A Bird on Thin Ice: A Proposal to List the Emperor Penguin Under the United States Endangered Species Act

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Introduction

The emperor penguin (*Aptenodytes forsteri*) is one of the most recognizable species of Antarctica. First described in 1844 (GBIF 2021), the emperor is the largest of all extant penguin species. Emperor penguins are native to Antarctica (GBIF 2021), and besides the Adélie penguin, they are the only penguins that are found exclusively on the continent (WWF). Though some individuals can accidentally end up on sub-Antarctic islands and even New Zealand (BBC 2011), all of the 50 known breeding colonies are on Antarctica proper (Fretwell and Trathan, 2020).

The emperor penguin is very large for a penguin, standing an average of 45 inches tall and weighing an average of 88 pounds in adulthood (National Geographic). They are very distinct from most other penguins in their appearance; they have white bellies, black backs and fins, and black-yellow heads and eyes. The notable exception to this is the king penguin, which looks very similar to the emperor in adulthood but is smaller in size. Emperor penguin chips have very different morphology from adults, taking on a light gray colour.

As piscivores, the emperor penguin relies exclusively on fish, krill, and squid to survive (WWF). Given this, all emperor penguins live close to the sea in order to provide easy access to food (Fretwell and Trathan, 2020). The life history of emperor penguins is interesting in the sense that many emperors spend their entire lives on sea ice. In a 2021 interview with scientific news outlet Live Science, Dr. Stephanie Jenouvrier of the Woods Hole Oceanographic Institution in Massachusetts explained how important sea ice is to the birds, and how sensitive they are to changes in the ice:

“Emperor penguins depend upon sea ice for breeding, molting and feeding… If there is too little sea ice, chicks can drown when sea ice breaks up early. If there is too much sea ice, foraging trips become too long and arduous, and the adults and chicks may starve." (Baker 2021)

Emperor penguins have the largest average mass of any extant penguin, which allows them to keep warm on the ice (Encyclopaedia Britannica).

The emperor penguin’s life history is complicated and revolves around feeding seasons and hatching seasons (NSF). Chicks will be laid in nesting areas many miles from the coast (Williams 1995), after which point the mothers will migrate to the coast to feed while the fathers will incubate the eggs during the harsh winter months (NSF). When the mother returns, it regurgitates food for the chick and relieves the father of his incubation duties (NSF). Emperors, like all penguins, are monogamous (Ancel et. al. 2013))(IUCN).

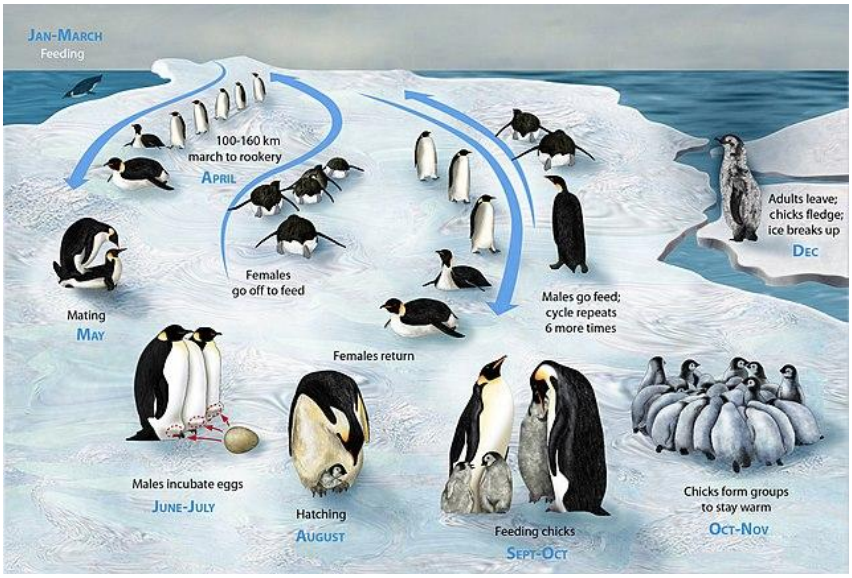

Fig. A: The life history cycle of the emperor penguin revolves heavily around the regular migrations from the rookery to the coast. Image: Zina Deretsky/NSF

The emperor penguin is not currently listed under the US Endangered Species Act (ESA). However, it is considered "Near Threatened" by the International Union for the Conservation of Nature (IUCN 2019).

Threats

The emperor penguin faces many existential threats. These threats can be broadly divided into two categories: climate-based and industry-based.

Two major industries affecting emperor penguins are fishing and tourism. Fishing is legal in many parts of the Antarctic Ocean, and given that emperors can swim hundreds of kilometers out to sea when fishing (Australian Antarctic Program), overfishing of important prey species is a major threat to the birds (Center for Biological Diversity 2014). Tourism can also be a danger to the penguins in some cases. The Antarctic Treaty of 1959 declares Antarctica to be an international zone, free for all humans to enjoy as a pristine nature reserve (Kariminia et al 2013). Tourism in Antarctica has become more popular in recent years (IAATO 2020), and oil spills, contamination of foreign species, and unruly tourists can cause pollution and stress the birds.

A major cause of the emperor's vulnerability is because of its highly specialized habitat and ecological niche— no other Antarctic penguin lives entirely on ice. This is a possible explanation as to why the Adélie penguin, the only other Antarctica-endemic penguin, is considered to be of "Least Concern" by the IUCN (United Nations, 1959). Adélies spend part of their lives on dry land (IUCN 2020).

This leads to the second category of threats: climate-based threats. It is well-established that global temperatures are increasing. Antarctic sea ice has been receding for some time (Australian Antarctic Program), which is extremely threatening to the sea ice-dependent emperor penguin. Recent modelling suggests that at current rates of sea ice melt, the emperor penguin will be virtually extinct by the year 2100 (Parkinson 2019). At least one emperor colony has been entirely wiped out by the effects of climate change (Jenouvrier et al 2019).

Current Population Trends

Across Antarctica, many emperor penguin colonies are in decline (Fretwell and Trathan, 2020). Undeniably, this is tied to the degradation of sea ice across the continent (Fig. B). As previously discussed, emperor penguins are the only penguins to live their entire lives on sea ice. Ecologically, it is simply not possible for emperors to spend parts of their lives on dry land like Adélie penguins do. A recent trend in some emperor penguin populations has become more apparent: migration to ice shelves. A 2014 study of satellite images and aerial surveys has revealed that at least four distinct emperor penguin colonies have been migrating inland to Antarctic ice shelves in the face of receding sea ice (Fretwell et. al. 2014). This is unprecedented behaviour for the emperor penguin, though it should be noted that these populations are only spending part of their lives on the ice shelves for the establishment of rookeries. They still return to sea ice for fishing (Fretwell et. al. 2014). All this is evidence that the emperor penguin can, at least in the short-term, adapt to these changes in the sea ice. That said, these adaptations are unsustainable, and living on shelf ice makes the annual journey to and from the coast much more difficult for the emperor penguin.

Emperor penguins are an indicator species for the health of ecosystems across the Antarctic continent (Baker 2021). Indicator species are species whose population status can serve as a reference for the health of a community or ecosystem at large. Numerous predators depend on both adult emperor penguins and emperor penguin chicks, including orcas, seals, and even skuas (Encyclopaedia Britannica). In an environment like Antarctica where food choices for carnivores are scarce, almost all species' diets are directly or indirectly tied to penguins. Therefore any statements about the health of emperor species are reflective of the future of biodiversity in Antarctica.

It is interesting to consider what short-term adaptations the emperor penguin might make. One can imagine that if some emperor penguins are forced to breed on the much warmer dry land instead of the ice, these populations may see an evolutionary shift towards a smaller average body mass. This would lower the bird's thermal inertia, but at the same time require less caloric intake. This is pure speculation on the author's part, but in situations where the emperor penguin is no longer able to breed on sea ice, evolutionary forces may be strong enough to see such short term adaptations.

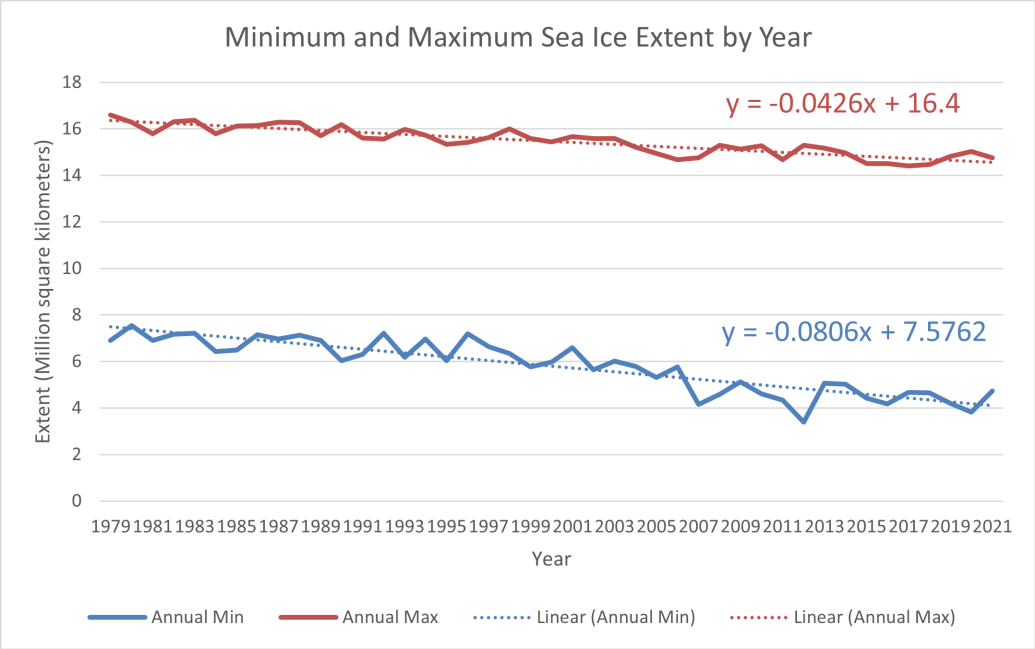

Fig. B: The total area of sea ice across the world has been in decline for decades. If this trend continues, more and more emperor penguin colonies will be forced to relocate to Antarctic shelf ice. Data: NSIDC

Despite the possibility of short-term adaptations, not all emperor penguin colonies are doing well. In 2009, the emperor penguin colony on Emperor Island (named for the penguin) was confirmed by aerial photography to be completely gone (Trathan 2011). This discovery was unprecedented in preceding years, and this incident is very strong evidence that climate change and changes in the patterns of sea ice is directly impacting the survival and reproductive success of the birds.

Conservation Efforts and Challenges

Assisted colonization has been a major topic of interest in the conservation world in the wake of climate change. For many threatened species, it is a viable conservation strategy to artificially relocate them to environments with similar climates to their native ranges, in order to raise their fitness. For the emperor penguin, though, this is not an option.

There are a few reasons for this. One is the very nature of the emperor penguin's habitat. Emperors, as previously discussed, are extremely dependent on sea ice. Such ice is rare on earth, and only found on the same scale in the Arctic ocean, over 120 degrees in latitude away. The arctic environment, though somewhat similar to the Antarctic, is actually experiencing even faster sea ice melt than Antarctica (Katz 2019). Furthermore, the Arctic has an ecological niche that Antarctica lacks: mammalian megafauna carnivores. The polar bear (Ursus maritimus) would pose an existential threat to enormous penguin colonies. Penguins have no morphological or behavioural adaptations to defend against such predatory threats, so it's easy to imagine that any established penguin colony in the arctic would be an easy feeding ground for the bear.

Fig. C: The emperor penguin lives in large colonies with thousands of individuals. In an arctic environment, such a colony would be extremely vulnerable to predators like the polar bear. Photo: Denis Luyten/Wikimedia Commons

Based on all of these facts, it seems that the future of the emperor penguin depends entirely on the health of its endemic continent of Antarctica. Earlier, two main types of threats to the emperor penguin were identified: climate-based and industry-based. Industry-based threats are far easier to control. Efforts to regulate Antarctic tourism and create protected bird areas would minimize the amount of pollution and disturbance to the penguins' habitat. Organizations such as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) are working to create fishing reserves, protected areas, and other legal policies to preserve marine and terrestrial biodiversity on the continent. Conversely, though, climate-based threats are almost impossible to control on a local level. Efforts to preserve sea ice for the emperor penguin will invariably be tied to the broader push to control climate change across the world.

All things considered, though noble efforts are being made to conserve the emperor penguin from an industrial standpoint, there is much work to be done, and the bird's ultimate fate is going to depend on the future of the global climate.

Recommendation

In my research I have concluded that the emperor penguin should be listed under the US ESA as a threatened species. Many threats face the bird today, and efforts are being made to assist it, however the emperor is undeniably on a downward trajectory, both in global population size as well as conservation outlook. From a legal standpoint it is feasible to expand existing marine protection zones and crack down on irresponsible tourists, however it is my opinion that the greatest threat to the emperor penguin is climate change and sea ice melt.These findings are in strong agreement with the findings of Dr. Stephanie Jenouvrier.

The rating of "threatened" is the ideal pick for the emperor penguin in its current state. Local populations are stable in many areas, however the global rate of sea ice melt is going to be a major threat to all emperor colonies.

The 21st century is a period in which the fate of not only the emperor penguin, but all Antarctic species and even the Antarctic continent itself, hangs in the balance. Antarctica is a pristine and almost entirely untouched wilderness the likes of which exists nowhere else on the planet. This is a result of the continent's remoteness, international diplomacy, and scientific interest in the continent. That said, none of this is necessarily permanent. The way that humanity goes about implementing protections for species like the emperor penguin will be indicators of Antarctica's future. Without active work from legislation such as the ESA, and organizations such as the IUCN, there is very little that the emperor penguin can do to protect itself from industrial and climate encroachment on its natural habitat.

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