

BORN TO ROAM

The Suffering of Polar Bears in Zoos



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FOREWORD



Will Travers

**Will Travers OBE,
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Can it be over 35 years ago that Born Free, then known as Zoo check, commissioned its first research project? Can it be that the subject was the plight of polar bears in zoos? Can it be that Paul Horsman's findings, all those years ago, so accurately reflect the findings of ***'Born to Roam: The Suffering of Polar Bears in Zoos'*** today?

You would have to be intellectually blind to ignore what has been happening to polar bears in zoos and circuses for so long. Their psychological suffering, physical suffering, behavioral stereotypies, low breeding success, curtailed longevity, premature mortality, the mortalities that result from the impact of disease or the ingestion of foreign bodies – the lack of meaningful conservation and education dividends.

These problems have been known to a greater or lesser extent for as long as Born Free and I have been involved in the world of wild animal welfare. The tragedy is not only that so little has been done to address them, but that zoos actively perpetuate them. Zoos continue to breed polar bears. They continue to house them in devastatingly inadequate settings. They continue to perpetuate the myth that the lifetime incarceration of polar bears in zoos is somehow addressing the conservation threats the species faces in the wild. Indeed, as this report indicates, zoos may be making matters worse for wild polar bears rather than better.

I believe ***'Born to Roam: The Suffering of Polar Bears in Zoos'*** is a watershed report, pulling together, perhaps for the first time, the full suite of problems, threats, inadequacies, suffering, and consequences confronted by virtually every polar bear held in a zoo.

Its conclusion is both damning and stark: it is time to humanely bring this tragedy to an end.

No more breeding, no more imports, phase-out the suffering – and have the honesty and integrity to recognize what has been staring us in the face for decades: that polar bears cannot endure a life in zoos and we must use all our ingenuity, experience and determination to protect the species in the wild and tackle the many threats it faces, including anthropocentric climate change that, ultimately, could be the downfall of all life on earth.

REPORT SUMMARY

Polar bears have adapted to survive and thrive in some of the coldest and most extreme climates in the world in the Arctic North and range for tens of thousands of miles, largely in solitude.

Despite these highly specialized evolutionary adaptations, as of 2022 at least 300 polar bears were kept in captivity around the world at zoos, aquariums, parks, and at least one circus. These animals are confined to spaces that are a tiny fraction of their wild home ranges and are typically many degrees too warm for these arctic-adapted animals. In addition, most of these solitary mammals are housed in groups in captivity with minimal opportunity to avoid potential conflict or escape harmful social stressors.

As a result of these and a myriad other factors, polar bears suffer greatly in captivity where meeting their species-specific needs is an impossible task. Polar bears experience a high level of stress-related fatalities, high infant mortality rates, elevated risk of captivity-induced diseases, and shortened lifespans. They frequently develop abnormal stereotypical behaviors and suffer fatalities due to consumption of foreign objects.

While the facilities that hold polar bears captive fight an uphill battle to keep them in their collections, the very real threats to the species, including global climate change, habitat loss, resource depletion, and human encroachment, continue to worsen. Further, the ongoing act of removing polar bears from the wild and holding them captive increases these environmental threats, as these involve substantially energy-intensive and resource-dependent processes.

The often-claimed educational benefits of holding polar bears in captivity as spectacles for zoo visitors do not offset the detrimental impacts on the animals and the wider environment, including their incredibly poor welfare, unchanging or worsening conservation status in the wild, and the substantial carbon footprint required to keep them in artificial environments.

Therefore, we recommend that, wherever possible, legislative bans on holding polar bears in captivity be enacted and we urge the zoo industry to begin phasing-out the keeping of polar bears in captivity for good.



INTRODUCTION

Polar bears (*Ursus maritimus*) are wide-ranging carnivores with specific and complex needs which cannot be met in captivity. This report will explore the history, the current status, and the future of polar bears in zoos, as well as the ways in which their unnatural captivity impacts both the individuals involved and their free-living counterparts.

Detailing welfare concerns, public safety risks, and the ways in which polar bear conservation is hindered by their continued presence in zoos, *Born to Roam: The Suffering of Polar Bears in Zoos* paints a clear picture of all that is wrong with polar bear captivity. Importantly, the welfare of these animals is irreparably compromised when held in zoos; no amount of husbandry adjustments or enclosure renovations can possibly meet their complex needs. This report does not call for the reform of polar bear captivity, but rather demands its humane abolition. In jurisdictions where there is political will to act, this could take the form of legislative bans, but failing that, would require the zoo industry itself to make reliable commitments to do what is right by the animals and phase-out their keeping for good.

HISTORY OF POLAR BEARS IN ZOOS

The keeping of polar bears in captivity can be traced as far back as 285BC and King Ptolemy II of Egypt, while records also imply polar bears were kept in Henry III's Tower of London menagerie in the 13th century (SDZWA, 2021; HRP, 2023). In 1859, Philadelphia Zoo was the first zoo to hold a polar bear captive in the United States (SDZWA, 2021). From the first entry logged in 1876 in the North American Polar Bear Studbook, which includes all captive polar bears on record that participated in the Association of Zoos and Aquariums (AZA) Species Survival Program throughout the U.S., Canada, and Mexico, to the year of its publication (2016), the total number of bears recorded was 987; 468 males and 519 females at 208 institutions. In 2016, there were 74 total polar bears (35 males and 39 females) at 35 institutions (Meyerson, 2016). As of 2022, at least 300 polar bears were kept around the world at 152 zoos, aquariums, parks, and at least one circus, most of which were located in Europe, North America, and Asia (Angeli & Rieck, 2019; Bear Conservation, 2022b).

In North America in 2022, 61 polar bears lived at 26 institutions, most of whom reside in the U.S. and Canada. One polar bear remains in Mexico at the Guadalajara Zoo. Twenty of the bears in the current population, or 32%, were wild born (Jungheim, 2022). In Europe, there are at least 150 polar bears, accounting for approximately half of all polar bears in captivity. They are kept in 55 zoos and at least one circus (Table 1). Despite zoos facing clear issues with poor survivability, substandard health, ethical concerns, and financial constraints, zoos continue to add polar bears to their collections in the U.S. and Europe. While only three polar bear births occurred in North America in 2022, at least 16 births occurred in European zoos throughout the same period.

In the 1990s and early 2000s, because of welfare issues, polar bears were gradually phased-out of most zoological collections within the UK until only one individual remained (Hosey *et al.*, 2013). As of February 2023, however, numbers have increased again to 12, with animals actively being bred. When the European breeding program for polar bears was established in 2006, one of the goals stated was "using this population if necessary for future reintroductions" however, to date, no such reintroductions have taken place (Szánthó & Spencer, 2015).



Table 1: Polar bears currently in captivity in North America and Europe as of December 2022. (*4 polar bears reported to be held in a circus) (Bear Conservation, 2022b).

Country	Polar Bears in Captivity	Zoos Keeping Polar Bears
North America		
Canada	21	5
United States	39	20
Mexico	1	1
Total	61	26
Europe		
Austria	2	1
Belgium	6	2
Czech Republic	3	2
Denmark	12	3
Estonia	2	1
Finland	2	1
France	10	4
Germany	27	11
Hungary	4	2
Italy	2	1
Netherlands	16	5
Poland	2	1
Russia*	43	17
Sweden	5	1
Ukraine	3	1
United Kingdom	12	2
Total	151	55

WELFARE

Polar bears suffer immensely when held captive in zoos. For these wide-ranging, solitary predators, the zoo environment creates conditions in which their welfare is severely and demonstrably compromised. These include: the inability to provide an adequate living environment; a high occurrence of stress-related fatalities; the manifestation of stereotypical behaviors (behaviors which serve no obvious goal or function); high infant mortality; the risk of captivity-induced disease; and even fatalities due to the ingestion of foreign objects, among others. This section explores specific examples of where welfare is compromised for polar bears in zoos using a combination of individual case studies and available industry-wide data.

Polar Bears in the Wild

Polar bears live in some of the harshest, most inhospitable environments on the planet. Localized to the Arctic North countries, including Canada, the U.S. (Alaska), Greenland, Norway, and Russia, polar bears have evolved to travel vastly greater distances than any other bear species in search of food and potential mates. The ever-changing sea ice distribution, which influences prey availability (primarily consisting of bearded and ringed seals (*Erignathus barbatus* and *Pusa hispida*), female denning habits, and mating opportunities, typically determines polar bears' ranging patterns and distances (Bechshoft, 2021). Climate change has progressively reduced the total amount of sea ice since the 1970s, and the time when the sea ice forms and retreats, which decreases polar bears' ability to hunt for seals, thus negatively impacting their survivability and the potential viability of future generations (Parks *et al.*, 2006). Polar bears are listed as Vulnerable to extinction on the International Union for Conservation of Nature (IUCN) Red List. The main threats to their wild population status include human encroachment on habitat/resources, habitat loss, and the effects of global climate change (Wiig *et al.*, 2015).

Polar bears have annual home range sizes of up to several tens of thousands of square miles. A study that tracked 49 female polar bears in the Canadian western Hudson Bay population determined that their average annual home range size was 66,247 square miles (Parks *et al.*, 2006). In a study that surveyed home range size from 1986 to 2016 in the southern Beaufort Sea subpopulation throughout areas experiencing rapid sea ice decline and fragmentation, the average home range size recorded here was much larger, at 232,393 square miles (Pagano *et al.*, 2021). One of the single-longest treks tracked by scientists via a satellite-monitored female totaled almost 3,000 miles, who traveled from Alaska's Prudhoe Bay to Greenland, onward to Canada's Ellesmere Island, and back to Greenland again (PBI, 2022).

Evolutionary Adaptations Conflict with the Restrictions of Captive Confinement

The physical adaptations of polar bears include a 4-inch layer of blubber, two layers of fur, large body mass (males can grow up to 2,000 pounds), small appendages, and an opportunistic, high-calorie diet. These adaptations allow them to thrive in extreme arctic environments by retaining body heat and minimizing heat loss. Most polar bears remain solitary for the majority of their lives, except for cubs, who stay with their mothers for up to three years after birth, and breeding pairs. Some sub-adult males have been documented forming temporary bonds while traveling or feeding. Polar bears will often avoid conflict by distancing themselves from others observed as being close by, a basic need denied by all enclosed in captive spaces.

The conditions for which these adaptations have evolved differ drastically (and often harmfully) from those provided by the captive zoo environments in which polar bears are housed around the world. The average temperature in the Arctic during the summer is below 50°F (NSIDC, 2022). In contrast, the average temperature in July in U.S. zoos that keep polar bears is 74°F. Even when compared to the average high temperature across the Arctic region in July, the temperatures endured in a captive environment remain far higher than a polar bear's wild environment (Figure 1).



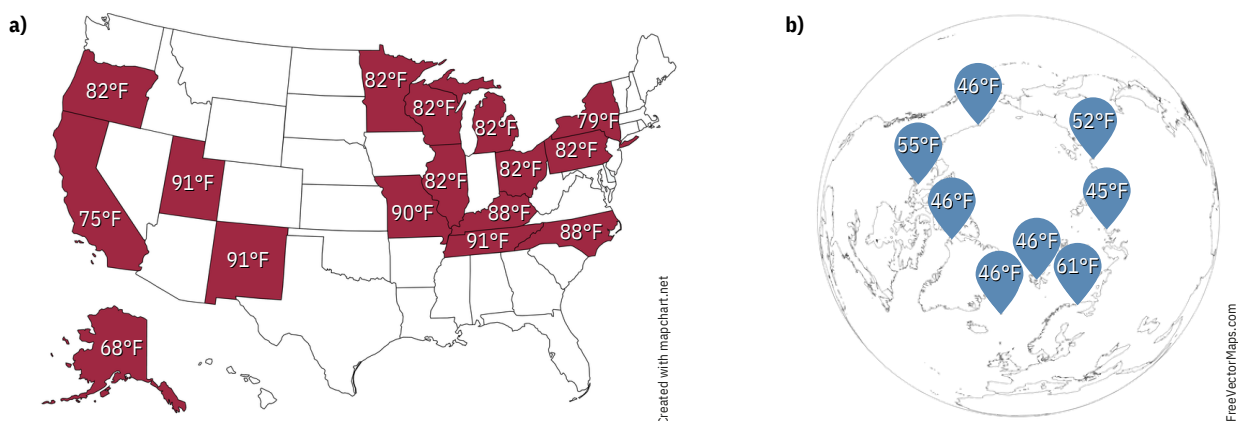


Figure 1. A map depicting the average July high temperatures in (a) each U.S. state with a zoo housing at least one polar bear (temperatures are shown for the zoo location, or, if multiple zoos are in one state, the average of the locations) and (b) locations which fall within the Arctic region. Temperatures taken from weatherspark.com.

Inadequate Environment

Wild polar bears have annual home range sizes of up to several tens of thousands square miles. In 2003, it was reported that the typical zoo enclosure for a polar bear was 0.23 acres, one-millionth the size of their minimum home range in the wild (Clubb & Mason, 2003) and smaller than an Olympic-size swimming pool. Twenty years on, AZA maintains that the minimum requirement of dry land for one or two polar bears should be 0.12 acres, as stated in the most recent polar bear care guide available on their website (AZA Bear TAG, 2009). Using the same natural home range estimation as Clubb and Mason (2003) of 31,000 square miles, approximately equivalent to the land area of Maine, this is approximately 160 million times the minimum recommended dry land space in an AZA zoo. A recent review of 37 polar bear housing facilities across the world found that only two provided space that exceeded 1.98 acres, while the largest U.S. polar bear exhibit is currently four-times smaller than the smallest polar bear enclosure in the UK (Veasey, 2022).

Yorkshire Wildlife Park, UK, provides one of the largest polar bear zoo exhibits in the world and houses the second largest number of polar bears in a captive setting. Their Project Polar 1 enclosure is just over 9.89 acres and houses four bears (Pastorino *et al.*, 2021). This enclosure, however, is not one single space, but is divided into four zones, each measuring approximately 2.47 acres. Therefore, the functional space available to each bear at any one time is much smaller when restricted to a partial combination of zones. Orsa Predator Park, Sweden, which claimed to have the largest polar bear enclosure in Europe (10 acres), recently announced that the zoo was closing in November 2022 (Orsa Rovdjurspark, 2022). As a result, it is likely that the five bears currently housed at the park will be transferred to inferior facilities.

Although these facilities represent two of the larger captive settings, they highlight the extreme disparities between captive and wild environments. In 2015, the European Association of Zoos and Aquaria (EAZA) announced: “Since 2010, EAZA institutions have accepted that small facilities are inappropriate for polar bears and have to provide much more space, sometimes many hectares” (Szánthó & Spencer, 2015). However, small polar bear exhibits are still evident across Europe to this day, with most new enclosures ranging from 0.25 acres – 1.24 acres (Szánthó & Spencer, 2015). A recent report concluded that “most” polar bear facilities are too small (Veasey, 2022). However, even if exhibit sizes were increased, it is likely that any positive impact on welfare would be marginal when considering the stark difference in size and complexity of captive environments compared to in the wild.

The creation of Yorkshire Wildlife Park’s polar bear exhibit was initially based on the ethos of rehoming bears living in inappropriate captive environments in Europe and tropical countries (Gillman, 2014). The zoo was part of a campaign to rehome a female polar bear, named Yupi, kept in desperate conditions at Morelia Zoo, Mexico, throughout the 2010s (Boniface, 2013). Over 24,000 USD was raised by readers of national newspaper, the Daily Mirror, to aid Yorkshire Wildlife Park in the necessary transport arrangements. However, the Morelia Zoo management would not agree to the transfer and Yupi tragically died in 2018 before any transfer could take place (Glaze, 2013; Zoocheck, 2018). Since then, Yorkshire Wildlife Park’s *modus operandi* changed to place an increasing focus on supporting the European breeding program rather than primarily rehoming bears from inadequate environments. While the zoo itself is not currently participating in breeding, it indirectly supports the breeding program by taking bears from or supplying bears to zoos which continue to breed their bears, rather than grasping the opportunity to take a stand against the perpetuation of keeping polar bears by the zoo industry.

The inadequacy of a captive polar bear's terrestrial environment is often surpassed by the stark reality of its aquatic environment. Polar bears are reportedly capable of swimming continuously for 427 miles over nine days (Durner *et al.*, 2011). Yet North American guidelines stipulate polar bear pools must have a surface area of 97ft² and be at least 5ft deep, as set out in the U.S. Department of Agriculture (USDA) Animal Welfare Act's Animal Welfare Regulations, and should have a surface area of 753ft² and a depth of 10ft according to the Polar Bear Protection Act (Polar Bear Protection Act, 2002; USDA, 2019). Within Europe, EAZA guidelines state that where an enclosure does not have a moat, a pool "sufficiently deep for bathing the whole adult bear must be provided" (EAZA, 2007). Minimum spatial requirements that are so far removed from the animal's wild ecology have been likened in their insufficiency to the space a closet would provide a human to sprint within (Veasey, 2022). This is before consideration is given to the fact that most pools are fresh water in contrast to the saltwater this species has evolved to encounter in the wild. In addition, consideration should be given to the fact that the filtration and salination requirements of an appropriately-sized water body would no doubt result in a large carbon impact as a consequence of its construction, upkeep, and day-to-day function. As such, to try to meet the welfare needs of polar bears in captivity, a zoo would be heavily contributing towards the climate change threat they use as justification for keeping polar bears in zoos in the first place.

Vastly unsuitable enclosure size is not the only spatial challenge faced by captive bears. Although polar bears in the wild are typically solitary, their captive counterparts are often housed in groups. This leads to socially-housed polar bears purposely avoiding each other, meaning that enclosures must be designed to facilitate social avoidance (Renner & Kelly, 2006). Especially given the small, recommended minimum enclosure size, there is concern that enclosures may not provide the topographical complexity and multiple pathways required to achieve this. Even when careful consideration has been given to facilitating social avoidance as is the case with the 4 acre enclosure at Detroit Zoo, Michigan, fatal conflict can occur. In 2021, a female polar bear which had been brought to the zoo in 2020, was killed by an adult male (see the case of Anana).

Considering that polar bears are adapted for winter temperatures that can fall to -50.8°F (PBI, 2017), there are obvious concerns when keeping polar bears in temperate regions, including the majority of Europe and the U.S. Polar bears can become severely heat-stressed at 70°F and a recent study found that temperatures above 68°F were associated with elevated levels of the stress hormone cortisol in adult polar bears (ACRES, 2015; Leishman *et al.*, 2022). This presents obvious challenges for zoos that keep polar bears in regions where the temperature often significantly exceeds 68°F in the summer.

For example, two polar bears are currently held at a zoo in Albuquerque, New Mexico, a city where the average temperature high is 91.4°F (Weather Spark, 2022). Another two bears are also held at Zoosafari Fasano in Italy, where temperatures may exceed 68°F from May to October inclusive (climate-data.org, 2021). In August 2022, Prague Zoo, Czech Republic, announced plans to replace their existing 80-year-old polar bear exhibit, describing it as "totally inconvenient" due to its location on a southern slope and the summer temperatures its polar bears must endure (Prague Morning, 2022). The new exhibit is expected to cost 800 million CZK (just under 34,026,020 USD). However, similar intentions were announced by the zoo in 2016, which failed to come to fruition (Bear Conservation, 2021). A recently-published report which aims to elevate the welfare of polar bears in captivity recommends that zoos where bears are frequently exposed to temperatures exceeding 68°F should strongly consider whether the conditions they provide meet the minimum temperature-related welfare requirements of polar bears (Veasey, 2022).

Although they are adapted for lower temperatures, sunlight remains important for polar bears, with zoos needing to consider the risk of vitamin D deficiencies in these fast-growing large carnivores and plan their diets accordingly (Kenny *et al.*, 1999; Lin *et al.*, 2005). Having the choice of accessing both indoor and outdoor space has been described as important for polar bear welfare (Ross, 2006). If elevated temperatures mean that access is restricted, this presents additional welfare concerns. These obvious difficulties in creating a tolerable artificial environment for polar bears indicate that they are completely unsuitable for captive displays.

Even when zoos choose to close existing enclosures, providing an opportunity for the zoo to end their keeping of polar bears, all too often they opt to continue by spending vast sums of money on newer enclosures. These enclosures are often improvements on previous facilities but are still woefully short of meeting the requirements of the polar bears they house. In 2017, Tallinn Zoo, Estonia, which has kept polar bears for more than 80 years and drawn concern for many years, opened its "Polarium" exhibit at a cost of 3,159,559 USD (approx. £2,600,000), rather than ending its polar bear program. Concerningly, the enclosure won an award in the competition "Concrete Building of the Year 2017" (Tallinn Zoo, 2022a). Point Defiance Zoo & Aquarium, Tacoma, Washington, has announced plans to spend 395,000 USD (£327,087) on "short-term improvements" to their polar bear exhibit following the death of their last surviving polar bear in May 2022 (Cockrell, 2022). While in 2011, Louisville Zoo, Kentucky, completed the construction of its Glacier Run exhibit at a staggering cost of 21.9 million USD (£18 million) (Zoo Lex, 2015).

Arturo

Arturo, often referenced as “the world’s saddest polar bear” by animal rights groups, died aged 30 at Mendoza Zoo in Argentina. His pool of water was only 20 inches deep, and zoo staff reportedly made feeble, very temporary attempts to cool the water by throwing in blocks of ice. He spent over 20 years in his fully concrete enclosure, where the temperature often climbed above 86°F (Revesz, 2016), leading to international public condemnation over Arturo being kept in an unsuitable environment. Petitions signed by thousands called for Arturo to be transferred to a zoo in Canada, which could have provided better conditions (Bowerman, 2016). This request was refused by officials at Mendoza Zoo, stating that he was “too old” and “close to his caretakers” to be sedated and moved.



Arturo reportedly became depressed after his long-term companion, Palusa, died of cancer in 2012. Shortly thereafter, he suffered several health complications: a blood circulation imbalance, overall weakness, failing eyesight, and loss of sense of smell. In his last days alive, he reportedly suffered a reduced appetite and significant weight loss. Euthanasia was considered to alleviate extreme suffering, but according to the zoo, “nature took its course.” Arturo came to Argentina from the U.S. aged eight. He was the last living polar bear in Argentina, after Winner, who lived in Buenos Aires and died in 2012 during a heat wave.

Stereotypies

The vast (and insurmountable) differences between natural wild and artificial captive environments frequently result in the development of stereotypical, or abnormally repetitive, behaviors. Often associated with chronic stress, boredom, frustration, physical or behavioral restriction, and/or the experience of trauma, such behaviors are frequently observed in captive polar bears. Research has identified stereotypical behavior as the most observed behavioral problem in bears kept in captivity (Vickery & Mason, 2004; Montaudouin & Le Pape, 2004; Mason *et al.*, 2007; Shepherdson *et al.*, 2013). These abnormal behaviors, which serve no obvious goal or function, often manifest in captive polar bears as pacing, repetitive swimming, and head swinging. Tongue-flicking, over-grooming, and jaw-clamping have been observed in other bear species (Wechsler, 1991 & 1992; Vickery & Mason, 2004; Fernandez, 2021). These behaviors are largely considered to be a consequence of being unable to fulfil their natural behavioral and cognitive repertoire due to small and significantly less complex captive environments.

The freezing temperatures, vastness of home range size, social structure, diet, swimming, and hunting behaviors polar bears experience regularly in the wild are impossible to replicate in captivity. Clubb and Mason (2003, 2007) highlighted a significant positive relationship between wild home range size and typical daily travel times with the tendency to exhibit stereotypic behavior in captivity in carnivores, including polar bears. These findings have been supported by the more recent work of Bandeli, Mellor, and Mason (2017). Polar bears arguably represent the terrestrial species in which the effects from this discrepancy are most apparent, as they have one of the largest home range sizes of all mammals. The high prevalence of stereotypies witnessed in polar bears in captivity was highlighted as a key indicator that the space they are provided in zoos is too small (Veasey, 2022).

Despite the known prevalence of stereotypical behaviors in captive polar bears and the wide acceptance that the species fails to thrive in captivity, little research has been conducted on them in a captive environment compared to other species kept by zoos. A 2021 literature review of polar bears in captivity found 46 publications which met the researcher’s inclusion criteria from 1972 to 2020 (Skovlund *et al.*, 2021). Of those publications, 21 focused on behavior, with abnormal behavior being identified most frequently (15). Research has included attempts to alleviate stereotypical behaviors by altering the degree of enclosure access (Ross, 2006), using unpredictable feeding schedules (Fernandez, 2021), providing novel (Canino & Powell, 2010), naturalistic (Kutska, 2009), and feeding enrichment (Forthman *et al.*, 1992), and through the administration of medication (Poulsen *et al.*, 1996).

Apart from the administration of medication (the use of which raises serious ethical questions), all strategies temporarily reduced but did not eliminate stereotypical behavior. All enrichment, without constant variety and novelty, can quickly become the new normal for the subject animal, and stereotypes can quickly resume once enrichment options have been exhausted (Mason *et al.*, 2007). Further, some enrichment strategies adversely affect polar bear welfare. The introduction of a novel odor (dog) increased abnormal behaviors (Linder *et al.*, 2020). Environmental factors such as starve days and noise near exhibits have also been observed to positively correlate with abnormal behavior (Cremer & Geutjes, 2012). Seasonal effects have been observed, particularly an increase in abnormal behaviors around breeding season in males (Kelly *et al.*, 2015). Publications frequently consist of small sample sizes and may only focus on one institution. Therefore, the true extent and persistence of abnormal behaviors in current captive populations of polar bears remains concerningly under-researched.

Researchers have recently attempted to distinguish between stereotypic and anticipatory behaviors (Krebs *et al.*, 2017). Anticipatory behaviors can also be repetitive but occur when the animal believes a “reward” is forthcoming, and such behaviors typically cease once the reward is acquired. As such, these behaviors are considered goal-oriented (Watters, 2014). In some circumstances, it has been argued that polar bear pacing in captivity is the result of husbandry-induced anticipatory behavior (Ross, 2006; Cambrelen & Nelson Slater, 2022). Tundra, at the Bronx Zoo, was reported to pace for upwards of three hours per day (Cambrelen & Nelson Slater, 2022). However, changes to husbandry procedure reduced but failed to eliminate this behavior entirely. Ultimately, it would seem that the lack of control over their environment cannot be mitigated when enclosures severely lack the complexity and space this species has evolved to inhabit.

A study published in 2013, which included data from 55 polar bears housed in 20 North American zoos, analyzed fecal glucocorticoid metabolites (FGM) over a one-year period to determine the relationship between stress and stereotypic pacing. In this study, 25% of the bears in the sample were wild born. Overall, 85% of the captive polar bears in this study performed stereotypic pacing. Bears exhibited stereotypic pacing during an average of 14% of the day, and this behavior accounted for 22% of their total locomotory budget. Concerningly, six bears spent at least 50% of their locomotory time pacing. Exhibit size was negatively correlated with FGM; in other words, the smaller the enclosure, the higher the stress level, and the more frequent the exhibition of stereotypic behavior.

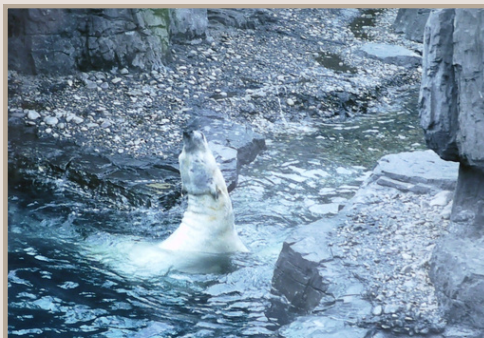
These findings demonstrate a clear positive correlation between stress and pacing in captive polar bears, suggesting that individual polar bear welfare in zoos is affected by confinement and made worse by smaller enclosures. The authors highlight that polar bear keepers have long speculated that the bears require an open environment where they can see for long distances to better mimic their wild habitat. In prioritizing economics over animal welfare, however, traditional polar bear exhibits at zoos have often been constructed with high concrete walls allowing the bears little view beyond their immediate surroundings, which likely exacerbates the conditions that promote the development of stereotypic behaviors in captivity (Shepherdson *et al.*, 2013). Despite being conducted ten years ago, this remains the largest study to date of polar bears in captivity in terms of sample size.

The behavioral effects of poor welfare undermine any theoretical conservation efforts, as diminished welfare often negatively impacts longevity and reproductive success (Cameron & Ryan, 2016). Further, given the “flagship species” status of polar bears in many zoos, abnormal behaviors, reduced behavioral repertoire, and poor welfare also undermine any educational message the facilities might attempt to impart to visitors. It can be argued that most research has attempted to treat the symptoms and decrease the occurrence of stereotypical behavior rather than address the root cause of the issue – that a captive environment simply cannot meet the welfare needs of polar bears.



Gus

Gus was transferred from Toledo Zoo in Ohio to New York's Central Park Zoo in 1988, where he quickly became the face of the zoo for numerous publicity releases. From the mid-1990s, Gus became notorious for demonstrating stereotypic behavior, including obsessively swimming laps in his pool in a figure-eight pattern for as many as twelve hours per day, which prompted the zoo to consult an animal psychologist at a cost of 25,000 USD and earned Gus the nickname "bipolar bear," along with a prescription for Prozac to lessen his excessive stress (Smith, 2014).



In 2011, when his enclosure companion Ida died of liver disease aged 25, Gus exhibited signs of depression. Zoo officials indicated that Gus was never the same after Ida's passing; he became less physically active, seemed apathetic, and generally confused when moving around his enclosure (Zuckerman, 2013). In 2013, Gus was euthanized when an inoperable tumor was discovered during a veterinary examination to investigate a potential toothache. He was 27 years old.



Nord

Nord was a male bear at Tallinn Zoo, Estonia, who was euthanized in 2019 aged just 17. He had been suffering from an ulcer on one of his paws believed to have been caused by a behavioral disorder, which caused him to constantly lick his paw. In 2018, Aleksandr Semyonov, Clinical Director and veterinarian at the Estonian University of Life Sciences, stated that the ulcer was not caused by a trauma, illness, or tumor, but was a psychological problem. They concluded that Nord had developed an obsessive-compulsive disorder, also known as a stereotypic behavior, common among animals in zoos. Nord's paw problem reportedly started several years before his death (Jöerand, 2018).

Nord was born at Schönbrunn Zoo, Austria, in 2001, transferred to Moscow Zoo, Russia, and then gifted to Tallinn Zoo, Estonia, in 2009 (Mäekivi & Oidermaa, 2019). Semyonov stated that Nord's behavior was due to him being held in small enclosures and excessive boredom. Nord was given oral antidepressants to try and change his behavior, and after a few weeks, the licking supposedly reduced, but it never went away (Jöerand, 2018). This was despite being moved to Tallinn Zoo's new 3.2 million USD polar bear exhibit in 2017.

The incredibly small spaces that zoos confine polar bears to in captivity are not the only cause of the high stress levels observed in these animals. Unnatural and forced social groupings, abrupt and stressful separations from long-time enclosure companions, and transfers between facilities also contribute to their poor welfare.

Szenja

In 2017, despite public disapproval and the story making national headlines, SeaWorld San Diego, California, separated longtime companions Szenja and Snowflake, both 21 years old, to ship Snowflake off to the Pittsburgh Zoo & PPG Aquarium in Pennsylvania, to participate in the captive breeding program (Neff, 2017).



Just two months after losing her companion, Szenja died. Keepers stated that she had demonstrated signs of lethargy and appetite loss for the week prior to her death. The cause of her death remains unexplained, but it was widely speculated that she died of a "broken Heart" after losing her companion of 20 years (Bekoff, 2017).

High Infant Mortality & Shortened Lifespan

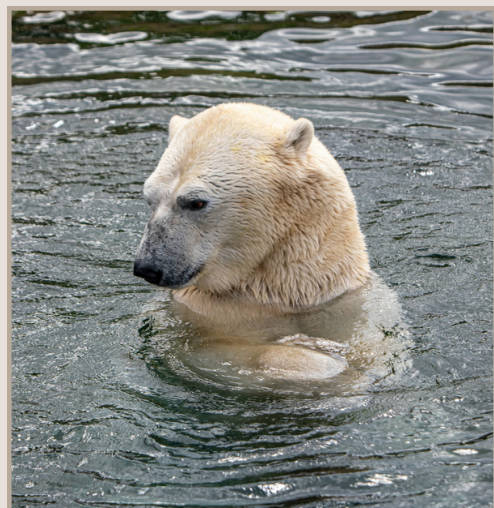
The limitations of captivity that cause the severe behavioral disturbances detailed above may also account for the high infant mortality rate and shorter life expectancy observed in captive polar bears. In captivity, very few polar bears live to their maximum wild lifespan of late 30s to early 40s, despite individuals in captivity having abundant food availability, freedom from competition, and readily available veterinary care (Robbins *et al.*, 2021). The 2018 International Studbook indicated the median age at death for captive polar bears that survived at least their first 30 days was 17 years for males and 21 years for females (Angeli & Rieck, 2019). Within North America, the AZA states the median life expectancy for polar bears in zoos is 23 (Point Defiance Zoo, 2022). The average lifespan of a wild polar bear is around 27 years (Rode *et al.*, 2021).

In the largest study of captive polar bear reproduction conducted to date, researchers analyzed 99 years of North American zoo records in the Polar Bear Studbook. They found that more than half of all captive born polar bear cubs died before reaching 30 days of age and only 30.4% reached adulthood (four years old) (Curry *et al.*, 2015). This high cub mortality may be attributed to few polar bears in captivity having the opportunity to perform “highly motivated natural denning behaviors” (Veasey, 2022). This behavioral restriction causes acute prenatal stress, which impacts the development and survival of juveniles in a range of species (Braastad, 1998; Malmkvist & Palme, 2008). The North American mortality trend coincided with findings observed in the 2018 International Polar Bear Studbook, which included data from the global zoo population of polar bears involved in the captive breeding program, where more than 50% of all males and females died within their first year of birth.

These figures parallel those observed in the wild: in 2006, 57% of polar bear cubs in Canada’s western Hudson Bay population died before their first year, whereas 35% died before one year old in the late 1980s and early 1990s. The higher mortality rate observed after the 1990s was attributed to melting sea ice caused by climate change and the corresponding negative effects on female body condition (Regehr & Amstrup, 2006). Therefore, the mortality rate of polar bears in captivity reflects that of wild polar bears suffering the most devastating effects of global climate change, including extreme habitat loss and food scarcity. Further research has found that the body mass of females was the only maternal metric related to cub survival during the period after spring emergence in Alaska (Rode *et al.*, 2020). Females greater than 353lb were found to have cub mortality rates of <20% whereas females below this weight experienced cub mortalities of up to 55%. Similar findings have also been reported during a 30-year study in Svalbard, Norway (Folio *et al.*, 2019). In captivity, without such environmental pressures, we may assume that the body mass of females mimics that of the heaviest of wild females. Despite these factors, polar bears cub mortality rates in captivity remain higher than expected compared to those in the wild, suggesting that the breeding and birthing of polar bears in captivity does not improve their survivability, nor does it aid the conservation of wild polar bears. Polar bears in captivity are utilized for producing future zoo-housed polar bears. Captive breeding, even if intended for reintroduction, cannot effectively improve their conservation, as there is no practical way to teach captive cubs how to hunt prey as their mothers would in the wild. There are no reports of successful reintroductions of captive-bred polar bears.

Friida & Raspi

In November 2021, the first cub born to 20-year-old Friida and 15-year-old Raspi, since their introduction at Tallinn Zoo, Estonia, earlier that year, died a few days after birth. The exact cause of the single cub’s death was unclear, but his abdomen was reportedly found to be full of blood, his liver was torn, and the umbilical cord was completely gone, leaving a hole. The autopsy also showed that the cub had never eaten as his stomach was empty (Kallaste, 2021). After another mating between Raspi and Friida the following year, triplet cubs were born at Tallinn Zoo in November 2022. The zoo announced that all three cubs died within the first week of life from meningitis and blood poisoning due to infections (Tallinn Zoo, 2022b). Despite the four cubs’ deaths, the zoo announced it would continue breeding polar bears following recommendations from the EAZA Polar Bear Breeding Program.



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Captivity-Induced Disease & Health Problems

While spatial limitations, unnatural social groupings, and frequent transfers in captivity threaten polar bear welfare by increasing stress and thus the occurrence of mental and physical disease, death in captive polar bears often involves inadequate dietary provision.

Concerningly, a recent study found that captive polar bears are very susceptible to renal failure and liver cancer, likely due to current dietary regimens not reflecting their macronutrient needs (Robbins *et al.*, 2021). This has been particularly linked to high protein captive diets resulting in a state of “chronic frustration and compromised welfare” (Veasey, 2022). It is believed that such feeding methods are used to facilitate the captive management of bears, including moving them into different enclosure areas, rather than attempting to meet their welfare needs. This fails to effectively recognize and replicate the complex behavioral and cognitive processes involved in prey acquisition in the wild including foraging, prey detection (dens or breathing holes), waiting for, capturing, killing, and consuming prey, using auditory, olfactory, and visual cues shaped by previous experience (Veasey, 2022). Small meals maintain the species in captivity but are unlikely to satisfy the animal or create stomach distension. Stomach distension is linked to the natural suppression of foraging motivation (Jeschke, 2007). Therefore, it is likely that captive polar bears are chronically motivated to forage, which may also cause a constant state of frustration potentially leading to serious health risks (Veasey, 2022). Of course, any attempt to provide live prey to polar bears would be ethically problematic, create significant and irreparable welfare issues for prey animals, and possibly breach national animal welfare regulations.

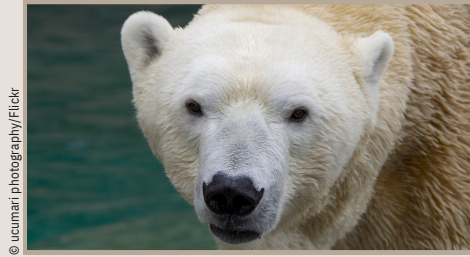
Polar bears in captivity with kidney disease suffer reduced lifespans by as much as ten years (Rode *et al.*, 2021). From 1995 to 2011, the primary causes of polar bear death in U.S. zoos were renal (23.5%) and liver or gallbladder disease or cancer (11.8%) (LaDouceur *et al.*, 2014). These issues continue to be a problem in zoos to this day. From 2015 to 2021, renal disease and liver disease accounted for 43% of captive polar bear deaths and contributed to a further 29% of deaths (Robbins *et al.*, 2021). Point Defiance Zoo, Tacoma, Washington, announced in May 2022 that Blizzard was euthanized at the age of 26 due to liver cancer (Point Defiance Zoo, 2022). In Europe, Olinka at Rotterdam Zoo, Netherlands, died of liver cancer aged 28 and Victor at Yorkshire Wildlife Park, UK, died of kidney failure aged 22 (Bear Conservation, 2022a). These figures mimic or are higher than those observed in Asiatic black (moon) bears (*Ursus thibetanus*), who have suffered organ injuries from repeated bile-extraction throughout their lives (Bando *et al.*, 2019). Further, there have been no reported incidences in wild polar bears of the diseases which commonly afflict captive individuals (Rode *et al.*, 2021). Such diseases result from long-term organ damage or dysfunction and affected bears will frequently suffer prolonged ill health and compromised welfare, potentially lasting years before death (Llovet *et al.*, 2003; Welzel *et al.*, 2007; Petreski *et al.*, 2021). The stark differences that exist between wild feeding ecology and captive management compromises the health and welfare of polar bears in captivity (Robbins *et al.*, 2021; Rode *et al.*, 2021).

Victor

Victor was a 22-year-old bear who died at Yorkshire Wildlife Park, UK, in 2020. A veterinary team had diagnosed him with terminal kidney failure, and he was subsequently euthanized. In 2018, Victor was sedated to undergo 50 skin prick tests. He had developed persistent abscesses on his feet and a suspected pollen allergy. Yorkshire Wildlife Park claimed that having spent most of his life on concrete, the change to their grassy enclosures possibly caused his allergy (Yorkshire Post, 2018). Victor was the first polar bear to arrive at Yorkshire Wildlife Park’s ‘Project Polar’ exhibit in 2014 after he was removed from the European breeding program. Born in Rostock Zoo, Germany, and then moved on to two zoos in the Netherlands, Victor sired 13 cubs in his life.



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Anana

Anana was a 20-year-old female polar bear at Detroit Zoo, Michigan, who died during a breeding attempt with a male bear named Nuka in February 2021. The Detroit Zoological Society released a statement revealing that Anana had advanced heart disease and that the cause of death was acute heart failure or fatal arrhythmia before or during the breeding attempt (Morrow, 2021).

Anana came to Detroit Zoo from Cincinnati Zoo, Ohio, in 2020, while Nuka had been at Detroit Zoo since 2011 (Witsil, 2021). According to the Detroit Zoological Society, the two bears had lived together without incident in 2020 but were separated for several months prior to being re-introduced the week before Anana's death, as part of the AZA Polar Bear Species Survival Plan (Detroit Zoo, 2021). The zoo, one of 240 participating members of AZA, was trying to boost the captive polar bear population through this mating event (Witsil, 2021).

Nora

In October 2022, 9-year-old Nora was euthanized at Schönbrunn Zoo, Austria. She was suffering from acute intestinal colic, a condition caused by a blockage that keeps food and liquid from passing through the body. Following an operation to investigate, the zoo reported that Nora's condition then worsened over the next few days. Vets reportedly decided that her recovery was unlikely, and Nora was euthanized (Kersa, 2022). Nora arrived at Schönbrunn Zoo in 2017 and had produced twin cubs in 2019, only one of whom, named Finja, survived.



Keeping many animal species in close proximity at zoos poses an additional risk to captive polar bear health. Countless pathogens, including those that polar bears would never encounter in the wild, can jump between species at zoos without animals having direct physical contact. With each jump to another host, pathogens may mutate to more infectious forms, making them potentially more deadly.

Further, asymptomatic infections can result in potentially dangerous pathogens remaining undetected. Pathogen spread to novel hosts may remain unnoticed if the outcome of infection is not readily apparent, as in the case with symptoms such as compromised fertility, or if more severe outcomes are restricted to less charismatic species that might be subject to less thorough investigation. The emergence of the zebra herpesvirus in captive polar bears illustrates a prime example of the deadly potential recombinant viruses have on zoo animals. The virus has resulted in fatal encephalitis in several polar bears and can infect at least five mammalian orders, without requiring direct contact with infected animals (Greenwood *et al.*, 2012). The herpesvirus was first observed to occur in polar bears at the Wuppertal Zoo, Germany, in 2010. Subsequent tests on ten additional Wuppertal polar bears, plus one who died in 2006, revealed that they all carried the virus (Platt, 2012). The case studies below exemplify the dangers polar bears face from pathogen spread in zoos.



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Kunik

In 2006, 26-year-old Kunik died at Toronto Zoo in Ontario, Canada, after contracting what veterinarians believed to be West Nile virus from a mosquito bite. Zoo officials suggested that the mosquito bit Kunik on his nose, as the rest of his body had skin and fur too dense to allow the mosquito to draw blood (Reuters, 2007). Kunik was euthanized due to the severity of his symptoms, including losing the use of his hind legs. The limb paralysis was likely caused by encephalitis, or inflammation of the brain, as his body failed to respond to the virus. It was the first known case of a polar bear dying from West Nile. The zoo vet, Jean Pare, stated that the initial blood tests were negative for West Nile, but the post-mortem examination of the bear's brain tissue returned strongly positive results. Evidence of the virus had previously been discovered in black bears in New Jersey, U.S., and in horses, dogs, and cats, but only a handful of cases developed the full-blown disease (Canadian Press, 2006).

Jerka & Lars

Jerka died in 2010 at 20 years of age. She was born in captivity and from the age of two lived at Wuppertal Zoo in Germany. In the summer of 2010, she began having epileptic seizures. Eight days later, she passed away. Shortly afterwards, Lars, a male bear who lived in the same enclosure, also became seriously ill with many of the same symptoms. Zoo staff treated him with IV fluids and anti-seizure medication. After several weeks, he made a full recovery. To better understand Jerka's cause of death, a team of scientists led by the Leibniz-Institute for Zoo and Wildlife Research analyzed her brain tissue for matches with genetic material from several potentially lethal viruses, including rabies and canine distemper. Just one virus returned a match, and it greatly resembled Equine Herpes Virus (EHV), a virus that infects horses. Jerka was infected with a "recombinant virus," or a combination of viruses that fuse to form a hybrid virus that can often be much deadlier than the original strain. The EHV1 strain combined with the closely related EHV9, indicating that at some point, EHV1 and EHV9 infected the same zebra and fused to form one virus that proceeded to infect both Jerka and Lars. EHV1 is known to have infected and killed animals in other zoos. In another German zoo, EHV1 killed four black bears (*Ursus americanus*). In another, it killed two Thomson's gazelles (*Eudorcas thomsonii*) and 18 guinea pigs, all from brain damage. EHV9 killed a polar bear at San Diego Zoo, California, who had been housed at least 200 feet away from a herd of Grevy's zebras (*Equus grevyi*) (Schrenzel *et al.*, 2008). Troublingly, herpesviruses can infect hosts without any of the same observable symptoms that killed Jerka and almost killed Lars.

The Leibniz-Institute discovered that another captive polar bear, named Struppo, who died of an unrelated kidney disease in 2006, was also infected with EHV1. His strain was identical to Jerka's strain; just without the extra fragment of EHV9 DNA. He was found to be carrying the virus in his blood rather than his brain, which may explain why he never developed any fatal symptoms.



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It remains unclear how commonly EHV1 and EHV9 are found among captive animals, the circumstances that may lead to their recombination, their method of transmission, and how to control them. Troublingly, it is known that they can infect mammals from at least five different species (Yong, 2012). One theory for the method of transmission postulates that mice or rats that travelled between the zebra and polar bear enclosures may have carried the virus. Concerningly, this would indicate that the viruses have not only recombined into a deadlier-than-normal strain, but that they also do not distinguish between species (Chant, 2012).

Knut

Knut was one of twin male cubs born at Berlin Zoo in Germany in 2006. Both cubs were rejected by their mother shortly after birth, and the zoo decided to try to hand-rear them. While one survived just four days before dying from an infection, Knut was reared in an incubator and became especially close to zookeeper Thomas Dörflein, who was largely responsible for his rearing and care regimen. In 2007, Knut made his public debut at the zoo with daily 'shows' featuring interactions with Dörflein. The zoo later stopped all physical contact with Knut due to concern that it was harmful to Knut's welfare. It was claimed that Knut was addicted to people, particularly Dörflein, and would whine and howl when he detected his scent or when nobody was near his enclosure.



Some years later, a female bear named Giovanna was moved in with Knut, despite them sharing the same grandfather and the associated risk of inbreeding. Knut's father, Lars, who was born in Hellabrunn Zoo, Germany, was believed to be a product of inbreeding, which raised speculation as to how this may have negatively affected Knut's own health. Giovanna left Berlin Zoo in 2010, and Knut was introduced to three other females, one of whom was his mother, Tosca. Knut was bullied by the females and, perhaps stemming from his frustration in being unable to escape the females' presence, Knut began exhibiting stereotypes, including excessive pacing back and forth.

In 2011, Knut died. He reportedly seemed to lose the ability to use his back legs, had a seizure, fell into his pool, and drowned in front of zoo visitors. The ultimate cause of death was encephalitis (inflammation of the brain), initially thought to be associated with a viral infection. Antibodies for the influenza A virus were found in Knut's blood, suggesting that he had been exposed to the flu virus, though researchers said this alone could not be determined as the definitive cause of death (Cave, 2012). One year later, in Scientific Reports, a German research team examining Knut's brain discovered that he suffered from anti-NMDA receptor encephalitis, an auto-immune disease that causes the immune system's antibodies to attack nerve cells in the brain. It is the most common type of non-infectious encephalitis that affects humans. It was the first time the condition had been found in a non-human animal. Still, many attribute Knut's cause of death to the unnatural circumstances and chronic stress he experienced throughout his life, stemming from the early human intervention and constant human attention (Nuwer, 2015).



Foreign Objects

Due to the barren and unpredictable nature of their native habitat, polar bears have developed an opportunistic diet, meaning that they exploit any opportunity to consume a potential meal that crosses their path. While beneficial in the wild, this adaptation becomes particularly problematic in captivity, where inedible or even toxic objects sometimes find their way, accidentally or intentionally, into polar bear enclosures.

Every year, there are several reports of captive animals at zoos consuming foreign objects thrown into their enclosures by zoo visitors, which can result in severe injury or death. For example, government inspection reports confirm that a Californian sea lion (*Zalophus californianus*) at Moody Gardens, Galveston, Texas, died in December 2021 from ingesting a small plastic fish which had been introduced as “enrichment.” In the same year, a young mountain lion who died at Cheyenne Mountain Zoo, Colorado Springs, Colorado, was found to have an object which resembled rope or wire in their stomach (Henderson, 2021). In February 2022, Zoo Miami, Florida, revealed the variety of objects swallowed by their animals, including sunglasses, a water bottle, bottle caps, and children’s pacifiers after they had been dropped or thrown into animal enclosures (Flood, 2022). Edinburgh Zoo, Scotland, revealed a vet had carried out 22 surgeries within four years to remove foreign objects swallowed by their gentoo penguin colony, including socks, gloves, and batteries (Scott, 2013). More recently, in August 2022, Tallinn Zoo, Estonia, announced that their northern ground hornbill suffered a “painful death” after swallowing a coin, which resulted in the bird hemorrhaging from their beak (Turovski, 2022).

In a 2017 article published in the Alexandria Journal of Veterinary Sciences, the authors advised the “need to make sure [captive wild animals’] habitat is free of foreign objects that can possibly be ingested out of boredom or sheer curiosity” to avoid endangering the lives of these animals, and also recommended that “adequate nutrition... is also advocated to prevent pica (the craving to eat non-food items) which may also result in animals ingesting otherwise inedible or non-digestible materials” (Sajeni *et al.*, 2017).

Even in situations where objects are intended to be in the enclosure for the betterment of the animal, they can still pose risks to their health. A tire in the polar bear enclosure at Aalborg Zoo, Denmark, had to be surgically removed after one of the bears got their head and front legs through the object and stuck around their abdomen (Eisbären im Zoo, 2022).

The following case studies represent some of the tragic (and completely preventable) instances where polar bears in captivity have died from foreign object consumption.

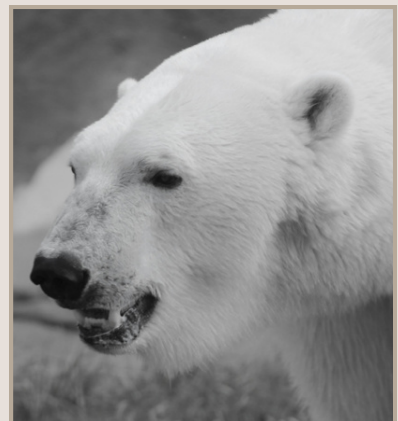


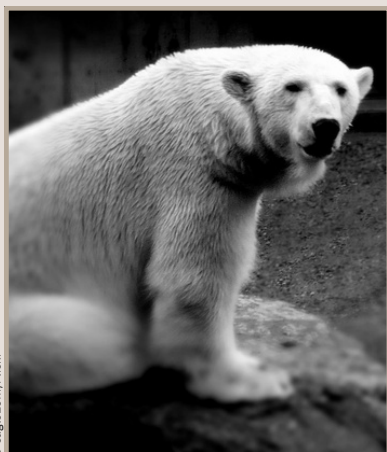
Barney

In 1996, at Scotland’s Edinburgh Zoo, 20-year-old polar bear Barney reportedly died in agony after swallowing a toy that had either been accidentally dropped or deliberately thrown into the enclosure by a young visitor. Keepers suspected he had an upset stomach when he started to show signs of illness. After one day of close observation, he collapsed and died. A post-mortem revealed a six-inch plastic toy bat lodged in Barney’s lower intestine (Daily Mail, 1996). Following Barney’s death, the zoo curator stated, “we hope his death will serve to highlight the dangers of litter both for zoo animals and animals in the wild” (The Scotsman, 1996). Barney had lived at Edinburgh Zoo for 18 years since age one. He had sired two cubs with the zoo’s female bear, Mercedes.

Andy

In 2003, 14-year-old male bear, Andy, died at Hogle Zoo, Salt Lake City, Utah, after swallowing a visitor’s glove that had found its way into his enclosure. According to zoo spokesperson, Stacey Phillips, the post-mortem examination revealed that the elastic band and plastic lining of the adult glove had become lodged in the bear’s intestines, causing a blockage. The blockage caused a rupture in his intestinal wall, leading to leakage of intestinal contents and fatal blood poisoning. She stated that the zoo had previously encountered numerous foreign objects entering zoo enclosures. “This was preventable. Animals eat what’s in there,” she said. Andy was born in 1989 and arrived at Utah’s Hogle Zoo in 1995 from the Buffalo Zoo, New York, on breeding loan. Andy sired five offspring at Hogle Zoo. All cubs were given to other zoos (Arave, 2003).





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Anton

In 2014, Anton, a 25-year-old male polar bear, died at the Wilhelma Zoo, Stuttgart, Germany, from severe intestinal injuries after swallowing a jacket or bag dropped into his enclosure by visitor. Zookeepers reported that they realized something was wrong with Anton when he started vomiting up pieces of fabric. His keepers suspected there was some food inside the item(s), encouraging Anton to ingest the materials. Shortly after the incident, the zoo appealed to visitors to report the loss of any objects on the premises, allowing keepers to remove them promptly should they appear within the confines of an animal's enclosure (Associated Press Berlin, 2014). Anton was not the first animal at Wilhelma Zoo to die from eating foreign objects: a hippopotamus died after swallowing a tennis ball and an elephant seal died after swallowing a teddy bear (Lyons, 2014).

Umka

A male polar bear named Umka died at Yekaterinburg Zoo in Russia's Ural Federal District in 2021 after swallowing a toy ball thrown into his enclosure by a young visitor. According to zoo authorities, the 25-year-old polar bear collapsed while eating breakfast in his enclosure. Although zoo veterinarians arrived at the scene within ten minutes, Umka had already died, according to the Daily Mail newspaper. A necropsy confirmed that the small rubber ball, which was still in his stomach upon examination, caused his death. Umka's female enclosure companion, named Aina, appeared saddened by his sudden death. "Unfortunately, not everyone knows how to express their love properly. Despite the numerous warning signs, some visitors throw 'treats' and foreign objects to animals, without even thinking about the possible sad consequences," the zoo's spokesperson told the Daily Mail (Indians in Gulf, 2021).



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Human Safety

The unnatural proximity to polar bears that humans can achieve in zoos endangers both polar bears and humans. In 2014, the AZA stated that zoo animal escapes occur about five times per year on average, which can typically be attributed to human error (e.g., zoo staff forgetting to lock an enclosure) and wild animals' natural instincts (e.g., aggression, attempting to escape a stressful situation), however the criteria for what incidents are defined as an "escape" are unclear (Adler, 2014). Therefore this number is likely an underestimate when considering at just one facility, The Smithsonian's National Zoo in Washington, D.C., 41 animals escaped from their enclosures from 2014-2021, or approximately seven animals per year (Smithsonian Zoo, 2021). Furthermore, many escapes may go unreported, and these figures do not include those that escape from the hundreds of non-AZA accredited zoos located throughout the U.S. The number of wild animal escapes at UK zoos is also largely unknown. As part of their licensing conditions, zoos must keep a record of all animal escapes, but it is only escapes which involve a non-domestic animal breaching the zoo perimeter which require the zoo to notify their local licensing authority within 24 hours (Zoo Licensing Act, 1981; Defra, 2012b). Escapes which involve animals remaining within the perimeter of the zoo are not required to be reported. The total number of escapes is rarely made public. Within the UK, polar bears are classified as a Category 1 "greater risk" species within the Secretary of State's Standards of Modern Zoo Practice - Hazardous Animal Categorization, where "contact between the public and animals in Category '1' is likely to cause severe injury or be a serious threat to life" (Defra, 2012a).

The following case studies emphasize that, as the public safety of humans must always be prioritized during a dangerous animal incident, the animals apparently kept in captivity to guarantee the preservation of their species' existence into the future must ironically often be killed as a result.

Franz

In 2007, 20-year-old male polar bear Franz escaped his enclosure at Tallinn Zoo, Estonia. Zoo officials stated that a keeper forgot to lock the door after a routine cleaning. Franz was shot with a tranquilizer dart and moved back to the enclosure, but his heart failed while under anesthesia and he died shortly after (Alas, 2007). In 2004, Franz had bitten off the hand of a drunk man who fell asleep at the zoo and tried to feed him a cookie. The man reportedly hit Franz on the head with a vodka bottle (Gunter, 2004).



Franz was one of the zoo's most popular animals since his arrival in 1988. He was taken as a cub from Franz Josef Land, an island located in the Arctic Ocean in Russia's far north. Franz sired three cubs during his lifetime. Tallinn Zoo had come under scrutiny several times for the conditions in which their polar bears were kept, referencing the depressing nature of the facilities: the polar bear exhibit included just a barren brick-walled box and a small play pool (Alas, 2007).



Gosha

In 2012, a 23-year-old polar bear named Gosha bit off two fingers of a visitor at the Primorsky Zoo, Russia. The woman had reportedly climbed over a barrier to get close enough to try and feed him through the cage bars. Gosha arrived at the zoo in Khabarovsk in the autumn of 2002 after being held in a circus for four years (Moscow Times, 2012).

Ivan

In 2015, a man reportedly jumped into the polar bear enclosure at Copenhagen Zoo, Denmark, and walked towards a 10-year-old bear named Ivan. While dozens of visitors watched, keepers yelled in attempts to divert Ivan's attention before ultimately shooting the bear with rubber bullets, forcing him to retreat. The man escaped with 'superficial injuries' (Charlton, 2015).

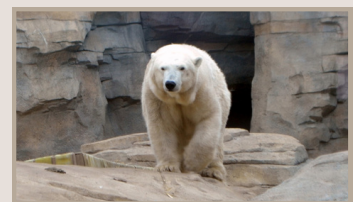


Berit

In 2016, a 17-year-old polar bear named Berit escaped her enclosure at Cincinnati Zoo, Ohio. She reportedly entered a 'behind-the-scenes hallway area' and visitors and staff had to be put on lockdown. Berit was shot with a tranquilizer dart to sedate and return her to the enclosure. The Zoo Director stated in media reports that "staff will spend time reviewing procedures and the area to make sure this doesn't happen again" (Weingartner, 2016).

Berlin

In 2012, a polar bear named Berlin escaped from her enclosure at Lake Superior Zoo, Duluth, Minnesota, after heavy rains caused flash flooding in the early hours of the morning. The flood resulted in damage to several areas, killing some animals and washing several others away, including two harbor seals, one of whom was reportedly found half a mile away.



Luckily, Berlin did not manage to escape the zoo grounds before being tranquilized by a zoo veterinarian. She was later taken to a temporary home at Como Zoo, St. Paul, Minnesota. The zoo's Animal Management Director, Peter Pruett, stated that "Berlin's escape could have been much worse" (Rosenfeld, 2012).

Berlin was transferred to Kansas City Zoo, Missouri, later in 2012, where she remained until her death. She had reportedly been suffering from poor health, including hypertension and kidney failure. She was euthanized aged 33 in January 2023, at which time she was the oldest captive polar bear in a U.S. zoo.

CAPTIVE POLAR BEARS & CLIMATE CHANGE

As the world wakes up to the impact of rising temperatures, the image of a polar bear on a melting iceberg has become a visual icon of climate change. Calving glaciers do produce these floating islands of ice but they are of little use to polar bears except perhaps as a place to rest during long swims far from land. This is because seals – the polar bear's preferred prey – seldom haul out onto steep-sided glacial icebergs, preferring flatter sea ice. The shrinking of the extent and duration of sea ice is what poses the greatest threat to polar bears around the Arctic Circle owing to it being their preferred habitat when hunting seals (Tandon & Pidcock, 2022).

Twenty distinct polar bear populations are now recognized - the newly-described Southeast Greenland population (Laidre *et al.*, 2022) adding to the 19 sub-populations that have long been known. All of these sub-populations have experienced a reduction in sea ice over recent decades (Stern & Laidre, 2016). The species is classed by the IUCN as Vulnerable, facing a high probability of a 30 percent reduction over the next 35-41 years or three generations (Regehr *et al.*, 2016).

Polar bears are the apex predator in the Arctic ecosystem, which plays an important role in stabilizing Arctic weather systems and the Earth's climate (Liodden, 2019). As such, in their natural habitat polar bears are critical to the functioning of an ecosystem that through sedimentation of organic particles acts as a globally significant oceanic carbon storage system. Contrast that to the carbon costs of captivity, especially in temperate and tropical zoos where energy-intensive refrigeration units are often used to maintain cool interior enclosures for polar species.

The concept of 'total carbon accounting' is now becoming the norm for corporations and governments following the commitments made at the UNFCCC CoP26 conference in Glasgow, Scotland, in 2021. Governments are facilitating this process by providing the tools, for example the MacKay Carbon Calculator (BEIS, 2020). For zoos to justify their claims to be a part of the solution to the environmental challenges the world faces, the calculation of the ecological footprint of their buildings and operations is essential. This would include:

Structure of enclosures: concrete production is responsible for eight percent of global greenhouse gas emissions (Nature editorial, 2021); steel production globally causes another eight percent, with 1.85 tons of carbon dioxide emitted for each ton of steel (Hoffman *et al.*, 2020); glass production also involves significant greenhouse gas emissions (U.S. Department of Energy, 2021). All these high carbon footprint materials feature in the construction of modern zoo enclosures.

Energy costs of the exhibit: polar exhibits will in most cases require a water filtration/purification system and industrial refrigeration equipment to maintain a temperature differential between the warm exterior (seasonal in temperate latitudes) and the cool interior. Refrigerants and energy consumption are of concern to the food industry, so tools are available to calculate the carbon footprint of such machinery (e.g. ACHR News, 2019).

Fuel use for harvest and delivery of polar bear food: in captivity, polar bears are fed a varied diet including whole fish, rabbits, manufactured zoo carnivore diet, dog food and plant matter (Lintzenich *et al.*, 2006). The purchase of fish harvested for human consumption removes those nutrients from the marine ecosystem and creates a waste disposal problem for the zoo, all of which adds to the carbon footprint. Fuel for trawlers or fish farms, trucks transporting seafood to inland zoos, refrigerants to store frozen produce, and related energy costs all need to be calculated.

Fuel use by zoo visitors driving to the zoo: the size of zoo parking lots is indicative of the wider carbon footprint of zoos which attract families from all over the surrounding area, as well as further afield for some enthusiasts. Only a proportion of this wider carbon footprint of the zoo is attributable to the polar bear exhibit, but every zoo polar bear birth that features in a news story will likely boost attendance by a measurable amount; this should be factored into the carbon accounting of keeping captive polar bears.

In summary, removing polar bears from the wild both diminishes their ecosystem's ability to provide services to the biosphere whilst adding to anthropogenic greenhouse gas emissions. The importance of animals in the functioning of ecosystems is becoming more widely recognized (Mustoe, 2022). Animal welfare aside, this begs the question as to whether zoos are doing more harm than good to the ecology of the planet in the 21st century.

CONSERVATION – A CANADIAN CASE STUDY

There are approximately 26,000 polar bears globally (Wiig *et al.*, 2015). For international management and conservation purposes, the world's wild polar bear population is divided into 20 discreet "subpopulations" as determined by scientifically derived information combined with Traditional Ecological Knowledge (TEK) of Indigenous peoples (Polar Bear Range States, 2022). Thirteen subpopulations occur in Canada, accounting for two-thirds of the world's wild polar bears, distributed among the five range states, all of which are party to the Agreement on the Conservation of Polar Bears.

A Polar Bear Technical Committee annually assesses the status of the Canadian subpopulations, informing the Polar Bear Administrative Committee, both working together to assess the status of each subpopulation. Canada's polar bears are spread over a vast area from the Yukon (adjoining Alaska) in the west, to Newfoundland and Labrador in the east, and as far south as the northern reaches of Alberta, Ontario, and Quebec. A western subpopulation is shared with the U.S., while three eastern subpopulations are shared with Greenland.

Some subpopulations are classified as "data deficient," meaning the number of bears and/or population trends within the subpopulation are unknown. Bears can travel from one subpopulation to another in numbers that may be unknown or may change through time.

Canada's federal Species at Risk Act (SARA) designated polar bears as a Species of Special Concern in 2011, mandating a Polar Bear Management Plan complementing internationally agreed-upon conservation strategies.

Of the five polar bear nations, only Canada allows trophy hunting. The species is listed on Appendix II of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES), which tightly regulates international trade in wild animals, plants, their parts and derivatives, but can allow regulated international trade, with bear hides and skulls much in demand. Past proposals to put the species on Appendix I, which could stop international transport of trophies, have been challenged by Canada and have failed to attain sufficient support.

Canada's collaborative approach to polar bear management can generate friction between science-based management recommendations and TEK-based opinions. The latter, often reflecting tradition and experience of past generations, can equate large gatherings of the bears with healthy populations overall. Research based on objective metrics, such as the weight of the bears and their ranging patterns as determined by radio telemetry, suggest the contrary. Food-deprived bears congregate at food sources, and these are often near villages and settlements and represent a much larger percentage of the overall population than claimed by TEK.

Some argue that science, often involving helicopter chases, tranquilizing, attachment of radio collars, tissue sampling, weighing, etc., is too invasive to generate reliable results, while others argue that most procedures produce reliable results.

Trophy hunting permits require hiring local Indigenous guides who can be paid by hunters who allocate to the hunter exclusive bear killing rights, as established by Land Claims Agreements. The hunters hire Inuit guides, thereby benefitting regions where employment opportunities are scarce, leading to the possibility of confirmation bias in considering bear population sizes that favor higher quotas. The sustainability of trophy hunting has been subject to controversy, even though every bear killed, by whomever for whatever reason, is subtracted from the quota.

It is estimated that parts or trophies from approximately two percent of Canada's polar bear population are exported annually. Most of the rest of each carcass is utilized, including for food where there are no farms and where food imports are unaffordable. Sport hunts constitute about ten percent of bears killed by humans.

The Arctic is warming three times faster than in other regions (Deshayes, 2021). Polar bear diets consist almost entirely of animal fat. Main sources of fat are ringed and other seal species, which in turn depend on ice floating on water – sea ice – which is in decline, disrupting vulnerable food chains. Other fat sources, such as beached whales and bird colonies, are not sufficient or dependable. Powerful males may keep females and young away from such bounties. Male bears can sometimes kill a fat-rich walrus or beluga whale. The females, who alone care for the cubs, are smaller and cannot overcome such large prey species (Galicia *et al.*, 2016).

Ice loss is opening sea lanes – the fabled Northwest Passage linking the North Atlantic to the North Pacific over the northern edge of the Canadian mainland and Alaska (NASA, 2007) – bringing to the Arctic the hazards to marine life food-chains caused by shipping and other boat access, such as oil spills, noise pollution, commercial fishing, and dredging of ports (Cirino, 2018). Increasing sea access to the region facilitates the exploration for and production of fossil fuels and other resources that in turn can lead to pollution toxic to wildlife, including bears and their prey. Easier access means more people, and thus more dangerous encounters with bears, with potentially tragic consequences for one or the other (WWF, 2022).

An esoteric threat to polar bears, also linked to climate change, is the subsequent range expansion of the brown (grizzly) bear. The two bear species diverged from common ancestry less than 500,000 years ago, and can still interbreed. Brown bears are far more adaptable to change than polar bears. Hybrids seem to occur with increasing frequency, creating a potential threat of “genetic swamping,” whereby genetically determined characteristics that distinguish the polar bear might slowly be replaced by those that genetically define brown bears (Cassella, 2022).

Another possible threat is the highly predatory orca whale. Not only do orcas eat seals and other prey essential to polar bears, but they can even injure and kill polar bears found swimming at sea. Sea ice has always blocked orcas from access to Hudson Bay, a huge inland sea where there are three subpopulations of polar bears. Orcas now swim into areas in which they have never occurred (Oosthoek, 2019; Ly, 2021).



CONCLUSION & RECOMMENDATIONS

In this report, we present conclusive evidence that polar bears do not thrive in zoos. No zoo on the planet can replicate the space, complexity, and climate required by these highly-specialized, wide-ranging carnivores and, as a result, the welfare of the bears held by zoos is irreparably compromised.

The bears themselves tell us of their suffering in the expression of stereotypical behaviors, and their premature deaths caused by stress-induced factors. Many experience nutritionally-deficient diets presented in smaller, more frequent meals with scant regard for their natural feeding behavior - something which could never be replicated in captivity - and to the detriment of their health. Furthermore, captive polar bears are exposed to diseases that they would never encounter in the wild and to which they have no immunity, along with access to foreign objects that, when consumed, may kill them.

While this suffering could never be justified, it adds further confirmation that their miserable captive lives serve no real conservation purpose. The challenges facing wild polar bears are not solved by zoos putting them on display. Indeed, polar bears raised in a zoo could never be released into the wild, as they would lack the most basic skills required to survive in their natural home. We argue that zoos offer an unhelpful distraction from the true risks facing free-living polar bears; those of climate change, trophy hunting, human-wildlife conflict, and complex socio-political factors. Zoos, in the meantime, continue to exhibit the bears and lull the public into a false sense of security that the species is being meaningfully protected.

The only way to protect future generations of polar bears from enduring the suffering of those whose stories are presented in this report is for the zoo industry to humanely phase-out their keeping altogether. This can be achieved by:

- Governments and other agencies with jurisdiction implementing legislation to phase-out the keeping of polar bears in zoos.
- Zoo industry bodies such as World Association of Zoos and Aquariums (WAZA), British and Irish Association of Zoos and Aquariums (BIAZA), European Association of Zoos and Aquaria (EAZA), and Association of Zoos and Aquariums (AZA) implementing policies for their member zoos to phase-out the keeping of polar bears.
- An immediate end to breeding polar bears in zoos and no new polar bear exhibits introduced.
- If in the animal's welfare interest, the moving of existing captive animals to zoos located in more suitable climates that can offer better facilities.

While these measures would do little to undo the damage already done to polar bears currently languishing in zoos around the world, it would be a positive step forward to ensure we bring an end to this outdated and demonstrably unacceptable practice. In this way, there will be no more future generations of captive polar bears to suffer the same fate as the hundreds gone before them.



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