The Northernmost Nostalgia

-An exploration on floating structure applicable to polar bear ecology and other Arctic lives

Zhe Li Spring 2023 Master Thesis
Supervisor: Kengo Skorick Examiner: Jonas Lundberg
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ABSTRACT

As global warming causes significant changes, the melting ice cap in the Arctic has drew more attention. Meanwhile, a sixth mass extinction has already occurred in the 'Anthropocene'. Arctic lives, including narwhals, polar bears and walruses, will be the first to get involved due to inadequate habitat. If human activity continues as it is, we could see the demise of polar bears sometime between 2050 and 2100. We certainly hope that the Paris agreement could limit global temperature change to 1.5 degrees Celsius above pre-industrial levels.

But in most cases, ice caps will disappear in a foreseeable future, so do polar bears. People have already realized the importance of biodiversity to ecosystems. Sanctuaries and national parks are set up in order to preserve wild animal's habitat. But polar bears are in a very special situation, their tracks range from the northernmost multiyear ice to the terrestrial hills and plains. Sea ice is a key platform for polar bears to accumulate a year's weight. It is also the most threatened habitat. Sea ice is an extremely fragile ecosystem that possesses a simple chain of energy transfer. When one of its links is disrupted, it will deal a serious blow to the whole system. It's not just the polar bear that's at stake, but also many other species that live in it, various kinds of algae and bacteria, polar cod, and polar bears' main food source, seals.

As some experts are investigating, artificially enabling sea ice re-formation is possible, such as pumping warm seawater from the deep sea to the surface and seasonal injections of aerosols to reduce solar radiation. But what can we do as Architect? What results are obtained by maximizing the benefits of space from a non-anthropocentric design perspective? The location and design core of this project are far from human society. It will not entagle with human interests in order to maximize the design opportunity regarding polar bear's minimal autonomy as well as the consciousness of vulnerable Arctic ecology.This will be a process of constant questioning and reflection.

The 'oasis' or 'oases' could only support limited amount of polar bears to hang on with their survival skills in hand. But they might be the seeds.

Key words:
non-anthropocentric, Arctic ecosystem, polar bear territory

DELIMINATION

This project will focus on exploration and discussion in the field of architecture, which does not have the expertise to discuss the feasibility of technologies outside the field of architecture.

This thesis will not include an in-depth exploration of the philosophical relationships between species, but I will set out an idealized scenario for the return of animal autonomy, explore possible directions for future animal welfare architecture, at the same time explore the possibilities for architectural material and form.

The design will begin with the needs of the polar bear as a specific Arctic creature, as helping them cope with their dire situation is the original mission of this project, but I will also consider the symbiotic relationship between other Arctic species and the polar bear in order to explore symbiosis possibilities with artifitial approaches.

THESIS QUESTIONS

-How could the architect's choice of materials echo with the original habitat of polar bears?

-How do polar bears' habits relate to the nature of their habitat? How can this help architects infer the artificial conditions that polar bears might choose?

-How do other Arctic creatures relate to this project? Is it possible for them to mutualize with polar bears?

METHOD

The project started with a direct question: How do we design a sanctuary for polar bears?

As we continuously think about it and learn about it, some interesting questions continue to go into the design process, some of which we rarely discuss. This means that the process is going to be iterated, It constantly moves between complete and not complete.

Each of those questions contains a series of possible alternatives. Our choices form the DNA of the project.

It simulates the form of a traditional commissioned architectural project, but the unfamiliar "client" makes every option less empirical. It requires more investigation and research, which makes the nodes of these problems clearer and gives us the opportunity to rethink the design steps that we seem to have taken for granted.

Research through design

It's a iteration process of experiments and verification. At the same time, I will keep finding improvement possibilities in the experiments and try to respond in the next loop.

Simulations

Try to use experiments and simulations to explore and understand the possible behavior of a new material in an unusal environment. Also to increase the evidence and credibility of the argument.

Non-anthropocentric design

POLAR BEARS
(Ursus maritimus)

The polar bear is a large carnivorous mammal native to the Arctic region, known for its distinctive white fur and strong, muscular build. With a height of up to 3 meters and a weight of over 600 kilograms, the polar bear is one of the largest land predators in the world.

THREATS

'Polar bears are the last remaining large terrestrial carnivore found throughout most of its original range, and in numbers similar to those of pre-industrial development. Most of the original habitat of the polar bearis still intact, although not legally protected, and much of the range occupied by the species is uninhabited by humans. From a management perspective the polar bear is thus in quite a unique and positive situation.

There are, however, serious environmental threats facing this species.These include large-scale habitat fragmentation, excessive hunting, pollution, and climate change. Though the over-harvesting of certain populations is currently the most urgent threat to bears in some areas, the IUCN Polar Bear Specialist Group considers climate change to be one of the major conservation challenges for the overall polar bear population. In the resolutions from meetings of this group held in Nuuk, Greenland in June 2001, climate change is listed as the number one threat. A warming trend has been observed over the arctic sea ice resulting in a three per cent decrease of sea ice extent per decade since the 1970s and more melt days per summer. This trend is expected to continue. Computer models suggest that with a doubling of CO_2 in the atmosphere the ice-free season will grow from 60 days to 150 days.

As the time bears have on the ice to hunt is cut short their opportunities for developing fat reserves to survive a longer ice-free season are more limited. There is evidence that climate change is already affecting the condition of polar bears in the Hudson Bay area of Canada. Female bears are in poorer condition going into the denning period suggesting difficulties obtaining sufficient food while hunting on the sea ice. These observations are indicative of what can be expected throughout the polar bear distribution in the future.
The combined effects of climate change are expected to negatively impact polar bear reproductive success,
and thus lead to a decline in the overall population. These effects must also be seen in the context of other
pressures facing this species, including unsustainable hunting practices and contamination by persistent organic pollutants.

As the polar bear is a keystone species at the top of the food web in the arctic seas, which include some of the world's most productive marine ecosystems, it is a good indicator of the overall status of these ecosystems (Eisenberg 1980). Successful conservation of polar bears and their habitats can thus have positive effects on many other species, in several key ecoregions, as well as on local human communities within the Arctic. Addressing the conservation of such keystone species therefore has a high priority within WWF.
Through its work in priority ecoregions, WWF is a driving force in the protection of large expanses of unfragmented land and marine areas to ensure that space-demanding species, such as the polar bear, can continue to roam undisturbed in intact ecosystems.'

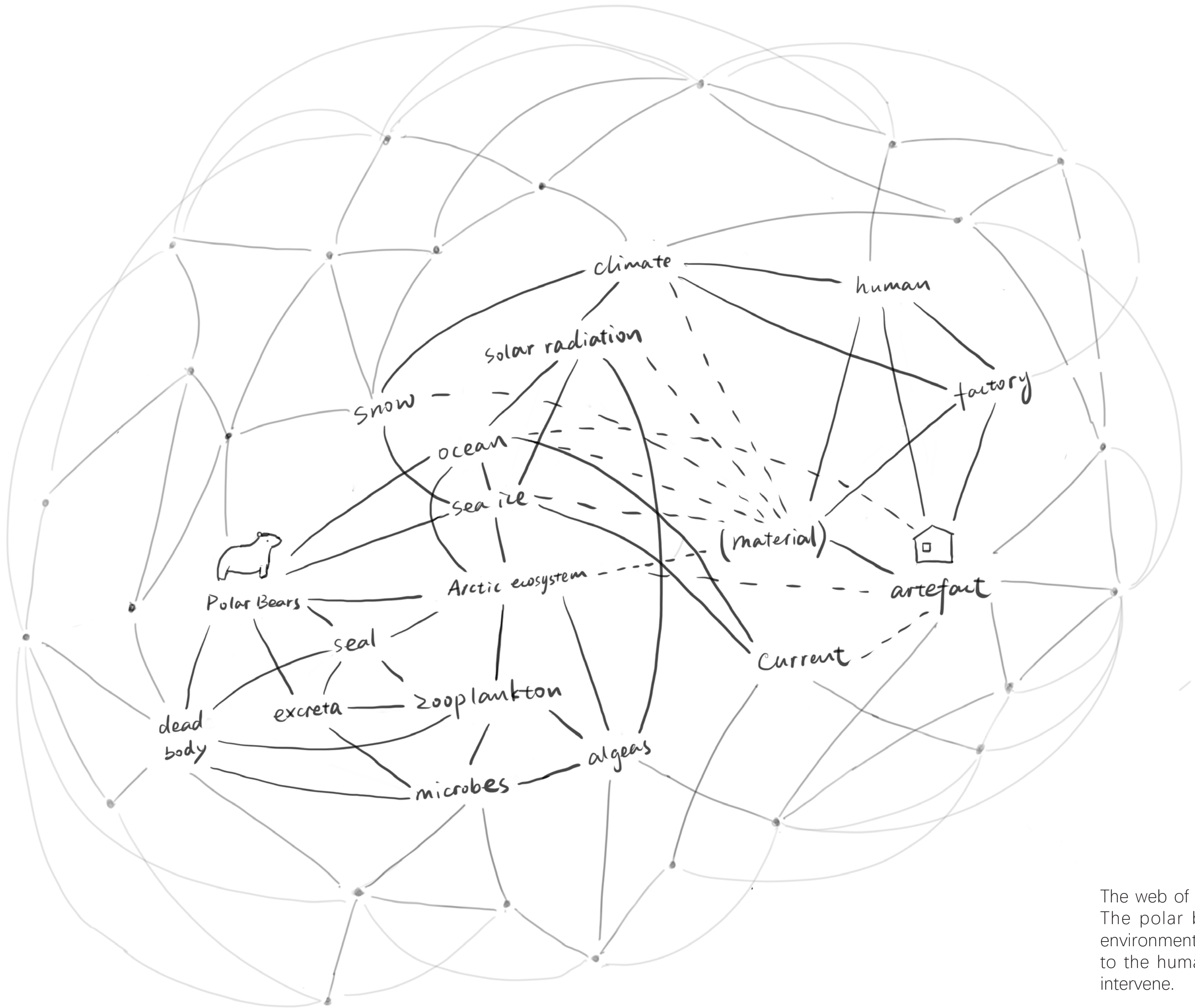
-Polar Bears at Risk: A WWF Status Report.

Non-anthropocentric & design

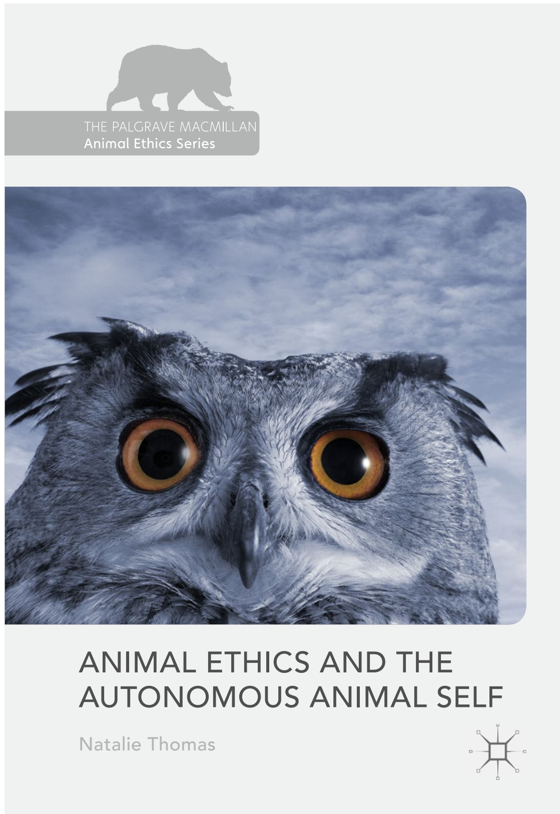
nonanthropocentric design is about embodying an entanglement of species. This is achieved through understanding that we are entangled, by acting in collaboration with diverse fields and through being humble. Moreover, the paper suggests design thinking can become non-anthropocentric - shifting its focus from human to earthling needs through thickening its current converging phases with speculative scenarios.

Realizing that there is no binary opposition between humans and nature, we need to map out the potential web of relationships between the two and discover the boundaries of collisions between matter. Eventually we will find that human beings are never independent of what we think of as external matter, we may be affected by any small change in nature, we are all one.

In the discussion of non-anthropocentric design methods in architectural design, practitioners generally believe that several aspects are indispensable. First of all, designers should recognize the web of relationships between materials and try to delineate it. During this period, we need to actively seek out and exploit the intersections between disciplines, which may require us to supplement the specific knowledge of ecology or other fields related to the project.A speculative vision of the future, which helps us see design in a completely different light, both for different time spans and for unfamiliar participants. In addition, it is important to realize that the network of materials and relationships is constantly changing. This will add another dimension to our design, which is not simply about delivery, but more about providing a service.Finally, there is a sense of humility in the design process, because everything is symbiotic and embedded, which constantly breaks your grip on design.



The web of matter is incredibly complex. The polar bear and the entire Arctic environment will be linked in many ways to the human creation that is about to intervene.



Are Animals Autonomous?

Autonomy can also be interpreted as preference. Humans tend to justify treating animals as objects and property by questioning their autonomy. Historically, people have defined autonomy according to human norms, and animals have inevitably become a group lacking autonomy, along with people with disabilities and "marginalized groups". This unfair classification has led to the oppression and exploitation of these groups. But what exactly is autonomy? Do animals really lack autonomy?

Nomy Arpaly believes that animals cannot be autonomous, whether their behavior is related to these aspects or not, due to their lack of rational ability. Natalie Thomas counters this in her book Animal Ethics and the Autonomous Animal Self. She thinks part of the argument against animal autonomy is that it will profoundly affect the way people treat animals and the way animal protection laws are set up, and that people are not ready for it. In fact, although they are not as rich as human beings in self-driven system, animals undeniably have their own preference, which means they have the consciousness to take actions based on their own reasons, which is the minimum autonomy. Children are the representatives with minimal autonomy, and their basic autonomy is recognized even though adults need to impose interventions and protections to protect their interests.

In its most fundamental form, autonomy is simply the capacity to govern one's own life and activities. Having self-awareness entails an evaluative feature that allows one to have a notion or sense of how one wishes to live, as well as a knowledge of one's own desires and preferences as the basis for making decisions.

A Natrual View of Autonomy

Bruce Waller (1998) argues that autonomy can be understood as vicarious autonomy, and that vicarious possibilities of action are the result of choices provided by the natural environment around us. Waller argues that since animals are products of their environment, their choices are determined by the options available to them, rather than by a mysterious, environment-independent factor that explains their choices. Most animals with a basic level of self are autonomous in their actions because they are able to choose between alternative paths offered by their environment. The more complex the ego level of a species or an individual, the more choices they can recognize in their environment. Social animals, for example, exhibit more complex patterns of behavior and a wider range of emotions due to their cognitive abilities. Limiting an animal's available choices by limiting the environment is a way for humans to disrespect an animal's autonomy because it limits an animal's choices.

Although animals can provide behavioral indicators of consent or lack thereof, this is a supposition on our behalf rather than a deliberate, vocal form of permission as occurs with people. This implies that, while I argue that animals are autonomous, they are constrained in how they may express their wishes and preferences to humans, and they are limited in exercising control over their own behaviors by the very structure of our domestic connections with animals. By considering animals as autonomous, humans are given more responsibility to discern behavioral indicators of permission (or lack thereof) and to adapt their behavior accordingly.

The distinction between human and animal autonomy is founded on the ability to think abstractly, which permits people to. The more sophisticated a species' or individual's sense of selfhood, the more possibilities they may detect in their surroundings. Those with lesser degrees of autonomy can benefit from human designers identifying a broader range of alternative action options given in their environment. Restricting available possibilities for animals to act by constraining their surroundings is disrespectful to their autonomy.

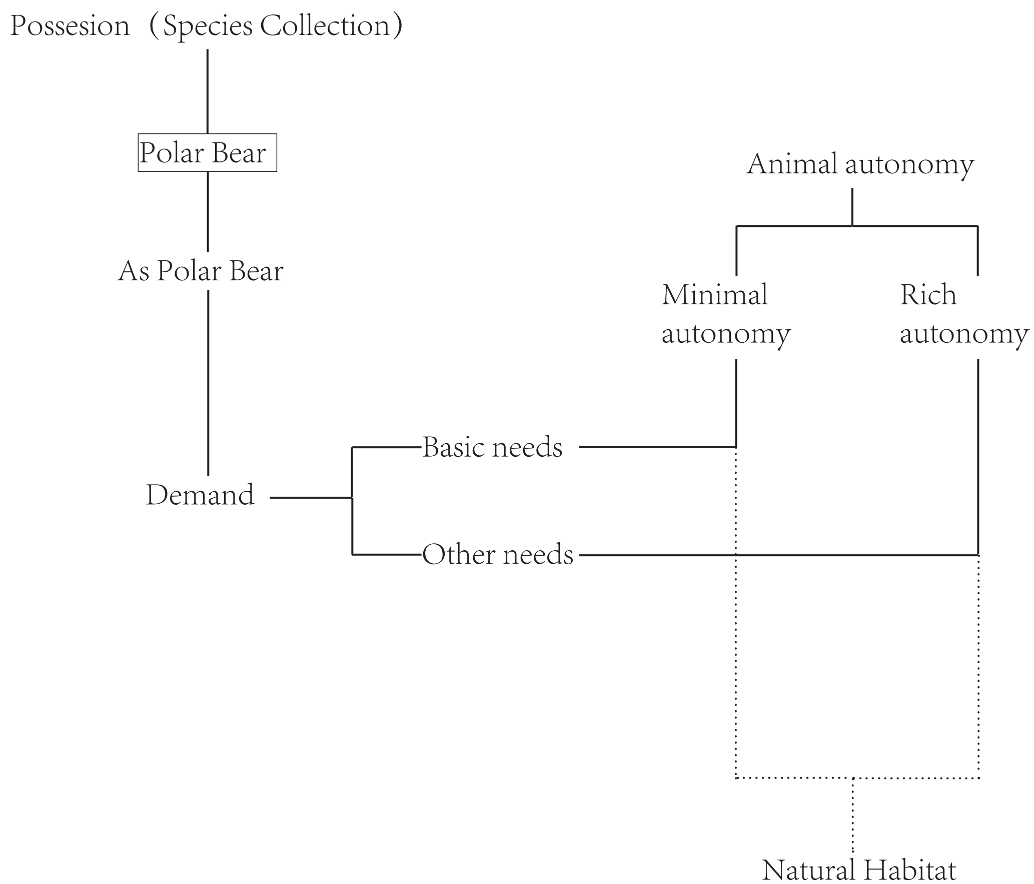
Respect for autonomous animals will mean amending their status according to the law, as well as more careful consideration of what kind of choices are made due to their mental abilities, and how we need to change our own behavior to best respect the autonomy with which they make those choices. In a harsh environmental constraint where we may not be able to provide many sophisticated alternatives, it is important to look at animal preferences in nature. Because this is already an environmentally validated conclusion, based on their desire for food, safety and comfort. In order to ensure minimal autonomy of animals, the living environment of animals cannot be overthrown. This is not a simple linear design problem, but a design decision should be made whether to open or tighten by combining human's ability to transform the natural environment with animal's level of autonomy and corresponding needs.

A utilitarian viewpoint, for example, might argue that as long as the dolphin is not in pain and has its basic survival needs addressed, there is no moral issue with its confinement. Respecting the captive dolphin's autonomy, in my opinion, necessitates a range of different natural settings, far broader confinement areas, and many more possibilities for social engagement with other dolphins than now exist. It would also imply that its interests would not be as easily overruled by human interests as they are presently.

This would be a violation of wild dolphins' sovereignty to spend their lives free of harmful human involvement.

Yet we may also properly assert that an animal wishes the freedom to pursue its own positive goals to the maximum degree possible without human intervention.

Depending on the particular animal and their capacity for agency and self-awareness, it provides us with a direction as to how we should treat other animals in certain ways, since it pushes us to recognize not just what harms them, but



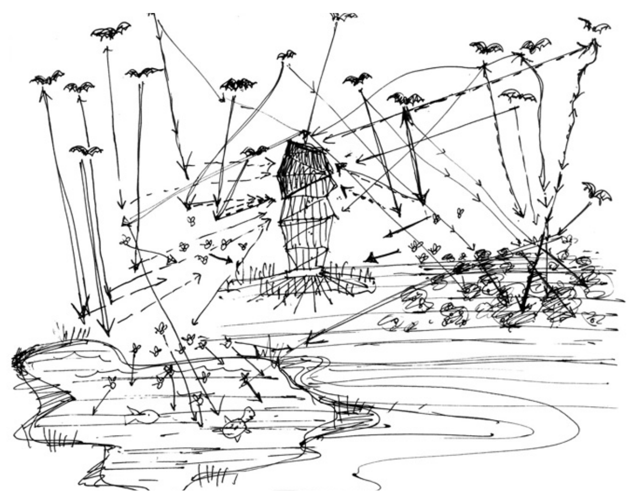
BAT TOWER
Joyce Hwang

Griffis Sculpture Park, East Otto, NY
Ashford Hollow Foundation, 2010

It's a welfare project for bats, which can't find enough habitat in cities today, also to change the public's perception of bats.

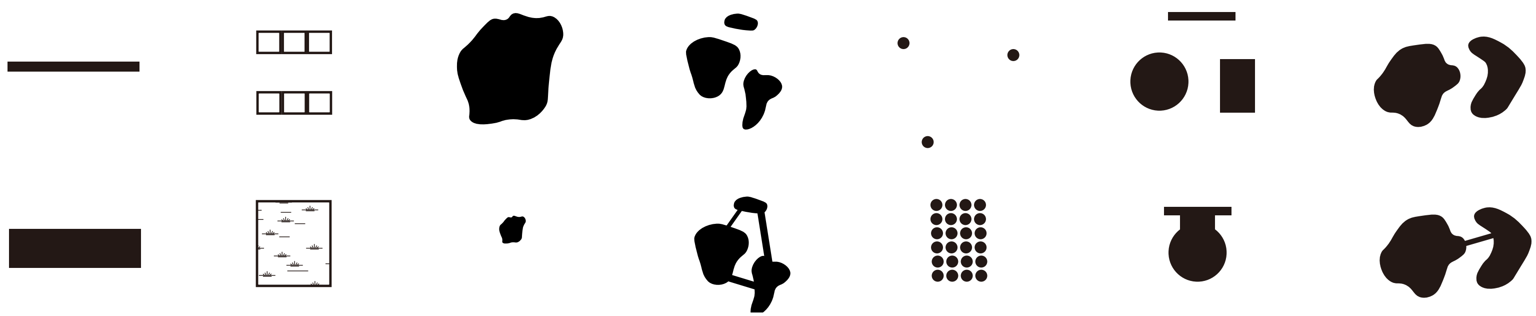
The BAT TOWER is strategically located and built to attract and enable bat inhabitation. The spot, which is near to a lake, is teeming with mosquitoes and other bat-attracting insects. Chives, oregano, and other bat-attracting herbs are planted at the tower's base. The project's ribbed design incorporates a number of 'landing pads' towards the top of the tower to aid in ingress. Bats may more readily climb inside the tower and cling to its 'ceilings' thanks to a network of grooves on both vertical and horizontal surfaces. To offer a warm interior for bat roosting.

For human designers, the best channel of communication between us and animals is through ecologists. The Bat Tower project carefully examines the bats' habitat and responds to their preferences to invite them into the building. This is a way of respecting the animal's initiative.



Delimination	HOUSE	FARM	ZOO	RESERVE	SEMI-INTERVENTION PROJECT		
Project	CATable	Automated Range Coop	Elephant House Zoo Zurich	Chengdu Panda Reserve	Prosthetic Lizard Homes	Prosthetic Lizard Homes	Prosthetic Lizard Homes
Material							
Animal Perceptions and Human Strategies	Visual (create hollows in the wood) Tactile thermal acoustic	Visual Tactile (rotatable soft ground) thermal acoustic	Visual (barrier between elephant and visitors) Tactile (imitate natural ground) thermal (roof to protect heat loss) acoustic	Visual (barrier between elephant and visitors) Tactile (natural ground) thermal acoustic	Visual Tactile (create hollow in bricks which imitate the insect's habitat) thermal acoustic	Visual Tactile thermal acoustic	Visual Tactile thermal acoustic
Function	Entertaining	Feeding	Sleeping Entertaining Feeding	Sleeping Entertaining Foraging	Sleeping Foraging	Sleeping Foraging	Transporting
Original Territory							
Restored Territory							
	Expand	'Liberate'	Simulate	Reunite	Rebuild	Integrate	Connect

Autonomy



This table shows how human construction technology has improved the living environment of animals, and from what aspects design considerations have been made. And how designed measures relate to their natural territory.

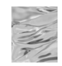
These examples try to satisfy the minimum autonomy of the animal within the human-set environmental framework, and the arrow points to the weakest end of the human-restricted environment. Wild animals, hitherto uninfiltrated by human activity, possess greater autonomy, which is necessary to hone and maintain their ability to survive.

Autonomy was an important consideration in this project, so the choice of materials and measures was an important step.

SEMI-INTERVENTION PROJECT

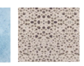
Autonomy

Floating island for Polar bears



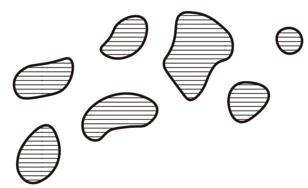
Visual
Tactile
(Compatibility with bears remains to be determined)
thermal
acoustic

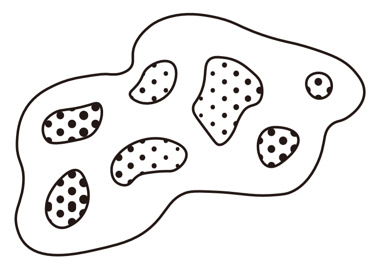
Sleeping
Hunting



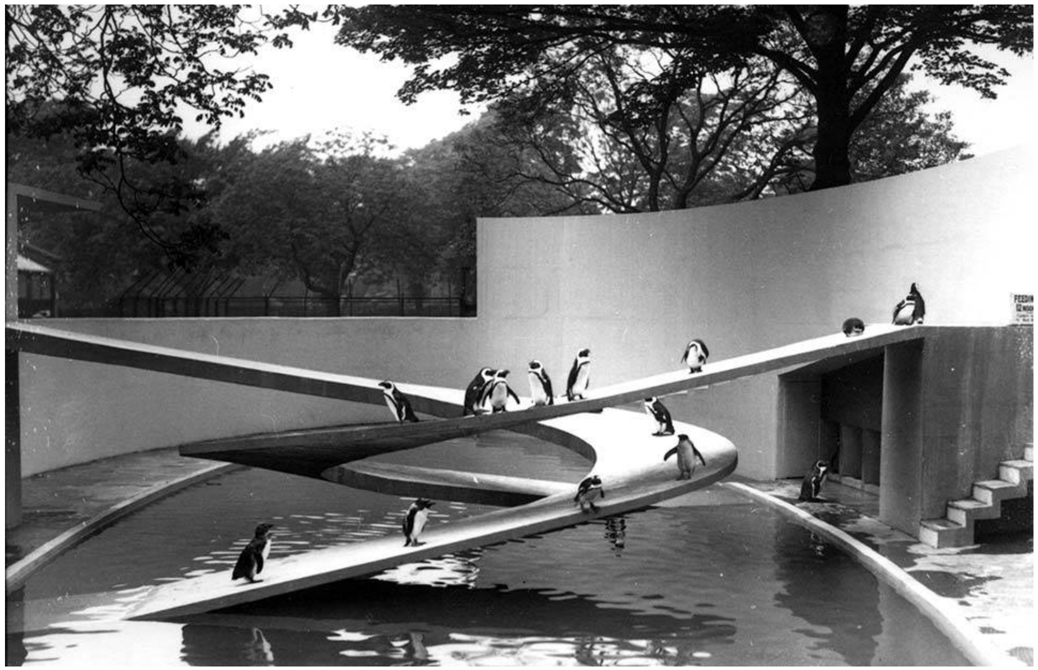
Visual
Tactile
(original tactile)
thermal
acoustic

Sleeping
Hunting





- Method
- References
- Experiments



-If penguins had a choice, would they choose a concrete floor so different from their original habitat that would cause infection in their feets?

Polar Bear Perception

Polar bears are well adapted for walking on snow and sea ice. Sea ice is rough and snow-covered. Unlike freshwater ice it is not particularly slippery, with the exception of snow-free refrozen leads. Polar bear feet, unlike those of other bears, are overgrown with hair.

Material Choosing Criteria

enviroment:
-water,
-extremely cold weather

-eco-friendly (micromolecules of plastic, bio-degradable)

-eduction to structual essentials can be advantageous
-durable, light structures are generally preferable to massive one
-the use of materials that retain CO2 is a positive factor
-invisible building components are particularly suitable for problem free optimization
-the longer a building is intended to be used, the more important it is to consider this phase of use
-building components with short useful lives are more enviromentally polluting because renewal costs accumulate more rapidly
-in housing construction, the enviroment impact made by building materials is particularly significant,because they are generally used in small pieces, and the level of finish is high.

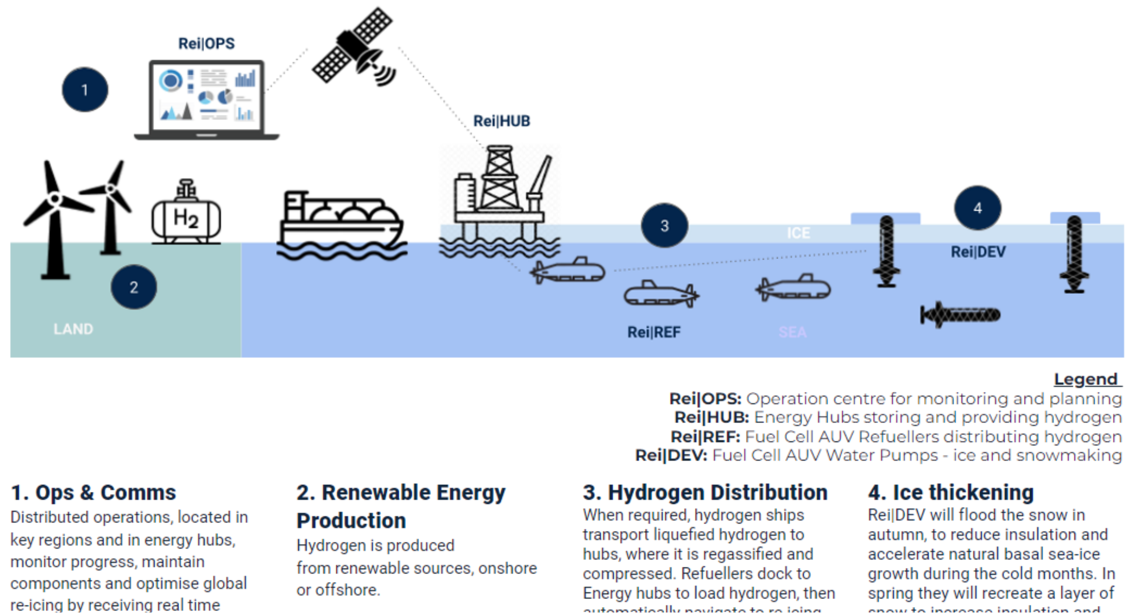
-'mechanism'
inner value: physical, mechanical and chemical parameters

-physical properties: gross density...
-mechanical properties: strength and rigidity, response to plastic or elastic distortion, surface hardness...porosity, capillarity
-chemical properties: corossion, leaching of salts, esistance to UV lights, reactions to other building materials.

-which polar bear sense should be stimulated, and how will they perceive the material?
-what natural and use related influences will the intended function have on the materials?

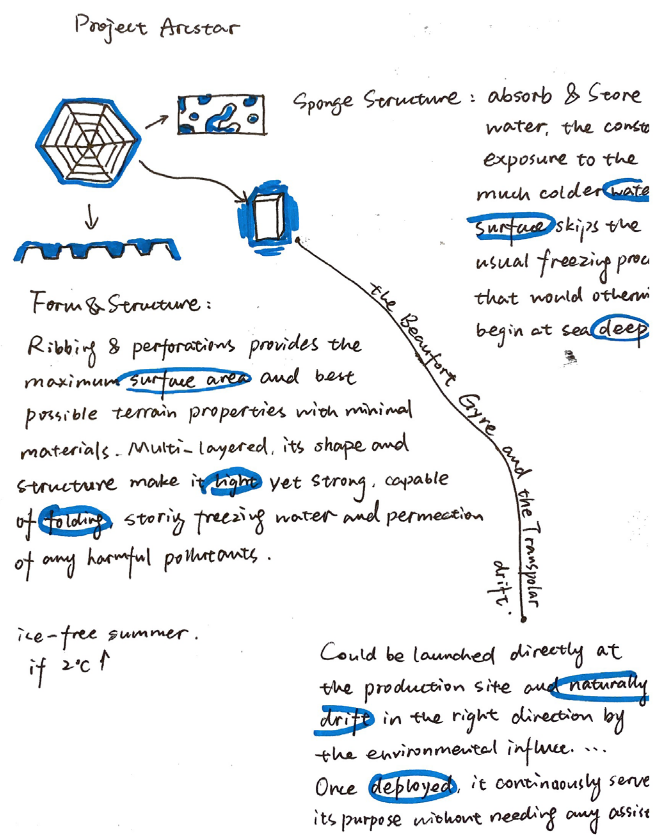
Arctic Sea Ice Restoration Project
Real Ice

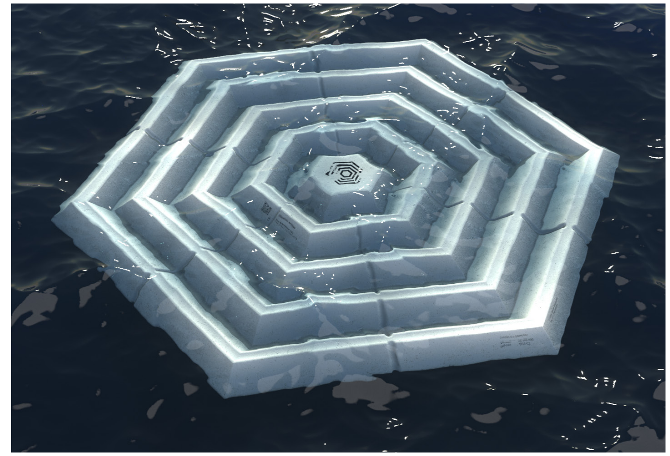
The possibility of regenerating ice. But the process itself may be a disturbance to arctic species. This goes against the view I have in the thesis.

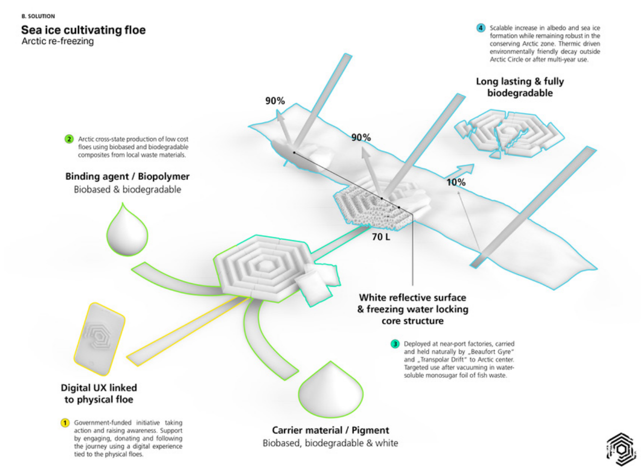


PROJECT ARCSTAR
Niklas Andreasen

FH JOANNEUM University of Applied Sciences







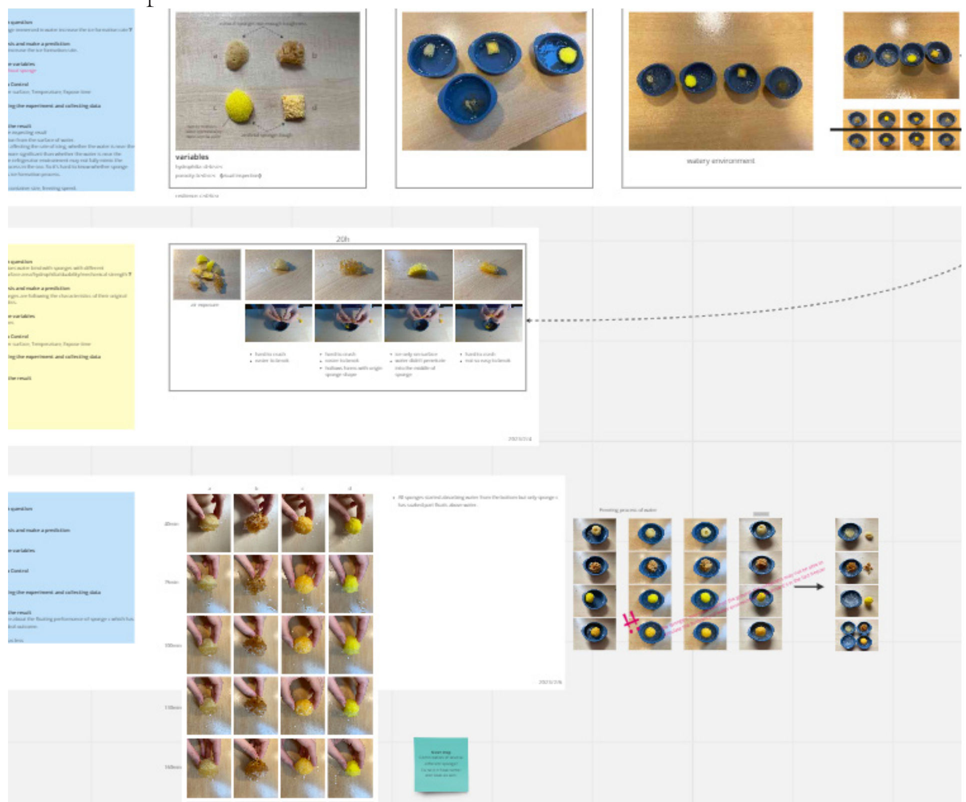
The sponge-like structure's potential to promote ice formation. Have minimal interference to the ecosystem, one-time delivery, and wait for the natural process.

Experiment

-Observe, verify and conclude the mechanism of the combination of sponge and ice

-observe, verify and conclude the performence of different sponges

Feasible Experiment



Sponge a
Natural Sponge: Protein skeleton of real sponge

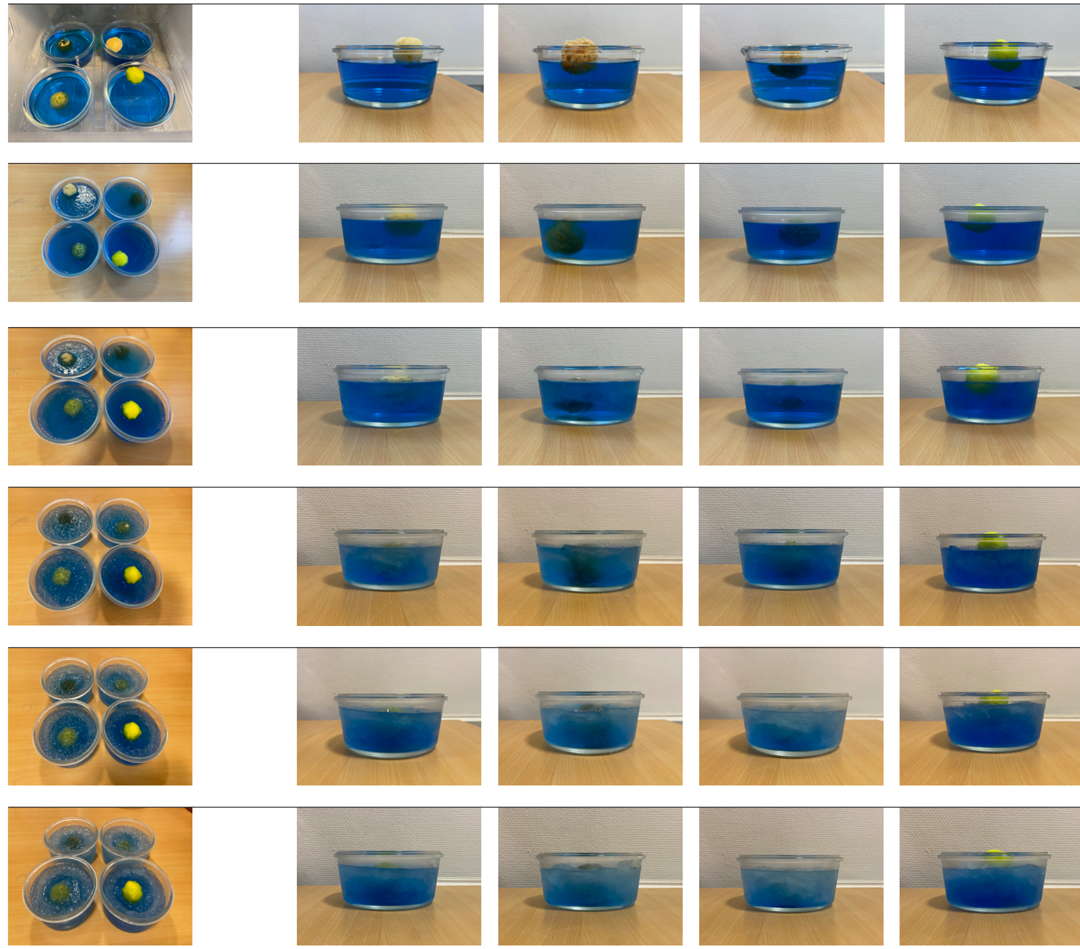
Sponge b
Natural Sponge: Protein skeleton of real sponge

Sponge d
Artificial Sponge: Plastic

Sponge c
Artificial Sponge: Cellulose

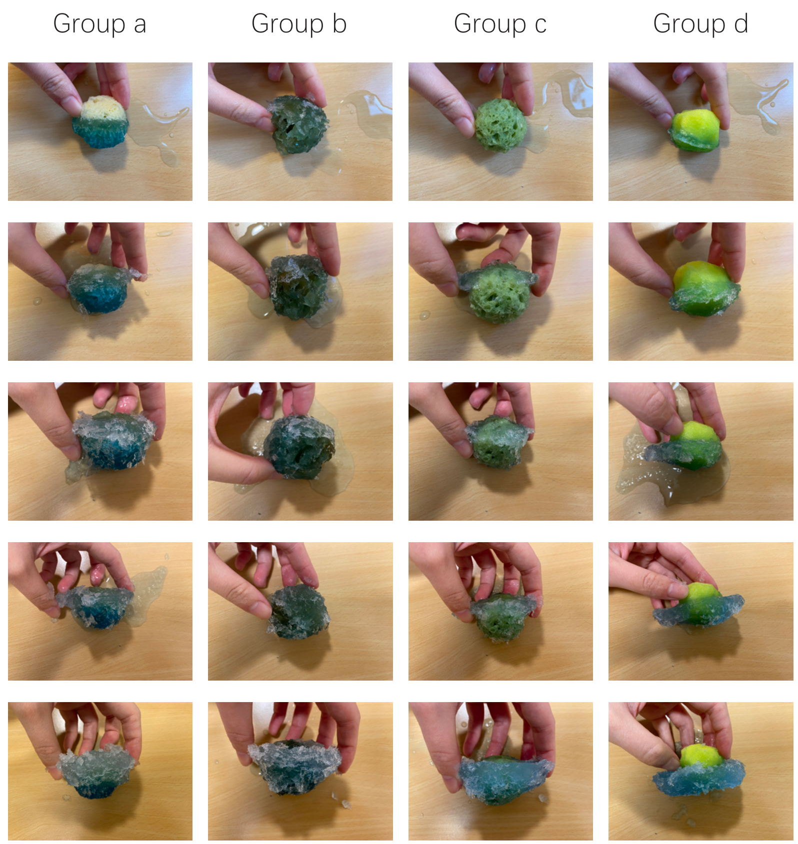
Group a | Group b | Group c | Group d

0h, 1h, 2h, 3h, 4h, 5h



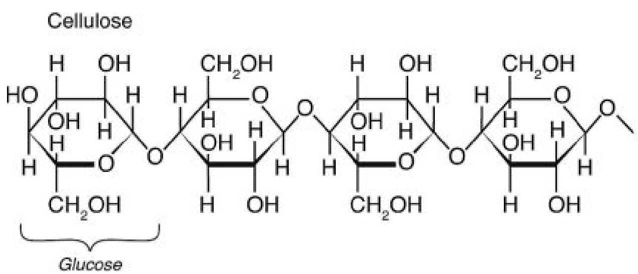
Condition

Water Saltility: 31PSU
Temperature: -5℃ ~-20℃


Group a
Group b
Group c
Group d

Group c got the best result among the four groups. The sponge was found to have the strongest water absorption efficiency in the observations, being completely saturated with water in a very short time. It is also the first to achieve ideal firmness during the freezing process.

In the previous sturdiness test, It is resistant to the common forces like bending and squeezing, both before and after freezing.



Gorup c

Material: Cellulse, hemp fibers and sodium sulfate crystals...

This is because cellulose has a strong affinity to itself and materials containing hydroxyls, especially water. Based on the preponderance of hydroxyl functional groups, cellulose polymer is very reactive with water. Water molecular smallness promotes the reaction with the cellulose chains and immediately formed hydrogen bonds.

Pros: In addition to being able to be connected to ice firmly, cellulose sponge is also a biodegradable artificial material.

Cons: Cellulose sponges tend to trap residue and bacteria, making them difficult to rinse out fully.3

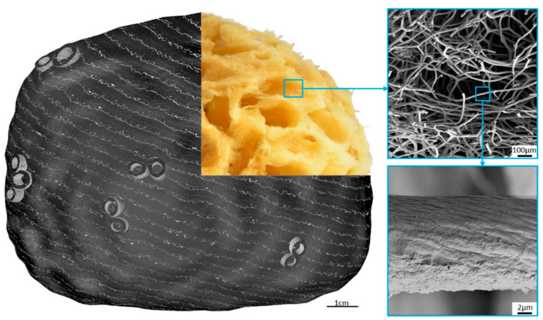
This drawback shortens the life of the sponge and causes it to break down or smell.
high price


Group b

-completely soaked from the very begining
-frozen from the top down
-The structure is initially weak because of the cavity inside


Group a

-gradually soaked as time goes
-frozen from the middle to the top then the bottom
-moderate solidness



Gorup a&b

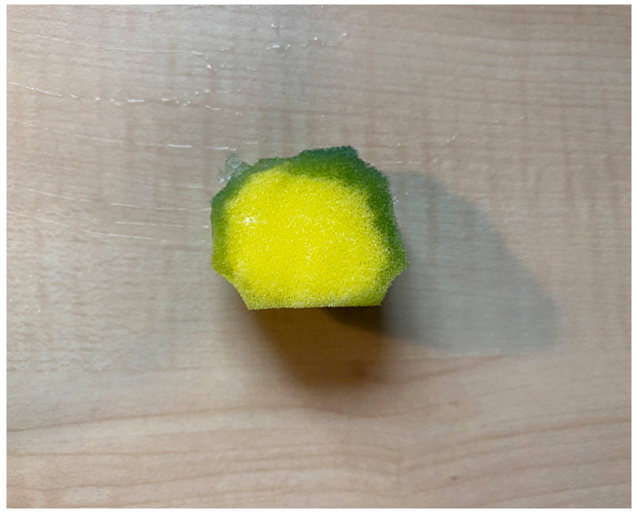
Material: calcium carbonate, silicon dioxide, spongin (a modified type of collagen protein)

(Experimental process description)

The natural sponges we use are actually animal skeletons. Bath sponges consist of a highly porous network of fibres made from a collagen protein called spongin. The skeletons are obtained by cutting the growing sponges and soaking the cut portions in water until the flesh rots away.

They absorb and store water through pores in their structure, but do not have strong bonds with water molecules.

Sea sponges have been over-harvested from the major sponge-gathering areas around the Mediterranean, Caribbean and Florida coasts, but demand remains high.



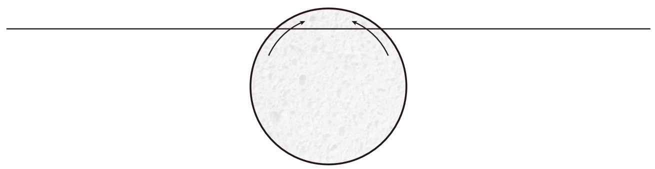
Group d

-barely absorb water without squeezing
-frozen from the middle part and outer part
-The volume of ice is much smaller than other groups

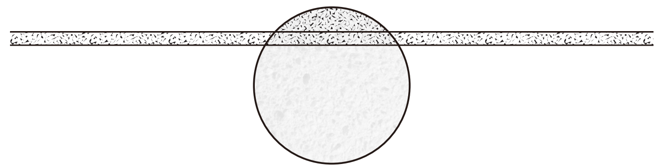
Gorup c

Material: Polyester sponges

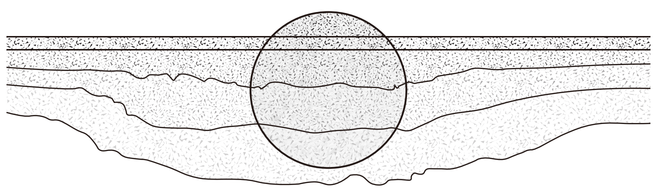
-worst performance
-non-recyclable and non-biodegradable



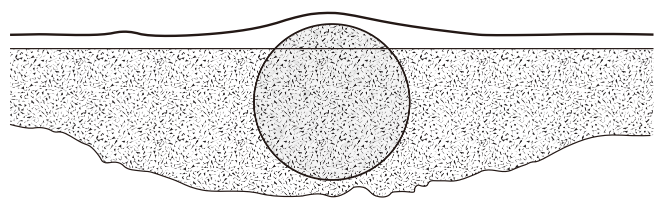
The sponge sinks as it absorbs water, the upper part also absorbs water due to the capillary effect.



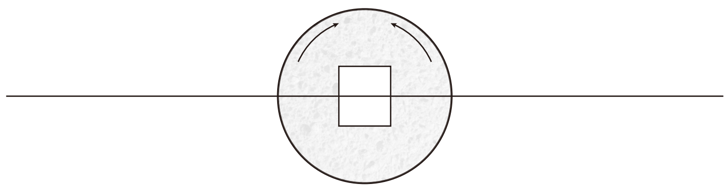
Water exposed to cold air freezes first. Includes the tip of the sponge and the surface of the water.



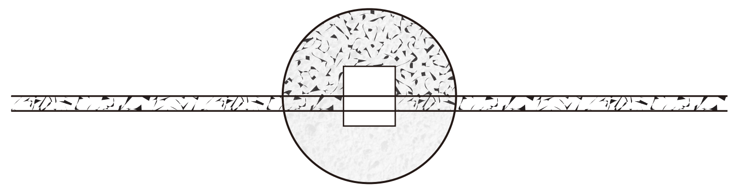
Over time, ice builds up under the surface.



The snow will settle firmly on the ice, creating a more enjoyable surface.



The sponge is combined with other materials to increase the buoyancy of the structure, which maximizes the capillary effect

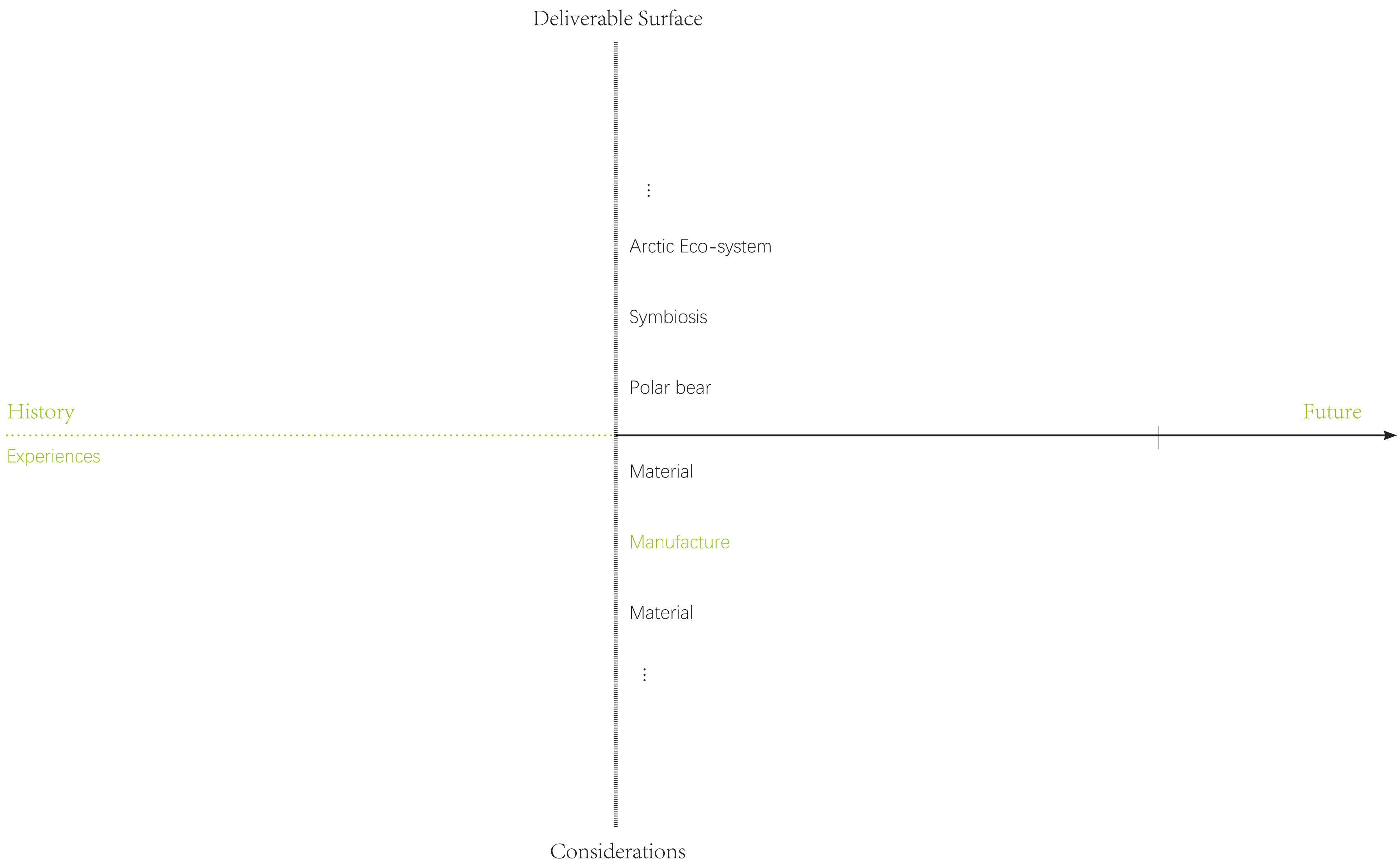


This allows more water to be exposed to cold air, which make the structure solidifies faster.and also remains longer.

Through careful study of the relationships between the elements of the Arctic ecosystem, a series of prototypes were created through imitation and substitution.

The principle of substitution is to carefully study the nature of the animal's needs and replace its natural space with an artificial one that meets the same needs.

My research on the Arctic is an ongoing process that goes hand in hand with my design. So the prototypes should keep evolving, both for accumulating experience and responding to new found needs.


Deliverable Surface
⋮
Arctic Eco-system
Symbiosis
Polar bear
History
Future
Experiences
Material
Manufacture
Material
⋮
Considerations

Design Phase 01: Imitate

Sea Ice   Carrier of Arctic species

Polar bears

Formation

Other ice-based creatures

Marine enviroment

Source of energy

Nesting area

Floating structure[island]

Hunting area

Avoidance behavior

Extreme weather

Design Phase 02: Supplement

Biologic Chain

Ecosystem

Benetho Species and vertical flux

Floating System

Connection with "Local"[site]

Design Phase 03: Substitute

Seals Nesting Habit

Food Chain

Den Ecology   Autonomy

Structure

Mechanism

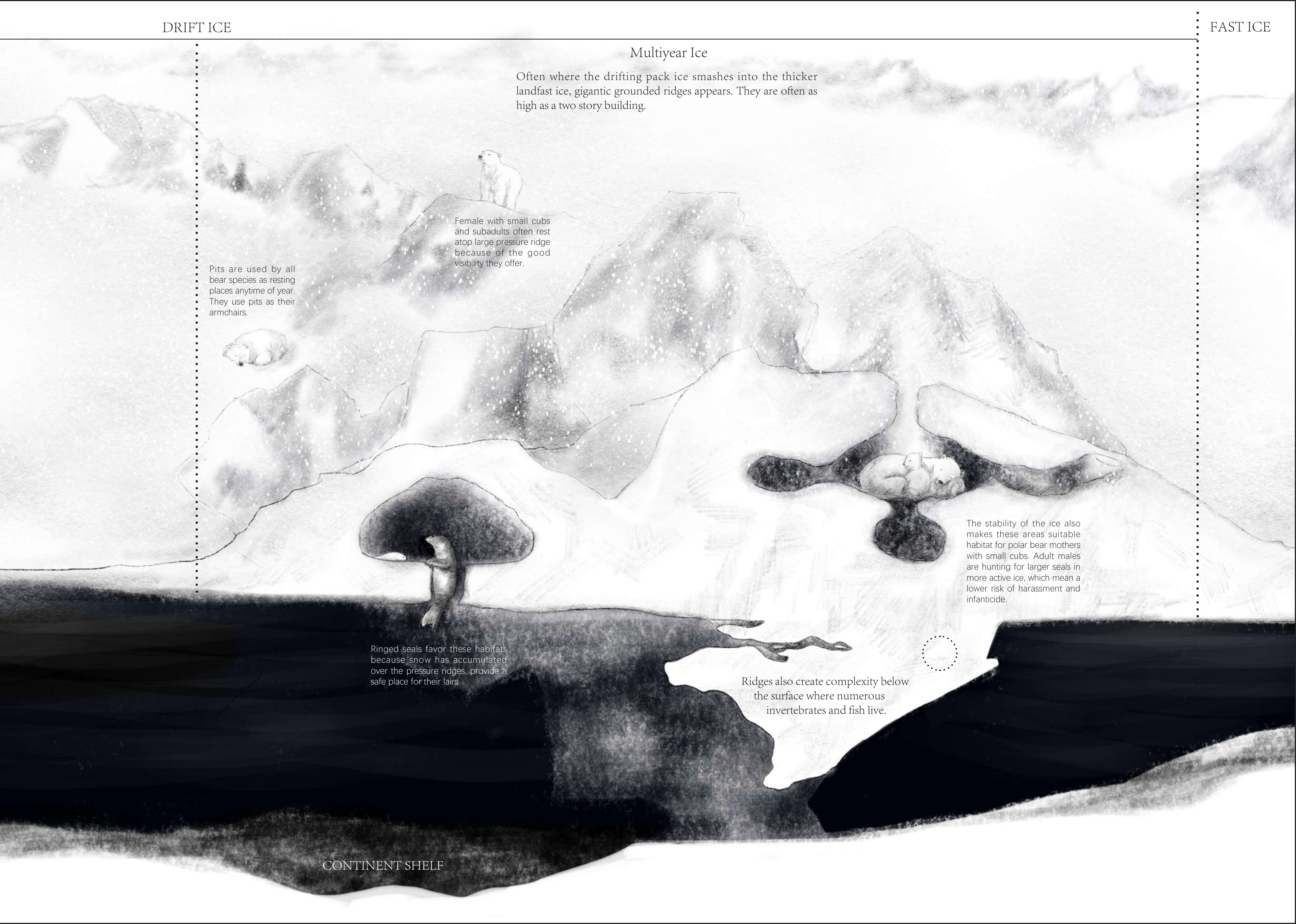
Sponge freezing mechanism

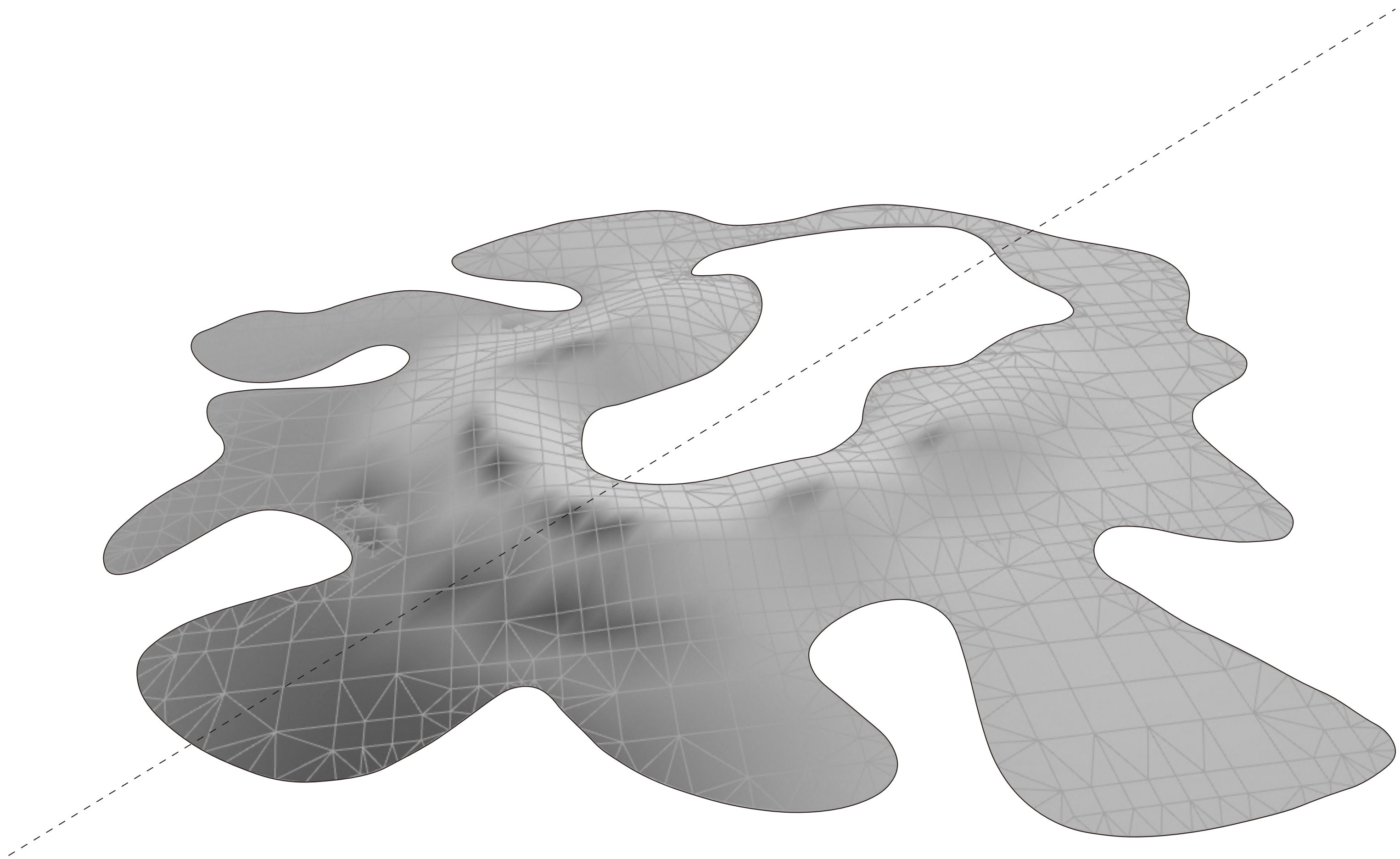
-Arctic Eco-system
-Symbiosis
-Polar bear ecology
-Material
-Construction

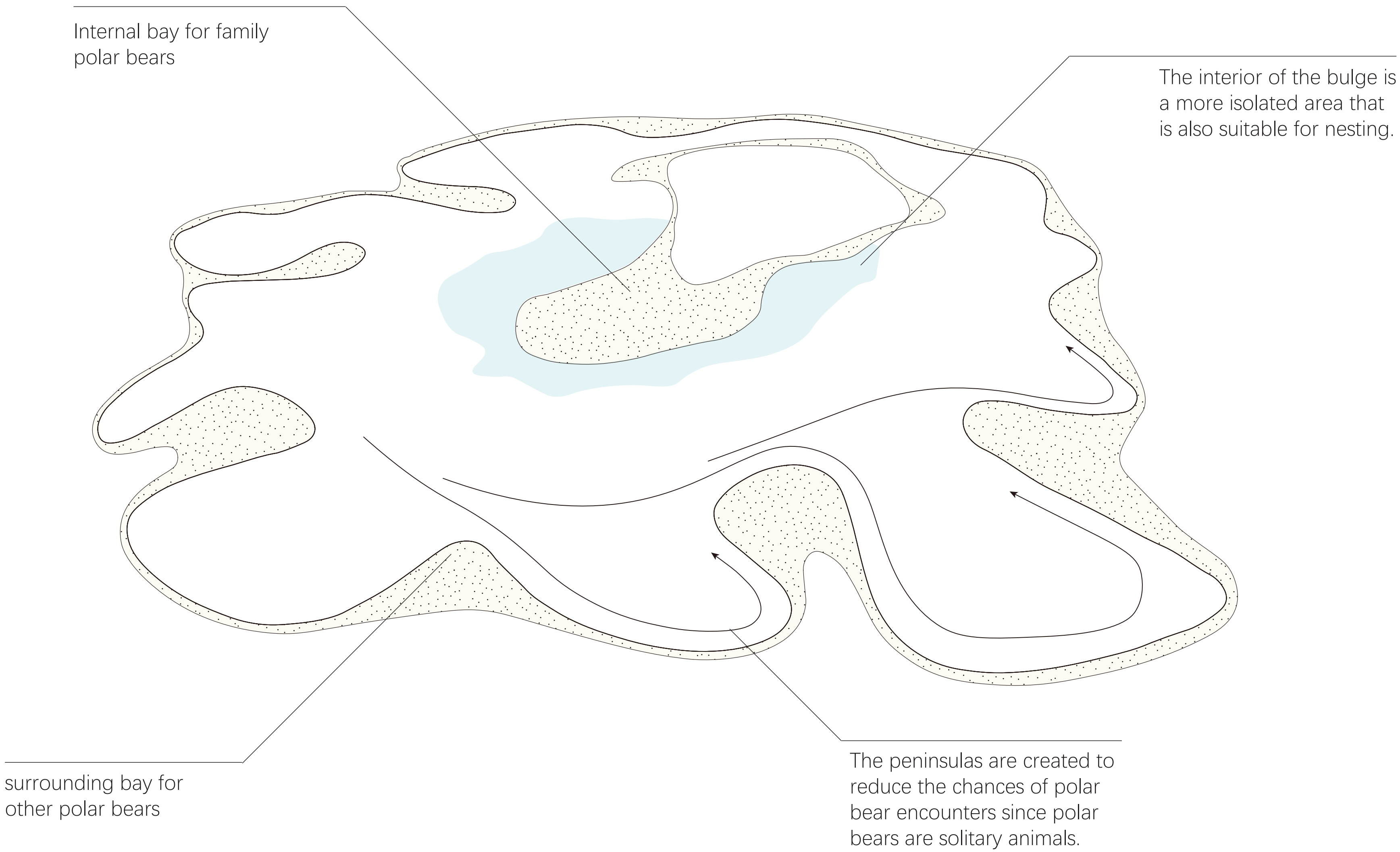
DESIGN STRATEGIES

	Nature Reference	Logic	Methods
Design Phase 01: Imitate	Habitats for various species on sea ice -Forms -Positions -Relations to the environment Ice Edges Avoidance behavior Ice Accumulation	Mimicking and condensing existing systems	Build up prototypes
Design Phase 02: Supplement	Passive demand of polar bears [Minimal Autonomy] Dynamic & balanced ecosystem A stable nutrient environment	Randomness as precondition design the system	Provide effecient route to support random energy transition Design system+Make room.
Design Phase 03: Substitute	Intiative demand of polar bears [Rich Autonomy] Moving Pattern (piece-division-unit)	Similar condition with variations. randomly qualified space	Qualified space generate+ give randomness. Design Randomness Provide enough place to hold random snow..

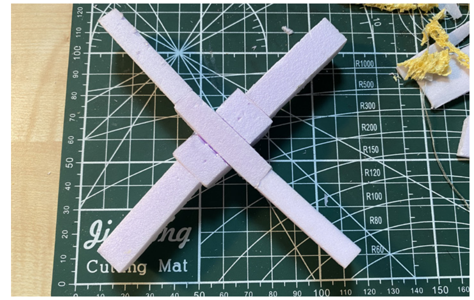

First Year Ice
Leads are critical hunting area for polar bears. They are usually formed by wind tide current. Ice can also form belts, tongues, and strips in open water. Harp seals often show up there.In many ways, the shore lead acts like a polar bear highway.
Polar bears hunt near annual ice (or first year ice) because seals usually make their breathing holes in the thinner ice
Bacteria, viruses, algea
Zooplankton
Polar cod

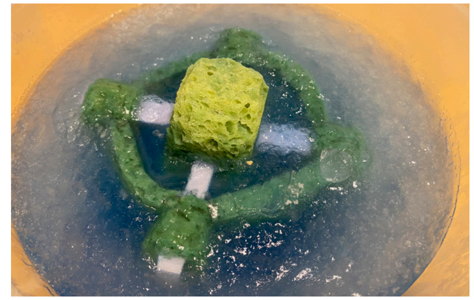

DRIFT ICE
FAST ICE
Multiyear Ice
Often where the drifting pack ice smashes into the thicker landfast ice, gigantic grounded ridges appears. They are often as high as a two story building.
Female with small cubs and subadults often rest atop large pressure ridge because of the good visibility they offer.
Pits are used by all bear species as resting places anytime of year. They use pits as their armchairs.
The stability of the ice also makes these areas suitable habitat for polar bear mothers with small cubs. Adult males are hunting for larger seals in more active ice, which mean a lower risk of harassment and infanticide.
Ringed seals favor these habitats because snow has accumulated over the pressure ridges, provide a safe place for their lairs.
Ridges also create complexity below the surface where numerous invertebrates and fish live.
CONTINENT SHELF

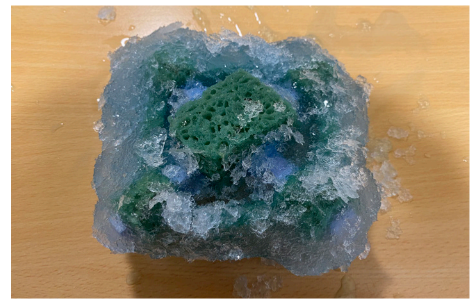



Internal bay for family polar bears
The interior of the bulge is a more isolated area that is also suitable for nesting.
surrounding bay for other polar bears
The peninsulas are created to reduce the chances of polar bear encounters since polar bears are solitary animals.

Substitution

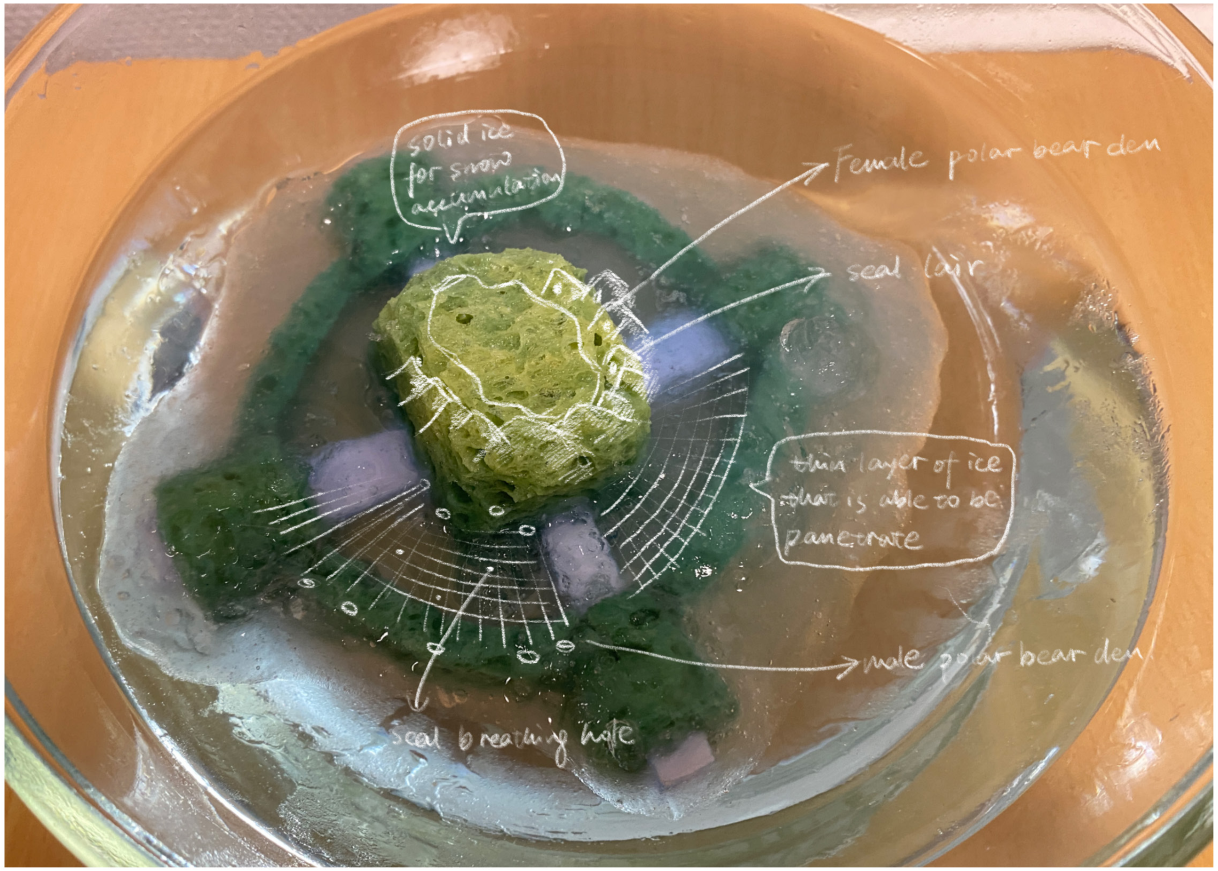






Condition

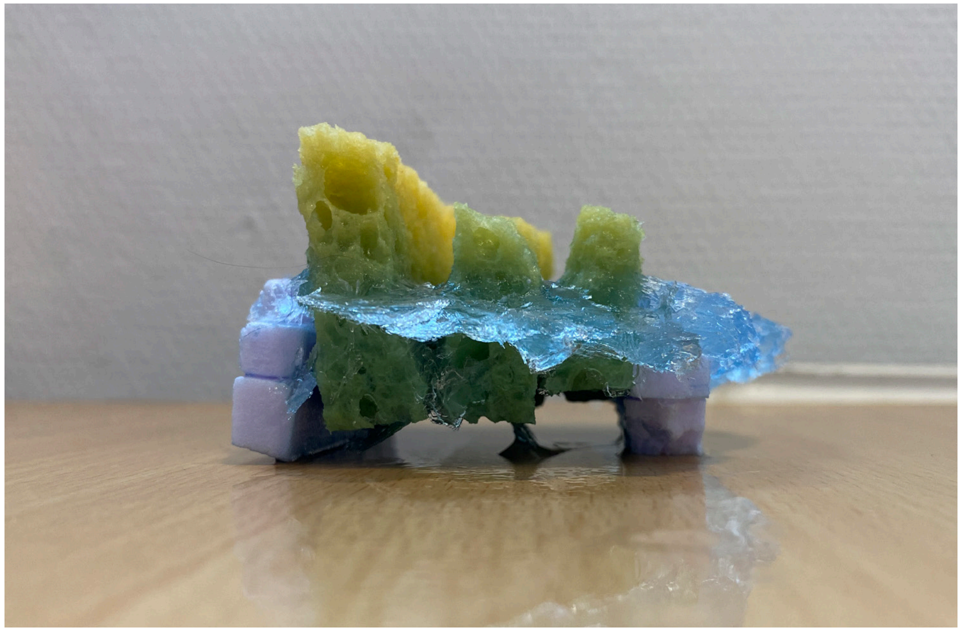
Water Saltility: 31PSU
Temperature: -5℃ ~-20℃



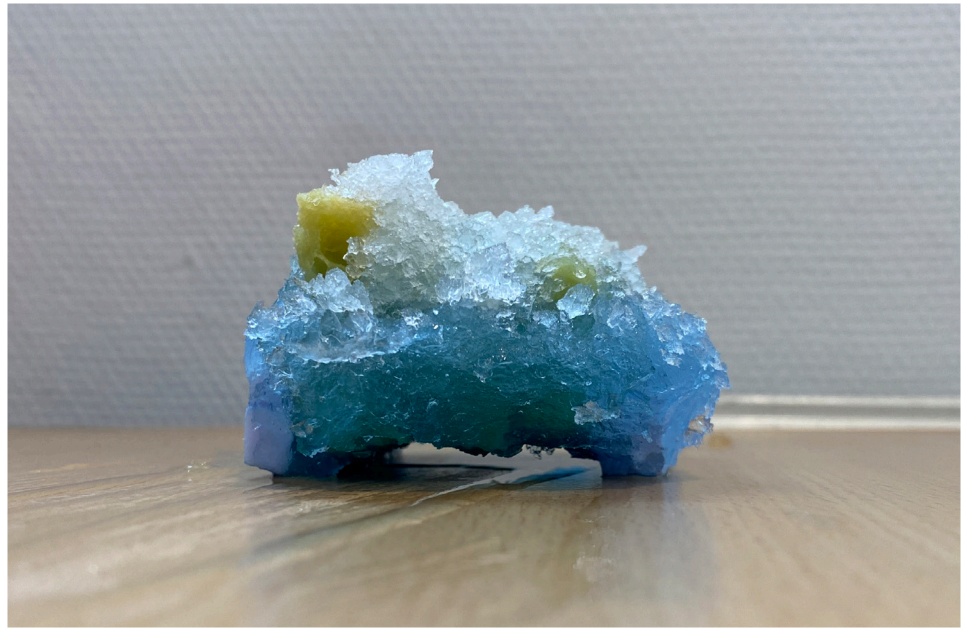
The first simple conceptual model takes into account the security needs and food access of different groups of polar bears, mimicing the form of nature sea ice structures which polar bear uses, however, without consideration of scale.


The gird structure could help hold the ice in the gaps.

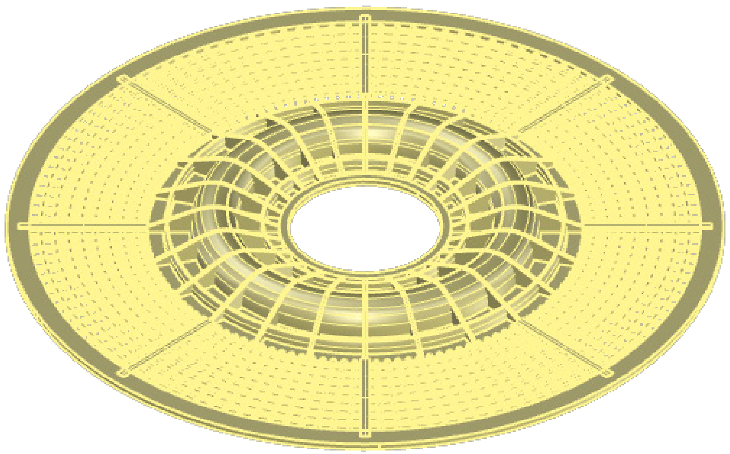

It can maintain a uniform thickness, and has a certain toughness



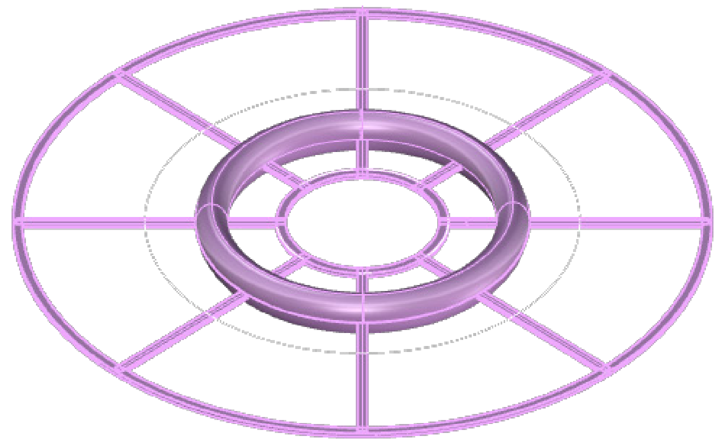
The ice near the surface of the water condenses first, ready to provide support for the fallen snow.



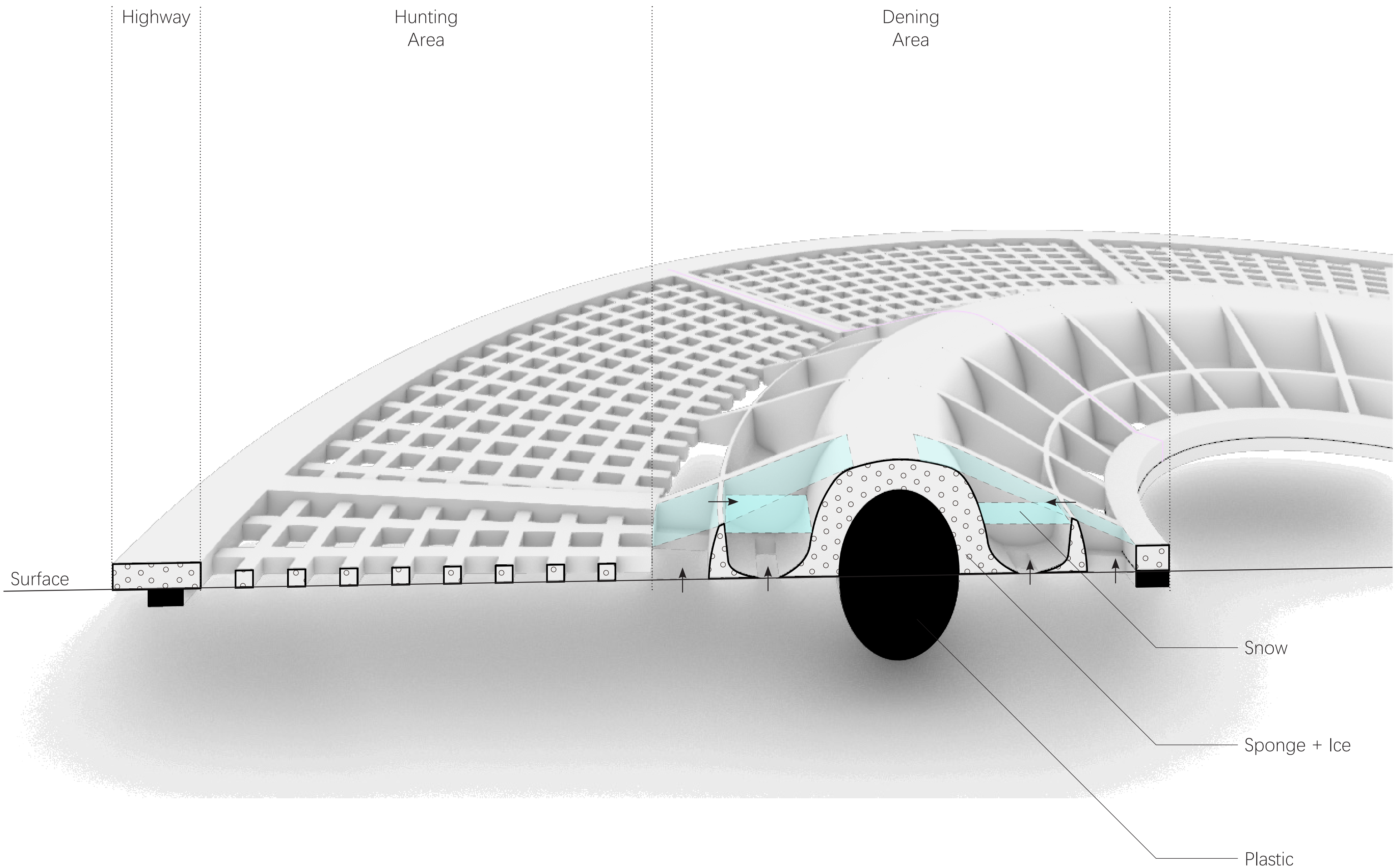
Snow covers the surface of the sponge, accumulates in the middle of the sponges' voids, and then re-strengthens in the cold air



The sponges use the isotropy of the circle to combine the structural features of hunting and living quarters, and ultimately form a basic system.



The plastic core inside provides buoyancy throughout the structure and supports the sponge shape during the initial placement of the structure.before freezing.


Highway
Hunting
Area
Dening
Area
Surface
Snow
Sponge + Ice
Plastic

Continuing design thinking:

-Vertical opening
Snow can fall to the bottom of the structure to maximize the use of sponge walls.

-Man-made elevation
Form a terrain similar to the original habitat by staggering the levels, make it easier for polar bears to dug their den's entrance , as well as to climb and detect threatens.

-Grid structure
Facilitate the formation of ice

New Attempts:

-How to break down the rigid system

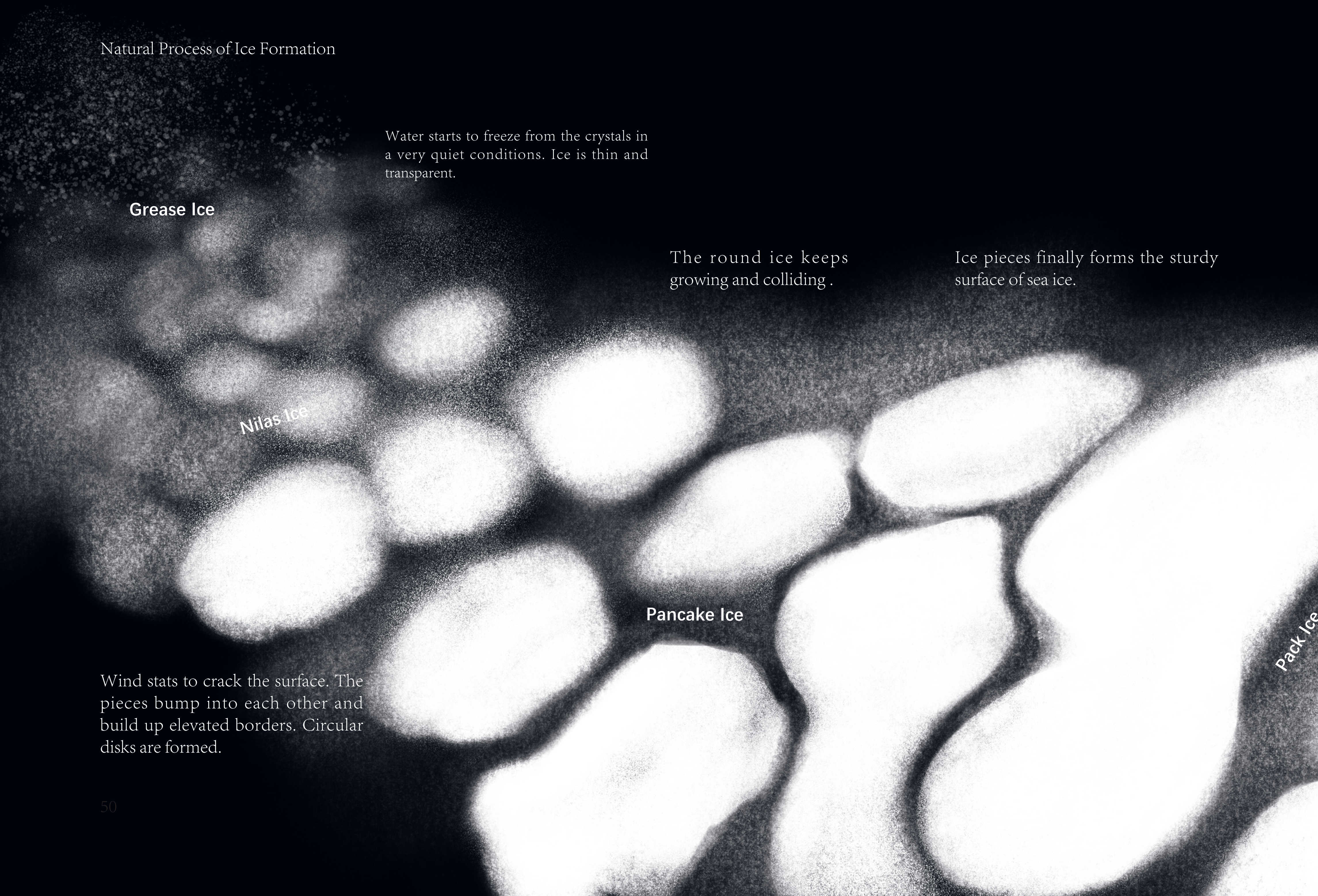
-How to add more variations in the structure for polar bears to choose from. At the same time maintain the stability of the system.

Design Phase 02: Supplement

	Nature Reference	Logic	Methods
Ice edge system	Ice formation Ice crack	Looking for randomness in the system, Look for systems in randomness.	Design system: It is no longer designed by local conditions, but by looking for conditions to determine the region.

Natural Process of Ice Formation

Water starts to freeze from the crystals in a very quiet conditions. Ice is thin and transparent.



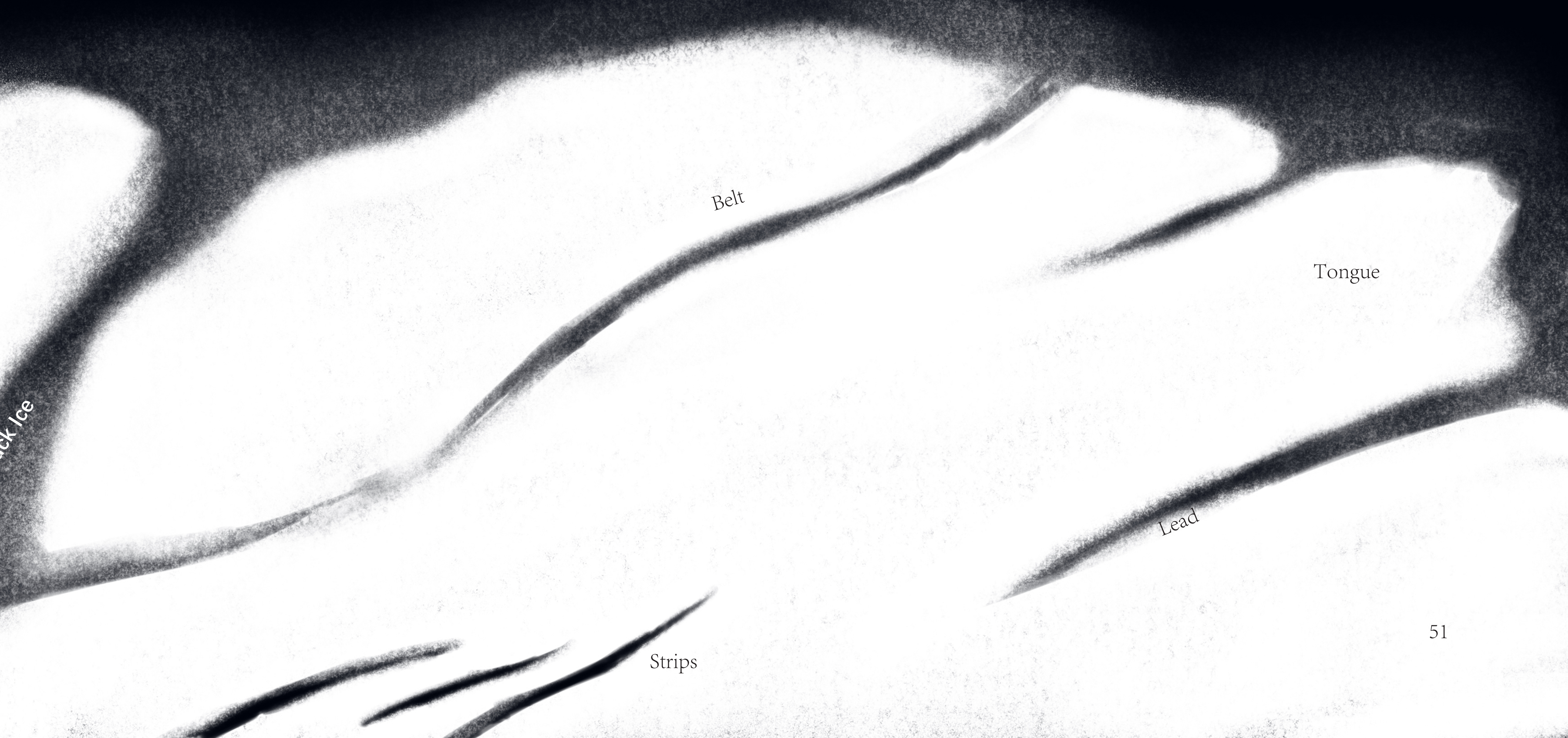
The round ice keeps growing and colliding .

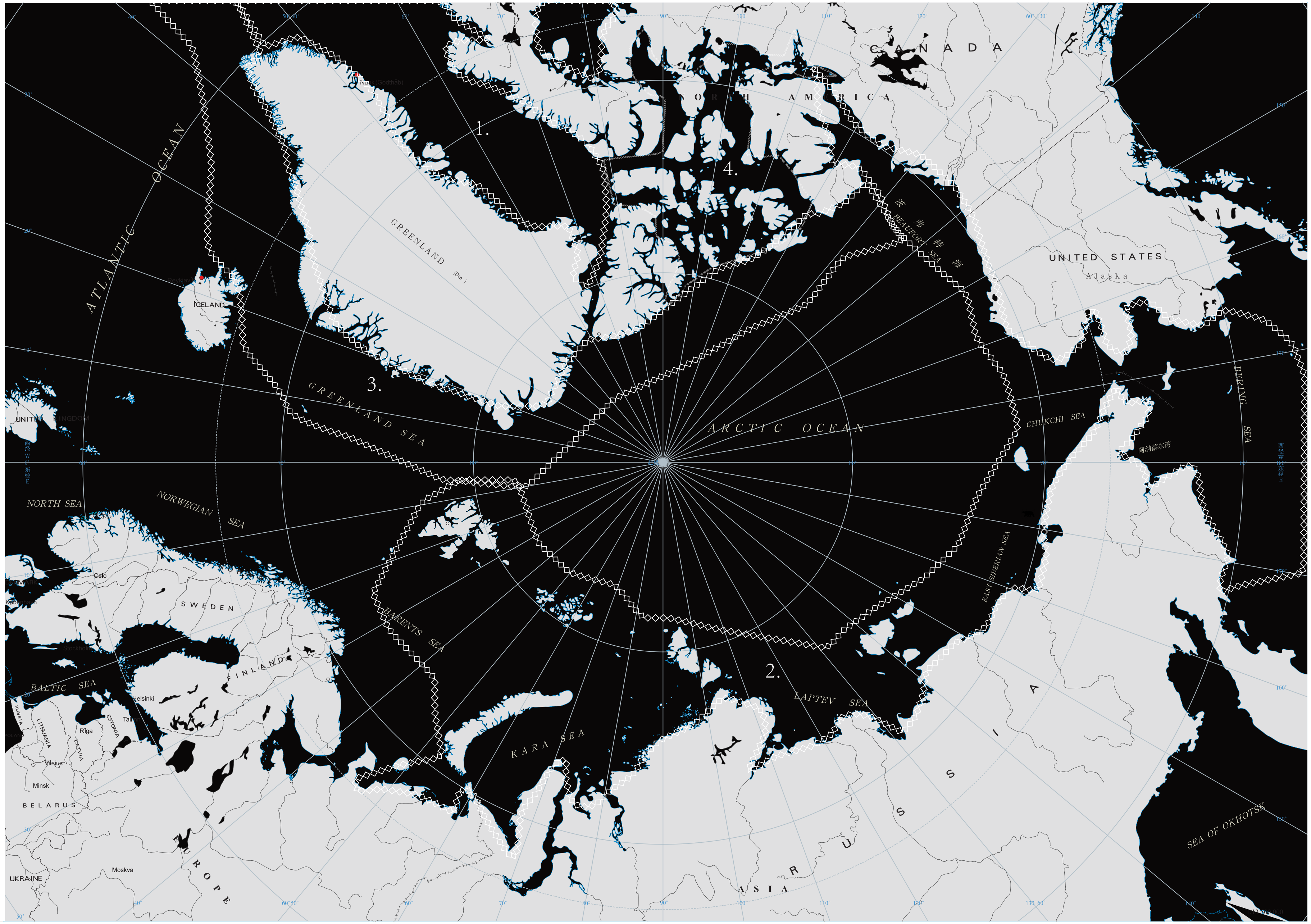
Ice pieces finally forms the sturdy surface of sea ice.

Wind stats to crack the surface. The pieces bump into each other and build up elevated borders. Circular disks are formed.

Ice Lead

Sea ice is frequently categorised based on whether it is adhered (or frozen) to the beach. It is referred to as land fast ice if it is connected. Otherwise known as drift ice, it is free to move with the currents and winds. This is why leads are usually found in the drift ice zone. They are thought to be a stress-relieving mechanism in reaction to divergent current flows or wind influences. Leads are fractures or fissures that begin inside an otherwise continuous sea ice cover and gradually open out. They are linear features, albeit not always absolutely straight, because they might consist of any number of small offsets at an angle to the main trend of the original fracture. This fracture has the potential to cut through both thin and thick ice. Because leads are connected with the early breakup of an ice cover, they pave the way for numerous dynamic processes involving the interaction of individual floes, such as the creation of pressure ridges, to occur later. Leads may also shut depending on the degree of tension inside the drift zone. As the two sides converge back near each other, finger rafting of the new ice inside the lead is possible.

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2.
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CANADA
NORTH AMERICA
GREENLAND
UNITED STATES
Alaska
ATLANTIC OCEAN
ICELAND
GREENLAND SEA
ARCTIC OCEAN
BEAUFORT SEA
波弗特海
CHUKCHI SEA
BERING SEA
阿纳德尔湾
NORTH SEA
NORWEGIAN SEA
SWEDEN
FINLAND
BALTIC SEA
BARENTS SEA
KARA SEA
LAPTEV SEA
EAST SIBERIAN SEA
RUSSIA
ASIA
EUROPE
SEA OF OKHOTSK
Oslo
Helsinki
Riga
Minsk
Moskva
ESTONIA
LATVIA
LITHUANIA
BELARUS
UKRAINE

-Original Ecoregion

There are four species of polar bear ecoregion, each of which faces varying degrees of challenge as a habitat for the polar bear's chosen era, where the water is nutritious and convenient for evacuation during the summer ice-free period.

Polar Bear Ecoregion

1.The Seasonalized Ice Ecoregion

This area is only composed of annual ice. Polar bears have to head to shore when summer. Polar bears historically doing just fine in the enviroment because it's mainly located on the continent shelf and is productive. So they could gain enough weight before heading to shore. But as global warming the ice is melting sooner and forming later.

2. The Divergent Ice Ecoregion

In this region ice form along the shoreline and drift away with current into the center of the polar basin. So in the summer there's huge gap between shoreline and sea ice. This wasn't a problem because the ice didn't retreat that far. Now the polar bear has to face the similar situation as those in seasonalized ice ecoregion. They either have to head north to the center of the polar basin or stay on shore where there's nothing to eat. But the water of the deep polar basin is not very productive.

3. The Convergent Ice Ecoregion

Now the ice from the divergent ice ecoregion is moving from shore out into the polar basin, but a lot of it piles up against the shoreline in northern Canada and also in northern Greenland. Historically polar bear didn't come ashore either and it remains a good polar bear habitat throughout the summer even now because the ice is continually drifting against the shore here.

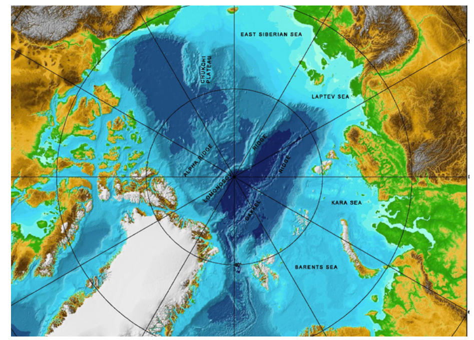
4. The Archipelago Ice Ecoregion

It is composed of the narrow channels of water between the high Canadian Arctic islands. They are very far north so is very cold even with global warming so polar bears don't have to come ashore.

Site Features

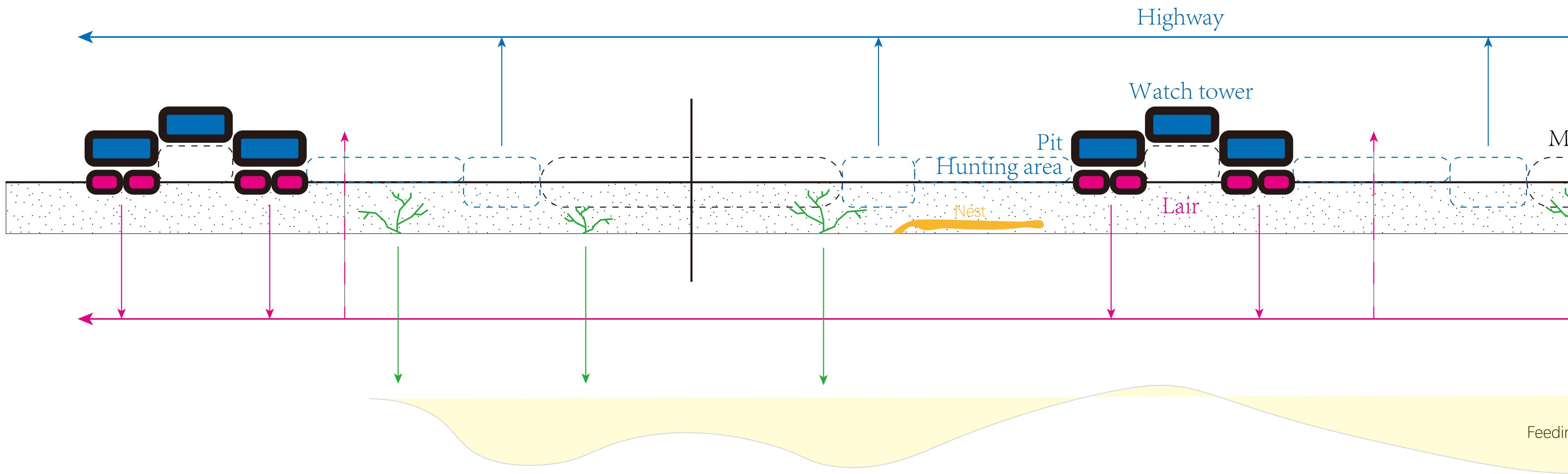
-Fragmented area

The area is still cold enough to freeze, we could slow down ice fragmentation by providing support for ice.



-Connected to continent shelf

This means that the device is positioned closer to the land on the southern side of the ocean, which is more nutritious and productive than that in the Arctic basin.



Bentho Communities

Arctic benthic communities are integral to the functioning of the ecosystem. They provide essential ecological services, including nutrient recycling, organic matter decomposition, and acting as a food source for higher trophic levels such as fish and marine mammals. Benthic organisms also play a crucial role in carbon storage, as the Arctic seafloor acts as a significant sink for organic carbon.

Vertical Flux

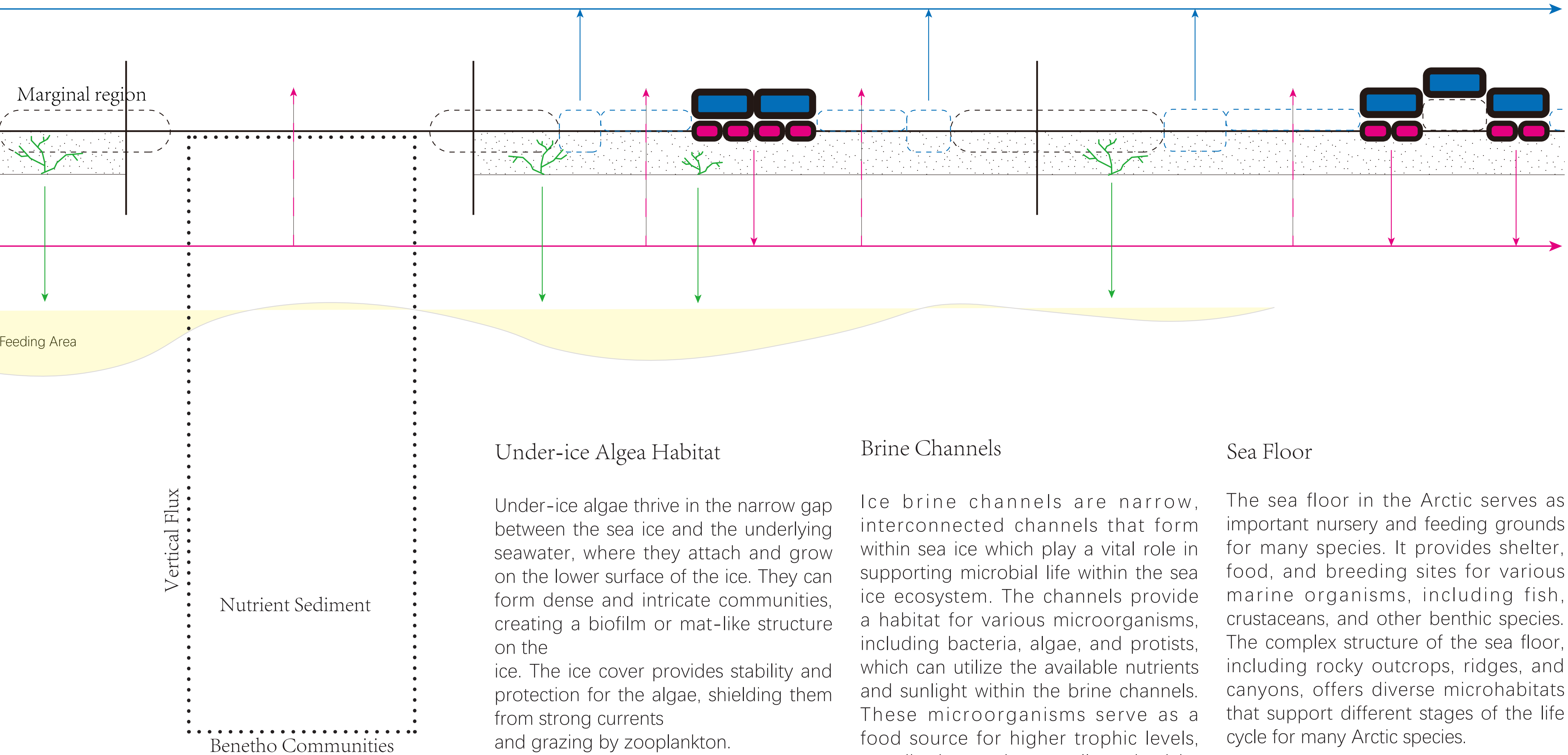
The vertical flux is driven by various processes and factors, including primary production by phytoplankton in the surface waters, sinking of particles and organic matter, physical mixing and turbulence in the water column, and biological activity.

These processes interact to influence the distribution and fate of nutrients, carbon, and other important elements in the Arctic ecosystem

The high primary output created by melting ice is not immediately utilized by planktonic grazers and eventually settles on the shelf bottom over a period of hours to days. These bottom sediments include high-quality food and grain sizes that are compatible with the anatomic features of benthic suspension feeders and other benthic groups..

Sub-ice Melt Pond

Sub-ice melt ponds can occur when the ice is sufficiently permeable, allowing water to flow or seep into the lower layers of the ice. This can happen through cracks, fractures, or porous regions in the ice structure. The accumulation of meltwater in these sub-ice ponds can contribute to the overall hydrology and energy balance of the sea ice system



Under-ice Algea Habitat

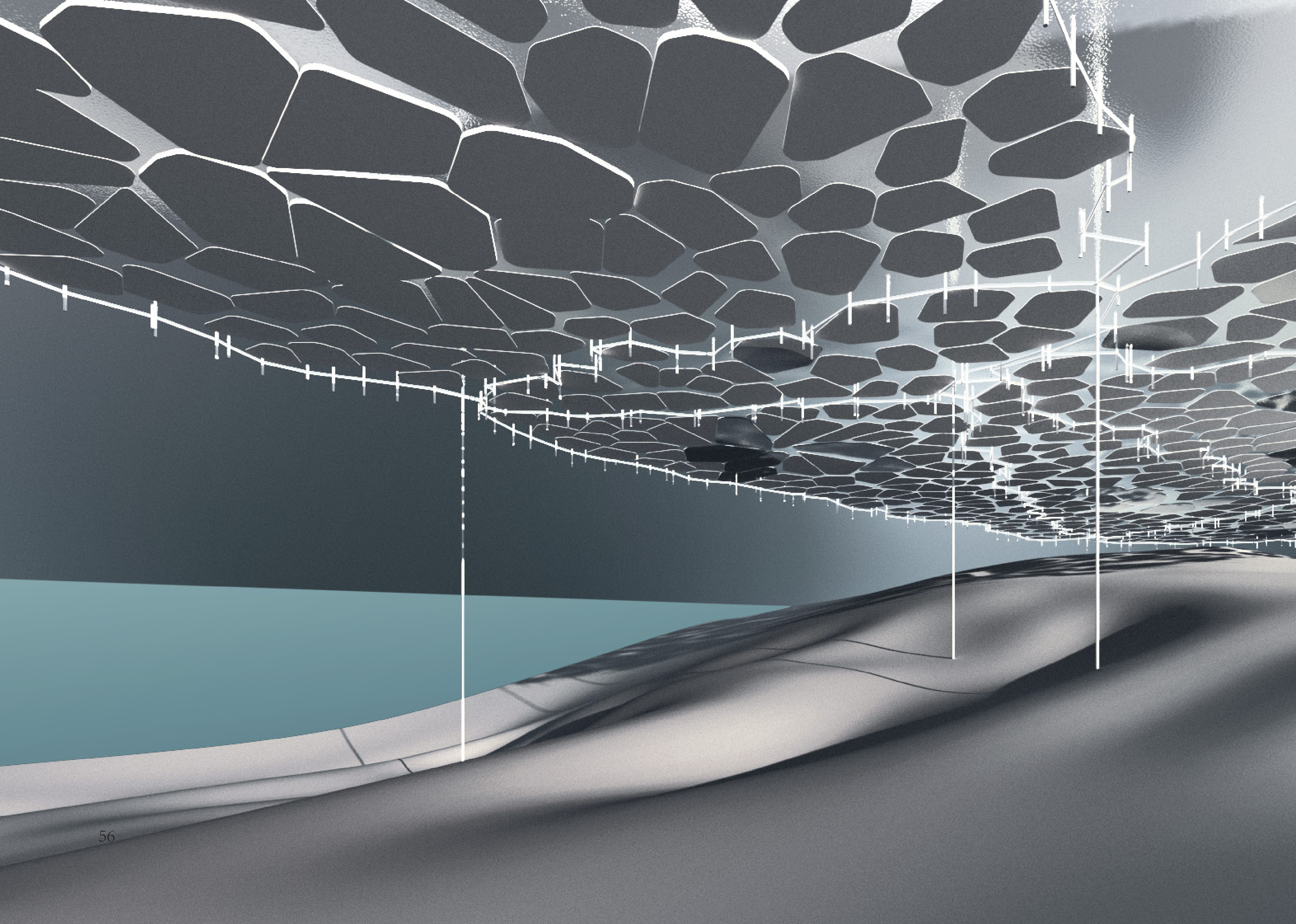
Under-ice algae thrive in the narrow gap between the sea ice and the underlying seawater, where they attach and grow on the lower surface of the ice. They can form dense and intricate communities, creating a biofilm or mat-like structure on the
ice. The ice cover provides stability and protection for the algae, shielding them from strong currents
and grazing by zooplankton.

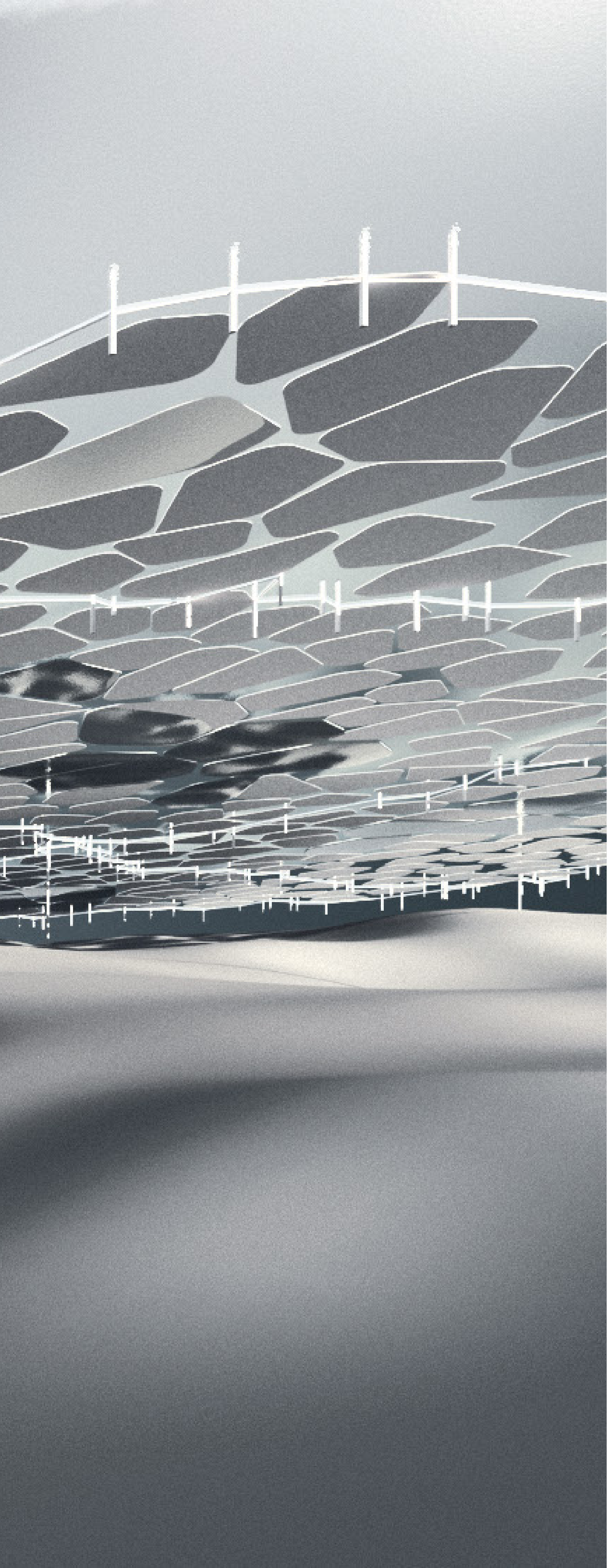
Brine Channels

Ice brine channels are narrow, interconnected channels that form within sea ice which play a vital role in supporting microbial life within the sea ice ecosystem. The channels provide a habitat for various microorganisms, including bacteria, algae, and protists, which can utilize the available nutrients and sunlight within the brine channels. These microorganisms serve as a food source for higher trophic levels, contributing to the overall productivity and biodiversity of the sea ice ecosystem.

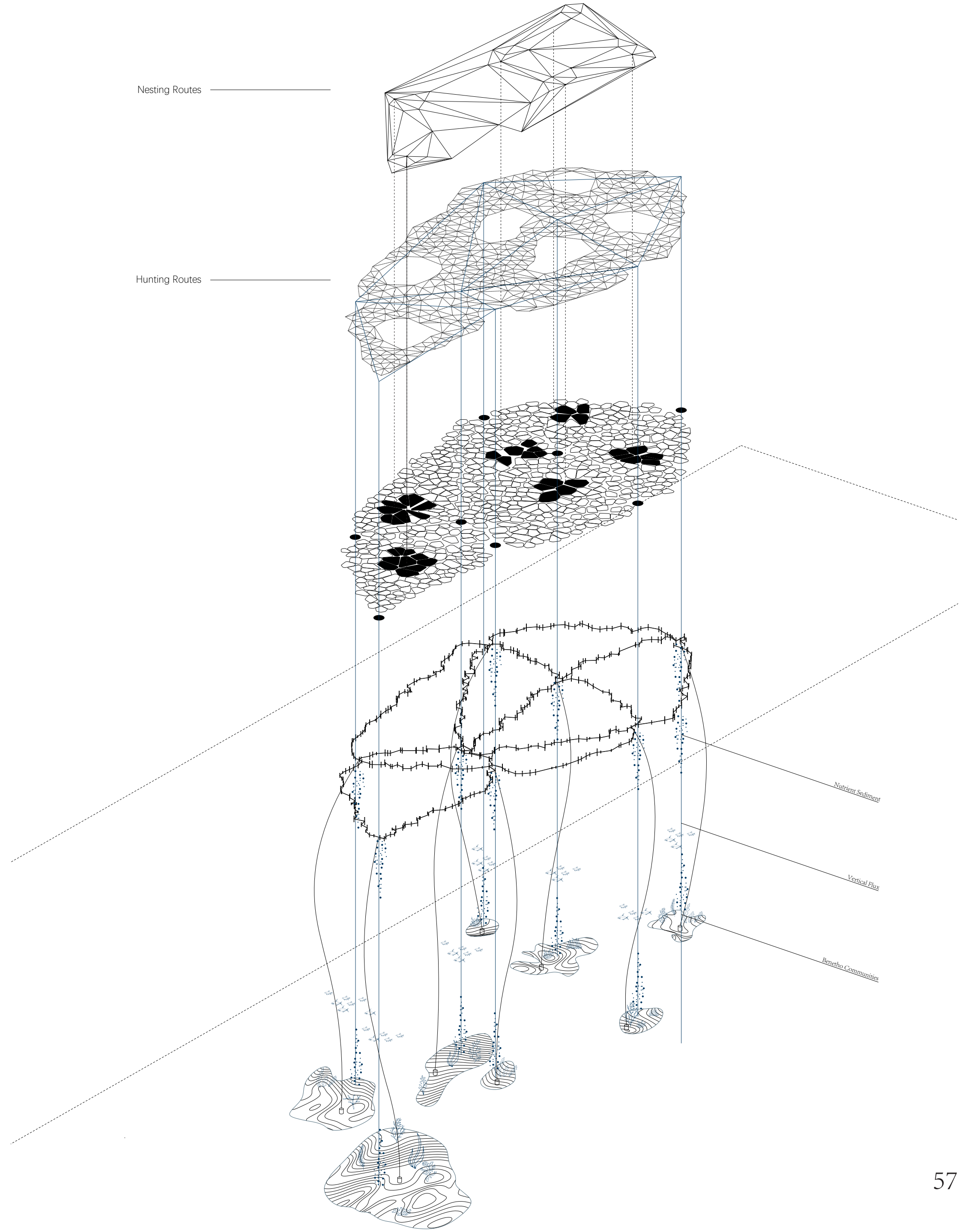
Sea Floor

The sea floor in the Arctic serves as important nursery and feeding grounds for many species. It provides shelter, food, and breeding sites for various marine organisms, including fish, crustaceans, and other benthic species. The complex structure of the sea floor, including rocky outcrops, ridges, and canyons, offers diverse microhabitats that support different stages of the life cycle for many Arctic species.





Ice Land Systems

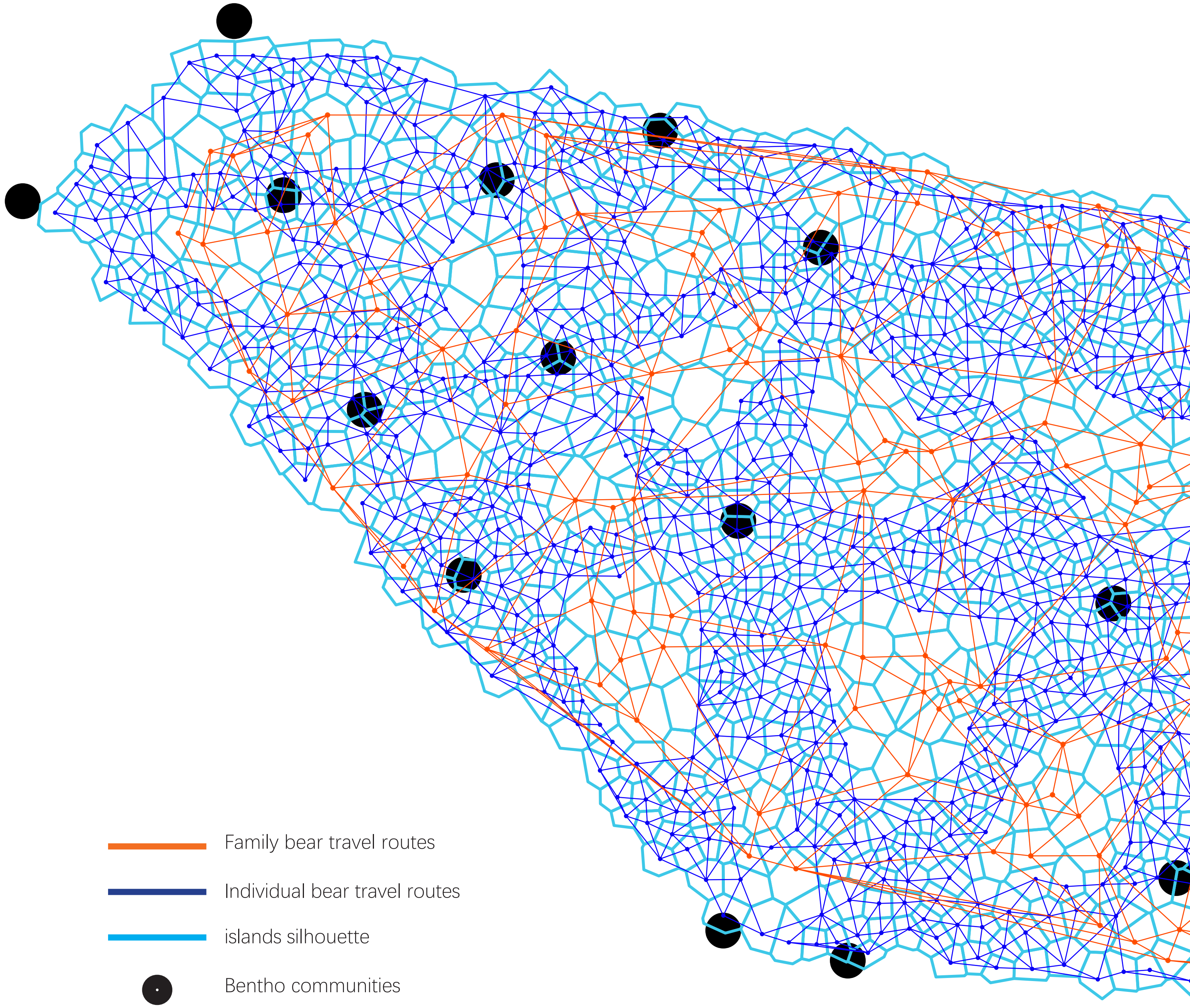


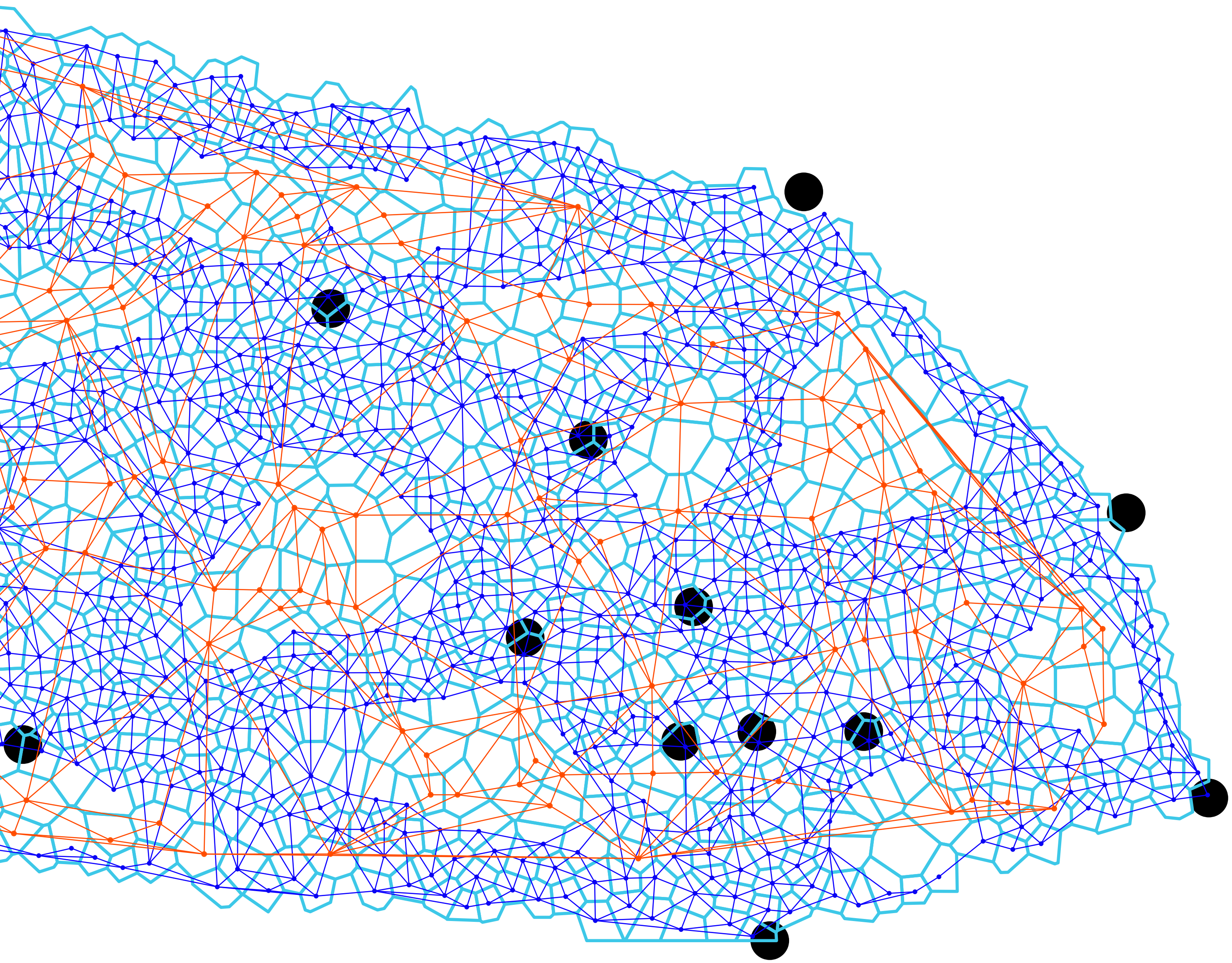
Family Polar bears:

The mother leads the family structure of the calf, and the main need is to find shelter. They hunt less and are more wary of males.

Individual Polar bears

Male polar bears usually have a very large hunting range, and they usually move around the edge of the ice, which is like a "highway" for them. They can adapt to active ice activity and make good use of the leads and belts formed by ice activity.





-Scientific Investigation on bentho topography

-stable substrate, moderate water flow, and high organic matter input

-Seamounts and ridges：underwater mountains and elevated areas

-Efficient network between desired bentho enviroment.

-Divide the habitat with segments of different sizes
-Resident
A larger, more stable cell at the center of the least disturbed network.

-Hunting
More fractured edges, increased sea ice activity and greater chances of seals.

Avoidance Behavior

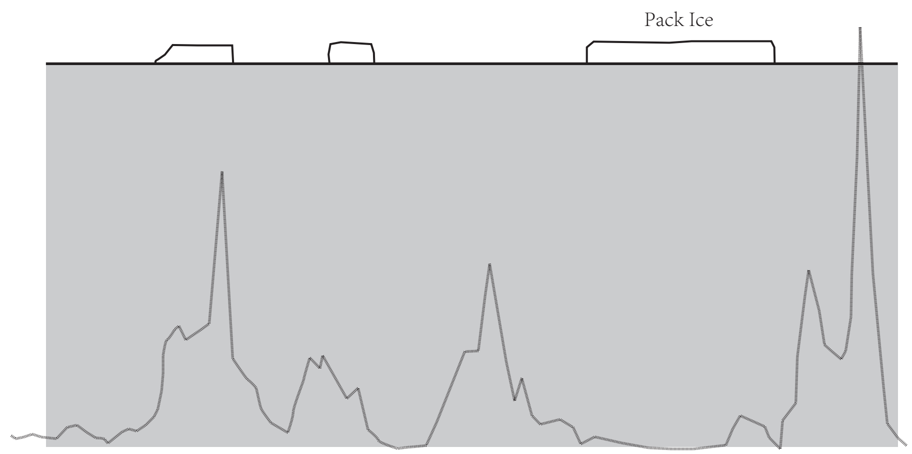
The edge of the movement also protects the seals to some extent to keep their numbers from getting out of balance with the polar bear population.

The Ice Edge

The ice edge (or marginal ice zone, frequently shortened to MIZ) is more than just a boundary where sea ice and its accompanying species vanish, to be replaced by open ocean and pelagicbiota.It is a dynamic zone (between 10 and 100 km wide) that is continually altering in position and interacting with the atmosphere to generate distinctive weather. Physical processes have a significant impact on biological processes.

The amount of energy that ultraplankton contributes to higher trophic levels has been debated. It is unclear if the general agreement that it does not apply to the MIZ. It has been proposed that food concentration by protozoa such as tintinnids and choanoflagellates might benefit relatively big zooplankton species such as krill. Regardless, higher trophic levels exhibit increased biomass and activity in the MIZ, as do lower levels.Microplankton productivity increases, organic debris deposition supports increased benthic production, and disintegrating ice floes provide shelter for bigger crustacea that attract fish, gulls, and seals.

The ice edge has sparked curiosity as one of the most biologically intriguing locations of the polar waters. Terrestrial ecologists have long recognized the unique characteristics of transitions between two or more distinct habitats, such as forest or grassland: tension belts or ecotones. Many creatures from neighboring communities, as well as those unique to, and occasionally confined to, the ecotone, are found in these communities. Ecotones often feature more species diversity and biomass density than surrounding communities, owing to the larger variety of niches and organisms' ability to draw on resources from neighbouring habitats. The ice edge is an ecotone, and it exhibits enhanced species variety and production, much like the terrestrial equivalents.



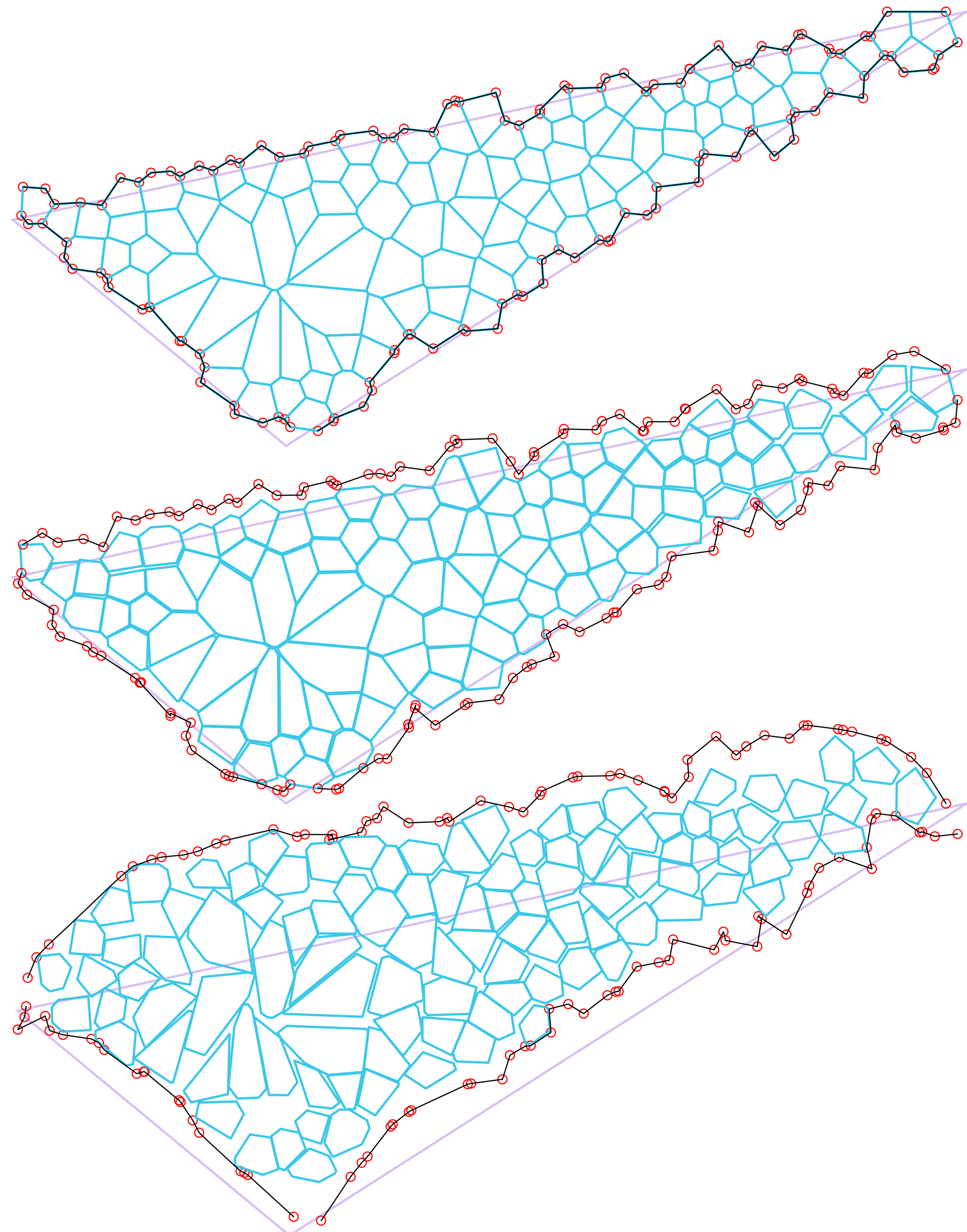
Detectable amounts of Phytoplankton associated with sea ice position.

Ice Edge System

The debris in the floating fence collides with each other under the influence of ocean currents, creating random gaps.

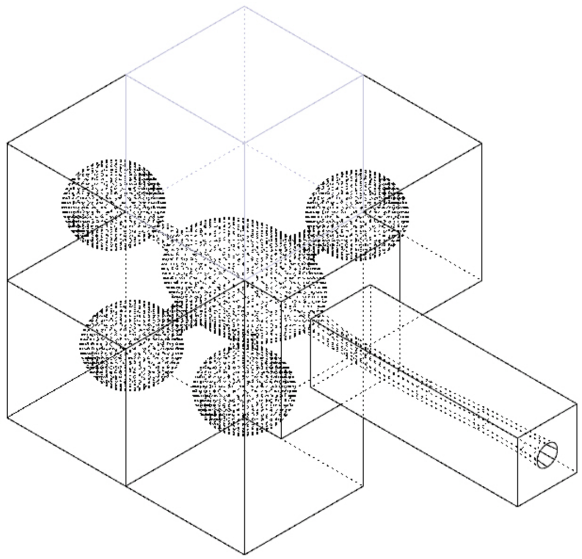
The system at rest in beginning is composed of tightly packed voronoi patterns, each fragment occupies a similar area, thus ensuring the functionality of each fragment.

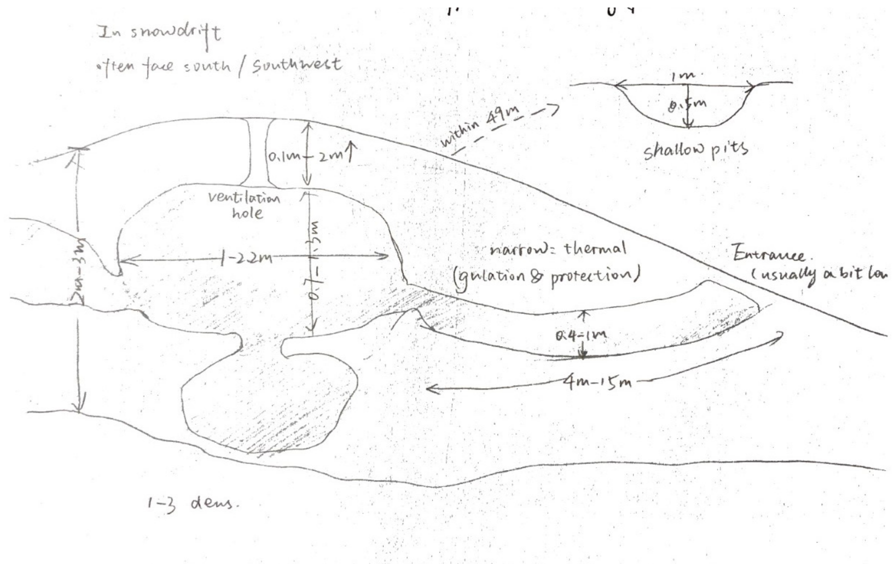
It also provide random edges which will significantly ruducing the possibility of the fragments being tightly packed when they collide.



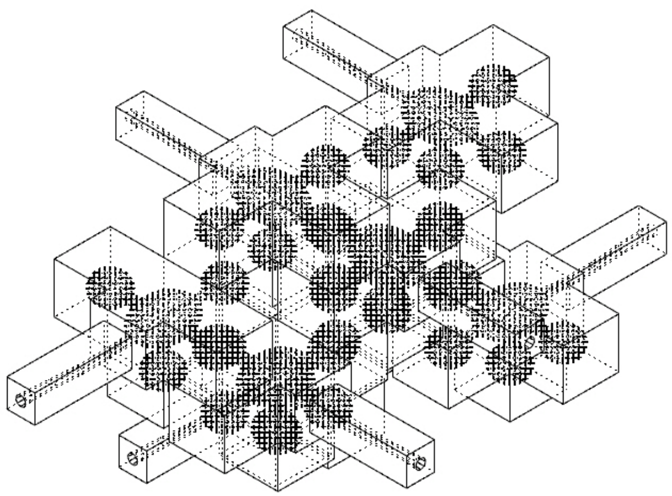
	Nature Reference	Logic	Methods
Demands of family polar bears	polar bear den ice ridges and habitat of other species	More options for polar bears to live in	Maximize snow use by identifying snow separation through polar bear needs.
	Relationship with other communities	Polar bear as architect themselves	Establish buffer isolation for seals.

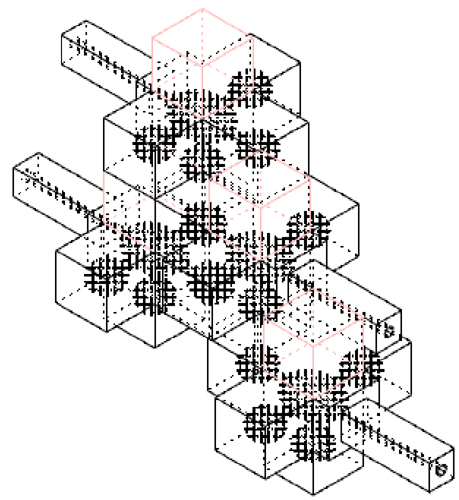
A Single Unit of Polar Bear den



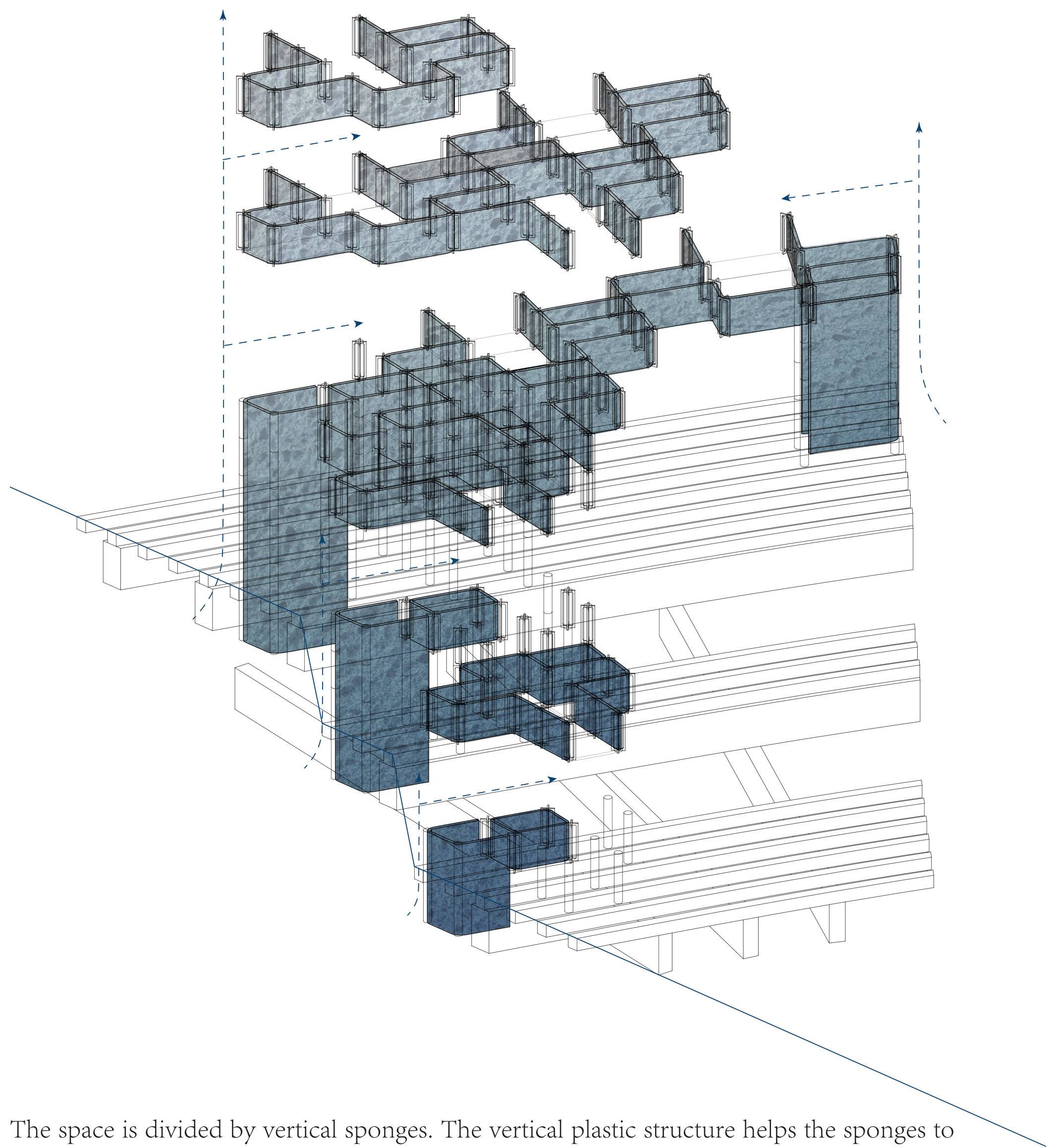


Staggering Method Test



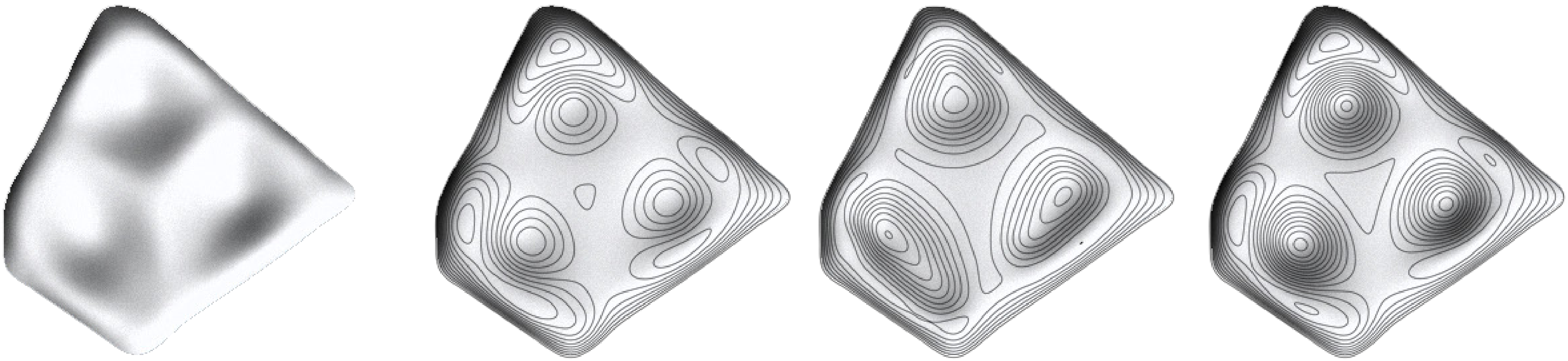


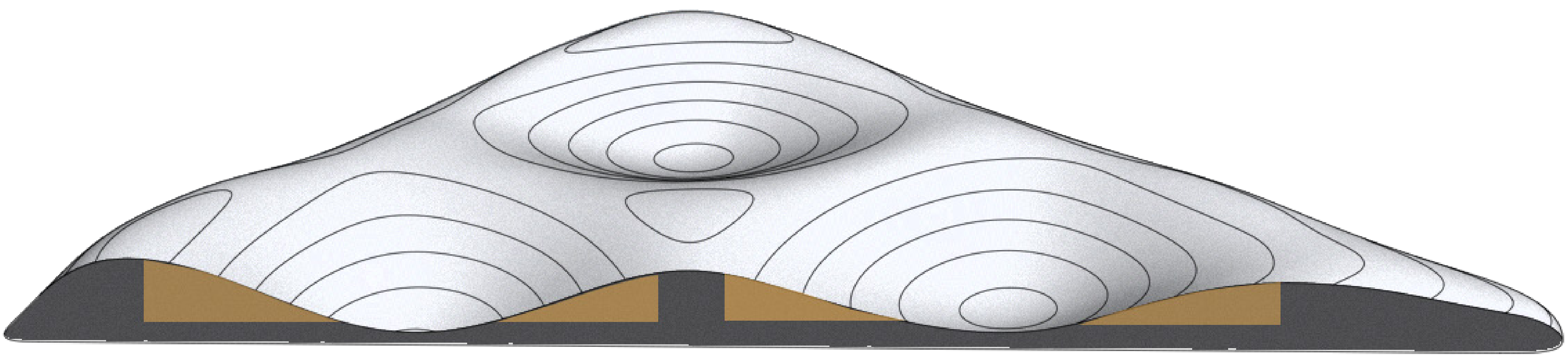
Mechanism



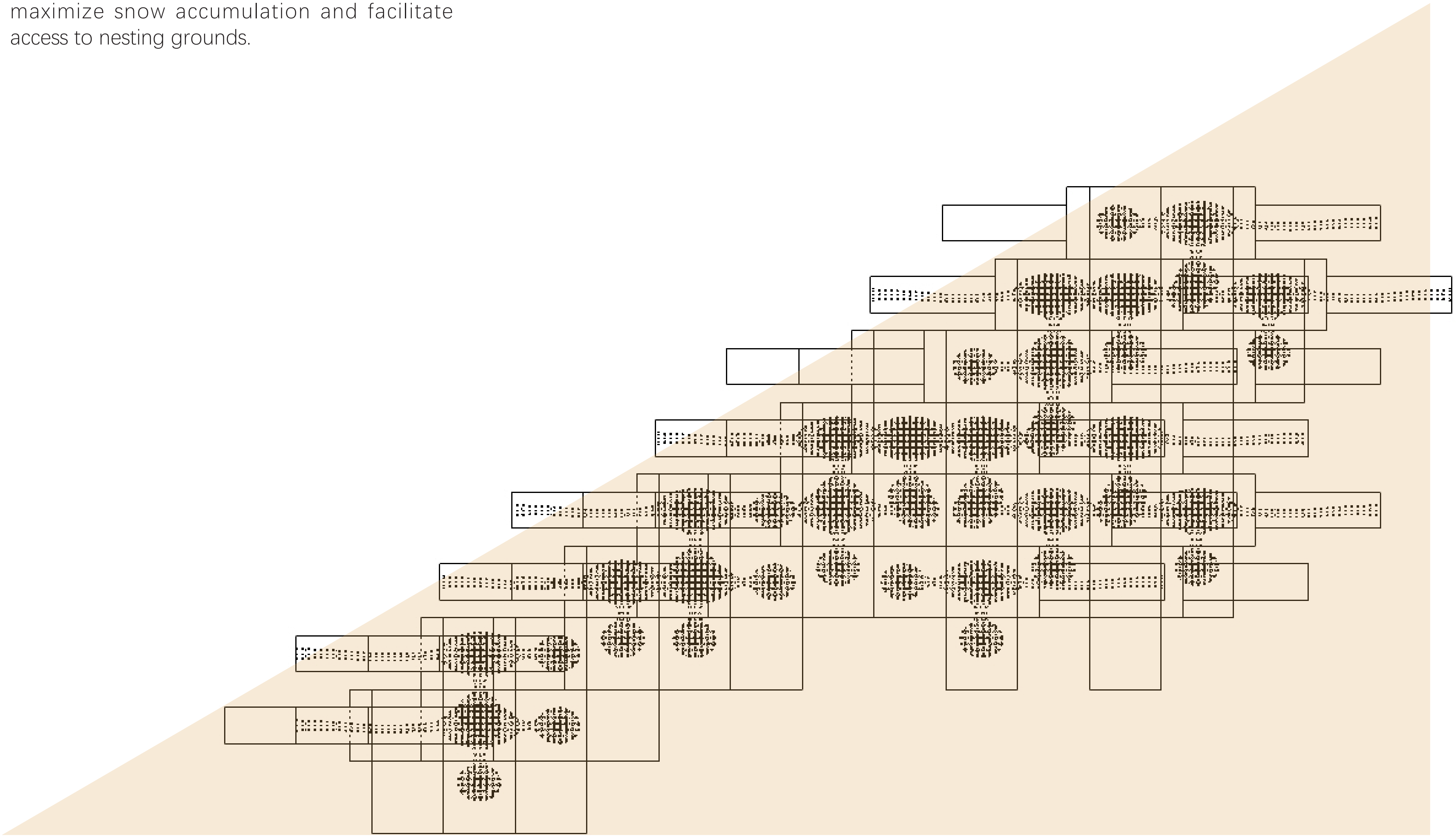
The space is divided by vertical sponges. The vertical plastic structure helps the sponges to determine the inflection point and thus freely enclose a layer of space. Water is transported by the sponge strip in the middle that stretched into water.

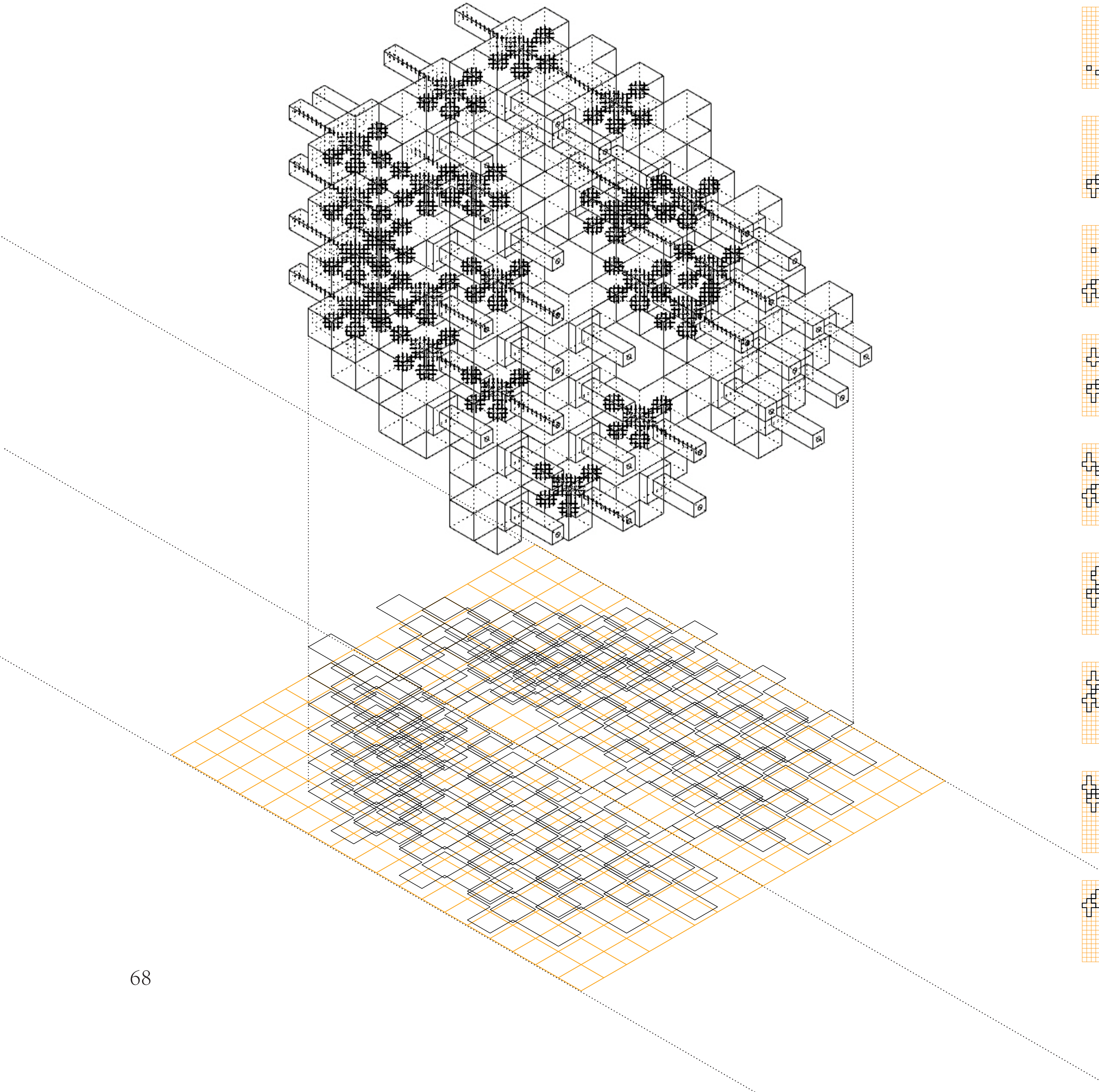
Terrain Typology

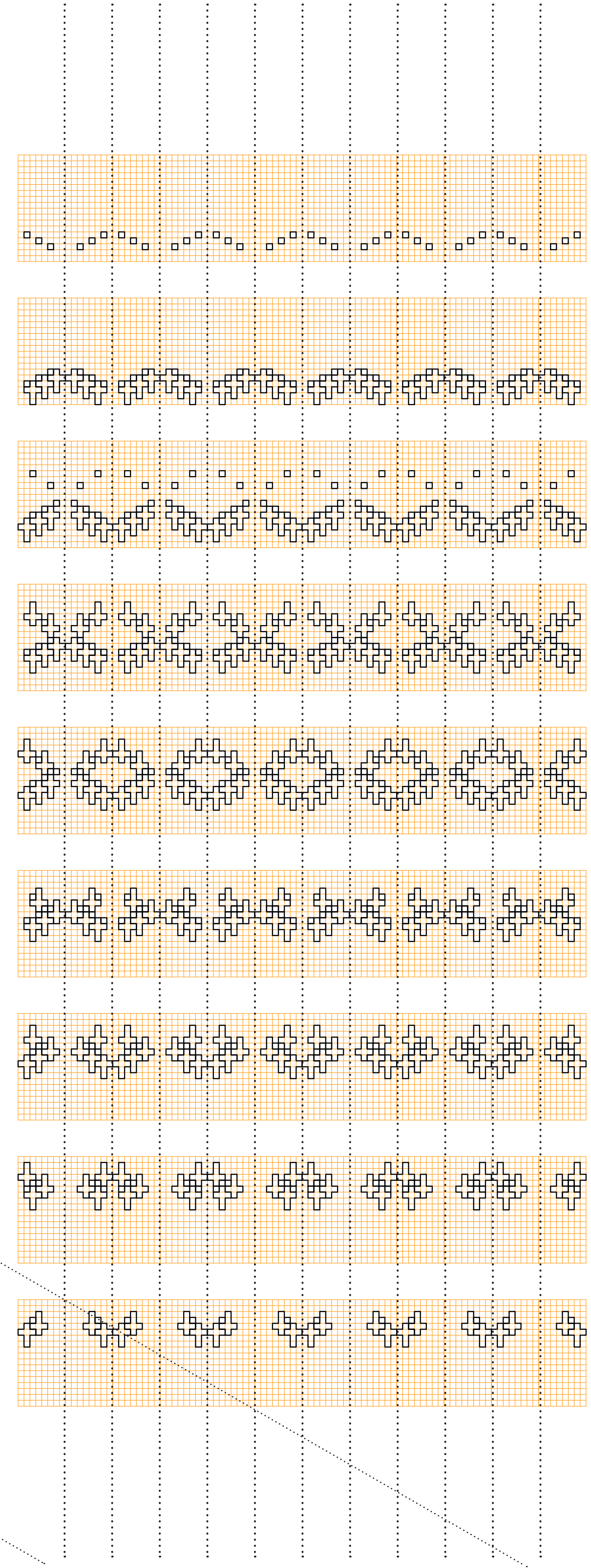


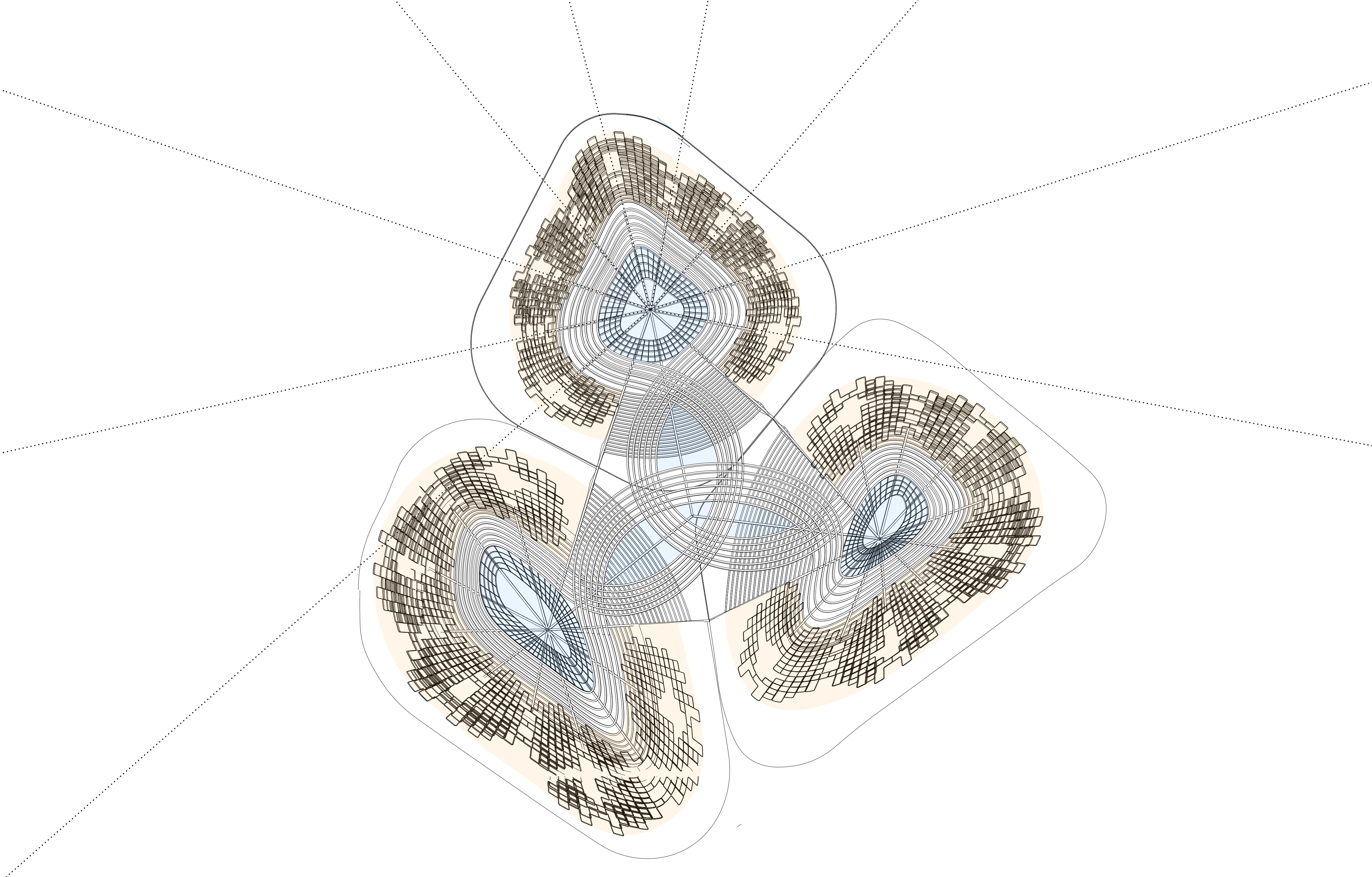


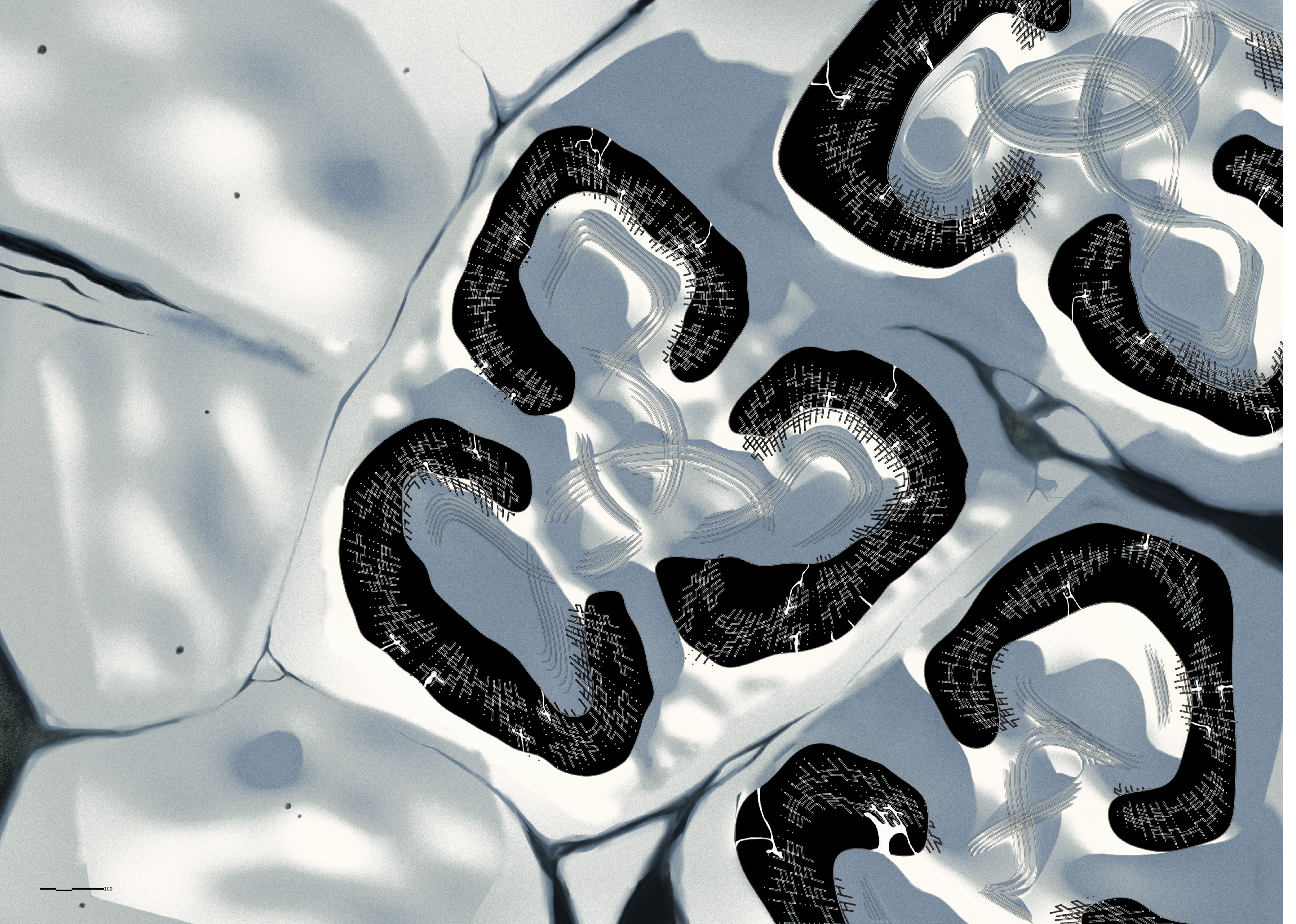
The separation of the terrain creates gradients that act as barriers to outside hunting bears, maximize snow accumulation and facilitate access to nesting grounds.










100

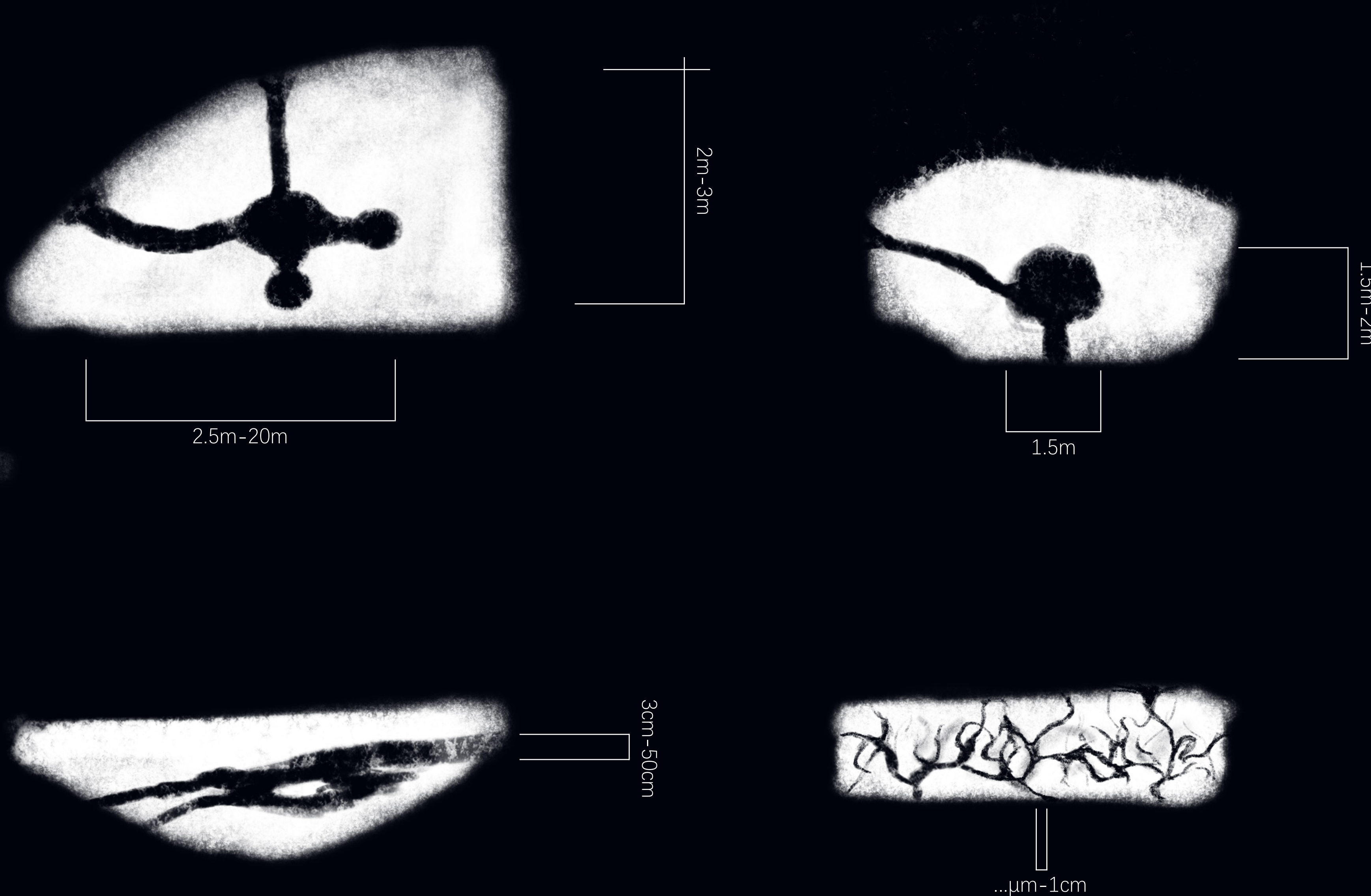
The process of snow covering the unit

Due to the effect of wind, snow accumulated on the site will not be evenly distributed around the structure, but form uneven snow drifts, which enriches the choice of living environment for polar bears.

For example, in deep snow, they can make deeper, more secure nests, whereas in shallower snowdrifts, they can build a nest with less effort.

Polar bears are also curious and adventurous. From time to time, they will search for a new nest. They will constantly find a more desirable spot in the field.

SECTION



Polar Bear Den

Polar bear dens are important structures used by female polar bears (sows) for giving birth and raising their cubs in the harsh Arctic environment.Polar bear dens are typically constructed in snow-covered areas, usually on land or on sea ice. Sows typically select sites in snowdrifts or in areas with deep, compacted snow to provide insulation and protection from extreme cold temperatures and winds.

Polar bears usually den during the winter months, typically from November to January. Sows enter the dens to give birth to their cubs, and they remain in the dens for several months until the cubs are strong enough to venture outside. During this period, the bears enter a state of torpor, reducing their metabolic rate and conserving energy.

Seal Lair

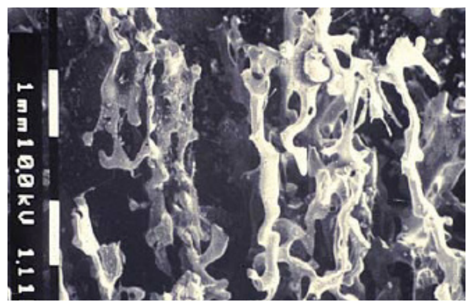
Seal lairs are typically situated on thick, stable sea ice in areas where there is sufficient snow accumulation. The location of the lairs is crucial for the survival and protection of the seal pups, as they need stable ice and adequate snow cover to create and maintain the lair structure.

Those lairs usually have an entrance or breathing hole that connects the interior of the lair to the atmosphere and the water below the ice. The breathing hole allows the seal mother to come up for air and facilitates the movement of the seal pups between the lair and the water when they are ready to begin swimming and foraging.

Polar Cod habitat

Polar Cod could be found swimming in the water column beneath the sea ice. They often inhabit the region where the ice meets the water, utilizing the gaps and channels between ice floes.

These ice-associated habitats provide polar cod with important resources, including food sources such as zooplankton and other small organisms that are associated with the ice. The ice cover also offers protection from predators and serves as a platform for foraging and reproductive activities.



Brine Channels

Ice brine channels are narrow, interconnected channels that form within sea ice which play a vital role in supporting microbial life within the sea ice ecosystem. The channels provide a habitat for various microorganisms, including bacteria, algae, and protists, which can utilize the available nutrients and sunlight within the brine channels. These microorganisms serve as a food source for higher trophic levels, contributing to the overall productivity and biodiversity of the sea ice ecosystem.


1
4.
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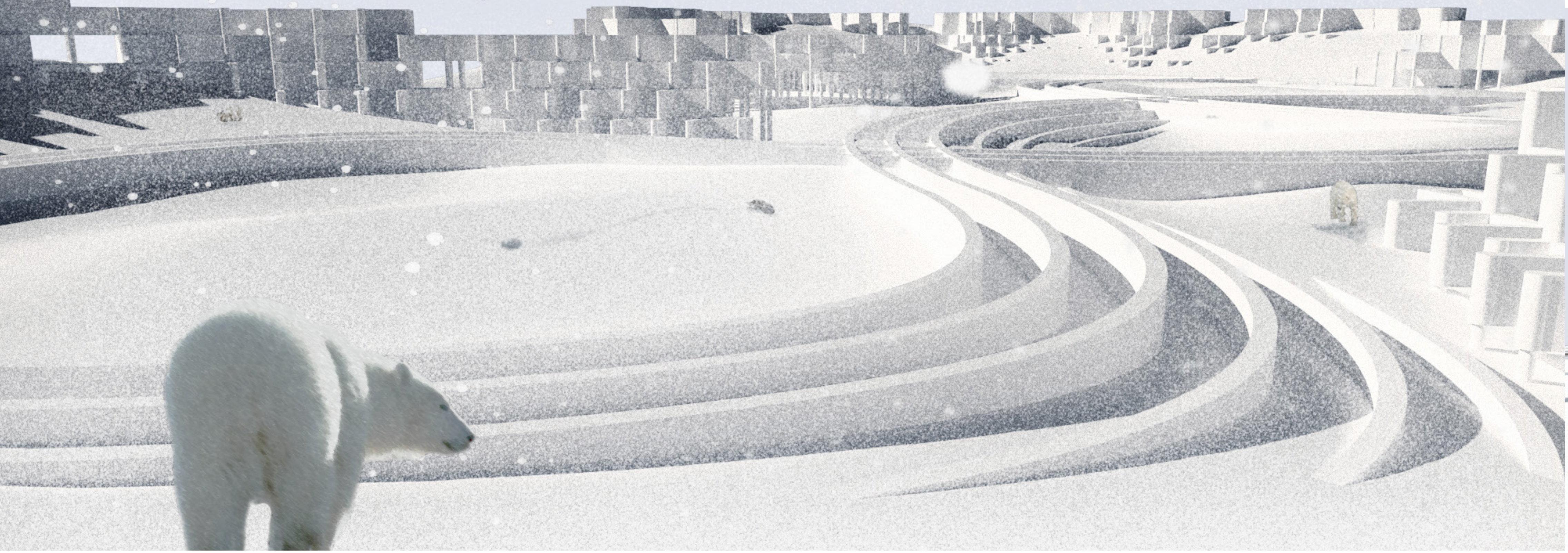
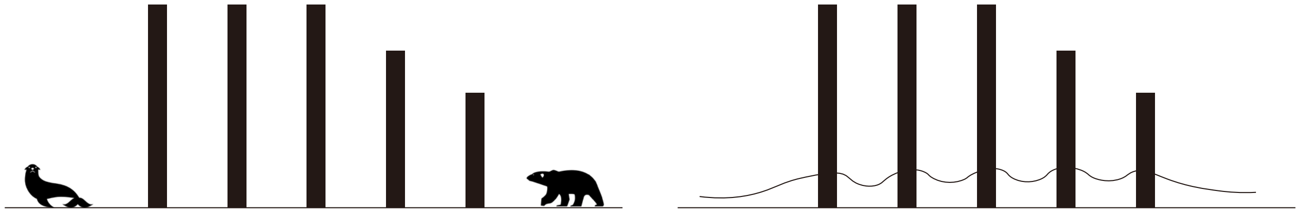
2

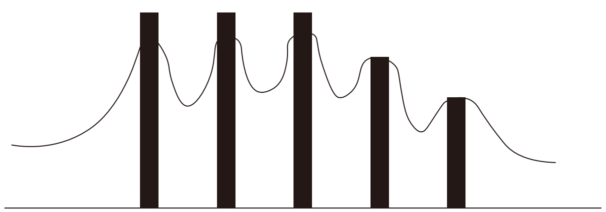
1.Ice-edge Bloom
2.Bentho Communities
3.Vertical Flux
4.Sub-ice Melt Pond
5.Seal Breathing Site
6.Polar Cod habitat
7.Seal Lair
8.Under-ice Algea Habitat
9.Brine Channels
10.Sea Floor

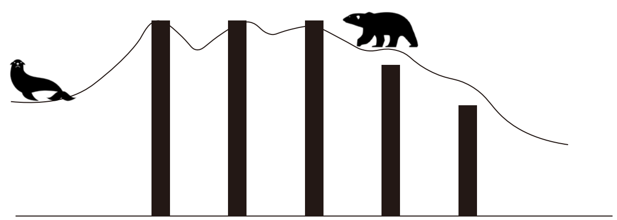


Buffer Barrier

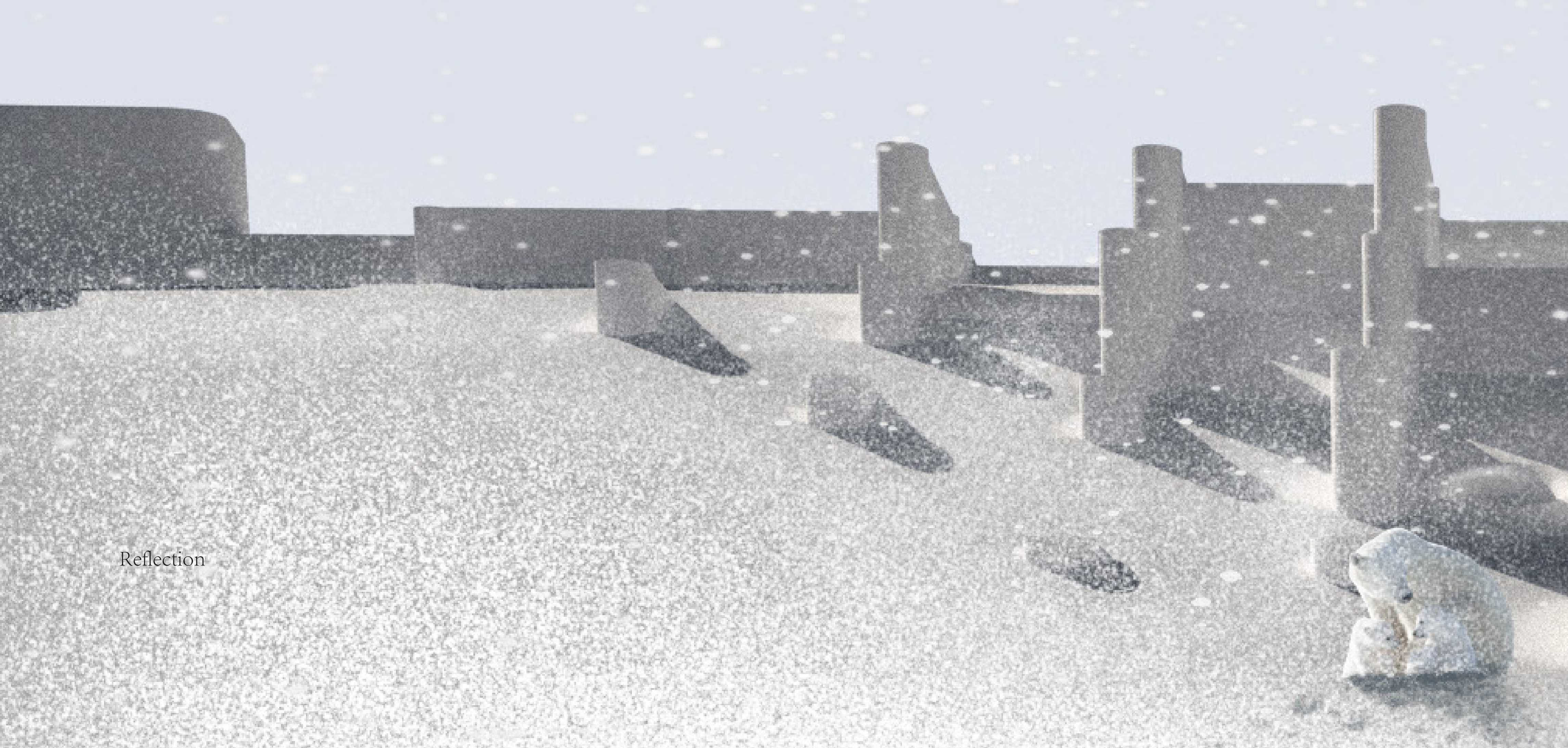


The barrier in the middle protects the seals during the early stages of sea ice formation before they begin to settle down.





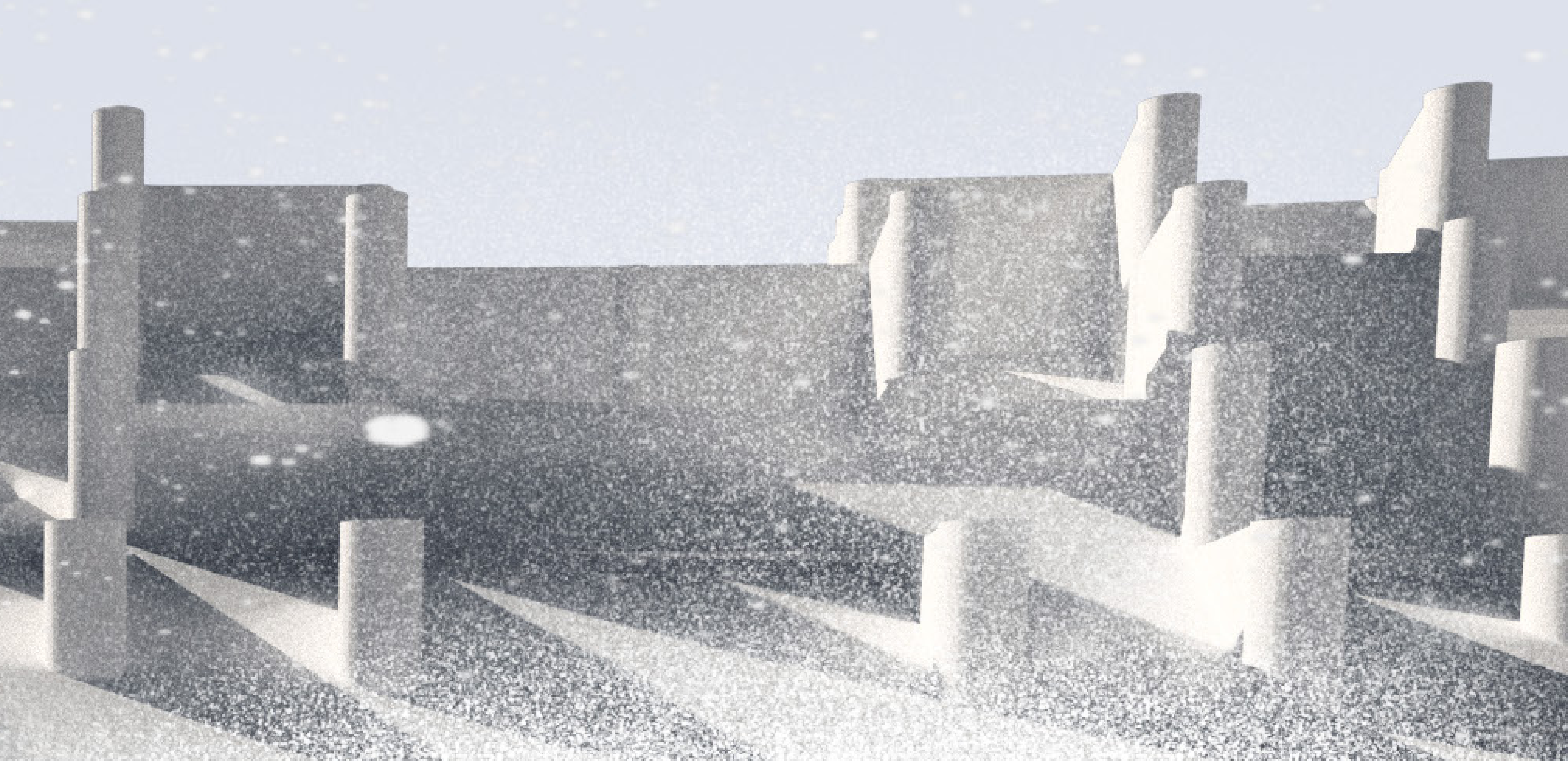
As the sea ice thickens and snow accumulates, the seal population stabilizes, allowing polar bears to move into seal territory.



Reflection

During the course of this project, I was often confused about my role as an architect. Compared to polar bear ecologists, architects often use the subject to pursue topics within their profession, which seems an easier way to go. One of my biggest challenges is trying to keep polar bears and the entire sea ice environment on the most importance place from the beginning to the end. This means constantly having to re-examine design strategies, because new knowledge is constantly being added, so strategies that make sense now may soon be found to be useless or even harmful. In this case, I chose a better and more relaxed approach, which was to take the polar bear's existing habitat and develop a system similar to it. So parts of the design become cautious, even monotonous.

Nature has a randomness that human architects cannot imitate. We can only construct new systems by using a limited number of materials in a more efficient way, and then give it a certain randomness again by either artificial or natural means. I am constantly aware of the inreplicability of nature, and that the imitation of nature mostly only come from a single phenomenon, rather than forming a fully functioning system, which would be expensive even if possible. This project, for example, may extend to the size of a city or more, but the actual number of polar bears likely to accommodate on the site won't convince many investor.I would say that this project is a bold and interesting



experiment, but by no means the best solution. It is a platform for thinking that helps me understand the gap between man and nature and seems to make me see the possibility of bridging it

In addition, it also took me to sort out and review each stage of the process of building from scratch, the proportion of each stage is constantly changing, and each stage can bring completely different possibilities to the building. Each stage requires a new connection with the subject and the client. As the most basic material begins to change, each step changes because of the new connection, and finally comes together to form an interesting result.

Looking back on the whole process, it was discouraging compared to previous projects, and it made me understand how little nature reveals to human beings, that as architects, we don't always understand what we are doing and how the building itself interacts with the world around us. By continuing to explore and learn the phenomena and principles of matter in nature, we will not only avoid harmful effects on the external environment, but also gain exciting new inspirations.

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