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Whales in Hot Water?

The Impact of a Changing Climate on Whales, Dolphins and Porpoises: A Call For Action

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The Impact of a Changing Climate on Whales, Dolphins and Porpoises

There is now unequivocal evidence that climate change is happening and that human activities are contributing to it [iii]. The earth is warming, glaciers are melting, sea levels are rising, droughts and storms are increasing in both frequency and ferocity. The Intergovernmental Panel on Climate Change (IPCC) recently concluded that 20-30% of plant and animals species assessed so far are likely to be at increased risk of extinction if global temperatures rise by more than 1.5 - 2.5°C.[iv]

A number of factors, including the complexity of marine food webs, affect our ability to accurately predict changes in the oceans, but it is clear that the impacts of climate change will include changes in: temperature, sea levels, sea-ice extent, water acidity and salinity, rainfall patterns, storm frequency, wind speed, wave conditions and climate patterns.[v]

Trying to predict the precise consequences of these changes for cetacean species (whales, dolphins and porpoises) is difficult. Very little is known about many cetaceans; basic status information is lacking in many cases, and knowledge regarding specific habitat preferences and adaptive capacity is virtually nonexistent. For example, 60% of the 67 cetacean species included in the IUCN red list are classified as 'data deficient'. Predicting the effects of climate change for cetaceans that we know so little about is therefore extremely problematic. Nonetheless it has been estimated that climate change is likely to decrease the range of all the cetacean species listed as threatened by the IUCN for which predictions can be made (see Table 1.) Over their evolutionary history, many marine mammal species have adapted their behaviours and distributions in response to changing environmental conditions. However, it is unclear to what extent cetaceans will be able to adapt to the rate of climate change predicted in the near future.[vi]

The impacts of climate change on cetaceans are expected to be diverse and mediated in various ways (see Figure 1.) Some impacts may be direct: for example, as temperatures

> ***"Northern Hemisphere temperatures during the second half of the 20th century were … very likely the highest in at least the past 1300 years … Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature."*** [i]
>
> **Intergovernmental Panel on Climate Change (IPCC).**

> *Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80 % of the heat added to the climate system.* [ii]
>
> **IPCC.**

change some cetacean species may respond by shifting their distributions to remain within optimal habitat. However, in some cases such range shifts will not be possible. For example, the northern Indian Ocean is fringed by land, limiting the ability of species to move northwards into cooler habitat as waters warm. Similarly the distribution of the endangered vaquita (*Phocoena sinus*) is limited to the warm waters at the northern end of the Gulf of California. River dolphins such as the Ganges river dolphin (*Platanista gangetica*) and the boto (*Inia geoffrensis*) may also be particularly vulnerable to temperature changes within their strictly limited habitats.[vii, viii] Other examples are less immediately obvious but still significant. Off northwest Scotland, the common dolphin (*Delphinus delphis*), a warm water species, is apparently increasing its range, while the white-beaked dolphin (*Lagenorhynchus albirostris*), a cold water species, is seemingly reducing its range, and fewer sightings and strandings of the latter are being reported. White-beaked dolphins are generally found in cold water less than 200m deep off northwest Europe.
Their ability to respond to climate change by locating new suitable habitat may be limited because there is a lack of suitable shelf waters further north. Temperature rise therefore is likely to have serious implications for white-beaked dolphins, and may lead to a decline in abundance or fragmentation of the species' distribution. [ix]

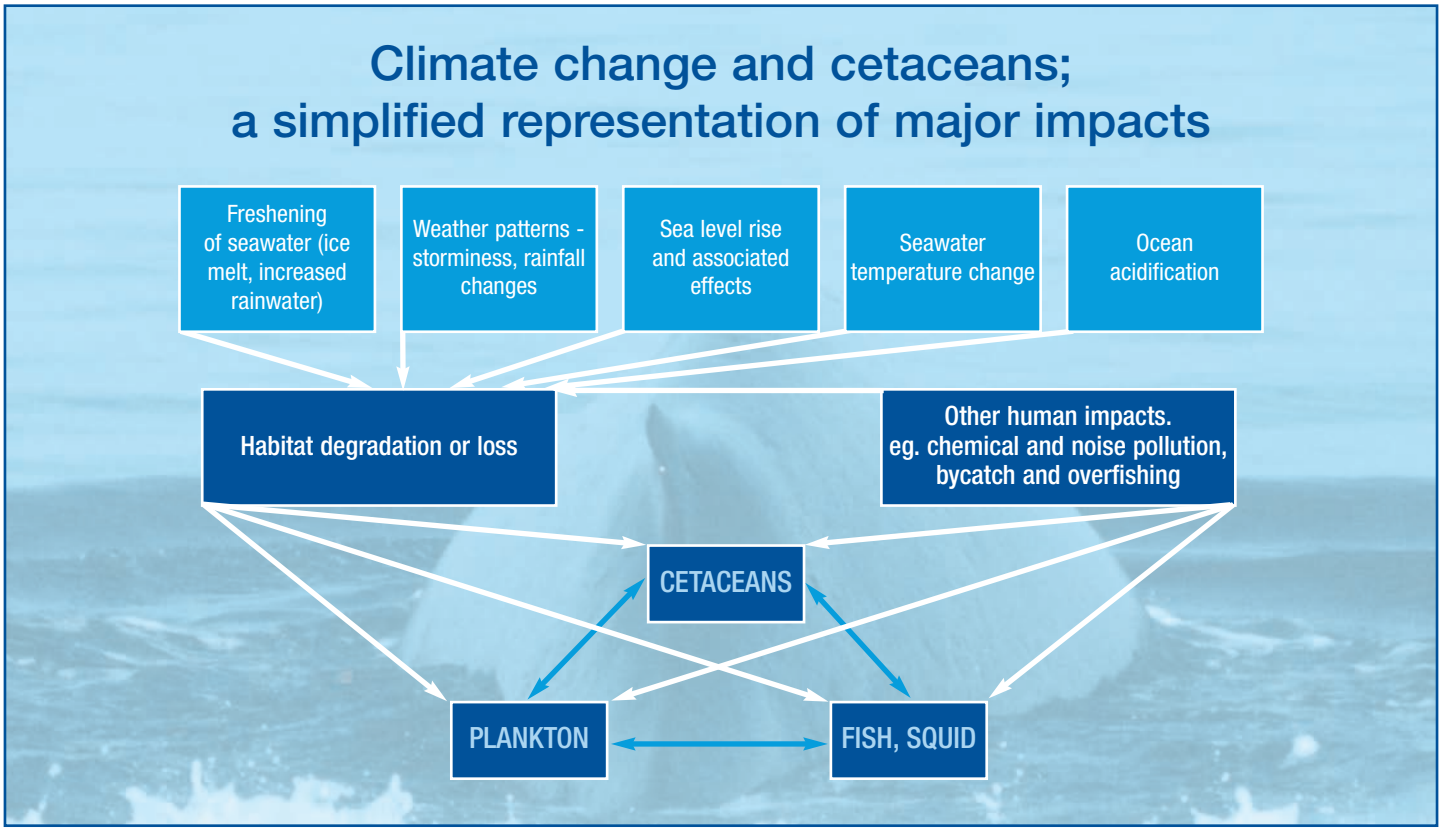
Climate change will also have indirect impacts on cetaceans, such as a probable increase in susceptibility to disease and contaminants and changes in the availability and abundance of food resources, particularly for whales which have specialised feeding habitats. The prey species of many

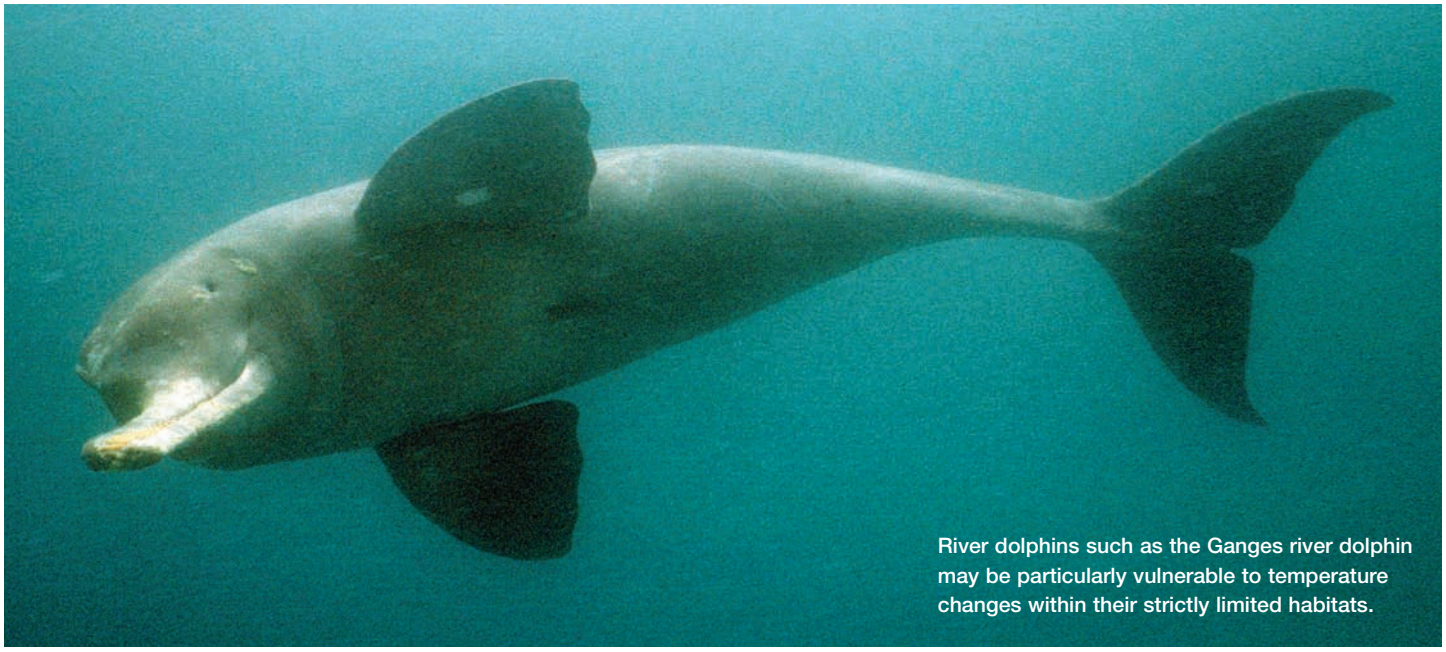
Table 1: Species range, status and potential effects of climate change on cetacean species listed as threatened by IUCN (either vulnerable, endangered, or critically endangered.)

Species name	Common name	Species range	IUCN status	Potential effects of climate change on species
Balaena glacialis	*Northern right whale*	*N Atlantic & Pacific: subpolar to tropical*	*EN (D)*	*? ↓*
Megaptera novaeangliae	*Humpback whale*	*Worldwide: cold temperate/ polar to tropical*	*VA (A)*	*?*
Balaenoptera borealis	*Sei whale*	*Worldwide: cold temperate to tropical*	*EN (A)*	*?*
Balaenoptera physalus	*Fin whale*	*Worldwide: polar to tropical*	*EN (A)*	*?*
Balaenoptera musculus	*Blue whale*	*Worldwide: polar to tropical*	*EN (A)*	*?*
Physeter macrocephallus	*Sperm whale*	*Worldwide: polar to tropical*	*VU (A)*	*?*
Platanista gangetica	*Ganges river dolphin*	*India, Nepal, Bhutan and Bangladesh: freshwater only*	*EN (A)*	*↓*
Inia geoffrensis	*Boto*	*Peru, Ecuador, Brazil, Bolivia, Venezuela, Colombia: freshwater only*	*VU (A)*	*↓*
Lipotes vexillifer	*Baiji*	*China: freshwater only*	*CR (ACD)*	*↓*
Delphinapterus leucas	*Beluga or white whale*	*Circumpolar in arctic seas: arctic to cold temperate*	*VU (A)*	*↓*
Cephalorhynchus hectori	*Hector's dolphin*	*New Zealand: coastal waters, cold to warm temperate*	*EN (AC)*	*↓*
Phocoena phocoena	*Harbour porpoise*	*N Pacific and N Atlantic: subpolar to cold temperate*	*VU (A)*	*? ↓*
Phocoena sinus	*Vaquita*	*Gulf of California: subtropical*	*CR (C)*	*↓*

Source: Learmonth et al. 2006. *Ibid.*
Note: ↓ indicates a possible decrease in range, and ? indicates that the effects on range are unknown.

Figure 1: Climate change and cetaceans; a simplified representation of major impacts.





River dolphins such as the Ganges river dolphin may be particularly vulnerable to temperature changes within their strictly limited habitats.

cetaceans concentrate in particular areas under specific environmental conditions. Cetaceans depend on finding these high prey concentrations at specific times and locations. If climate change affects the geographic distribution and timing of these oceanographic conditions, this can be expected to ultimately have serious consequences for marine mammal reproduction and survival. [x]

Cetaceans are already facing numerous non-climate related threats, such as chemical and noise pollution, commercial fishing, commercial shipping, naval activities, trophic modifications resulting from the introduction of non-native species and entanglement in fishing gear (bycatch). Bycatch alone is estimated to be responsible for the deaths of at least 300,000 cetaceans per year – nearly 1,000 every day. Climate change induced impacts are likely to compound and exacerbate these threats (see Figure 2) by reducing resilience and adaptive capacity because of resource deployment to competing needs. In many cases, it will be impossible to fully mitigate the negative impacts of climate change; therefore increased efforts must be made to reduce all other human-induced threats.

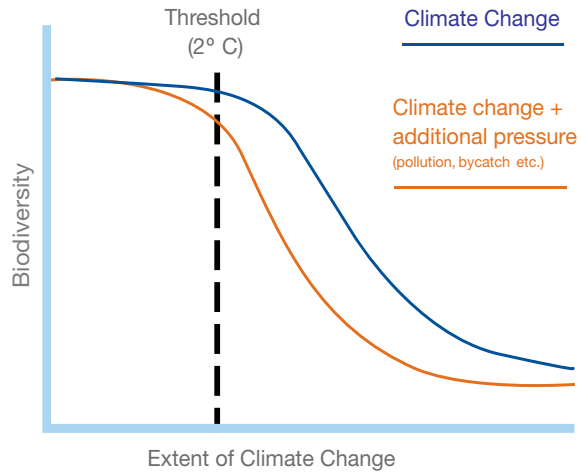


Figure 2:
Conceptual graph illustrating the compounding effect that climate change induced impacts can be expected to have on other non-climate stresses for any system.

The poles - where climate change hits first and hardest

Climate change induced impacts are already proving to be far more pronounced in the polar regions of the globe. Therefore the impacts of climate change on cetacean species that rely on polar habitats are likely to be particularly dramatic.

Furthermore, as temperatures increase, there are likely to be significant losses of polar "specialist" species and a general shift of more temperate species towards the poles, either due to animals searching out preferred temperature conditions or due to changes in the distribution and abundance of prey species. For polar-adapted species, this is likely to be particularly problematic as there will be a limited amount of colder habitats to move into.

> ***"Climate change in polar regions is expected to be among the largest and most rapid of any regions on the Earth, and will cause major physical, ecological, sociological, and economic impacts especially in the Arctic, Antarctic Peninsula and Southern Ocean."*** [xi]
>
> **IPCC.**

The Arctic Environment

Significant changes are already taking place in the arctic; average arctic temperatures have increased at almost twice the global average rate in the past 100 years. [xii] As a result, arctic sea ice extent has decreased by 14% since the 1970s, and March 2006 witnessed the smallest amount of arctic sea ice cover ever measured - an area about the size of Italy (around 300,000 km²) was lost compared to March 2005, which was already a record low year (see Figure 3). [xiii] Simulations suggest that this sea-ice retreat is likely to accelerate so rapidly that by 2040 the arctic basin could become nearly ice-free during summer. [xiv]

So what does this mean for cetaceans reliant on the arctic environment?

> ***Given the coupling between ice-edge habitat and the prey of many species of arctic marine mammals, we speculate that a sufficient reduction in the extent of the ice edge, and its associated community, may have deleterious consequences for marine mammals that have evolved with these unique systems.*** [xv]

Loss of ice – loss of habitat

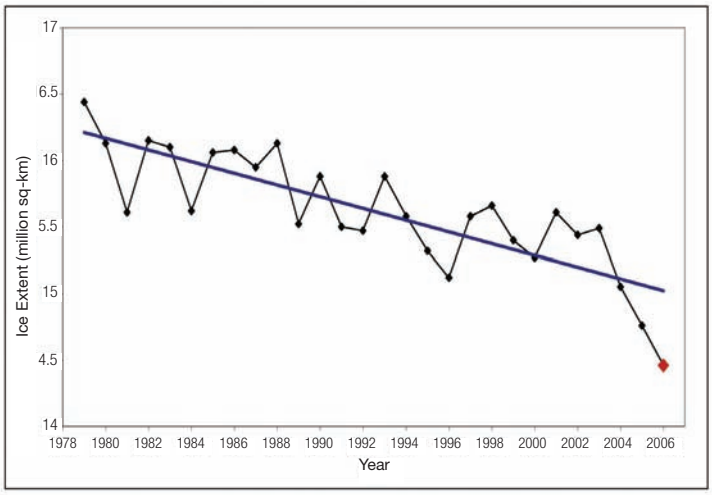
It is possible that northern oceans could become more productive due to warming trends, and that this could potentially benefit some top predators. However several cetacean species are permanently resident in the arctic and dependent to varying extents on the productive sea ice edge for foraging, in addition to using ice cover to avoid predation. These ice-associated arctic cetaceans are likely to be negatively impacted by climate change induced reductions in sea ice.

Ansgar Walk

Beluga whales are consistently associated with heavy ice cover, which may reflect their penchant for feeding on ice-associated arctic cod.

Bowhead whales (*Balaena mysticetus*) are regarded as an ice-adapted species but are not always associated with ice. Bowheads typically select habitats with moderate to light ice cover. [xvi] Beluga whales (*Delphinapterus leucas*) are consistently associated with heavy ice cover, which may reflect their penchant for feeding on ice-associated arctic cod. [xvii]

Figure 3: Decline in arctic sea ice extent over the last two decades



Narwhals (*Monodon monoceros*) are well adapted to life in the ice pack, and their wintering habitats in Baffin Bay can become so ice-dense that open water accounts for just 0.5% of the entire area. [xix] The reasons narwhals return year after year to an area with such dense sea ice cover is unclear, but could either be to seek refuge from killer whales or to ensure access to predictable prey.

The ability of species that prefer 'icy' habitats to adapt to long-term changes in sea ice extent and dynamics, and the resulting changes in prey availability, is presently an unquantifiable concern. For example, reduced ice cover could expand foraging opportunities for bowheads, but reduce them for belugas. [xx] However it is uncertain whether the bowhead whale would be able to adjust to ice-free waters [xxi] and this species may be heat intolerant. [xxii, xxiii] One study, looking at trends in sea ice cover within certain habitats used by bowhead whales in the western arctic, identified significant reductions in ice cover in eight of the 16 assessed regions of seasonal importance to this species. [xxiv]

In addition to the direct loss of ice-edge habitat, a warmer arctic with less ice and more exposed ocean may cause more temperate species to expand their normal distributions northward. This could result in changes in food webs and potentially alter any competitive interactions between species. However, as noted in the case of the white-beaked dolphins above, species that may try to move northwards in response to temperature change may not be able to find other key habitat requirements.

Furthermore species that currently migrate into arctic waters to feed, such as several large whale species, may also fare poorly if the resources that they seek at certain times of year are reduced or have moved outside of feeding grounds. [xxv]

Narwhals – trapped under the ice?

Whilst climate change is generally a warming trend, temperature increase is not being observed uniformly across the planet. Some changes might occur that may at first seem counter intuitive. One example concerns recurring polynyas, which are particular locations within the ice pack that are almost always clear of ice. Polynyas are caused by persistent physical conditions, such as upwellings or wind patterns, and are of critical importance for many arctic species, including several cetaceans such as belugas, narwhals and bowhead whales. [xxvii] They provide important places where the animals can come to the surface to breathe, and can also provide productive feeding areas. Although global warming has reduced sea ice formation in the arctic overall, this trend is not uniform and in some cases, the number, timing and location of polynyas are changing, with potential implications for the marine mammals dependent on them.

In Baffin Bay, home to a large concentration of wintering narwhals, sea ice actually increased (with an associated reduction in open water) between 1950 and 2000.[xxviii] The reduced number of openings in the ice available to narwhals during the winter and the fact that narwhals appear to return to the same areas of Baffin Bay year after year irrespective of ice patterns, suggests that narwhals may experience increasing risk of ice entrapment. During an ice entrapment, hundreds of whales can become trapped in a small opening in the sea ice and they can often die. Such ice entrapments may go undetected in remote offshore areas and consequently their importance may be under-estimated.

Over the last few years, trends in sea ice cover in Baffin Bay appear to have reversed and the extent of sea ice reduced. This highlights the increased variability in sea ice cover in this area; which is in itself a problem for cetaceans living within it.

> ***"With the evidence of changes in sea ice conditions that could impact foraging, prey availability and of utmost importance, access to the surface to breathe, it is unclear how narwhal sub-populations will fare in light of changes in the high Arctic."*** [xxvi]

Furthermore, the indirect effects of sea ice change on narwhals may include impacts on the food web in both Baffin Bay and Davis Strait; potentially including changes in the distribution and recruitment of their primary prey, Greenland halibut (*Reinhardtius hippoglossoides*). [xxix]

The winter habitat of the narwhal in Baffin Bay and Davis Strait is generally covered in ice with only a few openings available in the ice for breathing.

Image courtesy of Kristin Laidre.

Less ice – more disturbance

As the extent and duration of ice cover in the arctic decreases, there will be greater opportunities for human use and exploitation of areas that were previously inaccessible.

The Northwest Passage is the route connecting the Atlantic with the Pacific Ocean through Canada's high arctic. The Lancaster Sound region, in the eastern part of the Northwest Passage, is an important summer habitat and migratory corridor for belugas and narwhals. This region, and the southern portion of the North Water polynya of northern Baffin Bay, are among the richest areas for marine mammals and birds in the Canadian arctic. [xxx]

Climate change induced reductions in sea ice are likely to make the Northwest Passage more easily navigable, thus enabling increased boat traffic for longer lengths of time. In all probability this will result in an increased risk of additional chemical and acoustic pollution, and more collisions between whales and ships. An analysis of 292 large whale ship strikes worldwide revealed that 198 (68%) were fatal and 48 (16%) resulted in injury to the animal. [xxxi] In most cases the fate of injured whales is not known.

Furthermore, commercial fishing fleets may move north following changes in fish stock distribution (as well as retreating ice), and clearer waters may allow additional oil and gas exploration and development. These industrial activities would further contribute to increased noise (from seismic exploration and drilling for example), increased vessel traffic and an increased risk of accidents such as oil spills.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Oil pollution, Alaska, USA

Belugas have been reported to swim rapidly away from ice-breaking ships approaching within 35-50 km; narwhals have been reported to show less overt panic to approaching ships, although their underwater vocalizations temporarily cease. [xxxii] Bowhead whales are perhaps the most sensitive of all large whales with reaction distances of over 30 km to seismic and shipping noise; [xxxiii] and could abandon feeding areas if they became polluted with industrial noise. Like their 'cousins' the North Atlantic right whales (*Eubalaena glacialis*), it is reasonable to assume that bowheads will fare badly in the face of increased fishing activities. [xxxiv]

Consequently, it is expected that the opening of the Northwest Passage will have a strong negative effect on cetaceans in the area, particularly when the synergistic effects of these human activities and climate-change induced shifts in the ecosystem are considered. [xxxv]

Eastern James Bay	• *Decrease in numbers*
Eastern Hudson Bay	• *Decrease in numbers along coast* • *Moved to and travelling in currents farther off shore*
Hudson Strait	• *Decrease in numbers in Salluit area*
North Western Hudson Bay 122	• *Decrease in numbers in Repulse Bay and Arviat area*
Western Hudson Bay	• *Increase in numbers in Fort Severn and Winisk estuaries* • *Decrease in numbers in Nelson River*

Table 2. Changes in beluga distribution observed by Inuit and Cree
Source: McDonald, M., L. Arragutainaq, and Z. Novalinga. 1997. Voices from the Bay, Canadian Arctic Resources Committee and Environmental Committee of the Municipality of Sanikiluaq.

> *"It was a lot colder when I was young, months at a time. This weather nowadays is unpredictable; it just comes and goes anytime it wants to go. Even trapping is unpredictable now."*
>
> **Hudson Sam, Elder, Huslia, Alaska.**

Relevance for native arctic communities

The survival of the traditional way of life of many arctic communities is intrinsically linked to arctic wildlife, whose distribution and abundance is in turn intrinsically linked to the arctic climate. It has been suggested that the demise of the Thule culture 500 years ago was related to the climate-induced absence of bowhead whales along the rim of the Canadian Basin. [xxxvi, xxxvii]

> *"...you know, this all happens because of us humans, so really, we've got to tell the world what's going on!"*


© Tonje Folkestad / WWF-Canon

George Attla Jnr., Huslia, Alaska

Arctic communities are facing increasingly severe climate-related changes to their environment. One particularly rigorous study, based on traditional knowledge and the experiences of 78 Inuit and Cree hunters and elders from 28 communities, identified major changes in factors such as the weather, atmosphere and sea ice cover, as well as changes in the distribution, abundance and condition of arctic wildlife such as polar bear, fish, walrus, moose and caribou. These communities have noticed a decrease in beluga numbers in all but one area assessed (although this is not necessarily solely a result of climatic changes). In addition, the communities reported major changes in location, number and duration of polynyas in eastern Hudson Bay. As noted above, these areas are of significant importance for several cetacean species in the arctic.

The Arctic Council's 2004 'Climate Impact Assessment' (ACIA) concluded that "changes in the species' ranges and availability and the decreased ability to travel safely in changing and unpredictable ice conditions, are making people feel like strangers in their own land." [xxxviii]

The Antarctic Environment

Climate change impacts in the Antarctic are accelerating faster than the global average, similar to the situation in the arctic. Air temperatures in the Antarctic Peninsula region have risen by more than 2°C in the past 50 years, about 5 times faster than the global mean rate. Warming over the Antarctic in the middle troposphere (the layer of the atmosphere around 5 km above ground) is the largest regional warming on Earth at this level. [xl] However the impacts of this warming air on Antarctica's massive ice sheets are less clear, and high levels of regional variation have been observed.

The impact of climate change on the largest and smallest of the earth's creatures

The Southern Ocean supports more than 50% of the world's marine mammal biomass, including around one fifth of the world's cetacean species, [xli] and the eight species of baleen whale in this area feed almost entirely on krill (*Euphausia superba*). Krill are tiny shrimp-like marine animals that are dependent on sea ice - the permanent ring of frozen ocean which surrounds the Antarctic continent. Krill overwinter under the ice, and feed on algae found under the ice surface. Thus the sea ice edge is the area of highest productivity in the Southern Ocean ecosystem and the main foraging site for many whale species.

Recent studies have revealed that krill populations have declined by as much as 80% in the Scotia Sea and northern Antarctic Peninsula since the 1970s, with the declines linked to the loss of winter sea ice. [xlii] The decline in krill has had serious implications for the Southern Ocean food webs in these areas, including penguins, albatrosses, seals and whales, all of which have wide foraging ranges but are susceptible to krill shortages. [xliii] A 2001 study found that population size and reproductive performance were declining in land-based krill-eating predators such as seals and penguins in South Georgia, and concluded that "the biomass of krill… was sufficient to support predator demand in the 1980s, but not in the 1990s." [xliv]

Recent studies have revealed that krill populations have declined by as much as 80% in key areas of the Antarctic.

> ***"Climate change is likely to produce long-term – perhaps irreversible – changes in the physical oceanography and ecology of the Southern Ocean. Projected reductions in sea-ice extent will alter under-ice biota and spring bloom in the sea-ice marginal zone and will cause profound impacts at all levels in the food chain, from algae to krill to the great whales."*** [xxxix]
>
> **IPCC.**

Southern right whale mother with calf

The specific impacts of krill declines for whales was not immediately clear, but in 2006 additional analyses revealed that southern right whales *(Eubalaena australis)* in South Georgia were experiencing similar impacts to the seals and penguins; the breeding success of the right whales was found to be highly correlated with global climate signals and the impacts of those signals on their main food source - krill. The researchers concluded that "even quite small changes in oceanographic conditions in the Southern Ocean could affect southern right whale population dynamics." [xlv]

Although loss of sea ice and resulting krill declines have been observed in some areas, it is important to note that - at present - such changes are not being uniformly observed around the whole Antarctic continent. In fact, sea ice persistence and extent in East Antarctica and the Ross Sea region argues for the opposite effect. However the studies cited above do reveal significant changes that could be indicative of what may follow in other places in due course, particularly as "sea ice is projected to shrink in … the Antarctic under all SRES[1] scenarios." [xlvi,]

[1] SRES refers to the IPCC Special Report on Emission Scenarios (2000)

One species that is particularly vulnerable to any changes in its environment is the largest known animal to ever live on Earth – the blue whale (*Balaenoppera musculus*). Measuring up to 33.5m in length, with the largest weighing in at around 200 tons, the blue whale's heart is the size of a small car and its heartbeat can be detected from two miles away. At the beginning of the 20th century, it is estimated that around 575,000 blue whales lived in the world's oceans, but today only 3-5,000 remain, a decline that is primarily due to commercial whaling in the early 1900s. Although the blue whale is now protected, at such low numbers it is still extremely vulnerable to even small levels of stress. Climatic changes and a potential decline in their primary food source in the Southern Ocean - krill - could be of considerable concern; particularly as so little is known about the blue whale.

One species that is particularly vulnerable to any changes in its environment is the largest known animal to ever live on Earth - the blue whale.

> ***'Such dramatic changes in ocean pH have probably not been seen for millions of years of the Earth's history.'*** [xlvii]

Acidifying the Oceans

Another less well known, but potentially important problem in the marine environment, is 'ocean acidification'. As human activities increase the carbon dioxide levels in the atmosphere, increasing levels are absorbed by the oceans; leading to chemical changes which ultimately have an acidifying effect.

Dissolved atmospheric carbon dioxide increases the concentration of hydrogen ions, which combine with carbonate ions, thus leaving a net decrease of carbonate ions in the ocean. Many invertebrate organisms depend on the presence of adequate carbonate ions to build their calcium carbonate shells, including the coccolithophores, pteropods, gastropods and foraminifera which are major food sources for fish and some whale species. [xlviii] Cold polar waters are naturally less saturated with carbonate ions than warmer waters, so high-latitudes will be the first to suffer measurable impacts of ocean acidification and the resulting reduced carbonate availability. [xlix]

Squid, which are key prey for many deep-diving marine mammal species, such as the beaked and sperm whales, may be especially vulnerable to ocean acidification. Their high-energy swimming method and high metabolism require a good supply of oxygen, and their capacity to carry oxygen is reduced by lowered blood pH. [l]

In the Antarctic, the sea ice edge is the area of highest productivity in the Southern Ocean and the main foraging site for many whale species.

Female sperm whales have been found to have lower rates of conception after periods of unusually warm sea surface temperature.

Other climate change impacts on cetaceans

- There may be a link between climate and the reproductive success of whale species. For example, female sperm whales (*Physeter macrocephalus*) have been found to have lower rates of conception after periods of unusually warm sea surface temperature. [li]
- Breeding in many species may be timed to coincide with maximum abundance of suitable prey, either for the lactating mother or the calf at weaning. Therefore, any changes in the environmental conditions that determine prey abundance may cause a mismatch in synchrony between predator and prey, either in time or location. Migratory cetaceans that travel long-distances between feeding and breeding areas may be particularly vulnerable to this mismatching.
- The North Atlantic right whale (*Eubalaena glacialis*) is one of the most endangered of all large whales, with a long history of human exploitation. It is now primarily threatened by ship-strikes and entanglement in fishing equipment but a decrease in North Atlantic right whale calf survival has been related to the effects of climate variability on prey abundance. [lii] Between 300 and 350 individuals still exist, with little hope of population growth and climate change may be the agent that prevents the North Atlantic right whale's recovery and pushes it to final extinction. [liii]
- Whilst oceanic cetaceans are unlikely to be directly affected by rises in sea levels, important habitats for coastal species and species that require coastal bays and lagoons for breeding, such as gray whales (*Eschrichtius robustus*) and humpback whales (*Megaptera novaeangliae*), could be adversely affected. [liv]
- Climate change also has the potential to increase pathogen development and survival rates, disease transmission and host susceptibility. [lv] Higher temperatures may stress organisms, increasing their susceptibility to some diseases, especially if they are at the upper end of their thermal tolerance. [lvi] Climate change is expected to affect the range and migratory patterns of many marine mammals, which in turn could lead to a spread of viruses and the introduction of novel pathogens, for which cetaceans do not have established immune responses. Warmer waters may also favour the prevalence of some pathogens or toxic algal blooms. It may not be co-incidental that in the past few decades there has been an apparent increase in large-scale mortality events such as morbillivirus infections, which caused massive die-offs of striped dolphins (*Stenella coeruleoalba*) in the Mediterranean Sea and other species elsewhere, although the relative roles of different environmental factors in these die-offs are not fully understood. [lvii]
- If species or populations respond to climate change by shifting their distribution, this may result in them moving out of areas that have been established to protect them. This could be a particularly important issue for relatively small protected areas that have been established to conserve specific populations, or habitats used for critical parts of an animal's life history, such as breeding or calving.

Conclusions and Recommendations

Climate change could have far reaching implications for cetaceans, the entire marine environment and the people who depend on it.

There are two main avenues to address the threat of climate change to cetaceans: reduction of emissions, and strengthening the resilience of species and ecosystems.

The first priority is, and must continue to be, reducing greenhouse gas emissions to ensure global temperatures are kept at less than a 2°C increase compared to pre-industrial levels. If emissions are not reduced quickly and effectively, the success of all other measures is likely to be severely limited.

However it is clear that changes in our climate are already occurring, and will continue to occur in the future even under the most optimistic predictions for emission reduction. It is therefore critically important that climate change considerations be incorporated into conservation plans, assessments and strategies for cetaceans, [lix] and that the resilience of ecosystems and species to climate change be increased. There are three main ways to do this: [lx]

1) **Protection of adequate and appropriate space.**
   This should include the protection of habitats critical for breeding or feeding and the protection of climate refugia areas; those areas that are less vulnerable to changes in climate than others. In the design of protected areas and other zoning and conservation strategies, forward planning must be employed to determine how the geography of the most important attributes will be affected by climate-induced factors.

2) **Limit all non-climate related stresses.**
   There are a myriad of stresses on cetaceans and the marine environment, and climate change is expected to have a synergistic effect. As the non-climate stressors are often more locally controllable than climate change, increased efforts must be made to reduce them.

3) **Adaptive management.**
   Given the uncertainty about the exact nature of the impact of climate change on cetaceans and their responses, a responsive and flexible management approach is required, combined with rigorous monitoring.

The IWC Scientific Committee last looked at climate change in a substantive way in 1996. At that time it highlighted concerns, but also commented on the poor predictive ability of scientists to determine what such impacts were likely to mean. Mindful of the dramatic changes that have occurred to both our climate and the global knowledge base on climate change and its impacts over the last decade, it is now essential that the IWC revisit this issue in a concrete and comprehensive fashion.

Consequently, the IWC should:

- Direct its Scientific Committee to hold a special workshop on climate change impacts on cetaceans in order to facilitate research into predicting future impacts and elaborate conservation and management plans in light of climate change, including sufficient monitoring to allow for adaptive management.
- Increase efforts and resources for reduction of all non-climate threats to cetaceans, such as bycatch, pollution, oil and gas exploration and development, shipping and over-fishing, particularly through the IWC Conservation Committee.

Government members of the IWC should:

- Provide the IWC with appropriate resources to allow the Scientific Committee and the Conservation Committee to fulfil the tasks outlined above.
- Increase national resources and research funding for monitoring of climate change impacts on cetaceans and the ecosystems upon which they depend and implement appropriate adaptation strategies.

Most critically, all governments of the world need to act now to reduce the rate and extent of climate change.

ALL GOVERNMENTS MUST:

- Accept the imperative for the world to limit global warming to well below the dangerous threshold of 2˚C, compared to previous industrial levels.
- Agree to reduce global green house gas emissions by at least 50% by 2050.
- Launch formal negotiations at the United Nations Climate Change Convention meetings[3] in Bali this year under a timetable that concludes Kyoto-plus agreement by 2009.
- Urgently agree to deeper emissions cuts for developed countries. The EU recently took the first step and committed to reduce carbon pollution by 30% by 2020 compared to 1990 levels if others do their fair share. It is now critical that other governments match these commitments.

[2] The Inuit Circumpolar Conference is the international organization representing approximately 150,000 Inuit living in the Arctic regions of Alaska, Canada, Greenland and Chukotka, Russia.

[3] COP 13 and COP/MOP 3: Conference of the Parties (COP), thirteenth session and Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (COP/MOP), third session.

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“What can Inuit do to convince the world to take long-term action that will have to go far beyond Kyoto? How do we convince the major emitters, such as the United States, of the risks we face in the Arctic? How can we bring some clarity of purpose and focus to a debate that seems mired in technical arguments and competing ideologies?”

Sheila Watt-Cloutier, Chair of the Inuit Circumpolar Conference (ICC)[2], March 2004

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WWF is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in more than 100 countries. WWF's mission to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by: conserving the world's biological diversity - ensuring that the use of renewable natural resources is sustainable - promoting the reduction of pollution and wasteful consumption.

WDCS, the Whale & Dolphin Conservation Society is the global voice for the protection of cetaceans (whales, dolphins and porpoises) and their environment. We aim to reduce and ultimately eliminate the continuing threats to cetaceans and their habitats, and to raise awareness of these wonderful animals and the need to protect them in their natural environment. We take action to stop the threats faced by whales and dolphins, to protect the animals and the places they live, and to reach out to as many people as possible. Our work combines concern for the welfare of the individual animals with efforts to ensure the protection of whole species, populations and their habitats. Established in 1987, WDCS is staffed by over 70 people, along with many more volunteers. We have offices in Argentina, Australia, Austria, Germany, UK and USA and a worldwide network of consultants, researchers and supporters.

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