ecide

Begin Your Journey: Life as a Ringed Seal

You are a young ringed seal, born into an Arctic realm of shirnking ice and shifting seas. Hunger grows at your belly - your mother's milk sustained you only briefly before the thinning ice to forced her to abandon the lair early. Now, survival depends on your first solo hunt. Beneath the fractured ice, Arctic cod once thrived, but warming waters have scattered them deeper, while toxins lunk in their flesh. The ocean hums with distant ship propellers, masking the clicks and trills that once guided your kind. Dive now. Swim through the metting ice, avoid predators, and find food — but be careful = every choice could cost your energy, health, or your life. $\sim Will You Survice ... or Disappear?$



Your stomach growls — days of scarce prey have left you weak. You must hunt now,

1. Forage in Shallow Waters $\rightarrow 2$ (hints on the back)

2. Dive deep into the Dark -> 3

The Last Breath

As your strength fade, the Arctic's truth becomes clear =

You were never just a seal. You were a guardian of this fragile balance — a keystone holding together the food web, a nutrient cycler feeding the ice, a sentinel warning of the ocean's sickness.

Your blubber, thickened with toxins, tells the story of human skies. and polluted seas. You empty hunting grounds scream of warming waters. The silence where your pups' cries ashould echo? That is the sound of a collapsing world.

But this is not inevitable.

Less shipping noise could have saved your breathing holes. Stricter pollution laws might have spared your pups. Carbon cuts could have preserved your ice.

You decide to scour the shallows, Oops ! There's nothing left ! The thinning ice offers no ambush cover. The few cod here are small and swift, fleeting before you can strike. Hunger tightens its grip - you surface empty - handed, your energy wosted. Now, decide = a 1. Keep forage in shallow waters -> choose a card 2. Dive deep into the dark -> choose a card



0 You decide to plunge deeper, burning energy reserves to chose scattered cod. 0 You caught fish but your stamina drained & $\rightarrow 4$ C Yummy ! 50 C















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Term Project Summary

The Arctic, a vast and fragile ecosystem dominated by ice and extreme seasonal rhythms, is experiencing rapid transformations due to climate change and human encroachment. At the center of this ecological upheaval stands the ringed seal, a species whose survival is deeply intertwined with the stability of Arctic marine systems. This project seeks to illuminate the challenges faced by ringed seals through a fusion of scientific research and creative expression, translating complex ecological data into immersive narratives that resonate with diverse audiences. By bridging empirical knowledge with artistic interpretation, the work underscores the urgency of conservation efforts while fostering empathy for a species on the frontline of environmental change.

Ringed seals are not merely inhabitants of the Arctic; they are architects of its ecological balance. Their life cycle revolves around sea ice, which serves as a platform for pupping, molting, and evading predators. Female seals excavate snow lairs atop ice floes to shield newborn pups from polar bears and subzero temperatures—a behavior critical to reproductive success. However, the Arctic's sea ice is vanishing at an alarming rate. Satellite observations reveal a 13% decline per decade in ice extent since the late 20th century, with seasonal ice forming later and retreating earlier each year. This loss destabilizes the seals' reproductive strategies: thinner ice collapses under the weight of snow lairs, exposing vulnerable pups to predation and hypothermia.

Beyond their role as prey and predator, ringed seals function as ecosystem engineers. By maintaining breathing holes in the ice and redistributing nutrients through their movements, they sustain the productivity of Arctic marine food webs. Their predation on Arctic cod regulates populations of mid-trophic species, preventing zooplankton overgrazing that could devastate phytoplankton—the foundation of Arctic marine productivity. Yet, this delicate balance is unraveling. Rising ocean temperatures have driven zooplankton and fish species into deeper, colder layers, compelling seals to dive 20% deeper than historical averages to hunt—a behavioral adaptation that exacts a heavy energetic toll and heightens mortality risks.

Human activities compound these natural challenges. Industrial pollutants such as mercury and polychlorinated biphenyls (PCBs) permeate Arctic waters, accumulating in seal blubber at concentrations exceeding safety thresholds established by the U.S. Environmental Protection Agency. These toxins impair immune function, disrupt reproductive cycles, and cause developmental abnormalities in pups. Simultaneously, the expansion of Arctic shipping routes generates underwater noise pollution that masks critical vocalizations—seals rely on acoustic signals to locate mates, nurse pups, and evade predators. The cumulative effect of these stressors threatens not only ringed seals but the entire Arctic ecosystem, which depends on their ecological role.

In order to resonate with everyone and help them better understand this matter, I have created two projects. The project integrates three pivotal scientific concepts to craft narratives that

resonate emotionally and intellectually. Central to this effort is the exploration of sea ice loss and habitat fragmentation. The disappearance of stable ice platforms disrupts the seals' life history strategies, as they require snow depths of at least 20 cm to construct protective lairs. Thinning ice reduces snow accumulation, leaving pups exposed to predators and harsh weather. Chronic stress from habitat instability elevates cortisol levels, which suppress reproductive hormones such as estrogen and progesterone, leading to declining ovulation rates. Climate models project that 85% of Arctic summer ice could vanish by 2100, erasing critical refugee and pushing the species toward reproductive collapse.

Another critical theme is the bioaccumulation of toxins. Arctic food webs act as conduits for pollution, with zooplankton absorbing heavy metals from seawater. These toxins biomagnify in Arctic cod—the seals' primary prey—resulting in mercury concentrations in seal blubber that now average 1.2 ppm, four times the EPA's safety threshold for human consumption. Chronic exposure weakens immune responses, increasing susceptibility to parasites and reducing pup survival rates by 30%. This insidious contamination illustrates how human activities thousands of miles away reverberate through Arctic ecosystems.

Equally pressing is the issue of acoustic disruption and behavioral stress. The Arctic's acoustic landscape is increasingly dominated by industrial noise, with shipping activity elevating underwater noise levels by 12 decibels since 2010. This noise overlaps with the frequency range of seal vocalizations, which are essential for coordinating breathing holes, locating pups, and avoiding predators. In high-traffic zones, call detection rates drop by 50%, leading to failed nursing interactions and disrupted mating rituals. Prolonged noise exposure also induces chronic stress, exacerbating energy deficits and compromising survival.

To translate these abstract threats into tangible experiences, the project employs two interactive works that merge scientific rigor with emotional storytelling. The first, Echoes Under Ice, is an immersive acoustic installation simulating the disorienting effects of underwater noise pollution. Participants enter a darkened room filled with layered audio recordings—blending natural ice cracks, seal vocalizations, and the rumble of ship engines. Blindfolded and tasked with locating a "pup" emitting distress calls, they navigate physical obstacles representing thin ice and polar bears. Collisions trigger consequences such as energy loss or simulated predation, mirroring the metabolic costs of deeper dives and the chaos of anthropogenic disruption.

The second work, Arctic Survival: The Ringed Seal's Dilemma, is a narrative card game immersing players in the life cycle of a seal. Each card presents choices rooted in ecological trade-offs: diving deeper for prey at the cost of energy reserves, foraging in toxin-laden shallows, or resting on unstable ice. Randomized event cards introduce stressors like oil spills or ship noise, forcing players to adapt strategies. For example, a "Ship Strike" card deducts health points, while a "Zooplankton Bloom" offers temporary respite. The game's branching outcomes reflect ecological resilience theory, illustrating how cumulative stressors eventually overwhelm adaptive capacity. Toxin levels and energy thresholds align with peer-reviewed studies, ensuring scientific fidelity while maintaining narrative engagement. The project targets two interconnected audiences, each with distinct needs and pathways for influence. For the general public, the installation and game demystify Arctic science by framing data through relatable narratives. The struggle of a seal to feed its pup or navigate noisy waters personalizes abstract concepts like "biomagnification" or "acoustic masking." Early exhibitions revealed that participants who interacted with the installation reported heightened concern for Arctic conservation, underscoring the power of experiential learning.

Educators and students benefit from the card game as a classroom tool fostering discussions about ecosystem dynamics and climate ethics. Teachers observe that students engage more deeply with environmental issues when tasked with role-playing survival choices, sparking debates about intergenerational equity and planetary stewardship.

The intended impact is multidimensional: enhancing understanding of Arctic ecosystems' interconnectedness, fostering empathy for species grappling with anthropogenic pressures, and inspiring actions ranging from reducing plastic use to supporting marine protected areas.

The plight of the ringed seal is a microcosm of the Arctic's broader ecological crisis. Their decline signals the fragility of a system that sustains global climate stability and biodiversity. By merging scientific inquiry with creative expression, this project challenges audiences to perceive environmental degradation not as a distant abstraction but as an immediate moral imperative. The solutions—reducing greenhouse emissions, regulating pollutants, mitigating industrial noise —are within humanity's grasp. Yet, they demand a collective willingness to listen to the Arctic's silent cries and act before its icy heartbeat fades into memory.

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