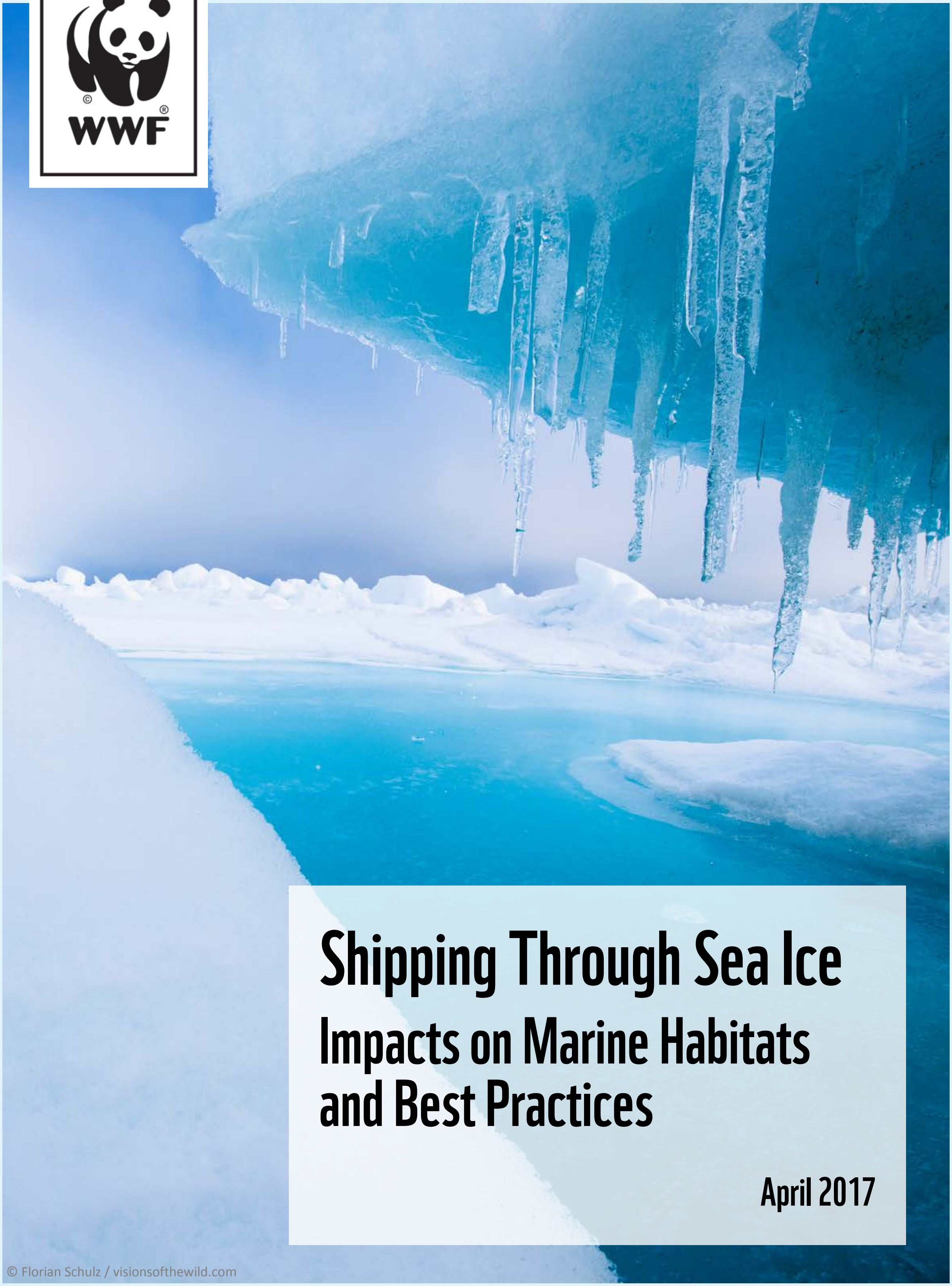

Shipping Through Sea Ice

Impacts on Marine Habitats and Best Practices

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Introduction

As the result of Arctic climate change and an increase in shipping season length, 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 (Huntington, 2009). The following literature review discusses the impacts of icebreaking on marine mammals and habitats. These impacts include: avoidance of areas where icebreaking is occurring, behavioral and physiological impacts of increased anthropogenic noise, entrapment, habitat destruction and fragmentation, and oil spills.

Avoidance Response

Beluga whales can hear ships transiting through sea ice over very long ranges of 35-78 km and tend to exhibit a 'flee' response as soon as they detect them (Erbe & Farmer, 2000). This response includes large herds undertaking long dives close to or beneath the ice edge, the breakdown of pod integrity, and asynchronous diving (Stewart et al., 2012). Belugas tend to avoid the area where icebreaking was heard for 1-2 days (Finley et al., 1990; Cosens & Dueck, 1993). 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 behaviors, such as mating, nursing, or feeding, they might not leave the area immediately but tolerate louder, and possibly harmful noise (Erbe & Farmer, 2000). It is assumed that narwhals detect icebreaking noise at similar distances to belugas (Cosens & Dueck, 1993). However, Finley et al. (1990) 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 (Canadian Science Advisory Secretariat, 2014).

Walrus are very mobile, using available ice floes as haul-out, whelping site and nursing platforms (Boltunov et al., 2010). Walrus in the Chuchki Sea showed a 'flee' response to icebreaking activity within 230 m and some at greater distances (>1km); mothers and calves are likely to escape into the water, causing small calves to be energetically compromised (Brueggeman et al., 1991).

Caspian breeding adult seals generally respond to icebreaking by moving away only at distances less than ~100 m (Härkönen et al., 2008, Wilson et al., 2008). While breeding ringed seal adults react to icebreaking at distances up to 230 m (Brueggeman et al., 1992). Caspian and harp seal pups innately follow their mothers, who usually try to lead their pups away from danger (Wilson et al., 2012; Kovacs & Innes, 1990), although, both adults and pups of the harp seal may display a 'paralysis' response to approaching danger (Lydersen & Kovacs 1995) and may therefore fail to move away. Ribbon seal adults show little avoidance or flight response to boats (Burkanov & Lowry, 2008) and are therefore at great risk of ship collisions.

The displacement of animals from preferred areas could results in negative consequences. The changes in food availability to marine mammals would likely affect their energy budget and thus their fitness (Canadian Science Advisory Secretariat, 2014). The possible increase in animal density caused by the displacement could subsequently result in increased competition and predation (Stewart et al., 2012).

Impacts of Noise

Cetaceans depend on sound for food-finding, communication, reproduction, detection of predators, and navigation (Weilgart, 2007). Therefore, cetaceans are sensitive to the introduction of anthropogenic noise into their environment. The impacts of anthropogenic noise on cetaceans include: behavioral changes (e.g., 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 (Moore et al., 2012; Weilgart, 2007). 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 (Moore et al., 2012). In addition, the risk that competitors, predators, or parasites may detect these calls is greater (Tyack, 2008).

Entrapment

Ice entrapment is usually a source of natural mortality for Arctic cetaceans. However, it has been speculated that icebreaking activity is the cause of a few recent ice entrapment occurrences (Laidre et al., 2012). The passage of a ship creates a temporary opening in the sea ice, which can act as an artificial polynya. This can confuse marine mammals, causing them to become trapped too far from the ice edge as the channel eventually refreezes. In 2008, an extreme ice entrapment occurred in Eclipse Sound, which resulted in over 629 narwhal deaths (DFO, 2012). This event occurred in the same year and season as BIM's bulk ore sample shipments. 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 (Laidre et al., 2012). Similarly, bowhead whales and belugas are also known to become trapped in ice. Entrapment could occur more frequently if shipping occurs late in the fall (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 (Anon, 1982). Icebreaking through fast or pack ice creates channels of brash ice, 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 (Härkönen et al., 2008). This places them at risk of ship strikes from further shipping in the same channel. Ringed seal pups are concealed in lairs for about 6 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 (Frost and Lowry, 1981; Lydersen and Gjertz, 1986).

The tolerance 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 ~4-6 weeks, such as Caspian pups, is compromised if forced into ice water, although ringed seal pups from ~25 days can enter the water if disturbed (Lydersen and Hammill, 1993). The larger pups of the hooded seal naturally enter the water gradually after weaning at ~4 days (Lavigne and Kovacs, 1988) 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 also stress to the mother, which may affect lactation, with consequential detrimental effects on pup survival (Wilson et al., 2008). Even if a floe bearing a pup drifts long distances at high speed, mothers will still follow the floe and attend the pup (Jüssi et al., 2008). It is likely that the destruction of a pupping floe would result in the death of a young pup.

The survival of 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 (Kovacs, 1995). Pup survival is therefore dependent on the integrity of the nursery site and structures lasting through the nursing period (Lavigne and Kovacs, 1988; Wilson et al., 2012). 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 presented about how bearded seals respond to icebreaking during the spring breeding season (roughly 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 (Van Parijs & Clark 2006). The breaking of sea ice may alter the ice habitat and thus the long-term mating success of individual males (Van Parijs et al. 2004), thus affecting reproductive success and population stability (Stewart et al., 2012).

Lastly, the creation of open-water lead systems can allow new marine species to take advantage of manmade lead systems (Stewart et al., 2012). Killer whales use openings in the sea ice to access prey (Stewart et al., 2012). Icebreaker activities may provide killer whales with increased access to wintering areas used by narwhal, beluga, bowheads, and pinnipeds. This can result in increased killer whale-related mortality in marine mammal populations.

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 (Jack Lawson, pers. comm.). Oil fouling at a lead where seals and whales breath 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 (Stirling & Calvert, 1983). Oil on the fur of polar bears can seriously affects their ability to thermoregulate, a factor particularly significant for younger animals, which use much of their metabolic energy in thermogulation. Oil ingested in grooming can be lethal. It is unknown if polar bears would avoid swimming in oiled leads or eating oil-covered seals (Stirling & Calvert, 1983).

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 as best as possible.
- 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, the area of landfast ice disrupted annually by ship traffic.
- Ships should not travel more than 11 km/h (6 kts) in landfast ice and 13 km/h (7 kts) in pack ice to moderate the bow-wave and wake effects on the ice.
- Avoid icebreaking during ice formation (until ice was a >20 cm thick), which could decrease the likelihood of introducing cracks into the new ice sheet.
- Should large pieces of landfast ice prematurely break away as a result of ice, ships routes (during spring only) are modified to follow a zig-zag pattern.
- Re-rout or halt icebreaking to avoid important species areas during sensitive time of the year, such as: caribou crossing areas, walrus and seal pupping areas, and polar bear denning locations.
- Support scientific research on the impacts 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 will 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 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 NORDREG every four hours

Summary

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

Impact	Consequence
Increased noise	Displacement of animals from preferred habitat, causing changes in food availability, increased competition and predation
Increased noise	Behavioural changes (e.g., 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
Temporary openings in the sea ice	Delayed migration to wintering grounds and risk of entrapment
Habitat destruction/fragmentation	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 (affect lactation, with consequential detrimental effects on pup survival)
Oil spills	Hard to detect in and under ice, difficult to clean up, and could contaminate marine mammal prey or haul-out areas

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