

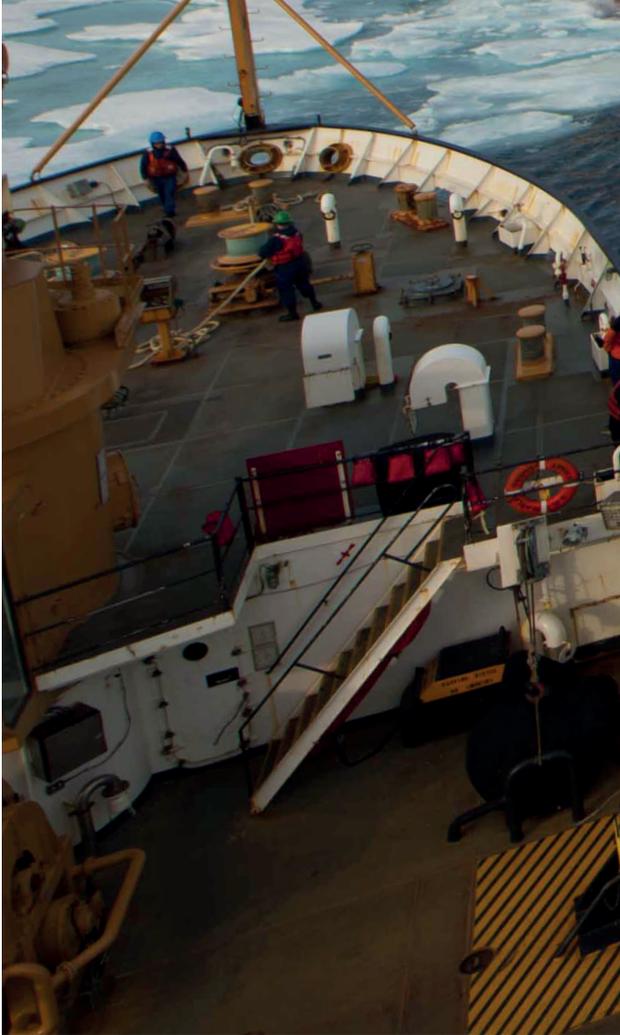


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CANADA



**REDUCING IMPACTS FROM SHIPPING IN MARINE
PROTECTED AREAS: A TOOLKIT FOR CANADA**



**SHIPPING THROUGH
SEA ICE: IMPACTS ON
MARINE HABITATS AND
BEST PRACTICES**

April 2017

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Contents

INTRODUCTION	3
AVOIDANCE RESPONSE	4
IMPACTS OF NOISE	5
ENTRAPMENT	5
SHIP STRIKES AND HABITAT DESTRUCTION/FRAGMENTATION	6
OIL SPILLS	8
BEST PRACTICES	9
Species habitat	9
Socioeconomics	9
Safety	9
SUMMARY	10
Table 1. Impacts of shipping through sea ice and the consequences to marine habitats and species.....	10
REFERENCES.....	11

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INTRODUCTION

As the result of Arctic climate change and an increase in the length of the shipping season, there is a growing interest in Arctic shipping operations. Sea ice serves as an important habitat for marine mammals; therefore, shipping through sea ice could lead to increased negative interactions with ice-bound marine mammals.¹ The following literature review discusses the impacts of icebreaking on marine mammals and habitats. These impacts include: avoidance of areas where icebreaking is occurring, behavioural and physiological impacts of increased anthropogenic noise, entrapment, habitat destruction and fragmentation, and oil spills.



¹ Huntington, 2009.

AVOIDANCE RESPONSE

Beluga whales can hear ships transiting through sea ice over very long ranges of 35 to 78 kilometres and tend to exhibit a “flee” response as soon as they detect them.² This response includes large herds undertaking long dives close to or beneath the ice edge, the breakdown of pod integrity and asynchronous diving.³ Belugas tend to avoid the area where icebreaking was heard for one to two days.⁴ The avoidance of belugas from icebreaking means that they usually do not get close enough for potentially harmful effects to occur, such as masking of their communication signals or damage to their auditory system. However, if belugas are engaged in important behaviours, such as mating, nursing or feeding, they might not leave the area immediately but tolerate louder and possibly harmful noise.⁵ It is assumed that narwhals detect icebreaking noise at similar distances to belugas.⁶ However, a 1990 study by Finley and colleagues described a “freeze” response of narwhals when in the presence of a ship breaking ice. This shows that the reaction of both narwhals and belugas are highly variable and hard to predict.⁷

Walrus are very mobile, using available ice floes as haul-out, whelping site and nursing platforms.⁸ Walrus in the Chuchki Sea showed a “flee” response to icebreaking activity within 230 metres and some at greater distances (more than one kilometre); mothers and calves are likely to escape into the water, causing small calves to be energetically compromised.⁹

Caspian breeding adult seals generally respond to icebreaking by moving away only at distances less than approximately 100 metres,¹⁰ while breeding

ringed seal adults react to icebreaking at distances up to 230 metres.¹¹ Caspian and harp seal pups innately follow their mothers, who usually try to lead their pups away from danger;¹² however, both adults and pups of the harp seal may display a “paralysis” response to approaching danger,¹³ and may therefore fail to move away. Ribbon seal adults show little avoidance or flight response to boats,¹⁴ and are therefore at great risk of ship strikes.

The displacement of animals from preferred areas could result in negative consequences. The changes in food availability to marine mammals would likely affect their energy budget and thus their fitness.¹⁵ The possible increase in animal density caused by displacement could subsequently result in increased competition and predation.¹⁶



2 Erbe and Farmer, 2000.

3 Stewart, et al., 2012.

4 Finley, et al., 1990; Cosens and Dueck, 1993.

5 Erbe and Farmer, 2000.

6 Cosens and Dueck, 1993.

7 Canadian Science Advisory Secretariat, 2014.

8 Boltunov, et al., 2010.

9 Brueggeman, et al., 1991.

10 Härkönen, et al., 2008; Wilson, et al., 2008.

11 Brueggeman, et al., 1992.

12 Wilson, et al., 2012; Kovacs and Innes, 1990.

13 Lydersen and Kovacs 1995.

14 Burkanov and Lowry, 2008.

15 Canadian Science Advisory Secretariat, 2014.

16 Stewart, et al., 2012.

IMPACTS OF NOISE

Cetaceans depend on sound for food-finding, communication, reproduction, detection of predators and navigation.¹⁷ Therefore, cetaceans are sensitive to the introduction of anthropogenic noise into their environment. The impacts of anthropogenic noise on cetaceans include: behavioural changes (such as feeding, breeding, resting, migration), masking of important sounds, temporary or permanent hearing loss,

physiological stress and changes to the ecosystems that result in a reduction of prey availability.¹⁸ As a possible consequence of icebreaking activity, marine mammals compensate for masking by emitting calls at higher frequencies. However, higher frequency calls travel shorter distances and require more energy to produce.¹⁹ In addition, there is a greater risk that competitors, predators or parasites may detect these calls.²⁰

ENTRAPMENT

Ice entrapment is usually a source of natural mortality for Arctic cetaceans. The passage of a ship creates a temporary opening in the sea ice, which can act as an artificial polynya (an area of water that remains ice-free in the winter while surrounding waters freeze over). This can confuse marine mammals, causing them to become trapped too far from the ice edge as the channel eventually refreezes. It has been speculated that icebreaking activity is the cause of a few recent

ice entrapment occurrences.²¹ For example, in 2008, an extreme ice entrapment occurred in Eclipse Sound, which resulted in over 629 narwhal deaths.²² Similarly, bowhead whales and belugas have also been known to become trapped in ice. It is thought that the breakage of sea ice might cause animals to delay their migration to their wintering grounds, putting them at risk of entrapment.²³ Entrapment could occur more frequently if shipping occurs late in the fall.²⁴



17 Weilgart, 2007.

18 Moore, et al., 2012; Weilgart, 2007.

19 Moore, et al., 2012.

20 Tyack, 2008.

21 Laidre, et al., 2012.

22 DFO, 2012.

23 Laidre, et al., 2012.

24 Heide-Jørgensen, et al., 2002.

SHIP STRIKES AND HABITAT DESTRUCTION/FRAGMENTATION

Ships breaking ice through the breeding grounds of seals have been predicted to impact both habitats and individuals. Nursing pups of ringed seals and bearded seals have been affected by collisions, crushing or displaced ice.²⁵ Icebreaking through fast or pack ice creates channels of brash ice (small, floating fragments), which may remain if the ice does not refreeze rapidly. Caspian and Baltic grey seals have been recorded as using these channels as leads into the ice, and Caspian seal females often create whelping sites along the edge of these open channels, behaving as if they were a natural polynya.²⁶ This places them at risk of ship strikes from continued shipping in the same channel. Ringed seal pups are concealed in lairs for about six weeks and are therefore vulnerable to icebreaker destruction, since the only visible indication of lairs at the surface may be ice holes or adults on the ice.²⁷

The ability of seal pups to withstand flushing into the ice waters due to the passage of an icebreaker varies based on the species. The survival of small-bodied pups in lanugo with a relatively long nursing period of approximately four to six weeks, such as Caspian pups, is compromised if the pups are forced into ice water; ringed seal pups, however, from approximately 25 days can enter the water if disturbed.²⁸ The larger pups of the hooded seal naturally enter the water

gradually after weaning at about four days,²⁹ but the impact of premature entry into the water is unknown.

In addition to ship strikes and small pups being wetted in ice-chilled waters, icebreaking impact is also likely to include separation of mother-pup pairs, displacement from their natal site and whelping site breakage. These impacts will result in energy loss to mother and pup and will also stress the mother, which may affect lactation, with detrimental effects on pup survival.³⁰ Even if a floe bearing a pup drifts long distances at high speed, mothers will still follow the floe and attend the pup.³¹ It is likely that the destruction of a pupping floe would result in the death of a young pup.

Pups of species with whelping site tenacity are likely to be more vulnerable to nursery habitat destruction by icebreaking vessels than those species using the ice only as a haul-out platform. Ice-breeding pinniped pups mainly rely on relatively stable fast or pack ice where the whelping site is predictably relatively stable for the duration of the nursing period. Caspian and harp seals generally have a well-developed nursery site, often for a small group of mothers and young, which incorporates a network of birth sites, pup shelters, water-access holes and seal tracks. Mothers and other adults learn the topography of their breeding site and learn to navigate back to it.³²

25 Anon, 1982.

26 Härkönen et al., 2008.

27 Frost and Lowry, 1981; Lydersen and Gjertz, 1986.

28 Lydersen and Hammill, 1993.

29 Lavigne and Kovacs, 1988.

30 Wilson, et al., 2008.

31 Jüssi, et al., 2008.

32 Kovacs, 1995.

Pup survival is therefore dependent on the integrity of the nursery site and the structures lasting through the nursing period.³³ The ability of mothers to navigate back to the nursing site can be affected by icebreaker activity in the nursery site area.

No information is available about how bearded seals respond to icebreaking during the spring breeding season (April until early July). During that period, male bearded seals maintain aquatic territories in which they produce vocalizations to advertise their breeding condition. Males defend small areas and show strong site fidelity and tenure over multiple years.³⁴ The breaking of sea ice may alter the ice habitat and thus the long-term mating

success of individual males,³⁵ thus affecting reproductive success and population stability.³⁶

Lastly, when new open-water lead systems (large fractures in sea ice) are created by ships, marine species can take advantage of the new leads, changing ecosystem dynamics.³⁷ Killer whales use openings in the sea ice to access prey.³⁸ Icebreaker activities may provide killer whales with increased access to wintering areas used by narwhals, belugas, bowheads and pinnipeds. This can result in increased killer whale-related predation and mortality in marine mammal populations.



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33 Lavigne and Kovacs, 1988; Wilson, et al., 2012.

34 Van Parijs and Clark, 2006.

35 Van Parijs, et al., 2004.

36 Stewart, et al., 2012.

37 Ibid.

38 Ibid.

OIL SPILLS

Oil spills from an icebreaker in sea ice cover can be hard to detect and clean up and could also contaminate marine mammal prey or haul-out areas.³⁹ Oil fouling at a lead where seals and whales breathe could cause irritation of skin, eyes and nostrils; fouling of baleen plates; and internal damages from ingestion. Whales breathing in oil-covered leads, with no alternative areas for surfacing,

could be at serious risk.⁴⁰ Oil on the fur of polar bears can seriously affect their ability to thermoregulate, a factor particularly significant for younger animals, which use much of their metabolic energy in thermoregulation. Oil ingested in grooming can be lethal. It is unknown if polar bears would avoid swimming in oiled leads or eating oil-covered seals.⁴¹



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39 Jack Lawson, Fisheries and Oceans Canada, Personal Communication, 2017.

40 Stirling and Calvert, 1983.

41 Ibid.

BEST PRACTICES

The following is a list of best practices relating to species habitat, socioeconomics and safety for ship owners and operators, which can be followed when icebreaking in the Arctic.

SPECIES HABITAT

- Follow a pre-existing ship track through sea ice to the best possible ability.
- Conduct landfast ice monitoring for the duration of the Project Operations phase, which will include: the number of ship transits that are able to use the same track and the area of landfast ice disrupted annually by ship traffic.
- Ships should not travel more than 11km/h (6kts) in landfast ice and 13km/h (7kts) in pack ice to moderate the bow-wave and wake effects on the ice.
- Avoid icebreaking during ice formation (until ice is >20cm thick) to decrease the likelihood of introducing cracks into the new ice sheet.
- Should large pieces of landfast ice prematurely break away naturally, ships' routes (during spring only) should be modified to follow a zig-zag pattern.
- Reroute or halt icebreaking to avoid impacting important species' areas – caribou crossing areas, walrus and seal pupping areas and polar bear denning locations – during sensitive times of the year.
- Support scientific research on the impacts of icebreaking, such as the number of marine mammals attracted to ship tracks, by providing access to ships for sampling by governmental and research groups.
- When marine mammals appear to be trapped or disturbed by vessel movements, the vessel should be required to implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife have moved away from the immediate area.

SOCIOECONOMICS

- Should icebreaking interfere with access to hunting grounds, ship owners whenever possible should cease operations. If operations must proceed, operators should mark the ship tracks to make

them visible to travelers; install ice bridging, such as pontoon bridges; and keep the public informed on icebreaking activities by providing a minimum of 24 hours' notice prior to icebreaking.

SAFETY

- Increased reporting; report to Northern Canada Vessel Traffic Services Zone Regulations every four hours

SUMMARY

Table 1. Impacts of shipping through sea ice and the consequences to marine habitats and species

Impact	Consequence
Increased noise	<ul style="list-style-type: none"> • Displacement of animals from preferred habitat, causing changes in food availability, increased competition and predation.
Increased noise	<ul style="list-style-type: none"> • Behavioural changes (e.g., feeding, breeding, resting, migration); • Masking of important sounds; • Temporary or permanent hearing loss; • Physiological stress; • Changes to the ecosystems that result in a reduction of prey availability.
Temporary openings in the sea ice	<ul style="list-style-type: none"> • Delayed migration to wintering grounds; • Risk of entrapment.
Habitat destruction/fragmentation	<ul style="list-style-type: none"> • Direct ship strikes to seal pups; • Separation of mother and seal pup; • Seal displacement from their natal site; • Small seal pups in lanugo being wetted in ice-chilled waters; • Stress to the mother (affects lactation, with consequential detrimental effects on pup survival).
Oil spills	<ul style="list-style-type: none"> • Hard to detect in and under ice; • Difficult to clean up; • Could contaminate marine mammal prey or haul-out areas.

REFERENCES

- Boltunov A.N., Belikov S.E., Gorbunov Yu.A., Menis D.T. and Semenova V.S. 2010. The Atlantic Walrus of the Southeastern Barents Sea and Adjacent Regions: Review of the Present-Day Status. WWF-Russia, Marine Mammal Council, Moscow.
- Brueggemann J.J., D.P. Volsen, R.A. Grotefendt, G.A. Green, J.J. Burns and D.K. Klungblad 1991. 1990 Walrus Monitoring Program: The Popcorn, Burger and Crackerjack Prospects in the Chukchi Sea. Final report for Shell Western E&P Inc.
- Brueggemann J.J., Green G.A., Grotefendt R.A., Smultea M.A., Volsen D.P., Rowlett R.A. and Swanson C.C. 1992. 1991 Marine Mammal Monitoring Program (Seals and Whales) Crackerjack and Diamond Prospects Chukchi Sea. Final Report prepared for Shell Western E&P Inc. and Chevron USA Inc.
- Burkanov V. and Lowry L. 2008. *Histiophoca fasciata*. In: IUCN 2014. IUCN Red List of Threatened Species, Version 2014. 1. iucnredlist.org
- Canadian Science Advisory Secretariat, and Canada Department of Fisheries and Oceans, Central and Arctic Region. 2014. Science Review of the Final Environmental Impact Statement Addendum for the Early Revenue Phase of Baffinland's Mary River Project. publications.gc.ca/collections/collection_2014/mpo-dfo/Fs70-7-2013-24-eng.pdf.
- Cosens, S.E. and L.P. Dueck. 1993. Icebreaker Noise in Lancaster Sound, NWT, Canada: Implications for Marine Mammal Behavior. *Marine Mammal Science*, 9(3), pp 285-300.
- DFO. 2012. Science Review of Baffinland's Mary River Project Final Environmental Impact Statement. DFO Canadian Science Advisory Secretariat Science Response 2012/016.
- Erbe, C. and M. Farmer. 2000. Zone of Impact around Icebreakers Affecting Beluga Whales in the Beaufort Sea. *Journal of the Acoustical Society of America*, 108(3), Pt. 1.
- ESL Environmental Sciences Limited.. 1982. The Biological Effects of Hydrocarbon Exploration . TD 195.P4 B4 Doc 24. Emar Library, Fisheries and Oceans Canada. 62981 05012599 c.1.
- Finley, K. J., Miller, G. W., Davis, R. A., & Greene, C. R. (1990). Reactions of Belugas, *Delphinapterus leucas*, and Narwhals, *Monodon monoceros*, to Ice-Breaking Ships in the Canadian High Arctic. *Canadian Bulletin of Fisheries and Aquatic Sciences*, 224, pp 97-117.
- Frost, K.J. and Lowry, L.F. 1981. Ringed, Baikal and Caspian Seals *Phoca hispida* Schreber, 1775; *Phoca sibirica* Gmelin, 1788; and *Phoca caspica* Gmelin, 1788. In: S.H. Ridgway and R.J. Harrison (ed) *Handbook of Marine Mammals*, pp 29-53. F.R.S. Academic Press, London.
- Härkönen, T., M. Jüssi, M. Baimukanov, A. Bignert, L. Dmitrieva, Y. Kasimbekov, M. Verevkin, S. Wilson and S.J. Goodman. 2008. Pup Production and Breeding Distribution of the Caspian Seal (*Phoca caspica*) in Relation to Human Impacts. *Journal of Human Environmental Systems*, 37(5), pp 356-361. doi.org/10.1579/07-R-345.1
- Heide-Jørgensen, M.P., Richard, P., Ramsay, M. and S. Akeegagok. 2002. Three Recent Ice Entrapments of Arctic Cetaceans in West Greenland and the Eastern Canadian High Arctic. *NAMMCO Scientific Publications*, 4, pp 143-148.
- Huntington H.P. 2009. A Preliminary Assessment of Threats to Arctic Marine Mammals and their Conservation in the Coming Decades. *Marine Policy*, 33, pp 77-82.
- Jüssi M., Härkönen T., Helle E. and I. Jüssi. 2008. Decreasing Ice Coverage Will Reduce the breeding Success of Baltic Grey Seal (*Halichoerus grypus*) Females. *Ambio*, 37(2), pp 80-85.
- Kovacs, K.M. 1995. Harp and Hooded Seals – A Case Study in the Determinants of Mating Systems in Pinnipeds. Arnoldus Schytte Blix, Lars Walløe and Øyvind Ulltang, (Ed.s), *Developments in Marine Biology*, Elsevier Science, Volume 4, pp 329-335. doi.org/10.1016/S0163-6995(06)80034-X
- Kovacs, K.M. and Innes S. 1990. The Impact of Tourism on Harp Seals (*Phoca groenlandica*) in the Gulf of St. Lawrence, Canada. *Applied Animal Behaviour Science*, 26, pp 15-26.
- Laidre, K., Heide-Jørgensen, M., Stern, H. and P. Richard. 2012. Unusual Narwhal Sea Ice Entrapments and Delayed Autumn Freeze-up Trends. *Polar Biology*, 35, pp 149-154.
- Lavigne, D.M. and Kovacs, K.M. 1988. *Harp and Hooded Seals of the Northwest Atlantic*. University of Waterloo Press, Waterloo, Ontario, Canada. 174pp.
- Lydersen, C. and Hammill, M.O. 1993. Diving in Ringed Seal (*Phoca hispida*) Pups During the Nursing Period. *Canadian Journal of Zoology*, 71, pp 991-996.
- Lydersen, C. and Kovacs, K.M. 1995. Paralysis as a Defence Response to Threatening Stimuli in Harp Seals (*Phoca groenlandica*). *Canadian Journal of Zoology*, 73, pp 486-492.
- Moore, S.E., Reeves, R.R., Southall, B.L., Ragen, T.J., Suydam, R.S. and C.W. Clark. 2012. A New Framework for Assessing the Effects of Anthropogenic Sound on Marine Mammals in a Rapidly Changing Arctic. *BioScience*, 62, pp 289-295.
- SMWMP (Shipping and Marine Wildlife Management Plan). March 2014. Baffinland, Mary River Project, 2013, Annual Report to the NIRB, Appendix N2.
- Stewart, R.E.A., Lesage, V., Lawson, J.W., Cleator, H. and K.A. Martin. 2012. Science Technical Review of the Draft Environmental Impact Statement (EIS) for Baffinland's Mary River Project. Canadian Science Advisory Secretariat Response. 2011/086. vi + 62pp.
- Stirling, I. and Calvert, W. 1983. Environmental Threats to Marine Mammals in the Canadian Arctic. *Polar Record* 21(134), pp 433-449.
- Tyack, P. 2008 Implications for Marine Mammals of Large-Scale Changes in the Marine Acoustic Environment. *Journal of Mammalogy*, 89, pp 549-558.
- Van Parijs, S.M., Lydersen, C. and K.M. Kovacs. 2004. Effects of Ice Cover on the Behavioural Patterns of Aquatic-Mating Male Bearded Seals. *Animal Behaviour*, 68(1), pp 89-96.
- Weilgart, L.S. 2007. A Brief Review of Known Effects of Noise on Marine Mammals. *International Journal of Comparative Psychology*, 20(2), pp 159-168.
- Wilson, S.C., Trukhanova, I., Dmitrieva, L., Dolgova, E., Crawford, I., Baimukanov, M., Baimukanov, T., Ismagambetov, B., Pazyzbekov, M., Jüssi, M. and S.J. Goodman. 2017. Assessment of Impacts and Potential Mitigation for Icebreaking Vessels Transiting Pupping Areas of an Ice-Breeding Seal. *Biological Conservation*, p 214.
- Wilson, S., Kasimbekov, Y., Ismailov, N. and S. Goodman. 2008. Response of Mothers and Pups of the Caspian Seal, *Phoca caspica*, to the Passage of Icebreaker Traffic. Proceedings of the Marine Mammals of the Holarctic, Odessa, October 2008, pp 593-595.

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