# The Effects of Declining Sea Ice on Narwhals

Joseph C. Giesbrecht
Helen E. Martin
Julia S. Murph
Marissa A. Nilsen
Henry M. Short

Gallifreyan Gastropods

Team Coaches:
Joni Johnson and Sunny Rice
jjohnson@pcsd.us

Petersburg High School, P.O. Box 289
Petersburg, Alaska 99833

*"This paper was written as part of the Alaska Ocean Sciences Bowl high school competition. The conclusions in this report are solely those of the student authors."*

# The Effects of Declining Sea Ice on Narwhals


## Abstract

Narwhal populations number around 80,000 individuals (Laidre, n.d.). Threats to narwhals include polar bears, orca whales, and entrapments in sea ice ("The Narwhal's Tale: Surviving Sea Ice Change," 2012). Other potential problems include the melting of global sea ice, which will reshape their habitat. In the past 25 years, the annual sea ice around Baffin Bay, the narwhal's main winter home, has declined by 3% per decade with perennial sea ice declining by 9% per decade (Laidre and Heide-Jorgensen, 2005). It has been predicted that in the next 65 years the sea ice extent, the summer extent, and the total amount of multi-year sea ice in the Arctic will decline (Keil, 2012). Along with the decrease of global sea ice, narwhals will also be affected by increased industrial activities ("Monodon monoceros," n.d.), such as shipping and oil exploration (Mcleish 2013 pg 3-4). Narwhals will have to deal with changes in their food web (McLeish 2013, pg 95), and migration patterns as a result. However, as the eminent issue of sea ice continues to endanger these arctic mammals, we propose four solutions: requiring reduced sound pollution, banning oil drilling, requiring vessel monitoring systems, and raising awareness.

## Introduction

Narwhals have been around for many years. Their name derives from Norse; *nar* meaning corpse, and *hval* which means whale ("Narwhal (*M. monoceros*)" n.d.). The Inuit call narwhals "tugaliik," meaning "with a tusk" ("Narwhal (*M. monoceros*)" n.d.). Mostly ignored as a whale minority group, narwhals may be greatly affected by changes in sea ice. The total population of narwhals is estimated to be 80,000 whales (Laidre, n.d.). The narwhals that summer in the Arctic make up 87.5% of the total population, while the remaining narwhals summer along Hudson Bay, the Greenland shoreline, and the East Baffin Island coast (Jefferson et al, 2014). The majority of narwhals spend their winters in Baffin Bay surrounded by sea ice, and because of the rapid sea ice loss (Laidre, n.d.), this can become a problem. Losing this natural ice protection can mean big changes for these Arctic mammals. Contrary to popular belief, narwhals do not possess magical unicorn powers to overcome these sea ice obstacles.

In the winter, narwhals reside in Baffin Bay where the average sea ice has decreased approximately 56% in the last 25 years (Polyak et al, 2010). Over the years, sea ice has begun to decrease greatly. In September of 1979, the sea ice extent reached around 7 million $km^2$ (Humpert, 2011). In contrast, the sea ice extent for September, 2011 only reached 4.8 million $km^2$ (Figure 1)(Humpert, 2011).

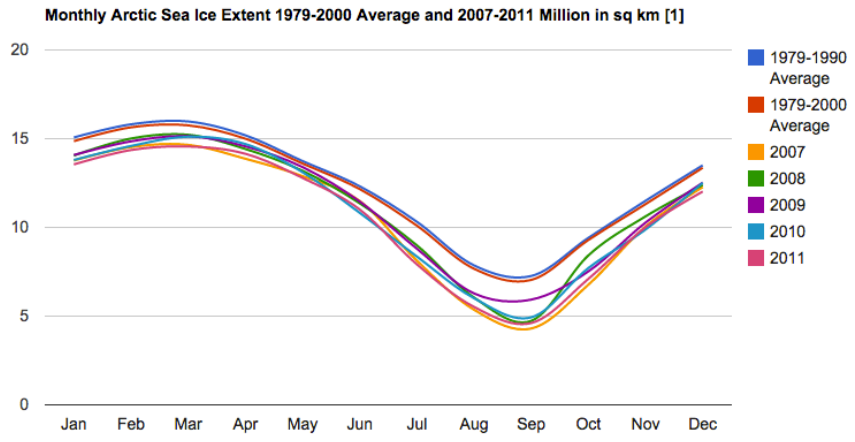


Figure 1: Monthly averages of Arctic sea ice extent from 1979-2011 (Humpert, 2011).

**General Description**

Narwhals (*Monodon monoceros)* are best known for their spiraled tusk that protrudes from their upper left jaw (Laidre and Heide-Jørgensen, 2012). The tusk, which grows in a counterclockwise spiral, can reach lengths of two to three meters ("The Biology and Ecology of Narwhals," 2012). Usually only males have this appendage, though some accounts show that females can sometimes grow them as well ("The Biology and Ecology of Narwhals," 2012). The tusks do not have a known use, though many marine biologists believe that they use them for mating rituals, as mostly males have them ("Narwhals (Monodon Monoceros)," n.d.). Females do not have this, yet live longer than males, suggesting these tusks are not necessary for survival ("The Biology and Ecology of Narwhals," 2012). Narwhals also lack a dorsal fin. ("Narwhal (M. Monoceros)," n.d.). They spend most of their life under ice, so this is an important adaptation to their environment (Laidre and Heide-Jørgensen, 2004).

McLeish (2013) summarizes Kristin Laidre's work on narwhals. He says that narwhals are highly adapted to survive in the cold Arctic waters. They have a layer of blubber three to four inches thick to keep them warm in the extreme cold. The water

temperature in Baffin Bay can get down to 7˚C, and only decreases as narwhals dive deeper underwater to get their food. The pressure can increase to 2,200 pounds per square inch. To accommodate this, narwhals have adapted a compressible rib cage that can be flexed without harm to the animal. (McLeish, 2013, pp. 81-82).

**Feeding**

Narwhals feed primarily in the winter in waters several hundred feet offshore covered in sea ice ("The Biology and Ecology of Narwhals," 2012). Laidre (n.d.) reports that narwhals dive up to 300 meters to get to their food, though the narwhal's record for the deepest dive is 1,800 meters. Because of the depths, no one has ever directly observed narwhals feeding. Instead, scientists looked into the stomachs of deceased narwhals. They found that narwhals' primary prey consists of Greenland halibut, but that they also eat Arctic cod and squid. There were very few other species found in narwhals' stomach, suggesting a very specialized diet (Laidre, n.d.).

**Life History**

Narwhals reach reproductive maturity at the ages of six to nine years (Laidre, n.d.). Females reproduce about every third year. The breeding period is in the spring, from March to April, when the narwhals are in their wintering grounds in Baffin Bay (Laidre, n.d.). The female gestates for about 14 months, giving birth to a single calf on the way to their summering grounds in May or June (Laidre, n.d.).

**Seasonal Movement**

In the summer, narwhals live in the Canadian bays and fjords (Laidre, n.d.). In the summer months when there is no ice, narwhals do not feed as intensely and tend to have very little in their stomachs (Laidre, n.d.). During an interview about her studies on

narwhals, Kristin Laidre stated that in autumn, those areas become covered in fast ice: ice that is attached to land ("Narwhals FAQ," n.d.). They migrate to Baffin Bay which is located between Baffin Island and the southwest coast of Greenland. The pack ice that surrounds the narwhals protects them from predators (Laidre, 2011). Pack ice, also known as ice caps, is made from seawater and forms in polar regions ("The Narwhal's Tale: Surviving Sea Ice Change," 2012).

**Behavior**

Narwhals use two types of deep sea dives, categorized as U dives and V dives. In his book Narwhals: Arctic Whales in a Melting World, Todd McLeish quotes Canadian narwhal researcher Jack Orr. He says that in the winter, narwhals use a V dive for feeding and a U dive for finding a breathing hole. When V diving, narwhals dive straight down to a spot in which they know they will find food, and straight up again. During a U dive, they dive down, but continue in a horizontal pattern before returning to the surface. Orr suspects narwhals are able to accomplish this by reaching a certain depth, then using echolocation to pinpoint a breathing hole (McLeish, 2013, p. 175-177). Narwhals also use echolocation to navigate and locate prey ("Narwhal (M. Monoceros)," n.d.).

**Threats/Hunting/Predation/Mortality**

The main threats to narwhals are polar bears, orca whales, and natives in that area that are allowed to hunt them ("The Narwhal's Tale: Surviving Sea Ice Change," 2012). According to Laidre (2011), another threat to narwhals is the danger of entrapments. Entrapments happen where the air temperature drops suddenly and their breathing holes freeze over. Hundreds of narwhals squeeze into the small holes left, trying to breathe, and many die from suffocation. For example, in mid-February, 2008,

approximately 30-40 narwhals were discovered in an entrapment on Amanga Island, East Greenland (Laidre and Heide-Jørgensen, 2011). Those that survive the diminishing breathing holes may become prey to polar bears and hunters ("The Narwhal's Tale: Surviving Sea Ice Change," 2012).

Hunting narwhals for their ivory has become an increasingly popular activity among Inuit communities in the Canadian Arctic. While on a narwhal hunting expedition, reporter Paul Nicklen made several accounts of modern narwhal hunting. The process results in many whales getting killed, but often they sink to the bottom of the ocean before they can be retrieved ("Hunting Narwhals," 2007). Today, narwhal ivory sells for $125 U.S. dollars per foot ("Hunting Narwhals," 2007). Given that an average tusk is 3 meters long, a tusk would sell for around $1,230.

Orca whales also add to narwhal predation. Marine biologist Todd McLeish recorded orca whale activity in the Canadian Archipelago. Orcas live in the Archipelago when the water is free of ice, but are rarely sighted. It is estimated that 200 to 300 narwhal deaths in their summering grounds were a result of orca whales in 2012 (McLeish 2013, p. 60).

**Changes In Arctic Sea Ice**

Arctic Sea Ice is an ever changing habitat for narwhals. The National Snow and Ice Data Center classifies pack ice into four groups based on thickness and age (NSIDC, 2014). "New ice" has a thickness of less than 10 cm. Ice between 10 cm and 30 cm is labeled as "young ice." There are two subsections of young ice, called "grey ice" and "grey-white ice." Grey ice thickness ranges from 10 cm - 15 cm, whereas ice between 15 cm - 30 cm is considered grey-white ice. Ice that exceeds 30 cm, but does not

survive a summer melt season is considered “first-year ice” or “annual ice.” Ice that survives through summer melt seasons is referred to as either “perennial” or “multi-year ice” (NSIDC, 2014).

**Historical Ice Extent**

Most Arctic sea ice is perennial, meaning it stays year round. According to Polyak et al (2010), coverage in the perennial sea ice zones can range from 97% in the winter to 85-95% coverage in the summer. Since the beginning of the 1900’s, ice margins show a general retreat of seasonal ice. In September 2007, the ice coverage was at 4.28 million km$^2$. This was 23% lower than the 2005 record low of 5.56 million km$^2$. The older ice in the Arctic Ocean decreased by 56% between 1982 and 2007. In the Arctic Ocean, the coverage of old ice has declined by 88%. The ice that is at least nine years old has disappeared almost entirely (Polyak et al, 2010).

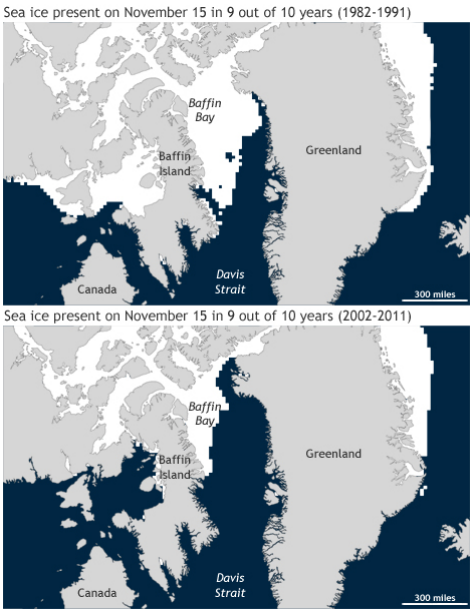

Figure 2: Baffin Bay Sea Decline in 10 Years (Kennedy, 2012)

The narwhal population that stays within and near Baffin Bay is facing similar changes in its habitat. In the past 25 years the extent of annual sea ice around Baffin Bay has decreased by 3% per decade with perennial sea ice decreasing at 9% per decade (Laidre and Heide-Jorgensen, 2005). Between 1982 and 1992, the average extent of sea ice in November reached far into Davis Strait in Baffin Bay (Figure 2a) (Laidre and Heide-Jorgensen, 2005). In the early 21$^{st}$ century, between 2002 and 2011,

the sea ice average extent retreated almost 150 miles into Baffin Bay (Figure 2b)(Laidre and Heide-Jorgensen, 2005).

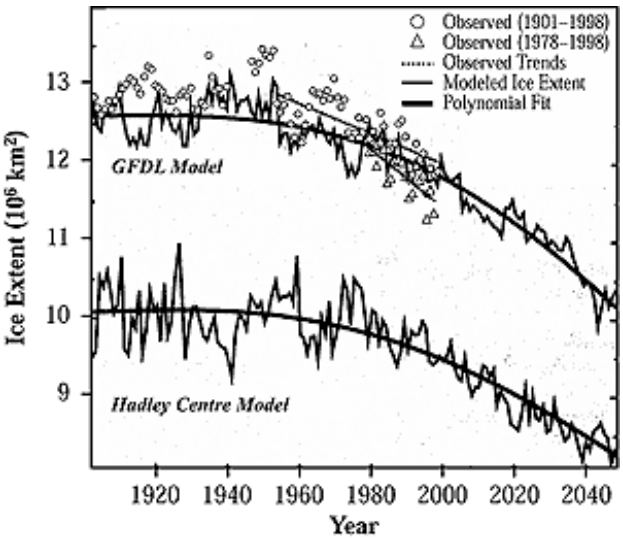

Figure 3: Pack Ice Extent Declining From 1901-1998 (IPCC, 2013)

Different models put forth by scientists all predict a major decline in pack ice, however these models do not reflect what we are currently seeing. We are currently seeing a decrease greater than any of these models have suggested (Stroeve et al, 2007). The International Panel on Climate Change (IPCC) reports findings of model variations in data produced from a Geophysical Fluid Dynamics Laboratory (GFDL) model, and Hadley Centre Model (HCM). These two models are both focused on ice extent in the Arctic, however, the GDFL predicts 10.2 million km$^2$ by 2050 compared to the HCM model that predicts only 8 million km$^2$ (Figure 3) (IPCC, 2013). The Arctic Climate Impact Assessment predicts up to a 100% reduction in pack ice by 2080 (Keil, 2012).

Based on data from the 2004 Arctic Climate Impact Assessment, it is predicted that in the next 65 years the sea ice duration, summer extent, and amount of multi-year sea ice in the Arctic will drop (Table 1) (Keil, 2012). Sea ice duration is estimated to be shortened by 20-30 days in 2080. In the year 2080, the summer sea ice extent will have 50%-100% reduction from 2000 (Keil, 2012) ("Canada in the Arctic - Arctic Shipping: Routes, Forecasts, and Politics," 2012). The IPCC (2013) report mentions that analyses done by Gordon and O'Farrell predict a 60% loss in summer sea ice in the Arctic for a

doubling of $CO_2$. The summer season is thought to increase from 60 to 150 days . The likely distance between northern coasts and Arctic pack ice will increase from the current 150-200 km to 500-800 km (IPCC, 2013) . These two sources both predict a decline, but the models have different predictions.

Table 1: Future Changes in Sea Ice Duration, Summer Sea Ice Extent and Multi-Year Sea Ice in the North American Arctic. [2]

| | 2020 | 2050 | 2080 |
|---|---|---|---|
| **Sea ice duration** | Shorter by 10 days | Shorter by 15-20 days | Shorter by 20-30 days |
| **Summer sea ice extent** | Shelves likely to be ice free | 30-50% reduction from present | 50-100% reduction from present |
| **Multi-year sea ice** | Some reduction especially on shelves | Significant loss with no multi-year ice on shelves | Little or no multi-year ice |

Source: From Impacts to Adaptation:Canada in a Changing Climate 2007, referring to Arctic Climate ImpactAssessment Chapter 9.

**Effects of Sea Ice Reduction on Narwhal Population**

Narwhals are mainly affected by changes in global sea ice, industrial activities, and hunting, all of which may be affected by sea ice levels (“Monodon monoceros,” n.d.). They are also the most specialized marine mammals in the Arctic; narwhals use a very specific habitat and have a very particular diet (McLeish, pg. 94).

Narwhals are impacted by changes in seasonality due to sea ice because they have summer and winter grounds, between which narwhals traditionally migrate. They feed all summer in their summer grounds until encroaching fast ice forces them to migrate to their winter grounds. They migrate because if they stayed in their summer grounds, they would get locked in the ice, or cut off from their food source (“The Biology

and Ecology of Narwhals," 2012). Narwhals are adapted to be successful in areas with pack ice. Because narwhals lack the ability to break air holes in the ice, and because they live in dense pack ice for half of the year, they are the most vulnerable to changes in the availability of open water (Laidre and Heide-Jørgensen, 2005).

While changes in the timing and extent of ice might impact breeding and feeding behavior, there are other aspects of the narwhals' biology that may be threatened by the reduction in sea ice. If the sea ice were to melt away, their whole lifestyle would be affected because they live most of their life under the ice (Laidre and Heide-Jørgensen, 2005). Even though there is open water near by, narwhals live under the ice for two major reasons: there is little competition, and they are well-adapted to surviving under the pack ice (McLeish, 2013, p. 108). Added competition as a result of the reduction of pack ice could affect them. Currently, narwhals, beluga whales, and seals compete for the same food source. Subarctic species' ranges might shift northward and become competition (McLeish, 2013, p. 95).

In addition to new competition, narwhals might also have to cope with changes in the food web. According to McLeish (2013), at the base of the Arctic food chain, there are producers known as phytoplankton which use photosynthesis to produce sugars on the underside of the ice. Zooplankton, such as amphipods and copepods, then feed on the phytoplankton. Bowhead whales and Arctic cod feed on these small crustaceans, and seals, narwhals, and beluga whales eat the cod. Narwhals will be affected nutritionally if their prey is affected, and their prey is all based upon the phytoplankton, which rely on the sea ice to produce its energy. Phytoplankton depend on the sea ice because they cling to the bottom of the ice to produce food. If the ice were not there,

then phytoplankton would not have insulated still water making their population levels plummet. If the ice were to melt, would this topple the entire food web due to less phytoplankton? More research needs to be done to answer this question (McLeish, 2013, p. 93).

Narwhals might also be affected by increased shipping and oil exploration if the ice continues to melt (Mcleish 2013 pg 3-4). This is because as the ice melts, marine passageways will open up, and shipping will increase. Along with the increase of shipping, there will also be an increase in tourist traffic, and development which may lead to severe conflicts with Arctic wildlife including narwhals (Reeves et al, 2013). Also, as marine passageways open up this will give more opportunities for oil exploration. If oil is found and drilled, this could have negative impacts, particularly if drilling fluid or toxic metals were dumped into the ocean. If these materials were to enter the narwhals' habitat, they would pollute it ("Impacts of Offshore Drilling," n.d.), possibly causing problems.

Narwhals are very sensitive to sound ("Narwhal (M. Monoceros)," n.d.). They are known to communicate with others in their pod using whistles. The acoustic environment could be affected by offshore drilling, shipping, and even recreational boating and fishing. The added sound in the Arctic habitat has been shown to confuse Arctic species, narwhals included (Reeves et al, 2013). Noise from all motors could also possibly disrupt the migratory behavior of narwhals. Their ice-entrapment mortality rate could increase (Reeves et al, 2013).

Cargo ships are not the only problem for the narwhals. Icebreaker ships are being improved with thicker and sharper hulls, allowing them to travel further into

narwhal habitat. This could further disrupt the narwhals' migration and feeding ("Canada in the Arctic - Arctic Shipping: Routes, Forecasts, and Politics," 2012).

In 1997, Finley and Greene studied how beluga whales and narwhals in the Northwest passage would react to marine traffic. The belugas reacted with alarm and quickly moved away from the oncoming ships approaching within 35-50 km. The narwhals had a "frozen" response and moved away slowly. These studies show narwhals cannot react as quickly to the threat of the icebreakers and the potential damage from their sonar. This makes them more vulnerable to injury and death (Finley & Greene, 1993).

**Possible Alternatives**

Narwhals will be facing many problems as their habitat changes. There are a few problems that we can help with: changes in their acoustic environment, increased marine traffic, and pollution due to oil drilling. However, we cannot help with these problems if people do not know about them. That is why our primary concern is raising awareness about narwhals. An example is the polar bear, which has seen an increase in response to their problems as awareness has grown. We would like this to happen to narwhals so that the issues of their acoustic environment, increased marine traffic, and pollution due to oil drilling can be addressed.

Narwhals' acoustic environment is threatened by marine traffic through their habitat. To solve this, restrictions can be put on the amount of sound released by passing vessels during certain times of the year and in areas of popular use.

To protect narwhals from increased marine traffic, the Vessel Monitoring System (VMS) allows law enforcement to use 21st century technologies to monitor individual

obedience of law, track violators, and supply evidence for prosecution ("Vessel Monitoring System Program," n.d.). If we were to set up VMS's on every cargo ship that travels through the Northwest Passage, we would be able to designate a marine highway. This marine highway would require large cargo ships to avoid important habitats, including those of the narwhals. Hypothetically speaking, GPS signals would keep track of the whereabouts of every cargo ship navigating the Northwest Passage. If the ships were to sail a certain distance off of the designated course, a warning would be automatically issued to the ship, following with a fine after the second offense.

The issue of pollution due to possible oil drilling in or near the narwhals' habitat can be solved by banning oil drilling in that area, or requiring additional restrictions when drilling the oil. These problems will only be solved if we work together.

**Conclusion:**

Narwhals, numbering around 80,000 (Laidre, n.d.), are often threatened. These risks are mainly presented by polar bears, orca whales, and entrapments ("The Narwhal's Tale: Surviving Sea Ice Change," 2012). The melting of global sea ice which will result in the changing of their traditional habitat. In the past 25 years the reach of annual sea ice around Baffin Bay, the narwhals' primary winter home, has decreased by 3% per decade with perennial sea ice decreasing at 9% per decade (Laidre and Heide-Jorgensen, 2005). It is predicted that in the next 65 years the sea ice duration, summer extent, and amount of multi-year sea ice in the Arctic will drop (Keil, 2012). Along with the decrease of global sea ice, narwhals might be affected by increased industrial activities ("Monodon monoceros," n.d.), like shipping and oil exploration (Mcleish 2013 pg 3-4). They might also have to cope with changes in the food web (McLeish 2013, pg

95) and changes in migration patterns. Narwhals will undergo many changes as sea ice levels drop. However, as changes in sea ice levels continue to threaten a plethora of species, it is our hope that narwhals get the attention and awareness that they need.

## References


The Arctic Institute, Center for Circumpolar Security Studies (2011). [Figure courtesy of www.iup.uni-bremen.de:8084/amsr/. *Arctic Sea Ice Extent Reaches New Historic Minimum*. Accessed at: www.thearcticinstitute.org/2011/09/090911-arctic-sea-extent-reaches.html

Crockford, Susan J. (2013, July 30) *Baffin Bay polar bear status - waiting for the count*. Retrieved from http://polarbearscience.com/2013/07/30/baffin-bay-polar-bear-status-waiting-for-the-count/.

Finley, K. & Greene, C., 1993. Long-range responses of belugas and narwhals to ice-breaking ships in the Northwest Passage. The Journal of the Acoustical Society of America, 94, 1828.

Heide-Jorgensen, M. P., Hansen, R. G., Westdal, K., Reeves, R. R., & Mosbech, A. (2013). Narwhals and Seismic Exploration: Is seismic increasing the risk of ice entrapments. *Biological Conservation*, *158*, 50-54.

International Panel on Climate Change (IPCC): Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO9781107415324.

Jefferson, T. A., Karkzmarski, L., Laidre, K., O'Corry-Crowe, G., Reeves, R., Rojas-Bracho, L., ... Zhou, K. (2008, July 1). *Monodon monoceros*. Retrieved from IUCN Redlist website: http://www.iucnredlist.org/details/13704/0

Keil, K. (2012, April 27). *Canada in the Arctic - Arctic Shipping: Routes, Forecasts, and Politics*. Retrieved from The Arctic Institute website: http://www.thearcticinstitute.org/2012/04/arctic-shipping-routes-forecasts-and.html

Kennedy, C. (2012, May 24). *The Narwhal's Tale: Surviving Sea Ice Change*. Retrieved from NOAA Climate website: http://www.climate.gov/news-features/features/narwhals-tale-surviving-sea-ice-change

Laidre, K. (n.d.). *Narwhal FAQ*. Retrieved from http://staff.washington.edu/klaidre/narwhalfaq.html

Laidre, K. L., & Heide-Jorgensen, M. P. (2005). Arctic sea ice trends and narwhal vulnerability. *Logical Conservation*, *121*, 509-517.

Laidre, K. L., & Heide-Jorgensen, M. P. (2005, January). Winter Feeding intensity of Narwhals (Monodon Monoceros)s. *Marine Mammal Science*, *21*(1), 45-57.

Laidre, K. L., Heide-Jorgensen, M. P., Ermold, W., & Steele, M. (2010). Narwhals document continued warming of southern Baffin Bay. *Journal of Geophysical Research*, *115*,

Laidre, K. L., & Heide-Jorgensen M. P., Stern H., Richard P. (2012). Unusual narwhal sea ice entrapments and delayed autumn freeze-up trends. *Polar Biology, 35:149-154*

Marcoux, M. (n.d.). *Narwhals (M. monoceros)*. Retrieved from The Society for Marin Mammalogy website: http://www.marinemammalscience.org/index.php%3Foption%3Dcom_content%26view%3Darticle%26id%3D510%26Itemid%3D319

McLeish, Todd. (2013). *Narwhals: Arctic Whales in a Melting World*. Seattle: University of Washington Press

"National Snow and Ice Data Center" *All About Sea Ice.* Web. November 26, 2014. Retrieved from http://nsidc.org/cryosphere/seaice/characteristics/index.html

Nicklen, P. (2007, August). *Hunting Narwhals*. Retrieved from National Geographic website: http://ngm.nationalgeographic.com/2007/08/hunting-narwhals/hunting-narwhals-text/1

NOAA (2012, December 31) *The Biology and Ecology of Narwhals*. Retrieved from http://oceanexplorer.noaa.gov/explorations/06arctic/background/biology/biology.html.

*Narwhal*. (n.d.). Retrieved from National Geographic website: http://animals.nationalgeographic.com/animals/mammals/narwhal/

*Narwhals*. (n.d.). Retrieved from World Wild Life website: http://www.worldwildlife.org/species/narwhal

Oceana. (n.d.). *Impacts of Offshore Drilling* . Retrieved from Oceana website: http://oceana.org/en/our-work/stop-ocean-pollution/oil-pollution/learn-act/impacts-of-offshore-drilling

Polyak L., Alley R. B., Andrews, J. T., Brigham-Grette J., Cronin T. M., Darby D. A.… Wolff E. (2010) History of sea ice in the Arctic, *Quaternary Science Reviews,* doi:10.1016/j.quascirev.2010.02.010

Stoeve, J., Holland, M., Meier, W., Scambos, T., & Serreze, M., (2007). Arctic Sea Ice Decline: Faster than Forecast. *Geophysical Research Letters, 34, Issue 9.*

*Vessel Monitoring System Program*. (n.d.). Retrieved from NOAA website: http://www.nmfs.noaa.gov/ole/about/our_programs/vessel_monitoring.html