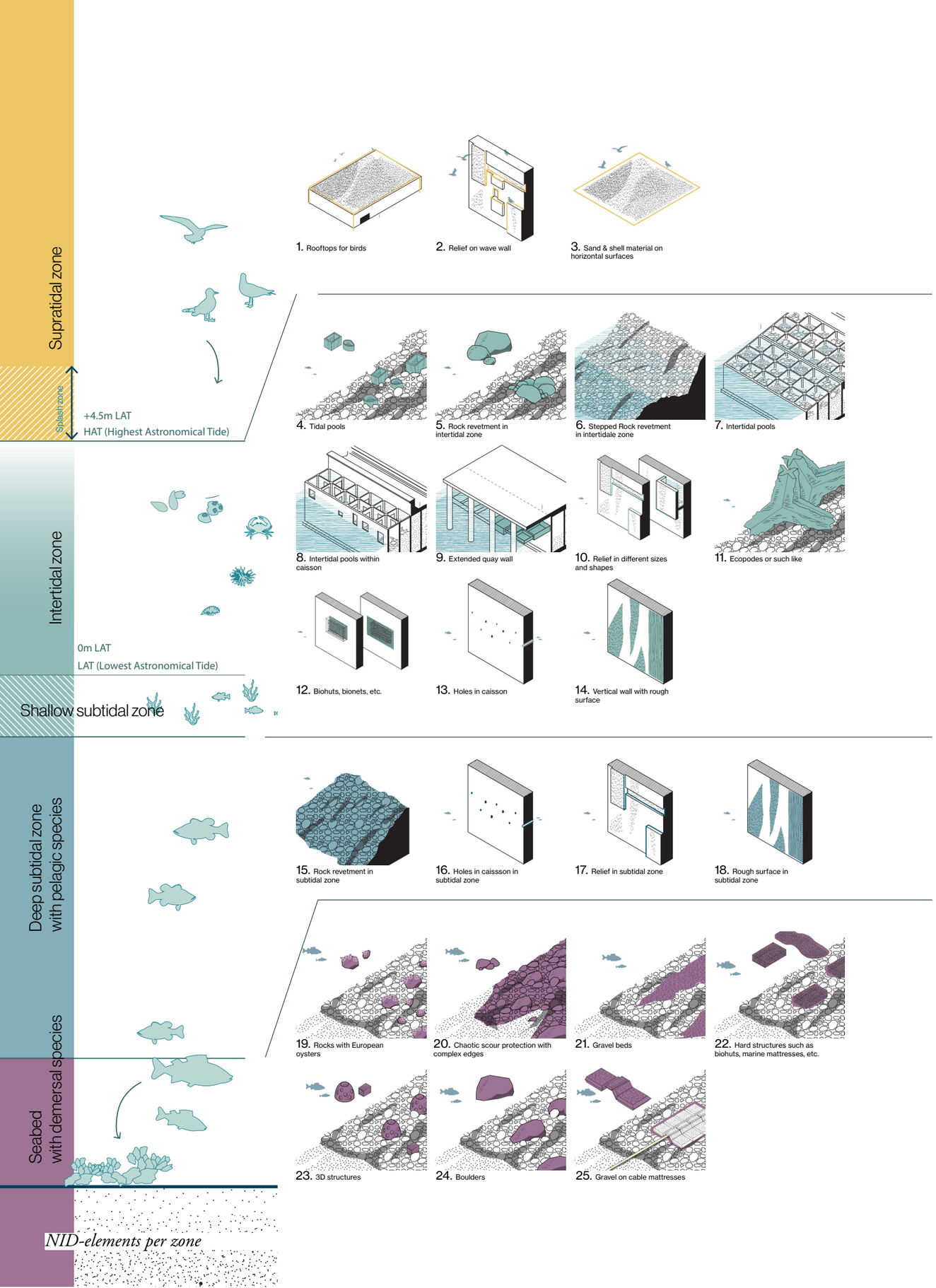
Location Natura 2000



Erosion versus sedimentation



90-95 cables



ELEMENTS FOR THE FOUR ZONES

In order to get a grip on the NID potential for the Princess Elisabeth Island, four zones were defined:

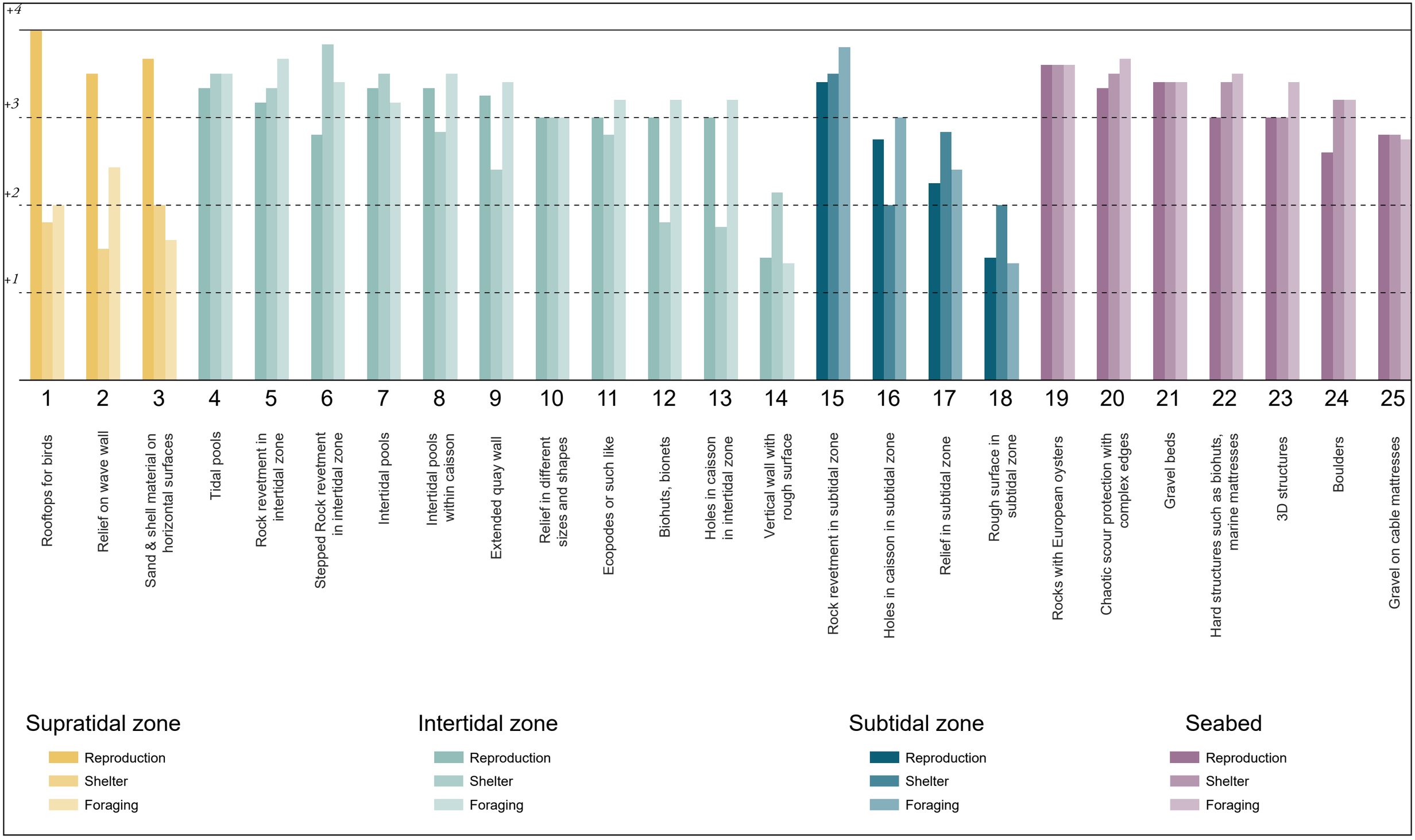
- Supratidal zone
- Intertidal zone and Shallow subtidal zone
- Deep subtidal zone with pelagic species
- Seabed with demersal species

Several potential NID elements were then examined for these zones. The drawing to the left provides a visual overview of the NID elements that were considered.

Before combining these elements into NID models, they were evaluated collectively on the basis of their contribution to ‘reproduction, foraging, shelter’ (see next page) and this in order to make efficient combinations in the next step.

On the basis of these elements and starting from the reference design, three NID models were co-creatively developed in order to explore the ecological potential of the Princess Elisabeth Island.

“Standalone NID elements by themselves do not suffice. There is a need for an ecosystem approach and integrated ecosystems are the goal.”



Evaluation of NID elements with regard to their contribution in terms of reproduction, shelter and foraging (+1 = weak contribution and +4 = large contribution). The values shown are the averages of the scores given by the experts who participated in the survey.

THREE NID MODELS

Reference design

The base design of the Princess Elisabeth Island serves as a reference design: a caisson island with a wave wall to protect the energy infrastructure. The seabed around the island is stabilised using a rock revetment or scour protection.

NID+

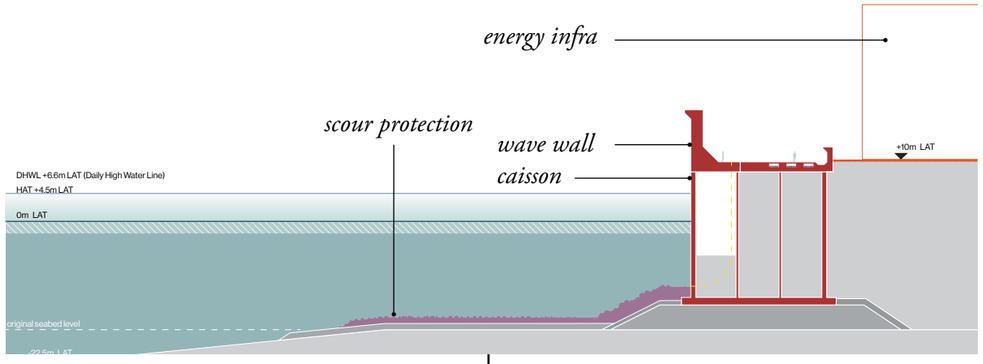
NID+ most closely matches the reference design. The vertical wall is provided with vertically placed intertidal pools. The wave wall is equipped with the necessary provisions for cliff breeders (at least black-legged kittiwake). All around, the rock revetment is created as a chaotic rock carpet. If desired, the first chamber of the caisson can be perforated to serve as a fish refuge.

NID++

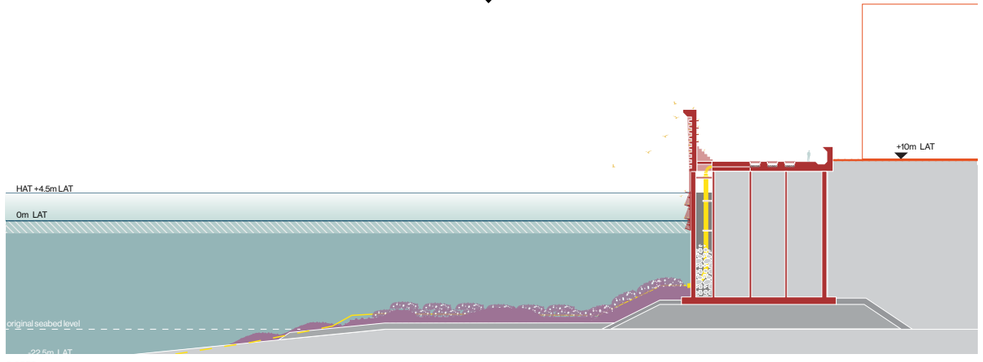
In the NID++ model, a lower caisson is added and the existing caisson is narrowed. On top of the lower caisson modules are installed that create an intertidal area (the cables can be integrated in this solution). By perforating the outer caisson chamber, these can also serve as a fish refuge. The wave wall is equipped with the necessary provisions for cliff breeders (at least black-legged kittiwake). The horizontal surfaces are equipped to serve as resting or breeding places for ground-breeders. As with NID+, around the 'rock revetment', a chaotic rock carpet is created.

NID+++

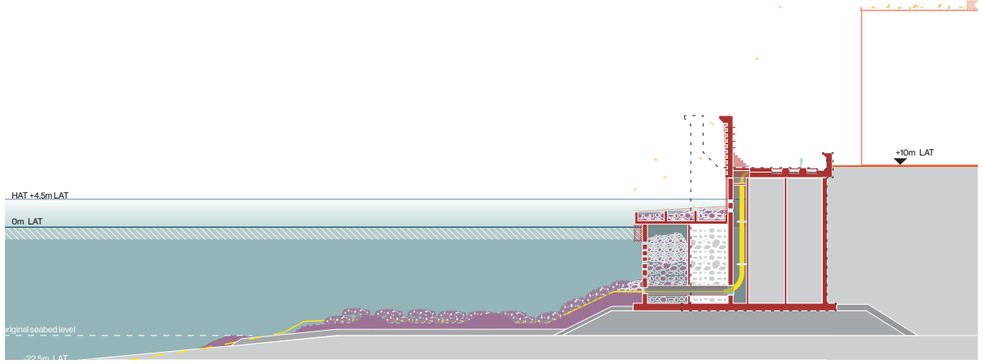
NID+++ provides an even wider intertidal area at the short sides of the island. This model also provides for a rooftop over the island for birds. Further the same NID provisions are made as for NID++.



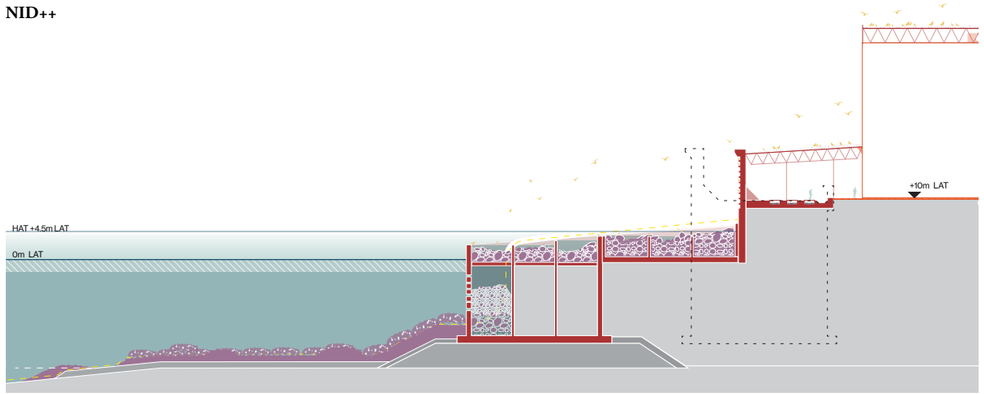
Reference design



NID+



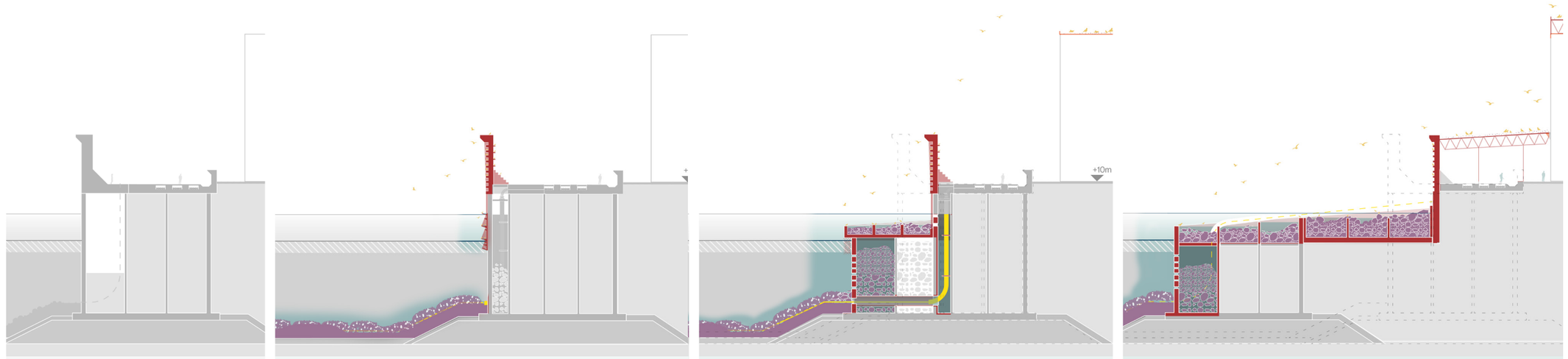
NID++



NID+++

The cross-section of the reference design as basis for the NID models

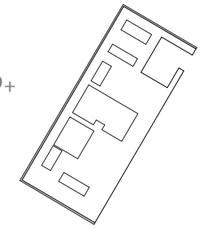
The models are the result of a search for the balance between a small footprint with maximum positive effects of the NID.



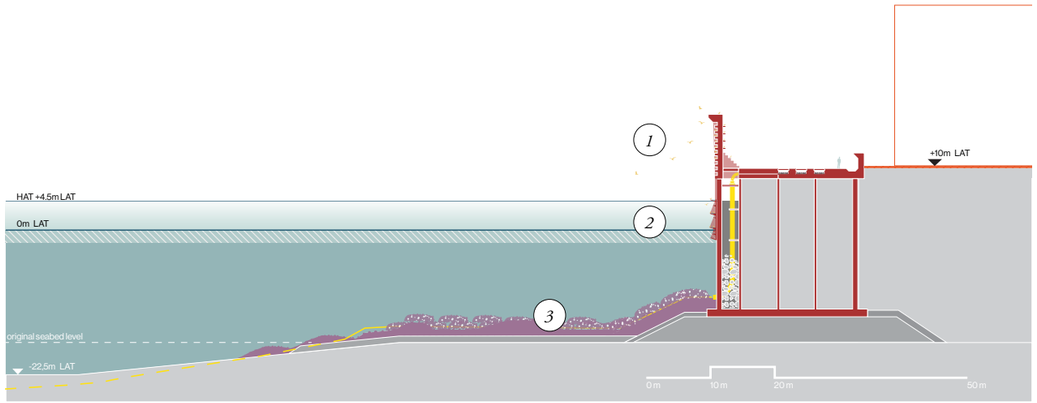
Comparison of models with reference island

NID+

NID+



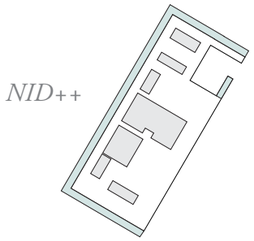
1. *Wave wall cliff*
2. *Relief Intertidal: 1m width*
3. *Chaotic scour protection with complex edges*



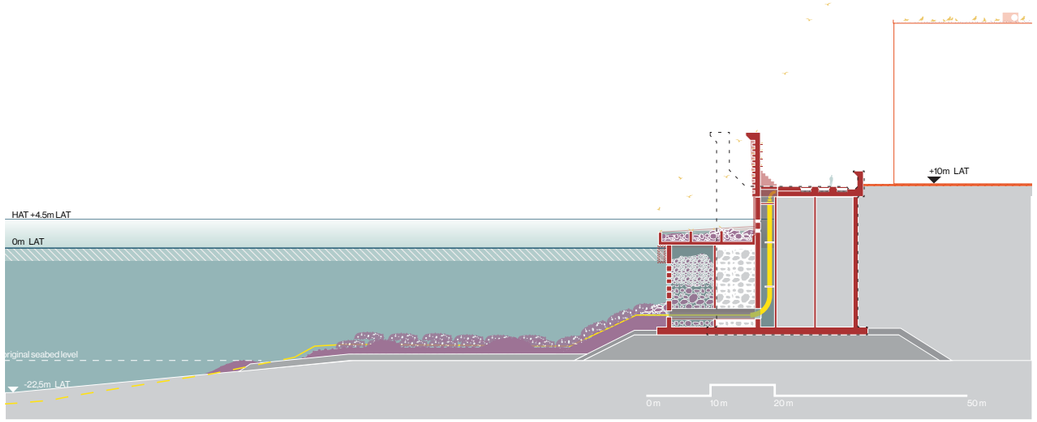
"A vertical wall will lead to a relatively poor ecosystem with dominant species. The more intertidal modules, the greater the chance of attracting predators and then creating a more diverse ecosystem."

“Note the time dimension: with the right integration of NID elements, the island will be teeming with marine life in 15 to 20 years.”

NID++

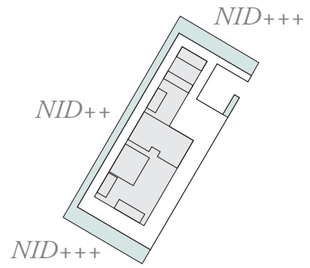


1. *Wave wall cliff + horizontal surfaces equipped for birds*
2. *Intertidal landscape with intertidal pools (15m)*
3. *First chamber of caisson equipped as fish refuge*
4. *Chaotic scour protection with complex edges*



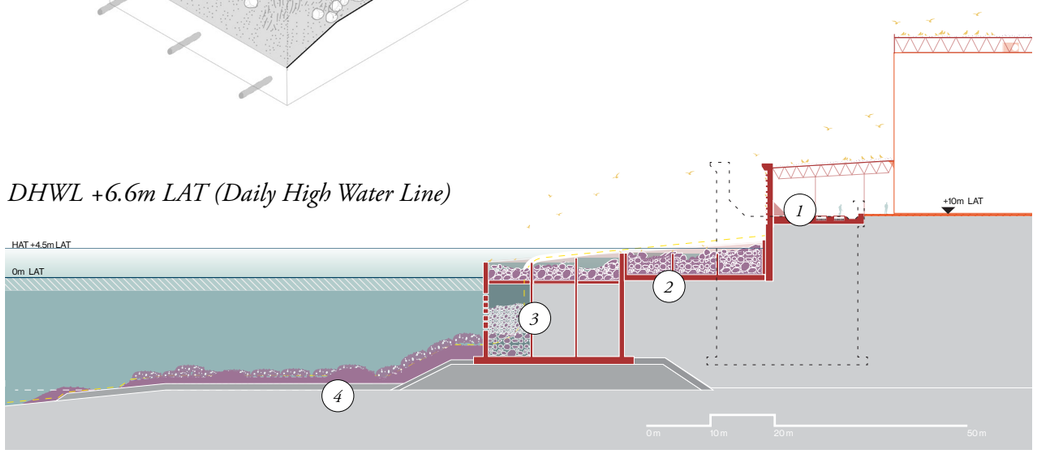
"The more complex the habitat, the richer the biotic community. And the more intertidal pools and the more variety of habitats, the better."

NID+++



1. *Wave wall cliff + Rooftops for birds*
2. *Intertidal landscape with intertidal pools (43m)*
3. *First chamber of caisson equipped as fish refuge*
4. *Chaotic scour protection with complex edges*

DHWL +6.6m LAT (Daily High Water Line)



NID ECOLOGICAL ADDED VALUE

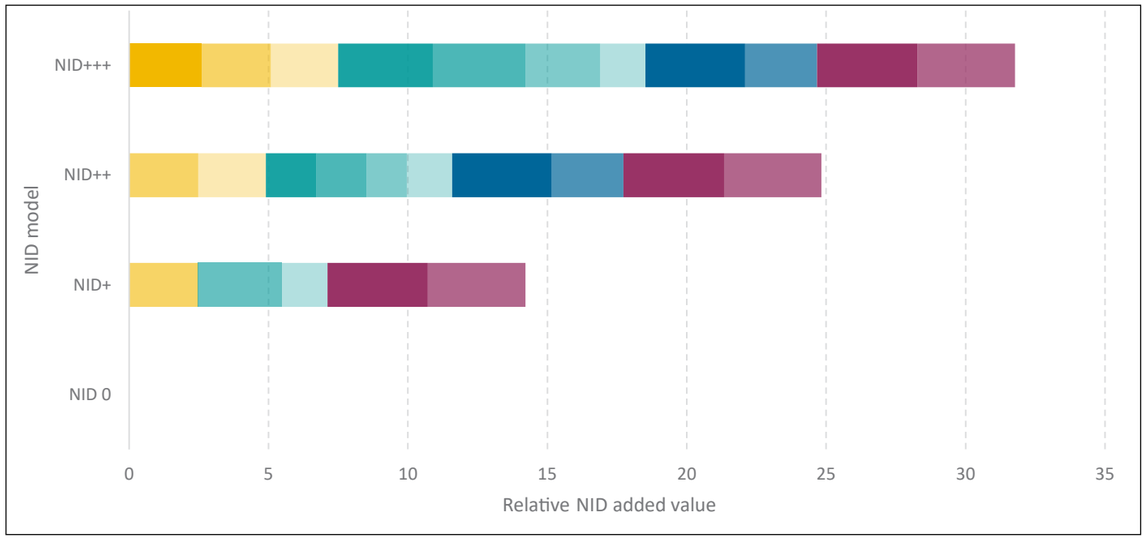
Added value score description

The relative ecological added value score is an indication of the relationship of the ecological added value of the different NID elements in the three models. The added value score is made up of the product of 2 relative scores:

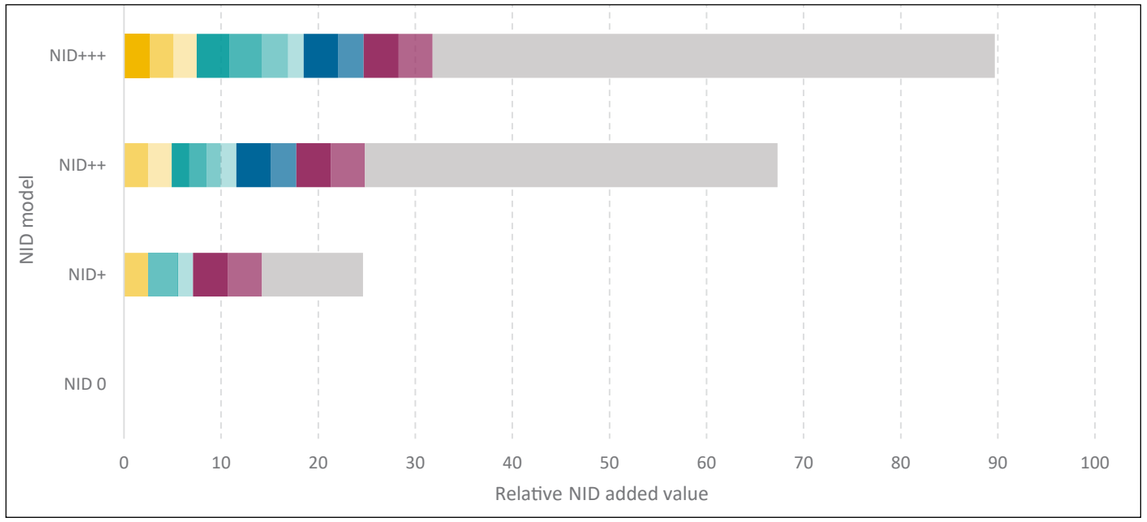
- An average indicative ecological score given by the experts regarding the contribution of the element to the reproduction, foraging and shelter function of the marine ecosystem;
- The relative surface area of the NID element compared to the total surface area foreseen in NID+++. Consequently, this score is always 1 for the elements in NID+++;

We also give an indication of the relative added value that follows from interaction effects between the different NID elements. Each potential interaction between 2 NID elements is scored by the experts. The resulting total interaction effect added value for each element has been added to the 'interactions' component in the figure below.

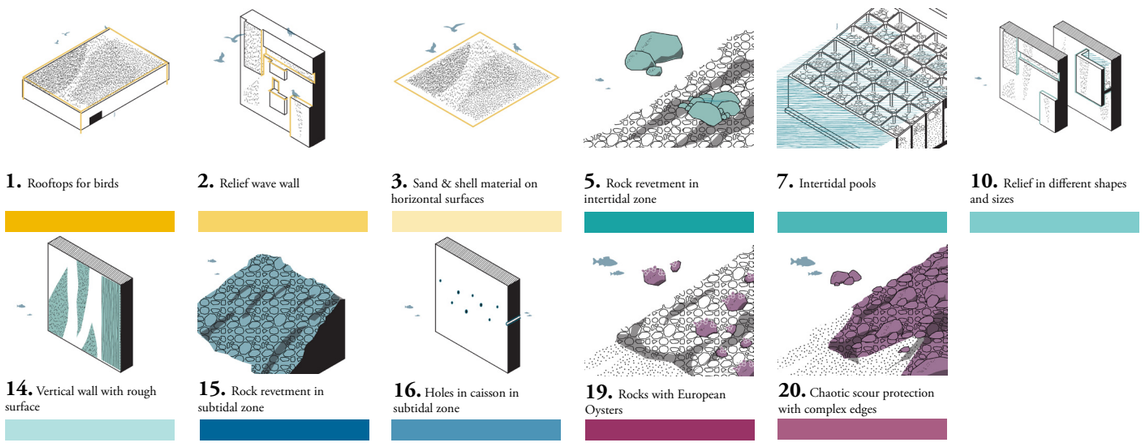
Note 1: During the last workshop, there was consensus on the importance of interactions for the added value of the NID design, but it was also noted that it is not easy to assign a score to this. The interaction score in the figure below should therefore not be interpreted as the 'absolute' added value that interactions bring, but as an illustration of the reinforcing effect of interactions on the added value of the NID design.

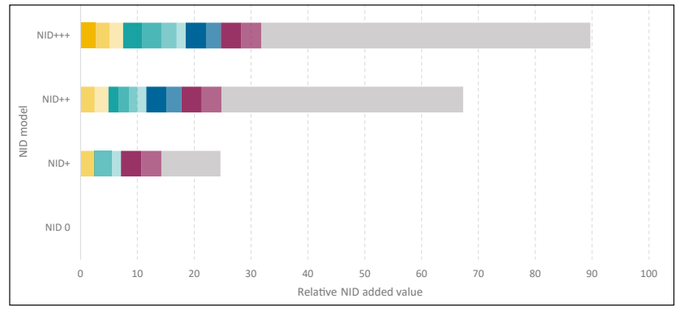


NID added value per model <u>without</u> interactions



NID added value per model





		1. Rooftops for birds	2. Relief on wave wall	3. Sand & shell material on horizontal surface	5. Rock revetment in intertidal zone	7. Intertidal pools	10. Relief in different sizes and shapes	12. Biohuts, bionets	14. Vertical wall with rough surface	15. Rock revetment in subtidal zone	16. Holes in caisson in subtidal zone	19. Rocks with European oysters	20. Chaotic scour protection with complex edges	NID+	NID++	NID+++
1	Rooftops for birds		0,13	0,38	0,28	0,28	0,28	0,10	0,03	0,03	0,18	0,03	0,18			1,58
2	Relief on wave wall	0,13		0,08	0,13	0,23	0,13	0,08	0,03	0,03	0,03	0,03	0,03	0,20	0,63	0,75
3	Sand & shell material on horizontal surface	0,38	0,08		0,18	0,18	0,18	0,10	0,03	0,03	0,08	0,03	0,08		0,75	1,13
5	Rock revetment in intertidal zone	0,28	0,13	0,18		0,50	0,38	0,20	0,03	0,08	0,03	0,03	0,03		1,18	1,45
7	Intertidal pools	0,28	0,23	0,18	0,50		0,38	0,15	0,03	0,08	0,03	0,03	0,03		1,23	1,50
10	Relief in different sizes and shapes	0,28	0,13	0,18	0,38	0,38		0,20	0,03	0,08	0,13	0,18	0,18	0,50		
12	Biohuts, bionets	0,10	0,08	0,10	0,20	0,15	0,20		0,38	0,38	0,43	0,33	0,43		2,45	2,55
14	Vertical wall with rough surface	0,03	0,03	0,03	0,03	0,03	0,03	0,38		0,38	0,38	0,43	0,33	0,80	1,98	2,00
15	Rock revetment in subtidal zone	0,03	0,03	0,03	0,08	0,08	0,08	0,38	0,38		0,38	0,43	0,43		2,18	2,20
16	Holes in caisson in subtidal zone	0,18	0,03	0,08	0,03	0,03	0,13	0,43	0,38	0,38		0,33	0,43		2,08	2,25
19	Rocks with European oysters	0,03	0,03	0,03	0,03	0,03	0,18	0,33	0,43	0,43	0,33		0,43	1,05	2,03	2,05
20	Chaotic scour protection with complex edges	0,18	0,03	0,08	0,03	0,03	0,18	0,43	0,33	0,43	0,43	0,43		0,95	2,18	2,35

Legend	
No interaction	0,00
	0,05
	0,10
Moderate interaction	0,15
	0,20
	0,25
	0,30
Strong interaction	0,35
	0,40
	0,45
Very strong interaction	0,50

Interaction matrix

Note 2: The total added value score is a relative score and should be interpreted as 'NID+++ has x times more value for nature than NID+'. Or 'NID+ element X has x times more value for nature than NID+ element Y'.

Note 3: The figure with interactions is scaled for reasons of readability.

Added value score conclusions

If interactions are disregarded, there is an approximate linear growth in added value. The added value of NID++ to the NID+ model is mainly due to the addition of a number of new elements. The added value of NID+++ to NID++ lies mainly with the larger surface area provided for the NID elements.

Interactions between NID elements create a magnified difference in added value between the NID models, which is especially pronounced in the NID++ and NID+++ models due to the greater variety of NID elements allowing for more interactions between them.

"NID elements are preferably selected based on compatibility and interaction so that the overall ecological added value is strengthened."

“The more natural the design, the better.”

AFTERWORD BY ELIA

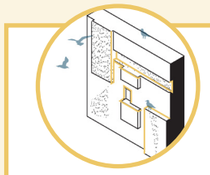
The rapid and large-scale development of offshore power production is recognised unanimously today as a key factor in achieving our societal goals of decarbonisation, security of supply and energy independence. Offshore technologies are becoming ever more efficient. Sustainability and respect for the marine environment are increasingly present in design and construction methods.

That is why Elia chose a nature-integrated design for its artificial energy island, the Princess Elisabeth Island. Not only did Elia want to minimise the disruptive effects on the marine environment, but at the same time it wanted to take the opportunity to add real ecological and environmentally friendly value to its project. This innovative and unique process of co-creation between an infrastructure manager and various experts from institutions, universities, consultancies and non-governmental organisations has now been recognised as such by all participants and has delivered some very valuable lessons.

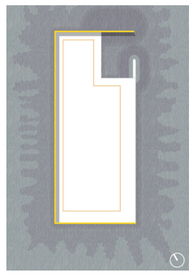
Elia thanks all the experts and participants in this process most sincerely. Their work will continue, with regard to the technical and financial feasibility, during the detailed design of the Princess Elisabeth Island. This project has already made an important contribution to scientific development in this field. Monitoring and experimentation are also opening up new possibilities. We are hopeful that the transparency and constructive approach of everyone who participated in this process - including us - will encourage more responsible collaborations that will accelerate the energy transition.

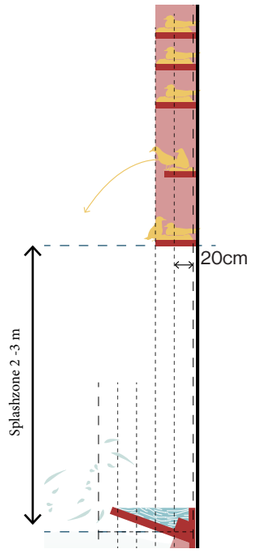
SHEETS

Supratidal

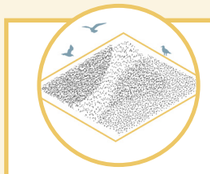


Wave wall designed as cliff

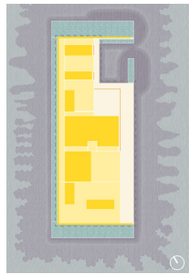


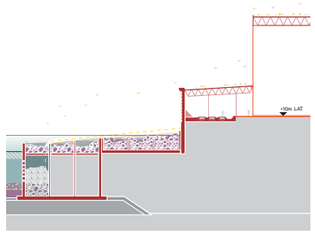


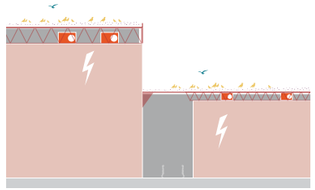
- Maximum focus on the black-legged kittiwake. The more opportunities they get, the better.
- ‘Shallow’ edges. The deeper they get, the greater the chance of disturbance by other species
- Bird ridges from +3m TAW
- Bird ridges on both sides of the storm wall can be an added value



Rooftops, horizontal surfaces

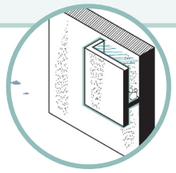




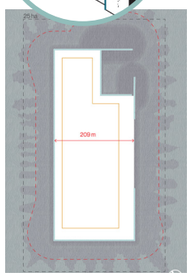


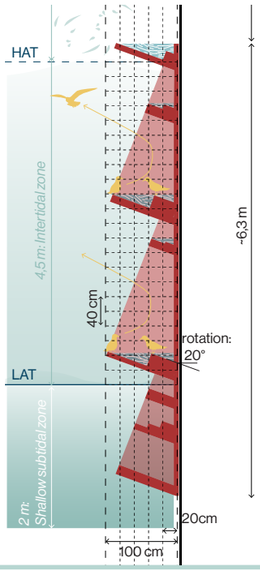
- Sea view essential for breeding birds
- Breeding colonies require 5 ha
- Gravel surface is preferable
- Provide pipes as a shelter; construction material can perhaps be reused for this purpose
- Provide an edge as fall protection for chicks
- Breeding colonies need min. 2 ha

Intertidal

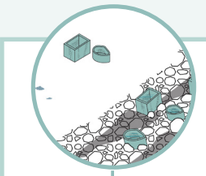


Vertical wall with intertidal pools

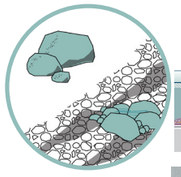


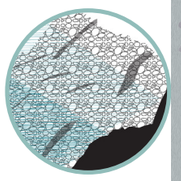


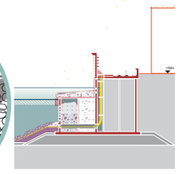
- Vertical intertidal wall: provide sufficient height between the pools
- Variety of pools between 20 cm and 1 metre
- Provide ‘small scale’ structures: holes and fissures of a few centimeters / decimeters
- Provide texture in the shallow subtidal
- Distance between saw teeth (40cm - 2m)
- A relationship between small scale structures and intertidal pools

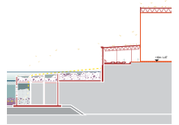


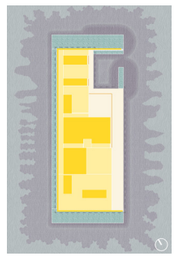
Intertidal landscape with intertidal pools





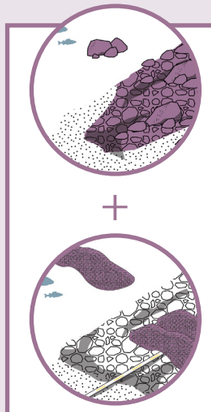




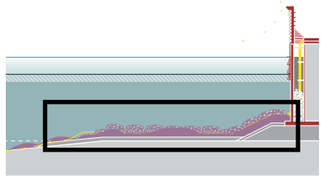


- The more and the greater the variation in intertidal pools and habitats, the better.
- The intertidal area is particularly attractive to young fish as a nursery and shelter
- Preferred: the use of non-smooth concrete for NID elements in aggressive marine environments because of better attachment possibilities

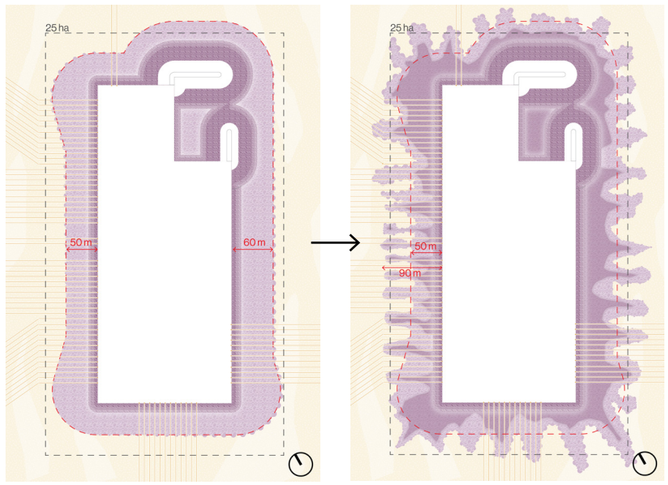
SHEETS



Chaotic scour protection (min. 2cm) with complex edges



- Stable scour protection: better to overdimension
- Variation in rock sizes from min. 2cm
- Complexity of edges + sand pockets, patches
- Experiment with different edges

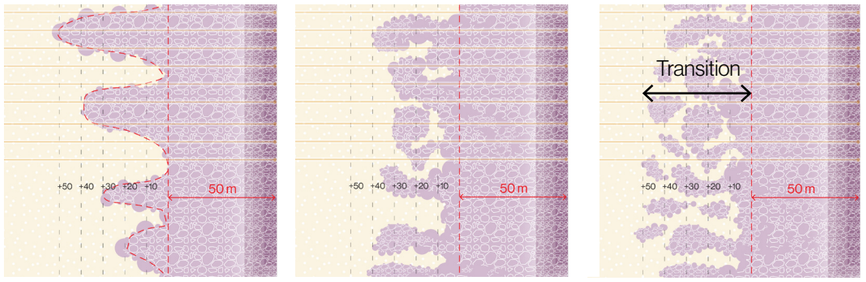


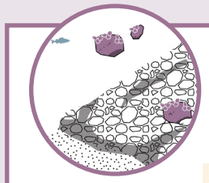
NID proposal:

14.2 ha

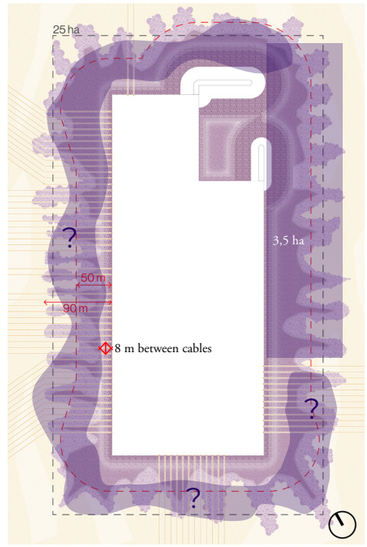
142.000 m²

4700 m of edges





Oyster reefs



- Special attachment conditions for oysters:
- For example, apply a liming layer beforehand to which larvae can attach
- For example, work with local aquaculture.
- For example, inoculate rocks with oyster splash beforehand.
- Deploy oysters on total surface of scour protection? Knowing that the reefs will be altered by the laying of the cables? (2026-2030)

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