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Efforts to Save Beluga Whales in their Natural Habitat:
A Systematic Review

Beluga whales, *Delphinapterus leucas*, are highly social animals that travel in large groups. They are the only living members of the genus *Delphinapterus*. Their prey consists mostly of fish such as salmon, flounder, cod and other fish species but they also eat shrimp, squid, isopods, clams, crabs, octopus, snails, and polychaetes (Quakenbush et al., 2015). They are white whales with no dorsal fin. This is because they are found in the Arctic and subarctic waters in the Northern Hemisphere meaning they need to conserve heat. The loss of the dorsal fin creates less surface area allowing less heat to be lost. In addition, they are able to swim under the ice without their fin impeding their movement (Jones et al., 2017). These animals are known to travel hundreds to thousands of kilometers each year between wintering grounds and summering grounds. In the winter, they are found in areas where there is shifting ice or in polynyas (Saxon Kendall and Cornick, 2015; O'Corry-Crowe et al., 1997). In the summer, they are known to inhabit coastline areas such as estuaries and inlets to rear their young, molt, and feed and are known to show site fidelity in these areas. (O'Corry-Crowe et al., 1997). They are currently listed as least concern and are protected by the Marine Mammal Protection Act (Lowry et al., 2017).

There is also an endangered, genetically distinct population of beluga whales that inhabit Cook Inlet. This area has an abundance of prey and few predators. These belugas are found in this area from June to October and, in the winter, they are found offshore, although they do not show seasonal migration patterns. National Marine Fisheries Services (NMFS) have done aerial surveys of this inlet starting in 1993 and found a 50% decrease in abundance with populations going from 653 in 1994 to 347 in 1998. In 1998, hunting was regulated to conserve these species, but their populations numbers are still decreasing with there only being 279 whales as of 2018. In 2008, they were considered endangered and are protected under the Endangered Species Act.

This is because of multiple other threats the whales face. Because they inhabit the inlet, it is close to human activities, so they are more vulnerable to anthropogenic threats. (Carlson et al., 2015; Hobbs et al., 2006). Some human activities that affect all populations of beluga whales include competition for fish with fisheries, hunting, contaminants, vessel strikes, noise pollution, and loss of habitat in coastal areas due to development. There are also some natural threats such as live stranding, predation, disease, and climate change (Norman et al., 2015).

To explore these threats further, beluga whales are considered to be at the top of the food web. In the summer, they feed on a variety of salmon species such as chum, coho, and chinook. Fisheries are often trying to catch salmon and compete with these whales for this fish. As a result, belugas have trouble finding food which causes starvation (Norman et al., 2015). In addition, these whales are also hunted in Greenland above the quota set by scientists which causes a decline in their population (Black and Servion, 2005). Contaminants are also a problem for these whales. Some of these include heavy metals and persistent organic pollutants which are compounds that do not degrade in the ocean and, as a result, accumulate in the food web. The chemicals enter the waters due to point and nonpoint sources such as runoff, oil spills, emissions from power plants, and dredging which causes chemicals in the sediment to become aroused and introduced back into the water column (Norman et al., 2015).

One of the biggest anthropogenic threats to belugas is noise pollution. They can hear between 45-80 kHz, where lower frequency sounds, such as industrial noise, affect them the most (Norman et al., 2015). A study was conducted to see what human noises affect belugas and they found a variety of sources such as watercrafts, trains, aircrafts, construction noise, gun noise, automobile noise, and wind surfers (Carlson et al., 2015). In-water construction is a large part of noise pollution that includes dredging, gravel fill, and pile driving. Pile driving is where

piles are hammered into the ground to provide foundational support for buildings. The sound can be heard from 70 km away. A combination of these activities can affect the beluga's ability to communicate. It can also mess with their echolocation causing behavioral changes and make them more susceptible to predators. This also makes it harder for them to find prey because they aren't able to detect them (Saxon Kendall and Cornick, 2015).

Climate change is quickly causing a problem for these beluga whales. Because they inhabit arctic waters, the sudden change in sea ice poses a threat for these animals. Entrapment in the ice is one of the major concerns with climate change. The Alaska Coastal Current causes strong currents, winds, extreme tidal changes, and large silt deposits from glacial scouring which results in sudden ice formations, rapid freezing of the ice, and ice moving into open areas. This can result in belugas becoming entrapped in the ice which can make it hard to capture prey and even come up to breath (Norman et al., 2015). It has even been found that polar bears will prey upon these entrapped whales because they may only have one breathing hole (Eliot, 2000). Another issue is the melting of the ice in general. With the ice melting, it allows more access points for ships to enter into. This causes an increased risk for boat strikes as well as more noise pollution which is already a large threat for these whales (Norman et al., 2015).

Stranding is also a problem for these whales. There are a variety of reasons why they may strand. For example, they are known to rub against rocky bottoms and ground themselves in the sediment during molting which could cause them to become stuck, especially during low tide. They could also become beached from fleeing to shallower areas to avoid predation from killer whales or by chasing prey into these waters. Or they can strand due to an injury, such as a vessel strike, or illness which causes them to float onto shore. Because most of these whales strand alive and during low tide, they are usually able to escape back into the ocean when high tide

comes around. That being said, these live whales can die if stranded too long from stress or hyperthermia. Most of the time, only one whale will strand at a time, but there have been cases of mass strandings in 1992, 1996, 1999, 2003, 2005, 2008, and 2014 (Moore et al, 2000; Norman et al., 2015). These mass strandings are primarily due to large changes in tides going from 9.5 m to 3.2 m meaning most of these whales were able to unstrand when high tide arrived.

If this organism were to strand in New York, there would be a bigger issue as these whales don't inhabit New York waters. That being said, the NMFS receives both live and dead stranding reports from the public, air taxi services, state troopers, and other organizations. When a stranding occurs, aerial surveys are often conducted to search for dead whales following the stranding event. If dead whales are found, the carcasses are examined, and samples are taken. Necropsies are also done to find the cause of death. Some samples that are taken include skin for genetic analysis, blubber, kidney, liver, or muscle samples to test for contamination, teeth for aging, stomach samples for diet analysis, and any odd growth such as tumors, parasites, and evidence of trauma or boat strike. It is important to search for dead whales after the stranding event because some can strand shortly after. For example, stranding for a couple of hours could result in compression of the chest cavity, hyperthermia, or shock. This can cause vascular collapse which leads to poor circulation and impaired organ function. This causes long term health problems which could prevent the animal from recovering even after being refloated, causing them to strand again shortly after (Vos and Shelden, 2005).

If the animal is dead, the carcass can be disposed of in three ways. The first step in all the options is to remove the skull so the public cannot collect it. The skull then can be sent to museums if applicable. The first option is to leave the carcass where it was found because things like scavengers, tides, and weather will decompose it, especially if it is unsafe to move or access

the carcass. This cannot be done if the animal was euthanized and should only be done if there is no risk to human health. The next option is to tow the carcass out to sea. This option is used if the animal is likely to sink and must be taken far enough offshore and away from shipping lanes, so it won't be brought back. The final option is to bury the carcass. This is not ideal as it takes a lot of work but it should be buried above high tide and deep enough so scavengers cannot dig it out or for erosion to uncover it. The body cavity should also be opened up to help with decay (Plan, 2009).

When there is an observed stranding, the first step is to report the stranding to NMFS. They will then send their response team and take appropriate action based on the situation. If the beluga is breached in an inaccessible or unsafe area, the NMFS will photograph the animal and count how many have stranded if there is more than one. Then the beluga is monitored to see if it will refloat during high tide or, if it dies, see if the carcass remains onsite or floats away. If the beluga is breached in a safe and accessible area, the cause of the stranding will be determined in order to know how to take appropriate action. For example, if there is an entanglement event, the next step may be to remove the gear and report the event as a human interaction case. If it is determined to be from the low tide, no action is taken except monitoring it to see if it refloats during high tide. Basic measurements are also collected, and care is provided based on the situation. If in the case of a mass stranding, each beluga is individually assessed. Euthanasia is an option depending on the health of the animal. If euthanized, a necropsy is done. Under very extreme and rare cases, and under the NFMS recommendation, can the animal be admitted for rehabilitation. This is because belugas can weigh up to 700 kg, making it very difficult to transport (Dhindsa et al., 1974). In addition, not a lot of facilities take in large cetaceans and most of the time that the animal is stranded, the animal is healthy, and the tide will refloat it.

(Plan, 2009).

If in need of care, it is given onsite where the whale is stranded. If possible, creating a barrier against the wind and digging holes for the flukes and flippers can help so the whale doesn't suffer from hypothermia. Positioning the whale on their side and digging holes again for their fluke and flippers gives them a more natural position. In addition, rinsing the eyes can be done to remove sand from them. Covering the animal with a damp, light colored sheet, applying zinc oxide, or keeping the whale moist by slowly applying water can all help avoid sunburn and hyperthermia. When doing these techniques, the blowhole and eyes should be avoided (Plan, 2009).

Data is also collected from the whales. A number is given to each whale and photographs are taken. Any human related injuries are recorded. Behavior of the whale is recorded from alert, to weak, to non-responsive. This can be tested by touching near the animal's eye to see if it blinks, pulling the flipper, tongue, or attempting to pry open the jaw to see if the animal resists, or pressing on the gums to see if they turn from pale back to normal in less than 2 seconds. If the back is arched (head and fluke is up) that can indicate the whale is in poor health. Respiration is also observed. Counting the number of breaths per minute can determine a whale's health with 2-6 breaths per minute being normal. If the breaths are long and drawn out, it is a sign of a fatigued animal. Blood from the blowhole or foul breath raises concern. Heart rate and temperature is also collected. The blowhole and lesions can be swabbed to test for bacterial and viral infections as well as fecal samples. If permitted by the NMFS, blood may be drawn, and tags may be placed to further survey the animal if it is refloated (Plan, 2009). If the animal stranded on a New York beach, refloating the animal should be done first, but euthanasia may be needed if the animal is not refloated because the New York Marine Rescue Center cannot rehabilitate large cetaceans

and there are no organizations nearby. Further research may be conducted, or samples may be taken to try and figure out what made the animal strand so far from its natural habitat.

Because the population of Cook Inlet belugas are so low and because of multiple anthropogenic threats, their population may not be able to recover. Even after hunting ceased, these belugas continued to decrease. Without proper protection methods, they may be extinct in the near future. That being said, the other beluga populations are thriving as of right now. For example, an unexpected effect of climate change is, as the sea ice melts, this opens up more space for the belugas to roam. They can also get into areas that were previously restricted by the ice where more prey could be found. These areas are found to be inaccessible to hunters as well (Heide-Jørgensen et al., 2010). Although this is an example of a favorable condition of climate change, it is still a threat and ultimately impacts belugas negatively. Belugas are adapted to living near the ice for food and predator avoidance and the melting ice could make them more vulnerable. In addition, a reduction in sea ice can cause phytoplankton blooms to come early, which could affect the prey abundance of belugas. They also rely on environmental cues for migration such as temperature and prey availability which could be altered in warmer temperatures (Bailleul et al., 2012).

In addition, with many oil reserves becoming depleted, the Arctic may be a hotspot for drilling. This can cause noise pollution that can harm the belugas. No long-term damage is documented as belugas will avoid or swim away from the noise once they hear it, but the increase in drilling activity may not allow an easy escape. If the beluga is engaging in an important task such as feeding, mating, or nursing, they might not try to escape the noise. The noise may allow them to not return to the habitat which would affect them, as they show site fidelity. This could cause their natural distribution to change which could cause their population to decrease as they

are not adapted to other habitats (Erbe and Farmer, 2000). Overall, there is potential for their populations to continue to thrive in the future if we can create conservation methods or areas such as reserves that will protect their habitat.

If the public is educated and understands these threats, they can help conserve these populations by not allowing oil drilling in the Arctic or by trying to reduce the anthropogenic threats along the coastline that they are facing. In order to convince the public to take action, education is required. Patience and facts are the most effective ways to convince someone to do something as well as sticking to your belief even if nobody listens at first. For example, signs could be placed that say that there are only 279 whales left in Cook Inlet and that saving them can only work if you are engaged. Information on future Arctic drilling could be published so people can protest it from happening. The most important thing is to convince the public why belugas are important to them. For example, beluga whales are at the top of the food web, so they regulate fish populations which allows for more fish for fishermen to catch. Creating programs where you can actually see belugas could be helpful because once you see an animal in its natural habitat, you want to help protect it. For example, Alaska has a viewing station along the coast where you can see belugas as well as learn about them through signage and it makes you want to save them so other people will be able to experience them in the future. This may inspire people to want to help belugas so programs such as Adopt a Beluga Whale can help raise money for conservation efforts and is a great way to further educate the public and keep them engaged. All in all, protection of belugas is possible. Most of the deaths of belugas are caused by human activity. If we can convince the public to take action, beluga populations can be saved.

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