REPORT

Mary River Project

2020 Marine Mammal Aerial Survey

Submitted to:

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1663724-270-R-Rev1-39000

7 September 2021

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Executive Summary

From 10 to 22 July and 20 August to 1 September 2020, Golder Associates Ltd. (Golder), on behalf of Baffinland Iron Mines Corporation (Baffinland), completed a Marine Mammal Aerial Survey Program (MMASP) designed to assess narwhal distribution and abundance in the Regional Study Area (RSA) and Admiralty Inlet. The 2020 MMASP was staged in two separate legs. Leg 1 targeted a 14-day window in mid-July and was designed to capture relative abundance and distribution of narwhal (*Monodon monoceros*) near the Pond Inlet floe edge prior to and during initial shipping and icebreaking operations. Leg 2 targeted a 14-day window in mid-August and was designed with the primary objective of obtaining an abundance estimate of the combined Eclipse Sound and Admiralty Inlet narwhal stocks during the open-water season. Survey design and data collection methodology previously developed by Fisheries and Oceans Canada (DFO) (Matthews et al. 2017; Marcoux et al. 2016; Doniol-Valcroze et al. 2015a; Asselin and Richard 2011) and implemented by Golder in 2019 (Golder 2020a) was adopted to allow for comparable abundance estimates.

Two types of aerial surveys were flown: a visual-based survey in which marine mammal sightings were collected along established line transects using a double-platform approach with Marine Mammal Observers (MMOs) stationed at independent observation platforms at the front and rear of the aircraft, and a photographic-based survey in which digital single-lens reflex (DSLR) cameras were installed on the aircraft to collect high definition photographic images of the survey area directly below the aircraft. Photographic surveys were only flown in areas of high narwhal concentrations where accurate counts would be difficult to obtain using visual means. Marine mammal sightings, environmental conditions and survey data were entered into a Mysticetus© database.

During the visual-based surveys, a total of 6,055 sightings of 12,735 individual marine mammals were recorded by the observers during July and August 2020. A total of eleven different marine mammals species were observed during the surveys: narwhal (4,459 sightings totalling 9,110 individuals), ringed seal (*Pusa hispida*; 591 sightings totalling 685 individuals), harp seal (*Pagophilus groenlandicus*; 256 sightings totalling 1,981 individuals), bowhead whale (*Balaena mysticetus*; 136 sightings totalling 180 individuals), polar bear (*Ursus maritimus*; 54 sightings totalling 88 individuals), sperm whale (*Physeter macrocephalus*; five sightings totalling six individuals), beluga (*Delphinapterus leucas*; five sightings of individual whales), bearded seal (*Erignathus barbatus*; four sightings of individual seals), killer whale (*Orcinus orca*; three sightings totalling 14 individuals), hooded seal (*Cystophora cristata*; one sighting of an individual seal), and walrus (*Odobenus rosmarus*; one sighting of an individual walrus). Unidentified seal (523 sightings totalling 641 individuals) and unidentified whale (17 sightings totalling 19 individuals) were also recorded during the surveys.

During the photographic surveys, a total of 16,367 sightings of 23,963 individual marine mammals were recorded during the 2020 MMASP photo review. A total of two different species of marine mammals were recorded during the photographic surveys: narwhal (11,779 sightings totalling 17,216 individuals), and bowhead whale (six sightings totalling ten individuals). Unidentified seal (4,582 sightings totalling 6,737 individuals) were also recorded during the photographic surveys.

Narwhal were primarily concentrated in the Navy Board Inlet, Baffin Bay, Pond Inlet, and Eclipse Sound strata during Leg 1, with a relative abundance of 0.33 narwhal/km along systematic transects and 2.21 narwhal/km along dedicated transects (leads/floe edge). Open water was present in the Baffin Bay, Pond Inlet, and at the north end of Navy Board Inlet strata. In the Eclipse Sound strata, ice was present and narwhal were concentrated

in the ice leads. Narwhal relative abundance during systematic transects in 2020 was similar to that seen in 2019 (Golder 2020a) in areas of <9/10 ice (0.33 animals/km and 0.30 animals/km, respectively).

The narwhal abundance estimate for the combined Eclipse Sound and Admiralty Inlet stock during the 2020 open-water season (Leg 2) was 36,044 individuals (Coefficient of Variation (CV) =0.12, 95% confidence interval (CI) of 28,267–45,961) based on surveys conducted on 28–29 August 2020. This estimate fell within the range calculated during the previous Fisheries and Oceans Canada (DFO) survey conducted in August 2013 (45,532 narwhal, CV=0.33, 95% CI of 22,440–92,384; Doniol-Valcroze et al. 2015a), and the 2019 estimate of 38,677 (CV = 0.11, 95% CI of 31,155–48,015).

For Eclipse Sound stock alone, the narwhal abundance estimate was 5,018 individuals (CV=0.03, 95% CI of 4,736–5,317) based on Baffinland's aerial survey conducted on 29 August 2020. The 2020 estimate is significantly lower than the 2016 estimate of 12,039 (CV = 0.23, 95% CI of 7,768–18,660; Marcoux et al. 2019) (Z-test = 2.53, p = 0.0057). The 2020 abundance estimate is also significantly lower than the 2013 abundance estimate of 10,489 (CV = 0.24, 95% CI of 6,342–17,347; Doniol-Valcroze et al. 2015a) (Z-test = 2.17, p = 0.0150) and the 2019 abundance estimate of 9,931 (CV = 0.05, 95% CI of 9,009–10,946; Golder 2020a) (Z-test = 9.53, p < 0.0001).

For the Admiralty Inlet stock alone, the narwhal abundance estimate was 31,026 individuals (CV = 0.14, 95% CI of 23,406-41,126) based on Baffinland's aerial survey conducted on 28 August 2020. This estimate is within the range of the 2013 DFO estimate of 35,043 narwhal (CV = 0.42, 95% CI of 14,188-86,553; Doniol-Valcroze et al. 2015) (Z-test = 0.26 p = 0.39) and within range of the 2019 Baffinland estimate of 28,746 narwhal (CV = 0.15, 95% CI of 21,545-38,354; Golder 2020) (Z-test = 0.37, p =0.36).

Results from the 2020 aerial survey indicate that: i) narwhal abundance in Eclipse Sound was statistically lower in 2020 than in previous aerial survey years carried out in the RSA (2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to that observed in previous years (2013 and 2019). These results suggest a potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020 but cannot discount the possibility of a potential displacement of these animals to another area (e.g., Eastern Baffin Bay summering ground) or a potential decrease in the Eclipse Sound summer stock.

These findings are not consistent with impact predictions made in the Final Environmental Impact Statement (FEIS) Addendum for the Early Revenue Phase (ERP), which stated that the Project is unlikely to result in significant residual adverse effects on narwhal in the RSA (defined as effects that would compromise the integrity of the population either through mortality or via large-scale displacement or abandonment of the RSA). Based on the results of the 2020 MMASP, further investigation regarding the cause(s) of the observed decrease in Eclipse Sound narwhal stock is warranted.

Despite the existence of uncertainty with respect to the cause of the observed effect in 2020, it is advisable for Baffinland to implement mitigation actions in 2021 to lower the potential of its activities contributing to the same effect in 2021 while continuing to investigate other potential contributors to changes in the narwhal population.

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ᓴᕐᒪᐱᑦ (ᔪᓚᐃ) 10-ᒥᑦ 22-ᒧᑦ ᐊᒻᒪᓗ ᐊᑯᓂᐸᕐᕕᒃ (ᐋᒌᓯ) 20-ᒥᑦ ᐊᒥᕋᐃᔭᕐᕕᒃ (ᓯᑎᐱᕆ) 1, 2020-ᒧᑦ, ᒎᓪᑐ ᑲᑐᔾᔨᖃᑎᒌᑦ ᓕᒥᑎᑦ-ᑯᑦ (ᒎᓪᑐ), ᐱᔾᔪᑎᑉᓗᒋᑦ ᐹᕝᕙᓇᓛᕐᑯᑦ, ᐱᐊᓂᓚᐅᖅᑕᖏᑦ ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑎᓂᒃ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᐃᓂᖓᑦ (MMASP) ᖃᐅᔨᓴᕐᓂᐊᕐᓗᒋᑦ ᑑᒑᓕᑦ ᓇᒧᙵᐅᖃᑦᑕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐊᒥᓲᓂᖏᑦ ᖃᐅᔨᓴᐃᕙᐅᔪᒥᑦ (RSA) ᐊᒻᒪᓗ ᐋᑦᒧᕋᓪᑎ ᑲᖏᖅᓱᖏᑦ (Admiralty Inlet). MMASP ᐋᖅᑭᒃᑕᐅᓚᐅᖅᑐᖅ ᒪᕐᕈᐃᖓᑉᓗᒍ. ᓯᕗᓪᓕᖅ ᑐᕌᒐᖃᓚᐅᖅᑐᖅ 14 ᐅᐸᓗᓂᒃ ᕿᑎᐊᓂᑦ-ᓴᕐᒪᐱᒻᒥᑦ (ᔪᓚᐃ) ᐊᒻᒪᓗ ᐋᖅᑭᐅᒪᓚᐅᖅᑐᖅ ᐱᓂᐊᕐᓗᑎᒃ ᐊᒥᓲᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓇᒧᙵᐅᓯᒪᓂᖏᓐᓂᒃ ᑑᒑᓕᑦ ᖃᓂᑕᖓᓂᑦ ᒥᑦᑎᒪᑕᓕᐅᑉ ᓯᓈᖓᓂᑦ ᓯᕗᓂᐊᒍᑦ ᐊᒻᒪᓗ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕐᕋᔭᒃᑦᑕᓕᖅᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᓯᑯᒥᑦ ᓯᕐᑯᑎᕆᓲᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐊᐅᓛᓕᖅᑎᓪᓗᒋᑦ. ᑐᓪᓕᐊ ᑐᕌᒐᖅᓱᓂ 14 ᐅᐸᓗᓂᒃ ᕿᑎᐊᓂᑦ-ᐊᑯᓪᓕᐸᕐᕕᖕᒥᑦ (ᐋᒌᓯ) ᐊᒻᒪᓗ ᐱᔭᕐᓴᐅᑎᒋᓗᐊᖅᑕᖓᑦ ᐱᓗᑎᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᕆᓂᕐᒥᒃ ᑲᑎᓪᓗᒋᑦ ᑕᓯᐅᔭᕐᒥᑦ ᐊᒻᒪᓗ ᐋᑦᒧᕋᓪᑎ ᑲᖏᖅᓱᖏᑦ (Admiralty Inlet) ᑑᒑᓕᑦ ᐊᐅᔭᐅᑎᓪᓗᒍ. ᖃᐅᔨᓴᐃᓂᖅ ᐊᒻᒪᓗ ᓈᓴᐅᑎᓂᒃ/ᑎᑎᖅᑲᓂᒃ ᑲᑎᖅᓱᐃᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ ᐱᓕᕆᐊᖑᖅᑲᐅᑕᐅᓚᐅᖅᑐᖅ ᑲᓇᑕᒥᑦ ᐃᖃᓗᓕᕆᔾᔪᑯᓄᑦ (Matthews et al. 2017; Marcoux et al. 2016; Doniol-Valcroze et al. 2015a; Asselin ᐊᒻᒪᓗ Richard 2011) ᐊᒻᒪᓗ ᐊᑐᓕᖅᑎᑕᐅᑉᓗᓂ ᒎᓪᓗᑐᒃᑯᓄᑦ 2019-ᒥᑦ (ᒎᓪᑐ 2020a) ᖃᓄᐃᓐᓂᖅᓴᐅᓂᖏᓐᓄᖅᑕᐅᔪᙳᕐᓂᐊᕐᓗᒋᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ.

ᒪᕐᕉᖕᓂᒃ ᐊᔾᔨᒌᙱᑦᑑᖕᓂᒃ ᐊᑐᖅᓗᑎᒃ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᐃᓚᐅᖅᑐᑦ: ᑕᑯᑉᓗᒋᑦ ᖃᐅᔨᓴᐃᓂᖅ ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑎᓂᒃ ᑕᑯᓚᖓᑕ ᑲᑎᑕᐅᖃᑦᑕᖅᓗᑎᒃ ᑐᑭᓕᐊᖅᓯᒪᔪᒥᑦ ᑲᑎᓐᓂᒃᑯᑦ ᐊᑐᖅᓗᑎᒃ ᒪᕐᕈᐃᖓᕗᖕᓂᒃ-ᑐᙳᕕᖕᓂᑦ ᑕᕆᐅᕐᒥᑕᓂᒃ ᓂᕐᔪᑎᓂᒃ ᑕᐅᑐᒃᑎᖃᖅᓗᑎᒃ (MMO) ᐃᓂᖃᖅᓗᑎᒃ ᓯᕗᓂᐊᓂᑦ ᐊᒻᒪᓗ ᑭᖑᓂᐊᓂᑦ ᑎᖏᒥᓰᑉ, ᐊᒻᒪᓗ ᐊᔾᔨᓕᐅᕆᓂᒃᑯᑦ ᖃᐅᔨᓴᐃᑉᓗᑎᒃ ᖃᕆᑕᐅᔭᒃᑰᑭᖓᖅᑐᖅ ᐊᑕᐅᓯᕐᒥᒃ-ᐃᒐᓛᓕᒃᑯᑦ (DSLR) ᐊᔾᔨᓕᐅᕈᑏᑦ ᐃᓕᓯᒪᔪᑦ ᑎᖏᒦᕐᒥᑦ ᑕᑯᒃᓴᐅᑦᑎᐊᖅᑐᓂᒃ ᐊᔾᔨᓕᐅᕆᔪᖅ ᖃᐅᔨᓴᐃᕙᐅᔪᒥᑦ ᐊᑎᑦᑎᐊᖓᓃᑦᑐᓂᒃ ᑎᖏᒦᑉ. ᐊᔾᔨᓕᐅᕆᓂᒃᑯᑦ ᖃᐅᔨᓴᐃᓃᑦ ᖃᖓᑕᓲᒃᑰᓚᐅᖅᑐᑦ ᑑᒑᓕᑦ ᑲᑎᓯᒪᔪᓂᑦ ᓇᓚᐅᑦᑎᔪᓂᒃ ᓈᓴᐃᓂᖅ ᐊᔪᕐᓇᕋᔭᖅᑐᓂᒃ ᑕᑯᓗᒋᑦ ᓈᓴᐃᒃᐸᑕ. ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᑕᑯᔭᐅᔪᑦ, ᐊᕙᑎᐅᑉ ᖃᓄᐃᓐᓂᖏᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐃᓕᔭᐅᓚᐅᖅᑐᑦ Mysticetus© ᖃᕆᑕᐅᔭᒥᑦ ᑐᖅᑯᖅᓯᓯᒪᕙᖓᒧᑦ.

ᑕᐅᑐᒃᓗᑎᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ, ᑲᑎᕝᓗᒋᑦ 6,055 ᑕᑯᔭᐅᓚᐅᖅᑐᑦ 12,735 ᐊᑕᐅᓯᐅᔪᓂᑦ ᑕᕆᐅᕐᑕᓂᑦ ᓂᕐᔪᑎᓂᑦ ᑎᑎᕋᐅᓯᐅᔪᑦ ᑕᐅᑐᒃᑎᓄᑦ ᓴᕐᒪᐱᒻᒥᑦ (ᔪᓚᐃ) ᐊᒻᒪᓗ ᐊᑯᓂᐸᕐᕕᖕᒥᑦ (ᐋᒌᓯ) 2020-ᒥᑦ. ᑲᑎᕝᓗᒋᑦ 11 ᐊᔾᔨᒌᙱᑦᑐᑦ ᑕᕆᐅᕐᑕᓂᑦ ᓂᕐᔪᑏᑦ ᑕᑯᔭᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᑎᓪᓗᒋᑦ: ᑑᒑᓕᑦ (4,459 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 9,110 ᐊᑕᐅᓯᐅᑉᓗᑎᒃ), ᓇᑦᑏᑦ (591 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 685 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᖃᐃᕈᓖᑦ (256 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 1,981 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᐊᕐᕕᑦ (136 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 180 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᓇᓄᐃᑦ (54 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 88 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᓯᕘᕐᓪ ᕿᓇᓗᒐᐃᑦ (sperm whale) (5 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 6 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᕿᓇᓗᒐᐃᑦ (5 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᐅᕐᔪᐃᑦ (4 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᐋᕐᓗᐃᑦ (14 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᓇᓴᓖᑦ ᓇᑦᑏᑦ (hooded seal) (ᐊᑕᐅᓯᖅ ᐊᑕᐅᓯᐅᑉᓗᒋᑦ), ᐊᒻᒪᓗ ᐊᐃᕖᑦ (ᐊᑕᐅᓯᖅ ᐊᑕᐅᓯᐅᑉᓗᒋᑦ). ᐃᓕᑕᕆᔭᐅᙱᑦᑐᖅ ᓇᑦᑎᖅ (523 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 641 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ) ᐊᒻᒪᓗ ᐃᓕᑕᕆᔭᐅᙱᑦᑐᖅ ᕿᓇᓗᒐᖅ (17 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 19 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ) ᑎᑎᕋᐅᓯᐅᓚᐅᕐᒥᔪᑦ ᖃᐅᔨᓴᐃᓂᖃᖅᑎᓪᓗᒋᑦ.

ᐊᔾᔨᓕᐅᕈᑎᒃᑯᑦ ᖃᐅᔨᓴᐃᑎᓪᓗᒋᑦ, ᑲᑎᕝᓗᒋ 16,367-ᓂᒃ ᑕᑯᓚᐅᖅᑐᑦ 23,963-ᖑᔪᓂᑦ ᐊᑕᐅᓯᐅᑉᓗᒋᑦ ᑕᕆᐊᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᑎᑎᕋᐅᓯᐅᔪᑦ 2020 MMASP-ᒥᑦ. ᑲᑎᕝᓗᒋᑦ ᒪᕐᕉᒃ ᐊᔾᔨᒌᙱᑦᑐᑦ ᓂᕐᔪᑏᑦ ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᐊᔾᔨᓕᐅᖅᑕᐅᓚᐅᖅᑐᑦ: ᑑᒑᓕᒃ (11,779 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 17,216 ᐊᑕᐅᓯᐅᑉᓗᑎᒃ), ᐊᒻᒪᓗ ᐊᕐᕕᒃ (6 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 10 ᐊᑕᐅᓯᐅᑉᓗᑎᒃ). ᐃᓕᑕᕆᔭᐅᙱᑦᑐᖅ ᓇᑦᑎᖅ (4,582 ᑕᑯᔭᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ 6,737 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ) ᑎᑎᕋᐅᓯᐅᓚᐅᖅᑐᑦ ᐊᔾᔨᓕᐅᕆᑉᓗᑎᒃ ᖃᐅᔨᓴᐃᑎᓪᓗᒋᑦ.

ᑑᒑᓕᑦ ᑲᑎᓯᒪᓂᖃᓗᐊᓚᐅᖅᑐᑦ ᐃᕐᓗᐊᓂᑦ, ᑐᖅᓱᑲᑦᑕᕐᒥᑦ, ᒥᑦᑎᒪᑕᓕᖕᒥᑦ, ᐊᒻᒪᓗ ᑕᓯᐅᔭᕐᒥᑦ ᓯᕗᓪᓕᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ, ᐊᒥᓲᑎᒋᓂᖏᓐᓄᑦ 0.33 ᑑᒑᓕᑦ/ᑭᓛᒥᑕᒥᒃ ᑕᑭᑎᒋᑉᓗᒍ ᑲᑎᓐᓂᐅᔪᓂᑦ ᐊᒻᒪᓗ 2.21 ᑑᒑᓕᑦ/ᑭᓛᒥᑕᒥᒃ ᑲᑎᓐᓂᐅᔪᒥᑦ (ᓯᑯᑕᓕᖕᓂᑦ/ᓯᑯᓈ). ᐃᒪᐅᓂᐅᓚᐅᖅᑐᖅ ᑐᖅᓱᑲᑦᑕᕐᒥᑦ, ᒥᑦᑎᒪᑕᓕᖕᒥᑦ ᐊᒻᒪᓗ ᐅᐊᖕᓇᖕᓂᑦ ᐃᓯᐊᓂᑦ ᐃᕐᓗᐊᓂᑦ. ᑕᓯᐅᔭᕐᒥᑦ, ᓯᑯᑕᖃᓚᐅᖅᑐᖅ ᐊᒻᒪᓗ ᑑᒑᓕᑦ ᑲᑎᓯᒪᑉᓗᑎᒃ ᓯᑯᑕᖕᓂᑦ. ᑑᒑᓕᑦ ᐊᒥᓲᓂᖏᑦ ᐋᖅᑭᒃᓯᒪᔪᓂᑦ ᑲᑎᓐᓂᕐᓂᑦ 2020-ᒥᑦ ᐊᔾᔨᓕᕆᓚᐅᖅᑕᖓ ᑕᑯᔭᐅᓚᐅᖅᑐᓂᒃ 2019-ᒥᑦ (ᒎᓪᑐ 2020a) <9/10-ᓂᑦ ᓯᑯᓕᖕᓂᑦ (0.33 ᓂᕐᔪᑏᑦ/ᑭᓛᒥᑕᒥᑦ ᐊᒻᒪᓗ 0.30 ᓂᕐᔪᑏᑦ/ᑭᓛᒥᑕᒥᑦ).

ᑑᒑᓕᑦ ᐊᒥᓲᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᑲᑎᕝᓗᒋᑦ ᑕᓯᐅᔭᕐᒧᑦ ᐊᒻᒪᓗ ᐋᑦᒧᕋᓪᑎ ᑲᖏᖅᓱᖓᓐᒧᑦ (Admiralty Inlet) 2020-ᒥᑦ ᐊᐅᔭᐅᑎᓪᓗᒍ (ᑐᓪᓕᐊ) 36,044 ᐊᑕᐅᓯᐅᑉᓗᑎᒃ (ᐊᒥᓯᐃᖅᑕᒃᑲᖅᑎᓇᒥᑦ ᐊᔾᔨᒌᙱᓐᓂᖅ (CV) =0.12, 95% ᓇᓗᓇᙱᓐᓂᖅ ᖃᑯᑎᒃᑯᖃᑦᑕᕐᓂᖏᓐᓄᑦ (CI) 28,267 ‑45,961) ᒪᓕᒃᓗᒋᑦ ᖃᐅᔨᓴᐃᓂᐅᓚᐅᖅᑐᑦ ᐊᑯᓂᐸᕐᕕᒃ 28-29, 2020-ᒥᑦ. ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ ᓈᓴᐅᓯᕆᔭᐅᔪᒧᐊᓚᐅᖅᑐᖅ ᓯᕗᓂᐊᒍᑦ ᐃᖃᓗᓕᕆᔾᔪᑯᑦ ᖃᐅᔨᓴᐃᓂᖏᓐᓄᑦ ᐊᑯᓂᐸᕐᕕᒃ (ᐋᒌᓯ) 2013-ᒥᑦ (45,532 ᑑᒑᓕᑦ, ᐊᒥᓯᐃᖅᑕᒃᑲᖅᑎᓇᒥᑦ ᐊᔾᔨᒌᙱᓐᓂᖅ (CV) =0.ᕐᕐ, 95% ᓇᓗᓇᙱᓐᓂᖅ ᖃᑯᑎᒃᑯᖃᑦᑕᕐᓂᖏᓐᓄᑦ (CI) 22,440 ‑92,384); Doniol-Valcroze et al. 2015a), ᐊᒻᒪᓗ 2019-ᒥᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ 38,677 (CV = 0.11, 95% CI of 31,155 ‑48,015).

ᑕᓯᐅᔭᕐᒧᑦ ᑑᒑᓕᓐᓄᑦ, ᖃᑉᓯᐅᓂᖏᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ 5,018-ᖑᓚᐅᖅᑐᑦ ᐊᑕᐅᓯᕐᓄᑦ (CV=0.03, 95% CI of 4,736 ·5,317) ᒪᓕᒃᓘᒋᑦ ᐹᕕᓐᓛᓐᑯᑦ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᐃᓂᖏᑦ ᐊᑯᓪᓕᕈᕐᕕᒃ (ᐋᒋᓯ) 29, 2020-ᒥᑦ. 2020-ᒥᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᓐᓂᖅᓴᑲᓪᓚᐅᔪᖅ 2016-ᒥᐅᖓᓂᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓚᐅᖅᑐᓂᑦ 12,039-ᓂᒃ (CV = 0.23, 95% CI of 7,768 ·18,660; Marcoux et al. 2019) (Z-test = 2.53, p = 0.0057). 2020-ᒥᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᓐᓂᖅᓴᑲᓪᓚᐅᖏᔪᑦ 2013-ᒥᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓚᐅᖅᑐᓂᐅᖓᓂᑦ 10,489-ᖑᓚᐅᖅᑐᑦ (CV = 0.24, 95% CI of 6,342 ·17,347; Doniol-Valcroze et al. 2015a) (Z-test = 2.17, p = 0.0150) ᐊᒻᒪᓗ 2019-ᒥᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓚᐅᖅᑐᑦ 9,931-ᖑᓚᐅᖅᑐᑦ (CV = 0.05, 95% CI of 9,009 ·10,946; Golder 2020a) (Z-test = 9.53, p < 0.0001).

ᐋᑦᒧᕋᓪᑎ ᑲᖏᖅᓘᖏᑦ (Admiralty Inlet), ᑑᒎᓖᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ 31,026 ᐊᑕᐅᓯᐅᑉᓗᒋᑦ CV = 0.14, 95% CI of 23,406-41,126) ᐊᑐᖅᓘᒋᑦ ᐹᕕᓐᓛᓐᑯᑦ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᐃᓂᕆᓚᐅᖅᑕᖏᑦ ᐊᑯᓪᓕᕈᕐᕕᒃ (ᐋᒋᓯ) 28, 2020-ᒥᑦ. ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᖃᓂᑖᓃᑦᑐᑦ 2013-ᒥᑦ DFO-ᑯᑦ ᓇᓚᐅᑦᑖᓚᐅᖅᑕᖏᓐᓂᒃ 35,043 ᑑᒑᓖᑦ (CV = 0.42, 95% CI of 14,188-86,553; Doniol-Valcroze et al. 2015) (Z-test = 0.26 p = 0.39) ᐊᒻᒪᓗ ᖃᓂᑖᓃᑦᑐᑦ 2019-ᒥᑦ ᐹᕕᓐᓛᓐᑯᑦ ᓇᓚᐅᑦᑖᓚᐅᖅᑕᖏᓐᓂᑦ 28,746 ᑑᒑᓖᑦ (CV = 0.15, 95% CI of 21,545-38,354; Golder 2020) (Z-test = 0.37, p =0.36).

ᖃᓄᐃᖓᓂᐅᔪᑦ 2020-ᒥᑦ ᖃᖓᑕᓲᒃᑯᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ: i) ᑑᒑᓖᑦ ᖃᑉᓯᐅᓂᖏᑦ ᑕᓯᐅᔭᕐᒥᑦ ᓈᓴᐃᓂᒃᑯᑦ ᐊᑦᑎᓐᓂᖅᓴᐅᔪᑦ 2020-ᒥᑦ ᐅᑭᐅᑦ ᓯᕗᓂᐊᓂᐅᖓᓂᑦ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᐃᓂᐅᓚᐅᖅᑐᓂᑦ RSA-ᒥᑦ (2013, 2016 ᐊᒻᒪᓗ 2019), ᐊᒻᒪᓗ ii) ᑲᑎᕝᓘᒋᑦ ᑑᒑᓖᑦ ᐊᒥᓲᓂᖏᑦ ᑕᓯᐅᔭᕐᒥᑦ ᐊᒻᒪᓗ ᐋᑦᒧᕋᓪᑎ ᑲᖏᖅᓘᖏᑦ (Admiralty Inlet) ᐊᔾᔨᒋᓚᐅᖅᑕᖏᑦ 2020-ᒥᑦ ᑕᑯᔭᐅᓚᐅᖅᑐᓄᑦ ᐅᑭᐅᑦ ᓯᕗᓂᐊᓂᑦ (2013 ᐊᒻᒪᓗ 2019). ᖃᓄᐃᖓᓂᐅᔪᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᐊᓯᐊᓄᐊᖅᓯᒪᑐᐃᓐᓇᓇᐊᒃᓴᖏᓐᓂᒃ ᐃᓚᖏᑦ ᑕᓯᐅᔭᕐᒦᖃᑦᑕᖅᑐᑦ ᐋᑦᒧᕋᓪᑎ ᑲᖏᖅᓘᖑᑦ (Admiralty Inlet) ᐊᐅᔭᒥᑦ ᓄᖅᑲᖓᕝᕕᑎᔭᖏᓐᓂᑦ 2020-ᒥᑦ ᑭᓯᐊᓂ ᐊᓯᐊᓄᐊᖅᓯᒪᑐᐃᓐᓇᓇᐊᖃᒥᔪᑦ (ᓲᕐᓗ, ᑲᓇᓐᓇᖅᐸᓯᖓᓄᑦ ᕿᑭᖅᑖᓘᑉ ᐃᒪᖓᓂᑦ ᐊᐅᔾᔭᒃᑯᑦ ᐅᕐᓂᒃᓯᒪᖃᑦᑕᖅᑕᖏᑦ) ᐅᕝᕙᓘᓐᓃᑦ ᐊᒥᓲᔪᓐᓃᖅᐹᓕᖅᑐᑦ ᑕᓯᐅᔭᕐᒥᑦ ᐊᐅᔭᒃᑯᑦ ᑕᐃᑲᓃᖃᑦᑕᖅᑐᑦ.

ᖃᐅᔨᔭᐅᔪᑦ ᐊᔾᔨᒋᙱᑕᖏᑦ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᓄᑦ ᑭᖑᓪᓕᖅᐹᖅ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᐅᑎᒥᑦ (FEIS) ᑎᑎᖅᑲᒧᑦ ᐃᓚᓕᐅᑎᓯᒪᔪᖅ ᑮᓇᐅᔭᓕᐅᖅᐸᓪᓕᐊᓕᕼᕐᓂᕐᒧᑦ (ERP), ᑕᒡᕙᓂ ᐅᖃᖅᓯᒪᔪᖅ ᐱᓕᕆᐊᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓗᐊᕋᔭᙱᑦᑐᖅ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᖏᔪᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᑑᒑᓕᓐᓂᑦ RSA-ᒥᑦ (ᑐᑭᓕᐅᖅᑕᐅᔪᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᐃᓗᐃᑦᑐᖓᑦᑎᐊᕐᓂᖏᓐᓂᒃ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᐊᒃᑐᖅᓯᓇᔭᖅᑐᑦ ᑐᕐᑯᕋᕐᓂᖏᓐᓄᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐊᒥᓱᐃᑦ ᐊᓯᐊᓄᐊᕐᓂᖏᓐᓄᑦ ᐅᕝᕙᓘᓐᓃᑦ ᕿᒪᐃᓂᖏᓐᓄᑦ RSA-ᒥᑦ). ᒪᓕᒃᓘᒋᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ 2020 MMASP-ᒥᑦ, ᖃᐅᔨᓴᐃᒃᑲᓂᕆᐊᖃᖅᑐᑦ ᐱᔾᔪᑕᐅᔪᓂᒃ ᖃᐅᔨᔭᐅᔪᓄᑦ ᐊᒥᓲᔪᓐᓂᕐᓂᖏᓐᓂᒃ ᑕᓯᐅᔭᕐᒥᑦ ᑑᒑᓖᑦ.

ᓇᓗᓇᕐᓂᖅᑕᖃᕋᓗᐊᖅᑎᓪᓗᒍ ᐱᔾᔪᑕᐅᔪᓄᑦ ᖃᐅᔨᔭᐅᔪᑦ 2020-ᒥᑦ, ᐹᕕᓐᓛᓐᑯᑦ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒥᒃ ᖃᓄᐃᓕᐅᕈᑎᖃᕆᐊᖃᖅᑐᑦ 2021-ᒥᑦ ᒥᒃᓵᒋᐊᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᖃᓄᐃᓕᐅᕐᓂᖏᓐᓂᑦ ᐃᑲᔪᐃᔾᔪᓇᖅᑐᓂᒃ ᐊᔾᔨᖓᓂᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ 2021-ᒥᑦ ᖃᐅᔨᓴᐃᓂᖃᐃᓐᓇᕐᓗᑎᒃ ᐊᓯᖏᓐᓂᒃ ᐃᑲᔪᐃᓂᖃᕈᓐᓇᖅᑐᓂᒃ ᐊᓯᐊᙳᕐᓂᐅᔪᓄᑦ ᑑᒑᓖᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ.

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Abbreviation and Acronym list

AIC	Akaike’s Information Criterion
AIN	Admiralty Inlet North stratum
AIS	Admiralty Inlet South stratum
ASL	Above sea level
Baffinland	Baffinland Iron Mines Corporation
BF	Beaufort Sea State
BB	Baffin Bay stratum
C_a	Availability correction factor
CI	Confidence Interval
CV	Coefficient of Variation
DFO	Fisheries and Oceans Canada
DS	Distance Sampling
ERP	Early Revenue Phase
ESE	Eclipse Sound East stratum
ESW	Eclipse Sound West stratum
FEIS	Final Environmental Impact Statement
ft	feet
Golder	Golder Associates Ltd.
GPS	Global Positioning System
IQ	Inuit Qaujimajatuqangit
km	Kilometres
km^2	square kilometres
km/h	Kilometers per hour
kn	knots
m	Metre
MEWG	Marine Environmental Working Group
MHTO	Mittimatalik Hunters and Trappers Organization

Milne Port	port at Milne Inlet
MIN	Milne Inlet North stratum
MIS	Milne Inlet South stratum
MMASP	Marine Mammal Aerial Survey Program
MMP	Marine Monitoring Program
Mtpa	million tonnes per annum
MMOs	Marine Mammal Observers
MR	Mark-recapture
MRDS	Mark-recapture distance sampling
MSV	Multipurpose support/supply vessel
NB	Navy Board Inlet stratum
NIRB	Nunavut Impact Review Board
PI	Pond Inlet stratum
Project	Mary River Project
PC	Project Certificate No. 005
RSA	Regional Study Area
SBO	Ship-based Observer Program
Steensby Port	port at Steensby Inlet
TS	Tremblay Sound stratum

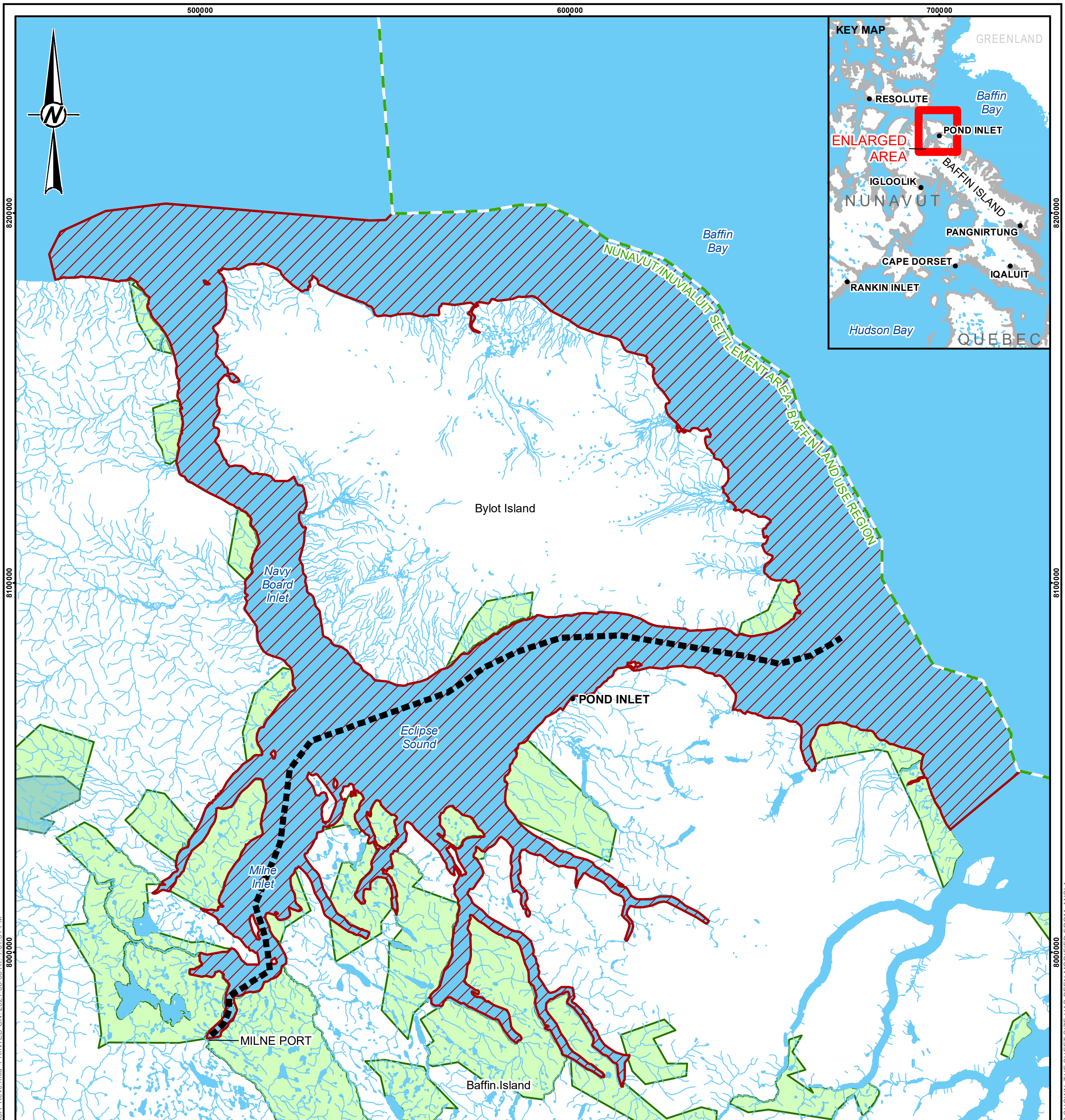
1.0 INTRODUCTION

This report presents the results of the 2020 Marine Mammal Aerial Survey Program (MMASP) conducted at North Baffin Island during July and August 2020. Marine mammal aerial surveys were conducted by Golder Associates Ltd. (Golder) using distance-based line-transect sampling combined with high-resolution photography. The primary objectives of the surveys were to determine the relative abundance and distribution of narwhal (*Monodon monoceros*) near the Pond Inlet floe edge prior to and during initial shipping and icebreaking operations, and to obtain abundance estimates of narwhal during the open-water season for the Eclipse Sound and Admiralty Inlet summering stocks. Relative abundance and distribution were also calculated for other marine mammals in the Regional Study Area (RSA).

1.1 Project Background

The Mary River Project (the Project) is an operating open-pit iron ore mine located in the Qikiqtani Region of North Baffin Island, Nunavut (Figure 1). Baffinland Iron Mines Corporation (Baffinland) is the owner and operator of the Project. The operating mine site is connected to a port at Milne Inlet (Milne Port) via the 100 km long Milne Inlet Tote Road. Approved, but undeveloped components of the Project include a South Railway connecting the mine site to a future port at Steensby Inlet (Steensby Port).

To date, Baffinland has been operating in the Early Revenue Phase (ERP) of the Project and is authorized to transport 4.2 Mtpa of ore by truck to Milne Port for shipping through the Northern Shipping Route using chartered ore carrier vessels. A production increase to ship 6.0 Mtpa from Milne Port was approved for 2018 to 2021 and shipping is expected to continue for the life of the Project (20+ years). During the first year of ERP Operations in 2015, Baffinland shipped ~900,000 tonnes of iron ore from Milne Port involving 13 return ore carrier voyages. In 2017, the total volume of ore shipped out of Milne Port reached ~4.2 million tonnes involving 56 return ore carrier voyages. Following approval to increase production to 6.0 Mtpa, a total of 5.44 Mtpa of ore was shipped via 71 return voyages in 2018 and 5.86 Mtpa of ore was shipped via 82 return voyages in 2019. In 2020, the total volume of ore shipped out of Milne Port reached ~5.5 Mtpa involving 72 return ore carrier voyages. The Northern Shipping Route is inhabited by a variety of marine mammals, predominantly narwhal, ringed seal (*Pusa hispida*), harp seal (*Pagophilus groenlandicus*), bowhead whale (*Balaena mysticetus*), polar bear (*Ursus maritimus*), bearded seal (*Erignathus barbatus*), beluga (*Delphinapterus leucas*), and walrus (*Odobenus rosmarus*).



LEGEND

- COMMUNITY
- SHIPPING ROUTE (APPROXIMATE)
- WATERCOURSE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- MARINE MAMMAL REGIONAL STUDY AREA
- NUNAVUT LAND CLAIMS AGREEMENT – ARCTIC BAY INUIT OWNED LAND
- NUNAVUT LAND CLAIMS AGREEMENT – POND INLET INUIT OWNED LAND
- WATERBODY

0 25 50

1:1,500,000 KILOMETRES

REFERENCE(S)

ABORIGINAL LANDS, HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
MARINE MAMMAL REGIONAL STUDY AREA

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AJA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	1

1.2 Regulatory Drivers and Community Engagement

In accordance with existing Terms and Conditions of Nunavut Impact Review Board (NIRB) Project Certificate (PC) No. 005, Baffinland is responsible for the establishment and implementation of the Marine Monitoring Program (MMP) which comprises environmental effects monitoring studies that are conducted over a sufficient time period such to allow for the following objectives:

- To measure the relevant effects of the Project on the marine environment.
- To confirm that the Project is being carried out within the pre-determined terms and conditions relating to the protection of the marine environment.
- To assess the accuracy of the predictions contained in the Final Environmental Impact Statement (FEIS) for the Project.

The Marine Mammal Aerial Survey Program (MMASP) is one of several monitoring programs that collectively make up the MMP for marine mammals. The MMASP was designed to address PC conditions related to evaluating potential disturbance of marine mammals from shipping activities that may result in changes in animal distribution, abundance, and migratory movements in the study area. Specifically, this included the following conditions:

- Condition No. 101 — "*The Proponent shall incorporate into the appropriate monitoring plans the following items:*
  - *b. Efforts to involve Inuit in monitoring studies at all levels.*
  - *c. Monitoring protocols that are responsive to Inuit concerns.*
  - *e. Schedule for periodic aerial surveys as recommended by the Marine Environment Working Group (MEWG).*"
- Condition No. 107 — "*The Proponent shall revise the proposed "surveillance monitoring" to improve the likelihood of detecting strong marine mammal, seabird or seaduck responses occurring too far ahead of the ship to be detectable by observers aboard the ore carriers. A baseline study early in the shipping operations could employ additional surveillance to detect potential changes in distribution patterns and behavior. At an ambitious scope, this might be achieved using unmanned aircraft flown ahead of ships, or over known areas of importance for seabirds or haul-out sites in the case of walruses, in accordance with the requirements of their Special Flight Operations Certificate*".
- Condition No. 108 — "*The Proponent shall ensure that data produced by the surveillance monitoring program is analysed rigorously by experienced analysts (in addition to being discussed as proposed in the FEIS) to maximize their effectiveness in providing baseline information, and for detecting potential effects of the project on marine mammals, seabirds and seaducks in the Regional Study Area. It is expected that data from the long-term monitoring program be treated with the same rigor*".
- Condition No. 109 (for Milne Inlet specifically) — "*The Proponent shall conduct a monitoring program to confirm the predictions in the FEIS with respect to disturbance effects from ships noise on the distribution and occurrence of marine mammals. The survey shall be designed to address effects during the shipping*

seasons, and include locations in Hudson Strait and Foxe Basin, Milne Inlet, Eclipse Sound and Pond Inlet. The survey shall continue over a sufficiently lengthy period to determine the extent to which habituation occurs for narwhal, beluga, bowhead and walrus".

- Condition No. 111 — "*The Proponent shall develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring".*
- Condition No. 126 — "*The Proponent shall design monitoring programs to ensure that local users of the marine area in communities along the shipping route have opportunity to be engaged throughout the life of the Project in assisting with monitoring and evaluating potential project-induced impacts and changes in marine mammal distributions".*

Since 2013, regular community engagement meetings regarding the Project have been carried out in Arctic Bay, Clyde River, Sanirajak, Igloolik, and Pond Inlet. Primary concerns identified by the communities with respect to potential Project effects on marine mammals along the Northern Shipping Route include:

- Loss or alteration of narwhal and ringed seal habitat due to port construction and shipping.
- Injuries or mortality of marine mammals due to ship strikes.
- Acoustic disturbance effects on marine mammals from port construction and shipping that may lead to changes in animal distribution, abundance, migration patterns, and subsequent availability of these animals for harvesting.

1.3 Existing Environment

Narwhal

The most current abundance estimate for the Baffin Bay narwhal population, corrected for availability and observer bias, is 141,909 individuals (DFO 2015a; Doniol-Valcroze et al. 2020). In Canada, the Baffin Bay narwhal population is currently managed as four summering stocks, each represented by a different geographic aggregation (Somerset Island, Admiralty Inlet, Eclipse Sound, and East Baffin Island; DFO 2015a). There are also large numbers of summering narwhal around Ellesmere Island that range over Jones Sound, Smith Sound, Norwegian Bay, and adjacent bays and fiords. Collectively, these narwhal are recognized by Fisheries and Oceans Canada (DFO) as the Jones Sound the Smith Sound stocks (DFO 2015a). Their relationship with the four recognized Baffin Bay stocks and the Inglefield Bredning stock in Greenland is unclear. The abundance estimate of the Eclipse Sound summering stock was estimated to be 20,225 individuals in 2004 (Richard et al. 2010), approximately 10,489 in 2013 (DFO 2015a), and 12,039 in 2016 (Marcoux et al. 2019). Lower numbers of narwhal observed in 2013 in the Eclipse Sound stock compared to 2004 was explained by possible mixing between the Eclipse Sound and Admiralty Inlet summering stocks given the relatively higher number of narwhal observed in Admiralty Inlet that same year (Doniol-Valcroze et al. 2015a). Documented movements of individual narwhal between Eclipse Sound and Admiralty Inlet also raised the possibility of some degree of exchange between the two summering areas during the period when aerial surveys are typically conducted (DFO 2020; Doniol-Valcroze et al. 2015a). Inuit Qaujimajatuqangit (IQ) also indicates that Pond Inlet and Arctic Bay share the same stock of narwhals (JPCS 2017). The combined abundance estimate of the Eclipse Sound and Admiralty Inlet summering stock was estimated to be 45,532 in 2013 (Doniol-Valcroze et al. 2015a).

Available information on narwhal distribution (Richard et al. 1994; Heide-Jørgensen et al. 2002; COSEWIC 2004a; Laidre et al. 2004; Marcoux et al. 2009; Richard et al. 2010; Watt et al. 2012; DFO 2015a; Elliott et al. 2015; Thomas et al. 2015, 2016; Golder 2018a) indicated that the RSA is regularly used during summer and fall, although the distribution of narwhal varies throughout the season. In spring and early summer, narwhal migrate to their summering habitats. In the case of the Eclipse Sound stock, they concentrate mainly in Milne Inlet, Koluktoo Bay, and Tremblay Sound during the summer. IQ also indicated that narwhal are concentrated in Tremblay Sound, western Eclipse Sound, Milne Inlet, and Koluktoo Bay in August (JPCS 2017).

Marine mammal aerial surveys in support of the Project were first conducted during the 2007–2008 open-water seasons. Subsequent aerial surveys were conducted in 2013 and 2014 to establish marine mammal distribution and density estimates along the Northern Shipping Route during the open-water season and prior to ERP operations. In 2015, aerial surveys were undertaken with a modified approach in an effort to attempt to examine potential effects of Project shipping on marine mammal distribution and density estimates during the first year of ERP operations. In 2016, photographic aerial marine mammal surveys were conducted by Fisheries and Oceans Canada (DFO) along the Northern Shipping Route and adjacent inlet areas. Aerial photography from these surveys was analyzed by Golder on behalf of Baffinland in 2016 to calculate narwhal abundance and density estimates for Milne Inlet, Eclipse Sound, Tremblay Sound and Pond Inlet, based on conventional distance sampling methods (Golder 2018b). The analysis was limited to two survey days (15 and 21 August 2016). DFO released the results of their analysis of the 2016 aerial surveys in June 2019 (Marcoux et al. 2019). In 2019, aerial surveys were conducted using distance-based line-transect sampling combined with high-resolution photography to determine the relative abundance and distribution of marine mammals near the Pond Inlet floe edge prior to and during initial shipping and icebreaking operations, and to obtain abundance estimates of narwhal during the open-water season for the Eclipse Sound and Admiralty Inlet summer stock areas (Golder 2020a).

Bowhead whale

Bowhead whale aerial survey abundance estimates for the Eastern Canada-West Greenland (EC-WG) population in 2002–2004 and 2013 indicate population numbers in the thousands and increasing significantly since commercial whaling protection was provided in the early 20th century (COSEWIC 2009, DFO 2015b). This population of whales spends summers in Baffin Bay and adjoining waters of the Canadian High Arctic with the RSA included as part of their summer aggregation area (COSEWIC 2009).

Milne Inlet, Eclipse Sound and Pond Inlet are not thought to represent important summering areas for bowhead given the low number of bowhead sightings reported in these areas during the summer season. During six years of shore-based monitoring conducted for Baffinland from 2013 to 2017 and 2019, a total of 16 bowhead were recorded near Bruce Head (Thomas et al. 2014; Smith et al. 2015, 2016, 2017; Golder 2018c; Golder 2020b). Similarly, a total of 14 bowhead were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted between 2013 and 2015 during the open water period (Elliott et al. 2015; Thomas et al. 2015, 2016). Based on the most recent High Arctic Cetacean Survey completed by DFO in the Project area, the predicted number of bowhead in Eclipse Sound during 2013 was 32 (Doniol-Valcroze et al. 2015a). During two aerial surveys conducted in July 2019, the calculated abundance of bowhead in the RSA was 176 and 1,291 whales, respectively (Golder 2020a). Bowhead numbers in August of 2019 were too low to calculate an abundance with only four bowhead recorded in the RSA (Golder 2020a). During four years of the ship-based observer (SBO) program conducted for Baffinland from 2013 to 2015 and 2018, bowhead whale were not observed (SEM 2014, 2016; Golder 2019). In 2019, 23 sightings of 25 individual bowheads were recorded during the SBO program (Golder 2020c). This is consistent with IQ which included observations of bowhead migrating through the RSA in Aujaq (end of July to September; JPCS 2017).

Killer whale

Killer whale (*Orcinus orca*) sightings in the Canadian Arctic have been reported throughout the year with the majority (87%) occurring during summer (Higdon 2007). Earlier studies reported that this species was uncommon in northern Baffin Bay and Lancaster Sound between August and October (Koski and Davis 1979). By 2001, regular sightings of killer whales were reported in Cumberland Sound, Lancaster Sound, and Pond Inlet (Baird 2001). Regular occurrences of killer whales have been reported in Pond Inlet during spring, summer, and fall, with most of the reported sightings occurring during July– August (Higdon 2007). Killer whales have also been observed in and around Eclipse Sound and Tremblay Sound (Campbell et al. 1988; Marcoux et al. 2009) and in Milne Inlet and Koluktoo Bay on several occasions when they were observed hunting narwhal (Ferguson et al. 2012). During five consecutive years of shore-based monitoring conducted for Baffinland from 2013 to 2017, no killer whale were recorded (Thomas et al. 2014; Smith et al. 2015, 2016, 2017; Golder 2018c). Although, killer whales were observed in South Milne Inlet by Mr. Panipakoocho as he departed Bruce Head camp in 2015 (Smith et al. 2016). On 18 August 2019, observers stationed at Bruce Head observed one sighting of eight killer whales in south Milne Inlet (Golder 2020b). Killer whale were not observed in the RSA during three consecutive years of aerial surveys conducted between 2013 and 2015 during the open water period (Elliott et al. 2015; Thomas et al. 2015, 2016). Killer whales were observed during the 2019 MMASP on 21, 26, and 29 August (Golder 2020a). While it is unclear whether the same killer whales were observed repeatedly in 2019, and where they travelled between surveys, the observations demonstrate that killer whales were likely in the RSA from 17–30 August during Leg 2 of the 2019 MMASP. IQ indicates that killer whales are generally not observed at floe edge or leads because their dorsal fins interfere with ice travel (QIA 2019). Killer whales normally do not arrive until Aujaq (i.e., July to September). Further, killer whales have been observed leaving before freeze up so that they will not be trapped in ice (QIA 2019). Killer whales have not been observed during any of the five ship-based monitoring programs between 2013 to 2019 (SEM 2014, 2016; Golder 2019, 2020c).

In 2009, Argos tracking tags were simultaneously deployed on killer whale and narwhal in Admiralty Inlet to understand how predation risk from killer whale affects narwhal behaviour (Breed et al. 2017). Results from the study showed that the presence of killer whale strongly altered the behaviour and distribution of narwhal. Killer whale presence also caused narwhal to move closer to shore when killer whales were present. Dive behaviour was also affected, causing narwhal to perform deeper dives and shorten their dives. Behavioural changes in narwhal were reported to extend beyond active predation events, with altered behaviour and habitat use persisting steadily for the duration (10 days) that killer whales shared the habitat with narwhal.

Beluga whale

Beluga in the RSA are part of the Eastern High Arctic – Baffin Bay population; one of seven populations known to occur in Canadian waters at some point during the year (COSEWIC 2004b). It is assumed these beluga shift from their winter habitat in Baffin Bay and along Western Greenland to the ice-free or pack-ice in Baffin Bay. During the spring migration, beluga travel from Baffin Bay into areas along east and north Baffin Island as the fast ice breaks up, occupying regions of Lancaster Sound, Barrow Strait, Peel Sound and Baffin Bay during the summer open-water season. The RSA lies within the full extent of beluga summer habitat though is not part of beluga core summer habitat and any beluga observed in the RSA are probably passing through on their way to their summer core habitat.

During five consecutive years of shore-based monitoring conducted for Baffinland from 2013 to 2017, no beluga were recorded (Thomas et al. 2014; Smith et al. 2015, 2016, 2017; Golder 2018c). In 2019, six beluga whales were recorded during the shore-based monitoring program (Golder 2020b). Beluga whale were not observed in previous Baffinland aerial surveys in the RSA from 2013 to 2015 (Elliott et al. 2015; Thomas et al. 2015; Thomas et al. 2016). A total of four beluga whales were observed in the RSA during the 2019 MMASP (Golder 2020a). Three were sighted during the early shoulder season and one was sighted during the open water season. During three consecutive years of ship-based monitoring conducted for Baffinland from 2013 to 2015, beluga were not observed (SEM 2014, 2016). No belugas were observed during the 2018 SBO program (Golder 2019), but one beluga whale was recorded during the 2019 SBO program (Golder 2020c).

Polar bear

Polar bear are common in the RSA and throughout most of the Canadian Arctic archipelago. Individuals belonging to the Baffin Bay population occupy drifting pack ice and landfast ice between Baffin Island and west Greenland during winter but can be concentrated along the landfast ice edge in Lancaster Sound (Koski 1980; Ferguson et al. 2000; Ferguson et al. 2001). Polar bears were also concentrated along the landfast ice edge near Pond Inlet and Navy Board Inlet during spring. In August, polar bear are forced ashore by the absence of ice (Taylor and Lee 1995; SWG 2016) and spend this period on Bylot Island and Baffin Island (Lunn et al. 2002). Denning activity by pregnant females is concentrated along the North coast of Bylot Island and coastal areas of Baffin Island near Pond Inlet, Admiralty Inlet and Navy Board Inlet (Baffinland 2010). Generally only males and subadults are found in offshore pack-ice areas with only rare sightings of females with young observed in these areas (APP 1982). Polar bears also frequent fast-ice edges in this area (APP 1982). Polar bears from the Lancaster Sound subpopulation tend to occupy the central and eastern part of their range during winter but move westward during spring to summer on multi-year pack ice in eastern Viscount Melville Sound (Schweinsburg et al. 1982).

During six years of shore-based monitoring conducted for Baffinland from 2013 to 2017 and in 2019, a total of 10 polar bears were recorded near Bruce Head (Thomas et al. 2014; Smith et al. 2015, 2016, 2017; Golder 2018c; Golder 2020b). A total of fourteen polar bears were recorded in the RSA during three consecutive years of aerial surveys conducted between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015, 2016). In 2019, six polar bears were recorded in the RSA during the shoulder season (July) and fourteen polar bears were recorded during the open water season (Golder 2020a). During three consecutive years of ship-based monitoring conducted for Baffinland from 2013 to 2015, polar bear were not observed (SEM 2014, 2016). Two polar bears were observed in each year of the 2018 and 2019 SBO program (Golder 2019; Golder 2020c).

Ringed seal

Population structures of ringed seal across the Canadian Arctic are poorly understood in general. The ringed seal population in Canada and adjacent waters (West Greenland, Alaska and Russia) is estimated at 2.3 million seals, with low confidence (COSEWIC 2019). Finley et al. (1983) estimated the Baffin Bay region (Canada and Greenland) to have approximately 787,000 ringed seals. Kingsley (1998) estimated the size of the Baffin Bay ringed seal population using two methods, one based on polar bear energetic models and another using published density data and estimates of ice areas. The polar bear model yielded a ringed seal population estimate of 1.2 million. The estimate based on sea ice type and availability and estimated ringed seal density was 697,200 hauled out seals, which would yield a similar population estimate as the polar bear predation model (1.2 million seals) (Kingsley 1998).

Aerial surveys of ringed seal in the RSA have been undertaken during the molting period (spring) when ringed seal are largely on the sea ice and easy to count (Yurkowski et al. 2018). Yurkowski et al. (2018) noted several ringed seal hotspots throughout the RSA during the June spring molt, well ahead of the start of shipping operations in July. IQ indicates that seal pupping season runs from February to March and there are no certain areas for seal pups; they are born everywhere (JPCS 2017). IQ also notes there are seal pups in the area until the middle of April (JPCS 2017).

Harp seal

Harp seal are seasonal visitors to the Arctic, arriving along the southwest coast of Greenland in late May and June (APP 1982) and then entering Lancaster Sound in July and August (Johnson et al. 1976; Greendale and Brousseau-Greendale 1976; APP 1982). Harp seal tend to enter Pond Inlet and Navy Board Inlet at the end of July (Miller 1955) with larger groups observed near the southern entrance of Navy Board Inlet and occasionally in Eclipse Sound throughout August and September (Miller 1955; Beckett et al. 2008). The number of adult harp seal entering Lancaster Sound and Eclipse Sound is variable (Tuck 1957; Greendale and Brousseau-Greendale 1976; Johnson et al. 1976; Riewe 1977, APP 1982).

Bearded seal

The distribution of bearded seal is largely determined by the presence of shallow water and distribution of ice (Burns 1981; Finley and Evans 1983; Kingsley 1986; Harwood et al. 2005; Kovacs et al. 2011). Bearded seal generally move into inlets and bays <200 m deep in order to feed during open-water periods and return to areas offshore of the floe edge in the fall once landfast ice has formed (Burns and Frost 1979). They are rarely found in fast-ice areas but are widely dispersed in open-water areas of pack ice where leads and cracks are frequent and where ice pans are sufficient for haul-out sites (McLaren and Davis 1982).

1.4 Study Objectives

The 2020 MMASP was staged in two separate survey legs. Leg 1 targeted a 14-day window in mid-July, when narwhal undergo their spring migration into Eclipse Sound and Milne Inlet. The objective of the Leg 1 surveys was to determine the relative abundance and distribution of narwhal, and other marine mammals, near the Pond Inlet floe edge prior to and during initial shipping and icebreaking operations.

Leg 2 targeted a 14-day window during mid-August corresponding with the peak open-water period. The objective of Leg 2 surveys was to obtain an updated (2020) abundance estimate for the Eclipse Sound and Admiralty Inlet narwhal summer stocks. Survey design and data collection methodology previously developed by Fisheries and Oceans Canada (Asselin and Richard 2011; Doniol-Valcroze et al. 2015a; Marcoux et al. 2016; Matthews et al. 2017) and implemented by Golder in 2019 (Golder 2020a) enabled for a comparison to previously reported abundance estimates. Relative abundance and distribution were also calculated for other marine mammals in the RSA during this period.

A third survey (Leg 3) was proposed to occur over a two-day period at the end of the shipping season in late October. The objective of the Leg 3 surveys was to conduct a visual clearance survey to confirm that no narwhal entrapment events have occurred in the RSA following completion of Baffinland's 2020 shipping operations along the Northern Shipping Route. Leg 3 did not take place in 2020 as ice conditions did not warrant it. This decision was made following consultations with the Mittimatalik Hunters and Trappers Organization (MHTO) and DFO.

2.0 METHODOLOGY

2.1 Survey Team and Training

The 2020 aerial surveys took place over two 14-day periods: Leg 1 (10–22 July 2020 with one aircraft) and Leg 2 (20 August–1 September with two aircraft). The survey team consisted of three Golder biologists, seven contracted marine biologists with previous marine mammal survey experience as Marine Mammal Observers (MMOs), four pilots, and one mechanic (Photograph 2.1). Each survey team (i.e., aircraft) included one survey coordinator, four marine biologist MMOs, and two pilots.

Prior to mobilization, a one-day data collection and safety training workshop was held at Mary River on 9 July 2020. The training and orientation session was led by a senior marine mammal biologist with Golder. The safety component of the workshop aimed to familiarize team members with the Health and Safety Plan that was developed for the program, to review Golder's and Baffinland's health and safety policies and requirements, and to discuss general expectations for the program. The technical component of the workshop including practical (hands-on) training in observational survey procedures, data collection techniques, proper use of equipment, data recording and data entry, and post-processing of the survey data. During the training, all participants were provided with a training manual (Appendix A) and obtained practical experience using the surveying equipment including recorders, clinometers, and geometer.

Photograph 2.1: 2020 Marine Mammal Aerial Survey Team – Leg 2.

2.2 Study Area and Design

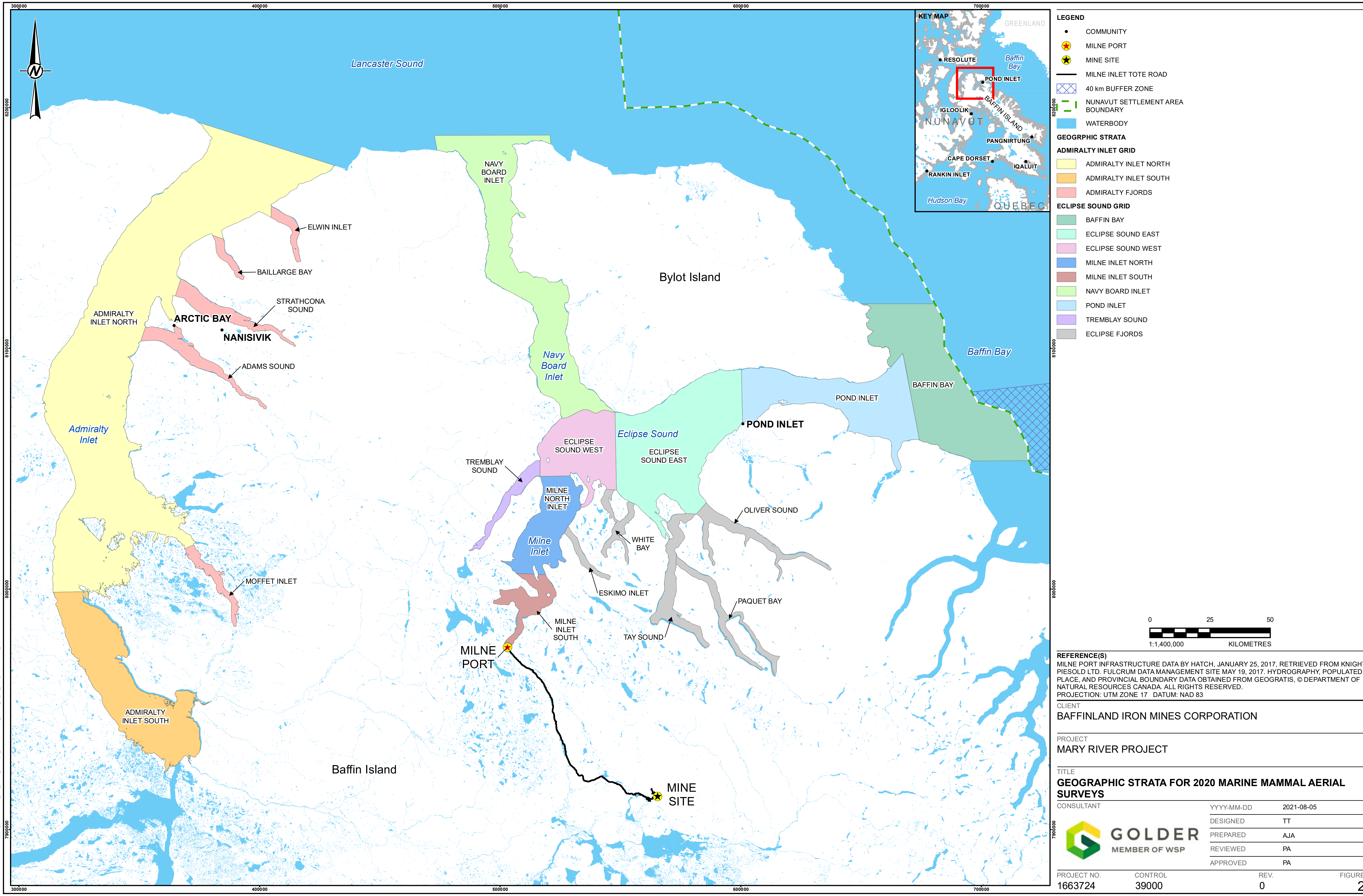
The study area for the Leg 1 surveys was based on the boundaries used in previous surveys from 2013–2016 (DFO 2017; Golder 2017), with an additional stratum in Baffin Bay added in 2019 (Figure 2; Golder 2020a). Leg 1 was designed to focus on the open-water area around the floe edge (Pond Inlet and Baffin Bay strata) where narwhal were known to stage prior to entering Eclipse Sound (blue transect lines in Figure 3). Reconnaissance flights were also flown periodically in Tremblay Sound and Milne Inlet to verify narwhal presence/absence in these areas. When narwhal were observed in Tremblay Sound or Milne Inlet, the entire survey grid was flown in the open water areas and ice leads were flown in the >8/10 ice conditions (effort switched from blue transect lines to red transect lines identified in Figure 3).

Systematic random visual line-transect surveys were flown for all strata in open water with the location of the first line chosen at random. The blue transects had an east-west parallel line design, with a transect line spacing of approximately 5 km (see Figure 3). The red transects had a north-south parallel line design, with transect line spacings of approximately 8.6 km for the Eclipse Sound East and Pond Inlet strata, and approximately 4.3 km for the Eclipse Sound West stratum. East-west parallel line design, with a transect line spacing of approximately 10 km was used for Navy Board Inlet due to the low numbers of narwhal observed in previous survey years and northeast-southwest parallel line design, with an ~4 km transect line spacing, was used for Milne Inlet North transects (see Figure 3). A single transect was flown down the center of each of the fjords.

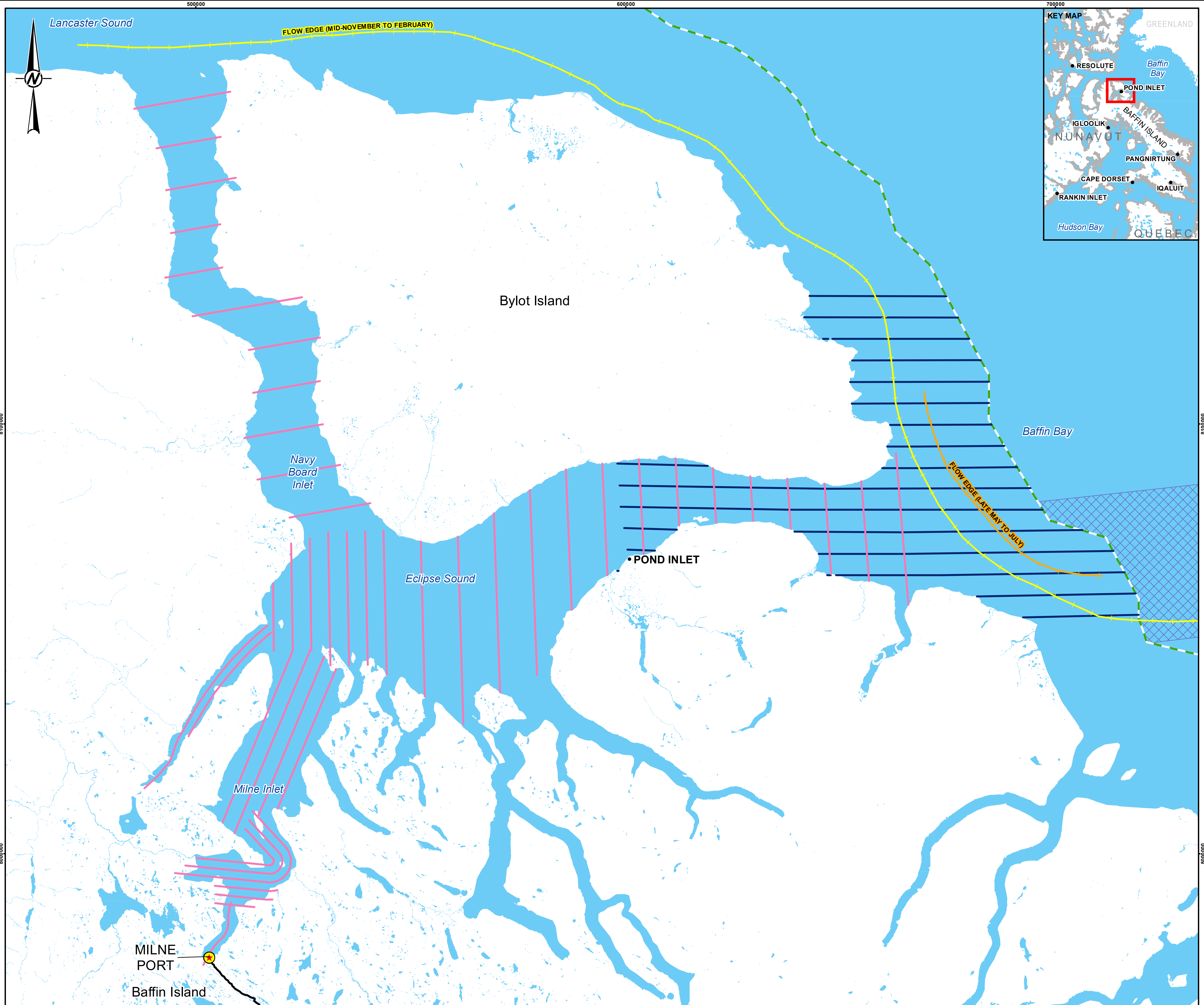
Leg 2 surveyed Eclipse Sound and Admiralty Inlet within a two-day period to obtain an estimate of narwhal abundance in the combined areas. The boundaries for the Eclipse Sound grid during Leg 2 were the same as those for Leg 1 with the Baffin Bay stratum removed (see Figure 2). As during Leg 1, systematic random visual line-transect surveys were flown for all strata (except Tremblay Sound and Milne Inlet South where photographic surveys were conducted) with the location of the first line chosen at random (Figure 4). Transect spacing was the same as those flown during Leg 1 in the Eclipse Sound grid. A photographic survey with complete coverage was flown for the Tremblay Sound and Milne Inlet South strata because IQ indicates that these are areas of high narwhal concentration (JPCS 2017) and past surveys (Doniol-Valcroze et al. 2015a; Elliott et al. 2015; Golder 2020a, Marcoux et al. 2019; Thomas et al. 2015; 2016) recorded high concentrations of narwhal in these areas. Transect spacing of 1,200 m for the photographic survey allowed lateral overlap of approximately 30% between photos from adjacent transects (see Section 2.4 for details).

Through consultation with the MEWG prior to the 2019 MMASP (Golder 2020a), the boundaries for Admiralty Inlet were divided into three strata (Admiralty Inlet North, Admiralty Inlet South, and Admiralty Fjords; see Figure 2). Systematic random visual line-transect surveys were flown for the North and South strata with the location of the first line chosen at random. An east-west parallel line design, with an 8.5 km transect line spacing, was used to provide uniform coverage probability (Buckland et al. 2001; Figure 4).

The survey design consisted of systematically placed and evenly distributed (when possible) line transects across the survey area (Figure 3 and Figure 4). Transects were generally straight and uniformly spaced across large waterbodies but were occasional skewed to follow the shoreline contour. This was necessary in areas where the survey aircraft could not safely perform the turns necessary to cross waterbodies perpendicular to shorelines.



Lancaster Sound
Bylot Island
Baffin Island
Baffin Bay
Admiralty Inlet
Navy Board Inlet
Eclipse Sound
Milne Inlet
ADMIRALTY INLET NORTH
ADMIRALTY INLET SOUTH
ELWIN INLET
BAILLARGE BAY
STRATHCONA SOUND
ADAMS SOUND
MOFFET INLET
ARCTIC BAY
NANISIVIK
NAVY BOARD INLET
ECLIPSE SOUND WEST
ECLIPSE SOUND EAST
TREMBLAY SOUND
MILNE NORTH INLET
MILNE INLET SOUTH
POND INLET
BAFFIN BAY
WHITE BAY
OLIVER SOUND
ESKIMO INLET
PAQUET BAY
TAY SOUND
MILNE PORT
MINE SITE
KEY MAP
GREENLAND
RESOLUTE
Baffin Bay
POND INLET
IGLOOLIK
NUNAVUT
BAFFIN ISLAND
PANGNIRTUNG
CAPE DORSET
IQALUIT
RANKIN INLET
Hudson Bay
QUEBEC
LEGEND
COMMUNITY
MILNE PORT
MINE SITE
MILNE INLET TOTE ROAD
40 km BUFFER ZONE
NUNAVUT SETTLEMENT AREA BOUNDARY
WATERBODY
GEOGRPHIC STRATA
ADMIRALTY INLET GRID
ADMIRALTY INLET NORTH
ADMIRALTY INLET SOUTH
ADMIRALTY FJORDS
ECLIPSE SOUND GRID
BAFFIN BAY
ECLIPSE SOUND EAST
ECLIPSE SOUND WEST
MILNE INLET NORTH
MILNE INLET SOUTH
NAVY BOARD INLET
POND INLET
TREMBLAY SOUND
ECLIPSE FJORDS
0 25 50
1:1,400,000 KILOMETRES
REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83
CLIENT
BAFFINLAND IRON MINES CORPORATION
PROJECT
MARY RIVER PROJECT
TITLE
GEOGRAPHIC STRATA FOR 2020 MARINE MAMMAL AERIAL SURVEYS
CONSULTANT
GOLDER MEMBER OF WSP
YYYY-MM-DD 2021-08-05
DESIGNED TT
PREPARED AJA
REVIEWED PA
APPROVED PA
PROJECT NO. 1663724
CONTROL 39000
REV. 0
FIGURE 2



LEGEND

- COMMUNITY
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

FLOE EDGE (APPROXIMATE)

- LATE MAY TO JULY
- MID-NOVEMBER TO FEBRUARY
- MILNE PORT

TRANSECT LINES

- FLOE EDGE ABSENT
- FLOE EDGE PRESENT

0 25 50
1:900,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
TRANSECT LINES FOR ECLIPSE SOUND GRID DURING LEG 1

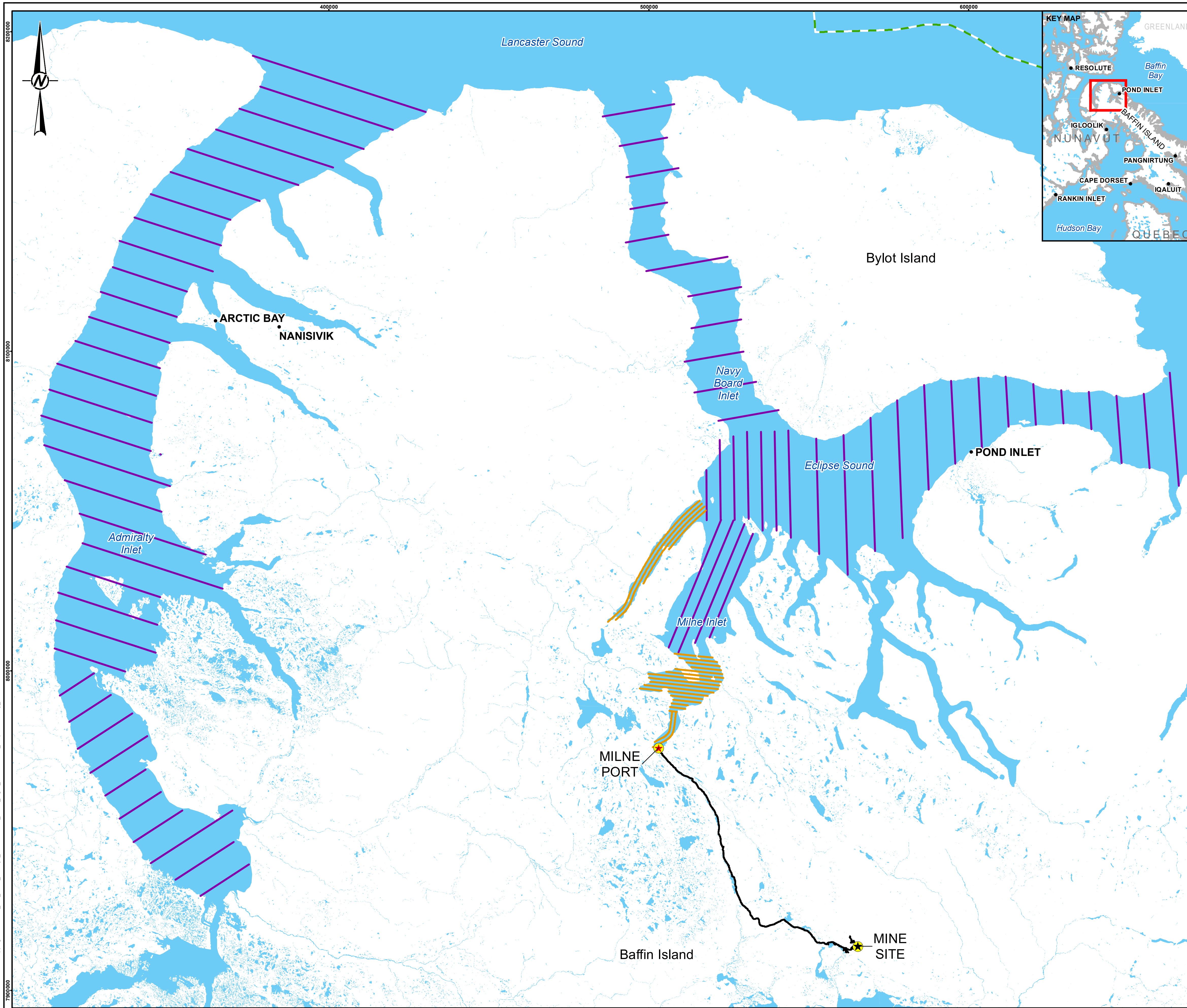
CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AJA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm



LEGEND

- COMMUNITY
- MILNE PORT
- MINE SITE
- MILNE INLET TOTE ROAD
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

TRANSECT LINES

- PHOTOGRAPHIC SURVEY
- VISUAL SURVEY

0 25 50
1:1,200,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
TRANSECT LINES FOR ECLIPSE SOUND AND ADMIRALTY INLET GRIDS DURING LEG 2

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AJA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	4

During visual line-transect surveys, if large aggregations (e.g., >50 narwhal or when observers indicated that they could not accurately keep up with narwhal counts) were identified, a photographic survey was flown with complete coverage over the group to allow for accurate counts of animals. To identify aggregations observed during visual surveys, all personnel on board the aircraft were instructed to look out for herds of narwhal and alert everyone when one was sighted. When such an aggregation was located, lines would be flown in a cross pattern over the group, to determine its spatial extent. Using pre-planned survey grids, the aggregation would be photographed using a systematic grid with complete coverage as seen in Figure 4 (yellow transect lines) for the Milne inlet South and Tremblay Sound strata.

For navigation during the survey to follow the survey track lines and also to log the flight tracks an iPad was connected to a Bluetooth Global Positioning System (GPS) (Bad Elf GPS Pro+) which provided information to a navigation app (Foreflight). Foreflight utilizes current and routinely updated digital aeronautical maps. The iPad was used by the navigator/camera operator to coordinate with the flight crew. The flight crew had their own iPad (with Foreflight app) which was sync'd with the other iPad each time modifications to the planned survey flights were made.

2.3 Visual Survey

Surveys were flown in a de Havilland Twin Otter (DH-6) equipped with bubble windows and an open camera hatch at the rear. Visual line transect surveys were conducted at an altitude of 305 m (1,000 ft) and a ground speed of 185 km/h (100 kn) with four experienced MMOs. MMOs were stationed at the front and rear bubble windows that provide a view of the track line directly below the aircraft. MMOs were instructed to focus their attention on the area closest to the track line and to use their peripheral vision for sightings farther afield. Speaking into a handheld digital recorder, observers counted all sightings of marine mammals. Using a geometer (or clinometer), the perpendicular declination angle to the center of each group was measured once it was abeam to the observer. MMOs noted the species and number of animals in the group. A 'group' was defined as animals within one or a few body lengths of each other and oriented or moving in a similar direction. When time permitted, observers were instructed to give additional details on the sightings, such as the presence of calves, tusked narwhal, behaviour and direction of travel. The visual surveys were conducted as a double-platform experiment with independent observation platforms at the front (primary observer) and rear (secondary observer) of the survey plane. The two MMOs stationed on the same side of the aircraft were separated visually and acoustically to achieve independence of their conditional detections. A fifth member of the survey team was responsible for monitoring the camera system, overseeing navigation along the survey grid, and entering additional sighting data obtained from the primary observers into the database.

Two MMOs were designated as 'Primary' observers and two were designated as 'Secondary' observers. In addition to counting animals, all observers were responsible for dictating the following environmental conditions throughout the surveys into the recorders: ice concentrations (in tenths), sea state (Beaufort scale), fog (% of field of view and intensity) and glare (% of field of view and intensity). These environmental conditions were recorded at the start and end of each transect, at regular intervals (every 2 minutes) along the transect or sooner if changes were detected throughout the transect.

The area directly below the aircraft was photographed continuously throughout each visual survey using the camera system described in Section 2.4. Photographs taken during the visual surveys were used to supplement visual sightings for missed geometer angles and group sizes.

Sightings from Primary observers were automatically entered into the Mysticetus program by the Primary observers using geometers during the survey. Geometers were linked to the Mysticetus program, allowing Primary observer data (i.e., date, time, location and declination angles) to be enter electronically into the Mysticetus program in real time. Additional sighting data and environmental conditions recorded on audio recorders were transcribed into the Mysticetus program after the flight. Sightings were georeferenced and transect lengths were calculated in Mysticetus. Strata areas were determined in ArcGIS. Sightings where angles of declinations were not recorded were compared to the photographic records. The perpendicular distance was retrieved from the pixel position of the sighting on the photo if a visual sighting was identified without ambiguity on the corresponding photo. If the sighting was not made within the swath width of the picture, could not be found, or could not be identified from other sightings unambiguously, the sighting was coded as missing distance (these sightings were not used in fitting the detection function, but were added to the total count per transect, as described in Doniol-Valcroze et al. 2015a). Sightings where group size were not recorded, or were coded as ‘uncertain’, were compared to the photographic records, and group size was retrieved if a match could be made based on perpendicular distance. Otherwise, sightings with missing group size were given the average group size in that stratum (posterior to estimation of the expected group size so that it does not affect the estimation of its variance).

2.4 Photographic Survey

The aircraft was equipped with two identical camera systems. The systems used Canon EOS 5DS R DSLR (digital single-lens reflex) cameras fitted with 35 mm lens (Sigma 35 mm f/1.4 DG HSM). The cameras were connected to a laptop computer to control exposure settings and photo interval. The cameras were installed within the optical glass covered camera hatch on a custom-made mount. Images were saved directly to internal camera cards. Photos were georeferenced (using GPicSync 1.32) at the end of the field season using saved GPS logs from a Bluetooth GPS receiver (Bad Elf GPS Pro+). Cameras and computers were synched with the GPS receiver, and the GPS receiver was calibrated to airport altitude at the start of every flight.

The cameras were oriented widthwise (long side perpendicular to the track line) and angled obliquely: one to the port side and the other to the starboard side. Each camera provided an oblique image starting at the track line, the viewing angle of each camera (α = 27°) equal to half its field of view (shown as β in Figure 5), calculated using (Covington 1985):

$$\alpha = \beta = arctan\left(\frac{SensorWidth}{FocalLength \times 2}\right)$$

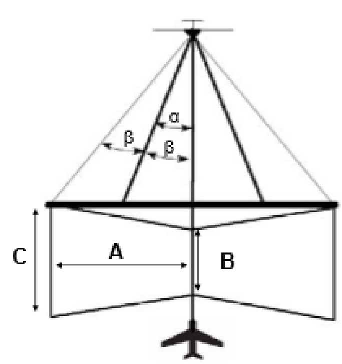


Figure 5: Geometry of oblique aerial photos (modified from Grendzdörffer et al. 2008).

Photographic surveys were conducted at an altitude of 610 m (2,000 ft) and a ground speed of 185 km/h (100 kn). Surveys were flown at an altitude of 305 m (1,000 ft) if conditions did not allow surveying at higher altitude (610 m). Using the methods described in Grendzdörffer et al. (2008), the photograph dimensions of the two-camera system (see Figure 5) and the necessary photographic interval were calculated to allow overlap of the photos while flying at 100 knots (Table 1). The photographic interval was set to maintain an overlap (on the inside edge) of approximately 15% between consecutive photos, and with a transect spacing of 600 m and 1200 m, the lateral overlap between photos from adjacent transects was approximately 30%.

Table 1: Dimensions of images at two possible altitudes.

	Altitude (m)	
	305	610
A (m)	423	846
B (m)	186	372
C (m)	318	636
Interval (sec)	3	5

Two sets of grid lines (one for 305 m and a second for 610 m altitudes) were prepared prior to field work so a photographic survey could be coordinated within minutes of spotting an aggregation of animals.

All photographs were orthorectified at the end of the field season to create an orthophotograph prior to analysis (Figure 6). An orthophotograph is an aerial photograph that has been geometrically corrected such that the scale is an accurate representation of the earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt.

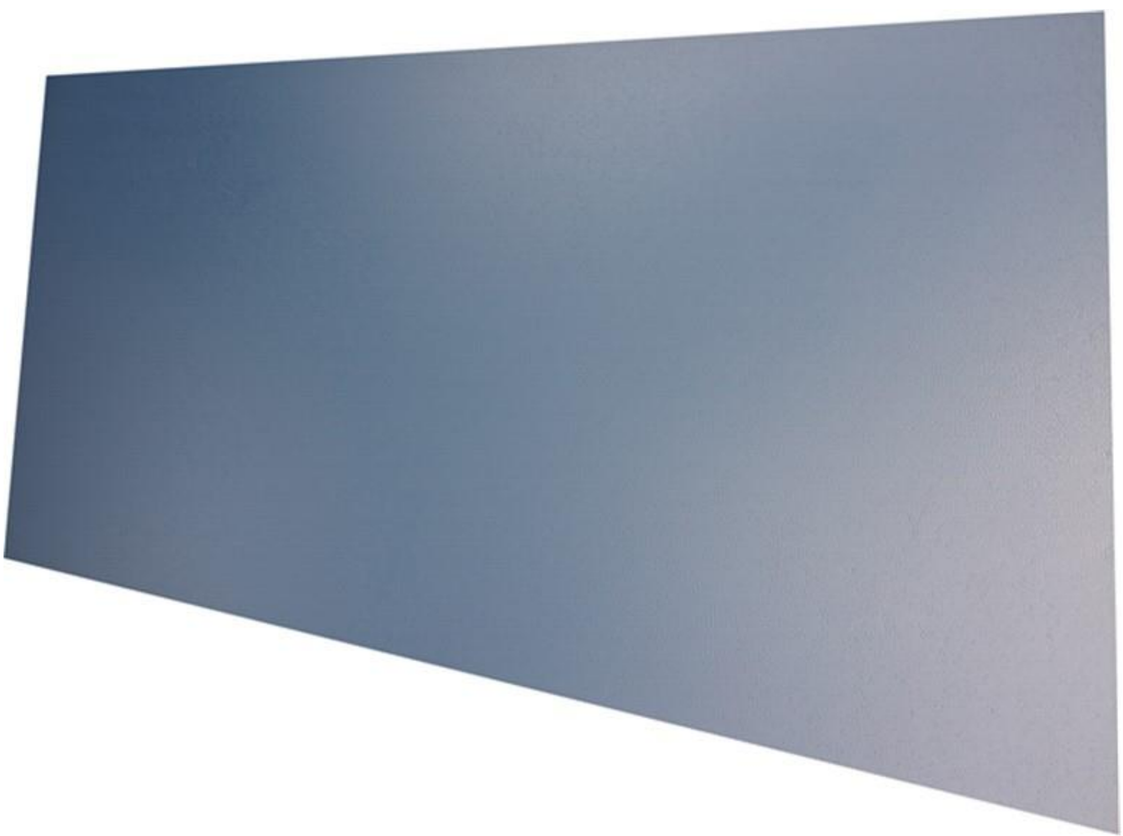


Figure 6: Orthophotograph of an image taken at 610 m (2,000 ft) in Eclipse Sound on 20 August 2020.

2.5 Data Analysis

2.5.1 Leg 1: Early Shoulder Season Surveys in Eclipse Sound

Animal detection rates were calculated and expressed as number of sightings/km and number of animals/km (used as a proxy for relative abundance). Observational effort was calculated relative to survey distance in linear kilometres using trackline GPS data extracting segments of effort using start and end times recorded during surveys while on transect. Sightings were therefore expressed relative to observational effort consistent with other similar studies and methods (Nichols et al. 2005). Relative narwhal abundance was calculated using the following methods:

1) Systematic — A pre-established grid of systematic transect lines[1] was surveyed in areas in the RSA with <9/10 ice concentrations. This included open-water areas and areas associated with low to moderate ice cover.

2) Dedicated — Transect lines were surveyed along open-water leads associated with consolidated sea ice (≥9/10 ice concentrations), along the floe edge, and along the ship route.

Animal sighting rates were calculated and expressed as number of sightings/km (no. of sightings relative to survey effort in km). Animal detection rates were calculated and expressed as number of animals/km (used as a proxy for relative abundance) [2].

2.5.2 Leg 2: Open Water Surveys in Eclipse Sound and Admiralty Inlet

An adaptive sampling plan to estimate narwhal abundance that combines visual line-transect sampling of the survey area and aerial photographic surveys of designated strata was used (Asselin and Richard 2011; Marcoux et al. 2016; Matthews et al. 2017). Animal detection rates were also calculated for other marine mammal species and expressed as number of sightings/km and number of animals/km (used as a proxy for relative abundance).

2.5.2.1 Visual Survey

2.5.2.1.1 Distance Analysis

The standard analysis method of this design assumed that on average, over multiple replications of the survey, each point within the survey area had an equal likelihood of being sampled (uniform coverage probability). Given that the locations of the transect lines were considered random with respect to the location of marine mammals, the average density of marine mammals was considered to be the same irrespective of distance from the transect line. Subsequently, any observed change in marine mammal sightings with increasing distance from the transect line was considered a change in the probability of detection, rather than a true change in animal density. The change in detection probability with respect to sighting distance from the track line (flight path) was measured to provide an estimate of the average probability of detection of an animal, which was, in turn, used to estimate the density of marine mammals in the survey area.

[1] A systematic transect survey throughout the entire RSA was not possible in Leg 1 given sea ice conditions (inherent assumption of distance sampling is that animals are homogeneously distributed throughout their habitat which is not the case when heavy ice is present).

[2] Observational effort was calculated relative to survey distance in linear kilometres using trackline GPS data and extracting segments of effort using start and end times recorded during surveys while on transect.

Density was calculated by using the line transect estimation method (Buckland et al. 2001). In the standard approach, animal density (D) was estimated using the following equation:

$$\frac{n * f\ (0) * \hat{E}(s)}{2 * L *\ g\ (0)}$$

Where n is the number of observed objects (single or clusters of animals), f (0) is the estimated probability density function at zero distance, $\hat{E}(s)$ is the estimate of expected value of cluster size (estimated group size), L (effort) is the total length of transect lines surveyed and g (0) is the probability of detection on the transect line. Effort was calculated as total length of transect lines surveyed using trackline GPS data. Transits between transects were not included in effort calculations.

An implicit assumption of this method was that the probability of detection depended solely on an animal's perpendicular distance from the transect line. Line transect theory assumes that all animals on the transect line were detected with certainty (g (0) =1). In reality, this is an unrealistic assumption for animals that spend considerable time underwater where observers may fail to detect animals due to availability bias (animal was not detected because it was diving) (Marsh and Sinclair 1989). Correcting for availability bias requires published dive profile data to reliably estimate the proportion of time different marine mammal species spend diving (Laake et al. 1997). The most current time-series dive data collected from tagged narwhal near Arctic Bay and Pond Inlet were used to apply a correction factor for availability bias in photographic data (Watt et al. 2015a; Table 2), as was used in the previous DFO narwhal abundance estimates (Doniol-Valcroze et al. 2015a; Marcoux et al. 2019). Mid-August included the period from 13 August (the earliest tagging date) until 24 August and late August included the period from 25–31 August (Watt et al. 2015a). As correction factors for July were not available, Leg 1 surveys applied mid-August correction factors. For narwhal visual surveys, correction factors ($C_α$) from Watt et al. (2015a) tagging data were used with an additional correction for time in view and animal dive cycle applied from Doniol-Valcroze et al. (2015a) measurements (Table 2).

Table 2: Availability bias correction factors.

Species	Survey Type/Date	Correction Factor	CV	Source
Narwhal	Photo / Mid-Aug	3.18	0.03	Watt et al. 2015a
	Photo / Late Aug	3.16	0.03	Watt et al. 2015a
	Visual / Mid-Aug	2.94	0.03	Watt et al. 2015a; Doniol-Valcroze et al. 2015a
	Visual / Late Aug	2.92	0.03	Watt et al. 2015a; Doniol-Valcroze et al. 2015a

Encounter rate [$\frac{n}{L}$ from the equation above] was calculated as the number of marine mammal sighting per transect kilometre and was specific to each survey area. Although encounter rate was calculated (not estimated), there was a degree of variability in its value since encounter rate may vary among individual transects. Encounter rate variance was estimated using the S2 estimator available within Distance 7.3 (Fewster et al. 2009).

Group size [$\hat{\mathrm{E}}(s)$ from equation above] was estimated to correct for observer size-bias whereby larger groups were more likely to be seen at long distances than smaller groups (or individuals). The regression of the natural log of cluster size was tested against the estimated *g*(x) and considered significant at an alpha level of 0.1; the value of mean group size was used for non-significant results. Distance truncation of the data was performed to remove sightings past a selected distance to remove outliers from the dataset that would otherwise inflate density and abundance estimates, and to eliminate hard-to-fit portions of the dataset.

2.5.2.1.2 Perception Bias

Distance sampling (DS) methods can be used to estimate detection probability away from the track line while assuming that detection on the track line is certain (denoted by *g*(0)=1). However, aerial survey observers miss some of the narwhal visible at the surface (Richard et al. 2010). This "perception bias" (Marsh and Sinclair 1989) can be corrected for by using mark-recapture (MR) methods on the sighting data from two observers on the same side of the plane (Laake and Borchers 2004). Thus, the combination of MR and DS (MRDS) methods can be used to estimate abundance without assuming that *g*(0)=1. The two observers in the front of the plane were considered to be the first platform and referred to as "primary observers", and the two observers in the rear were considered to be the second platform ("secondary observers").

To conduct MRDS analysis, duplicate sightings (those seen by both the primary and secondary observer) must be identified. The following criteria, based on previous DFO surveys (Asselin and Richard 2011; Doniol-Valcroze et al. 2015a), were used to identify sightings:

- Timing of sightings within 10 seconds
- Perpendicular declination angle within 10°

As MRDS analysis in Distance requires that duplicate sightings be identical, when this was not the case, the following adjustments to the data were made:

- Used the average perpendicular declination angle as measured by the two observers
- Used the largest group size as measured by the two observers
- Used group differentiation as measured by the primary observer

Although primary and secondary observers were acting independently, detection probabilities of observers can be correlated because of factors such as group size (for example, both observers are more likely to see only large groups at long distances). Buckland et al. (2009) developed a point-independence model, which assumes that detections were independent only on the track line. This model is usually more robust than a model assuming that detections were independent at all perpendicular distances.

Line-transect analyses to estimate density and abundance were performed with the MRDS package in R. A point-independence model involved estimating two functions: a multiple covariate DS detection function for detections pooled across platforms, assuming certain detection on the track line, and a MR detection function to estimate the probability of detection on the track line.

2.5.2.2 Photographic Survey

For the post season photographic analysis, an analyst experienced in analysing aerial photos from previous DFO narwhal surveys and the 2019 photographic surveys analyzed all of the 2020 photographs.

A randomly selected photo survey was re-analyzed by a second experienced photo analyst to evaluate reliability and repeatability. A simple linear regression was run on the comparison of the photo survey readings. Photographic readings from the original photo readers were used in the photo analysis.

Some photographic surveys have observed a decrease in marine mammal detectability with increasing distance from the track line (Golder 2018b). To assess if this was occurring on the photographic surveys, a survey was selected with no glare or land, to assess if a decrease in detectability with increasing distance from the track line was occurring. Removing re-sightings from subsequent photographs on a track line and measuring the distance from the trackline for each sighting allowed assessment of detectability with increasing distance from the track line. The Distance program was used to measure a change in marine mammal sightings with increasing distance from the transect line, referred to as detection probability. The change in detection probability with respect to sighting distance from the track line (flight path) was measured to provide an estimate of the average probability of detection of an animal, which was, in turn, used to estimate the density of narwhal in the photographic survey area.

Aerial photos were viewed in ArcMap (Esri Inc.) and all narwhal within the top 2 m of the water column were counted. Photographs were examined for narwhal on a high resolution 50” 4K television. Photographs were orthorectified prior to being examined in ArcMap 10.1 (Esri). Water clarity was subjectively evaluated in each photo and classified as either murky (water in which narwhal could only be observed at the surface) or clear (water in which narwhal could be observed down to 2 m).

The area covered by each photograph was calculated in ArcMap (Esri) based on the orthophotograph which accounted for survey altitude, focal length of the camera sensor (35 mm), the length of the camera sensor (35.9 mm), the width of the camera sensor (24 mm), angle of the camera (27°), and the tilt of the aircraft. The area of land was subtracted from each photograph. On some photos, a proportion of the photo was masked by sun glare, which made it impossible for the reader to evaluate if narwhal were present. Therefore, the area of the photo covered by sun glare was measured for each photo in ArcMap (Esri) and subtracted from the photograph. When ice was present in concentrations greater than 10%, the proportion of ice was estimated and deducted from the area left after subtracting the land and glare.

Based on the methodology used in past DFO surveys (Asselin and Richard 2011; Marcoux et al. 2016; Matthews et al. 2017), the total area of a photograph A_{total} examined to detect narwhal was calculated by subtracting the area of each photograph A_{photo} from the area on land A_{land}, the area covered in sun glare A_{glare}, and area covered in ice A_{ice}.

$$A_{tot} = A_{photo} - A_{land} - A_{glare} - A_{ice}$$

The area covered by each photographic survey (A_{survey}) was determined by calculating the area of a polygon made of all the photographs merged together and removing the areas that were on land. Due to photograph sidelap and endlap, some narwhal were photographed more than once. To estimate the total number of narwhal at the surface in each survey (N_{tot}) (i.e., exclude the positive bias of double-counts), the within-photo animal density was calculated and multiplied by the total area covered by photos:

$$N_{tot} = A_{survey} * \sum_{i=1}^{I} \frac{N_{surface}}{A_{tot_i}}$$

Where:

$N_{surface}$ is the total number of narwhal detected near or at the surface in a photograph

A_{tot} = area of photo i (excluding land, sun glare and ice cover on water)

A_{survey} = total area covered by merged photos (excluding land)

I is the number of photographs per survey

The total number of narwhal in each survey was corrected for the instantaneous availability bias and detectability bias:

$$N_{cor} = N_{tot} * C_a * C_d$$

Where:

N_{tot} = is the total number of narwhal detected near or at the surface in each survey (excluding the positive bias of double-counts)

C_a = is the availability correction factor taken from Watt et al. (2015a and b)

C_d= is the detection correction factor accounting for decreasing detectability from trackline (i.e., 1/p where p=probability of observing a narwhal in a defined area in Distance analysis)

N_{cor} = number of narwhal in survey corrected for availability bias

The variance of the the surface abundance of narwhal (N_{tot}) was calculated:

$$var(N_{tot}) = \frac{\sum(x_i - \bar{\bar{x}})^2}{N_{photos}}$$

Where $\bar{x}$ is the average number of narwhal per photo, x_i is the number of narwhal for each photo and N_{photos} is the number of photographs. The coefficient of variation (CV) of the photographic count estimate (N_{tot}) was calculated (Marcoux et al. 2016; Marcoux Pers. Comm. 2020):

$$CV(N_{tot}) = \frac{\sqrt{var(N_{tot})}}{N_{tot}}$$

The total variance of the estimate from the photographic survey was calculated following the delta method (Buckland et al. 2001):

$$var(N_{cor}) = N_{cor}^2 * \left\{\frac{var(N_{tot})}{(N_{tot})^2} + \frac{var(C_a)}{{C_a}^2} + \frac{var\ (C_d)}{{C_d}^2}\right\}$$

The coefficient of variation (*CV*) of the estimate from the photographic survey was calculated:

$$CV(N_{cor}) = \frac{\sqrt{var(N_{cor})}}{N_{cor}}$$

2.5.2.3 Abundance Estimate

The total estimate for each Survey (N_i) was calculated by summing the estimate from the visual survey, corrected for availability bias, detectability bias and perception bias (N_{iV}), with the estimate from the photographed area, also corrected for availability bias and detectability bias (for narwhal) (N_{iP}):

$$N_i = N_{iV} + N_{iP}$$

Where: N_{iP} is the abundance of whales in the photographic survey previously referred to as N_{tot} for narwhal

With variance calculated (e.g., Asselin and Richard 2011; Matthews et al. 2017):

$$var(N_i) = var(N_{iV}) + var(N_{iP})$$

The coefficient of variation (CV) of the estimate from the total estimate was calculated:

$$CV = \frac{\sqrt{var(N_i)}}{N_i}$$

Confidence intervals (95%) were calculated using the lognormal method of Buckland et al. (2001):

$$(N_i/C, N_i * C)$$

Where: $C = exp\left[z_\alpha * \sqrt{var(log_e N_i}\right]$

and: $var(log_e N^*) = log_e\left[1 + \frac{var(N_i)}{N^{*2}}\right]$

The final averaged abundance estimate ($\widehat{N}_{avg}$) was calculated by combining the estimates from two surveys (Visual and Photo) using a mean weighted by effort (Buckland et al. 2001 eqn. 8.7):

$$\widehat{N}_{avg} = \frac{E_1\,\widehat{N}_1 + E_2\,\widehat{N}_2}{E_1 + E_2}$$

Where E_i is the effort calculated as the area covered by the survey *i*

The variance of the mean estimate is calculated as follows (Buckland et al. 2001 eqn. 8.8):

$$var(\widehat{N}_{avg}) = \frac{E_1^2\,\widehat{var}(\widehat{N}_1) + E_2^2\,\widehat{var}(\widehat{N}_2)}{(E_1 + E_2)^2}$$

3.0 RESULTS

Aerial surveys for narwhal were conducted in the North Baffin area during July and August 2020. The objectives of the surveys were to determine the relative abundance and distribution of narwhal near the Pond Inlet floe edge prior to and during initial shipping and icebreaking operations, and to obtain abundance estimates of narwhal during the open-water season for the Eclipse Sound and Admiralty Inlet summer stock areas. Early shoulder season surveys (Leg 1) were flown in the Eclipse Sound grid from 10–22 July. A total of nine surveys were attempted in Leg 1. Open-water surveys (Leg 2) were flown in the Eclipse Sound grid and Admiralty Inlet grid from 20 August–01 September. A total of four surveys were attempted in each survey grid during Leg 2, but only two surveys had complete coverage of the combined grids.

3.1 Leg 1: Early Shoulder Season Surveys in Eclipse Sound

3.1.1 Survey Coverage

When surveys began on 10 July 2020, ice was still present through much of Eclipse Sound, North Milne Inlet and some fjords (Figure 7). Open water was present in South Milne Inlet, Baffin Bay and northern portion of Navy Board Inlet. The floe edge was situated approximately 20 km northeast of Pond Inlet. By the time surveys ended on 22 July 2020, most of the ice had broken up and only the western portion of Eclipse Sound and the southern portion of North Milne Inlet had >8/10 ice (Figure 8).

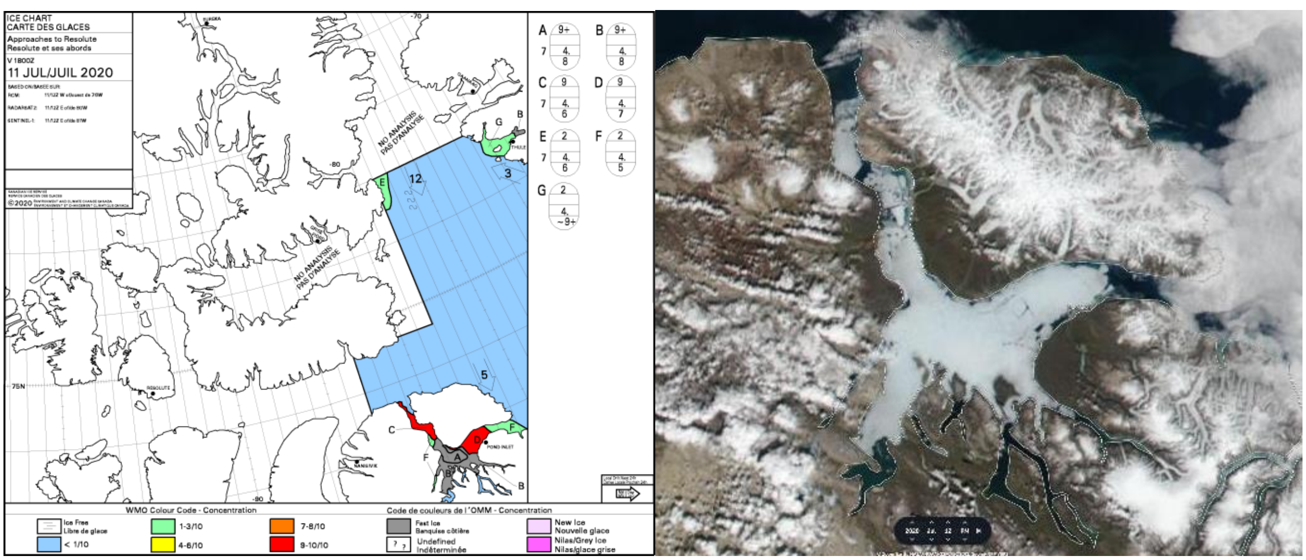


Figure 7: Ice chart for 11 July 2020 (left; Canadian Ice Service) and satellite image for 12 July 2020 (right; Zoom Earth; https://zoom.earth) showing ice conditions in Eclipse Sound area.

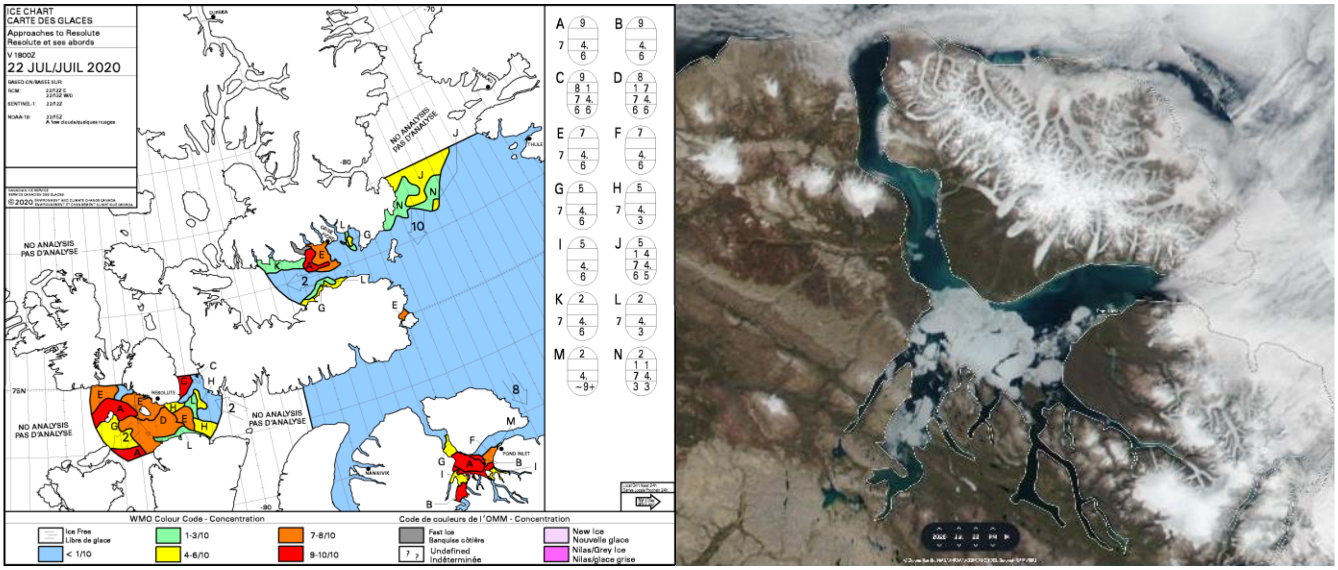


Figure 8: Ice chart for 22 July 2020 (left; Canadian Ice Service) and satellite image for 22 July 2020 (right; Zoom Earth) showing ice conditions in Eclipse Sound area.

Nine surveys were flown over 13 days during Leg 1 (see Appendix B; Figures B-1 to B-9). Over the course of the nine surveys, a total of 7,115.1 km of survey effort was conducted. This effort included systematic transect lines, dedicated transects (i.e., ice leads, floe edges, and ship route), and reconnaissance flights (Table 3). Systematic transects (i.e., pre-planned transects; see Figures 3 and 4) were flown in areas with <9/10 ice to open water and dedicated transects were flown in ice leads, along the floe edge, and along the ship route. Systematic transect lines totaled 4,292.9 km, dedicated transect totaled 2,488.7 km and reconnaissance flights totaled 333.6 km of total effort. The first Baffinland vessel to enter the RSA in 2020 was the MSV *Botnica*. The MSV *Botnica* was used to escort Project vessels through the RSA on 21 July 2020.

Table 3: Summary of survey flights during Leg 1. Systematic transect lines (S), dedicated transect lines (D), and reconnaissance (R) were flown over nine surveys in nine strata.

Survey Stratum	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	Survey 7	Survey 8	Survey 9
	10-11 July	12-13 July	15 July	16-17 July	18 July	19 July	20 July	21 July	22 July
Baffin Bay (BB)	S	S	S	S	S	—	—	—	—
Pond Inlet (PI)	S&D	S	S	S&D	S&D	—	—	—	—
Eclipse Sound East (ESE)	D	D	D	D	D	—	D	D	D
Eclipse Sound West (ESW)	D	D	D	D	D	D	D	D	D
Milne Inlet North (MIN)	—	R	—	D	D	D	S&D	S	S
Milne Inlet South (MIS)	R	R	S	S	S	S	S	—	S
Tremblay Sound (TB)	—	—	—	R	R	—	—	R	—
Navy Board Inlet (NBI)	S	S&D	—	D	S&D	—	—	—	—
Fjords	S	—	—	—	—	S	S	—	—
Systematic transects (km)	**904.1**	**865.2**	**518.1**	**425.9**	**273.5**	**377.1**	**340.5**	**165.9**	**422.6**
Dedicated transects (km)	**115.3**	**213.8**	**224.9**	**442.2**	**340.8**	**84.6**	**277.2**	**628.3**	**161.6**
Recon. (km)	**61.8**	**101.1**	**0**	**47.1**	**47.0**	**0**	**0**	**76.6**	**0**
Total Effort (km)	**1,081.2**	**1,180.1**	**743.0**	**915.2**	**661.3**	**461.7**	**617.7**	**870.7**	**584.2**

3.1.2 Sighting Conditions

MMOs recorded environmental sighting conditions during visual surveys at the beginning and end of each transect and when conditions changed along the track. Sighting conditions were recorded within the MMO field of view (1 km of the transect line; see Appendix A) and were evaluated based on survey effort when each condition was observed.

Ice Cover

Ice cover ranged from <1/10 to 10/10 ice cover during Leg 1 of the 2020 MMASP (Figure 9). Ice conditions changed from the first survey on 10 July to the last survey on the 22 July (see Figures 7 and 8). Fast ice was present in the RSA until the 17 July (see Appendix B; Figures B-1 to B-4). Survey effort in areas of high ice concentrations (i.e., 9-10/10 ice) focused in ice leads, which were consistently present throughout Eclipse Sound for the duration of Leg 1 surveys. Areas of <1/10 ice represented 52% of the total survey effort flown, whereas areas of 9-10/10 ice represented 36% of the total survey effort flown.

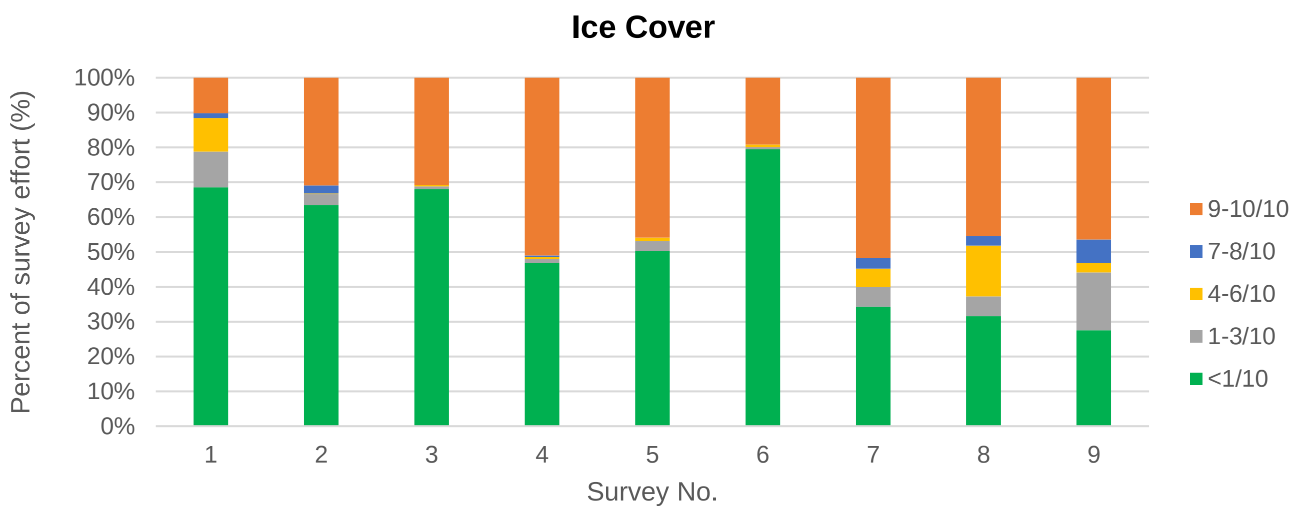


Figure 9: Ice Cover during Leg 1 of the 2020 MMASP.

Fog

Two measurements of fog were used as sighting conditions. Fog cover was assessed as the percent (0–100%) of fog obscuring the viewing area and fog intensity (four levels: “none” when there was no fog, “light” fog that animals were visible through, “moderate” when animals were likely missed in the fog, and “thick” when animals were certainly missed in the fog). Areas that were forecasted to be foggy were avoided when daily surveys were planned. In Figure 10, ”Present” represent a condition when 1–100% of the viewing area was obscured with fog. Surveys 1, 3, 4, and 5 had fog present. Fog was present on 1.8% of the total effort flown in 2020.

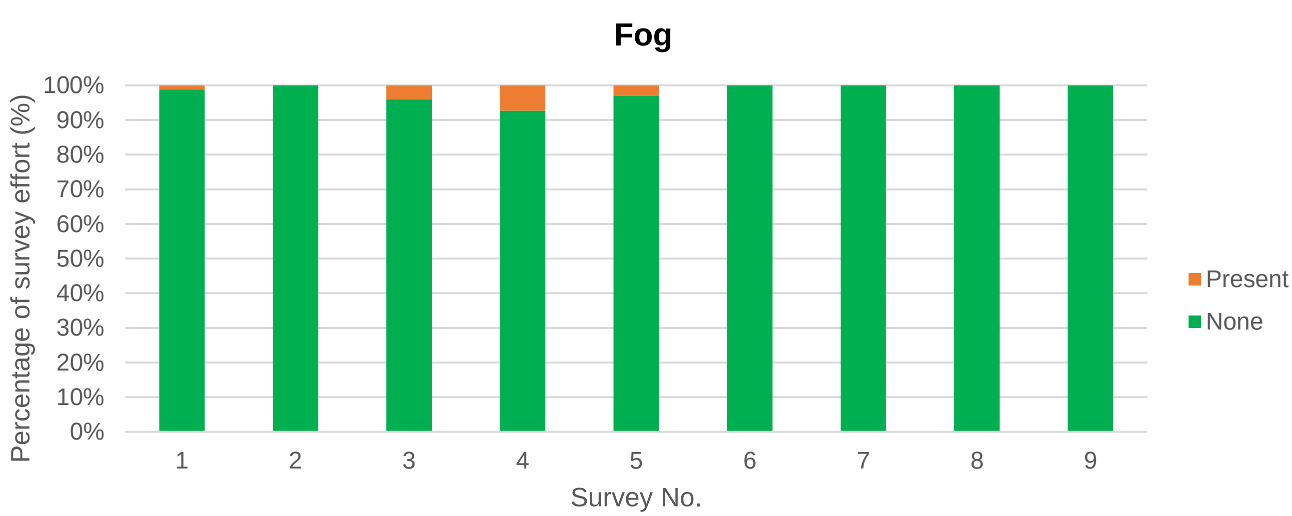


Figure 10: Fog Cover During Leg 1 of the 2020 MMASP

Beaufort Sea State

On a scale of 0 to 12, the Beaufort Sea State (BF) ranged from BF 0 (glassy mirror) to BF 6 (large waves) during Leg 1 of the 2020 MMASP (Figure 11). Sea state conditions were recorded between BF 0 (glassy mirror) and BF 3 (large wavelets, scattered whitecaps) for 87% of the total effort flown. Areas that were forecasted to have high sea states were avoided when daily surveys were planned. If sea state conditions exceeded a BF 4, the area was generally abandoned, and the survey was resumed in an area with more favorable environmental sighting conditions.

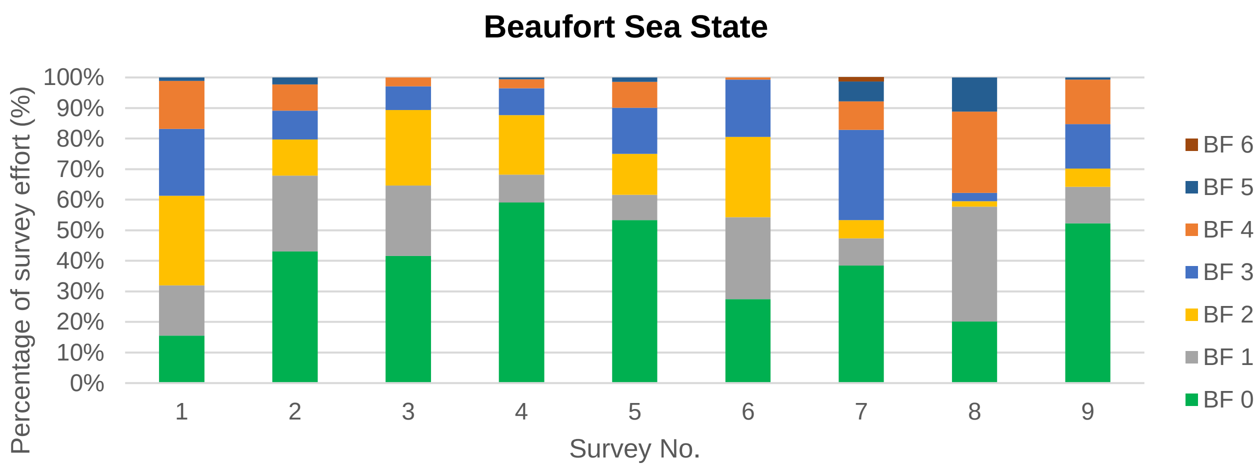


Figure 11: Beaufort Sea State During Leg 1 of the 2020 MMASP.

Glare Cover and Intensity

Two measurements of glare were used as sighting conditions. Glare cover was assessed as the percent (0–100%) of the viewing area affected by sun reflection and glare intensity (four levels: “none” when there was no reflection, “low” when animals were likely detected in center of reflection angle, “moderate” when animals were likely missed in the center of reflection angle, and “intense” when animals were certainly missed in the center of reflection angle). Glare was present on 45% of the total effort flown in 2020. Intense glare was present on 19% of the total effort flown in 2020.

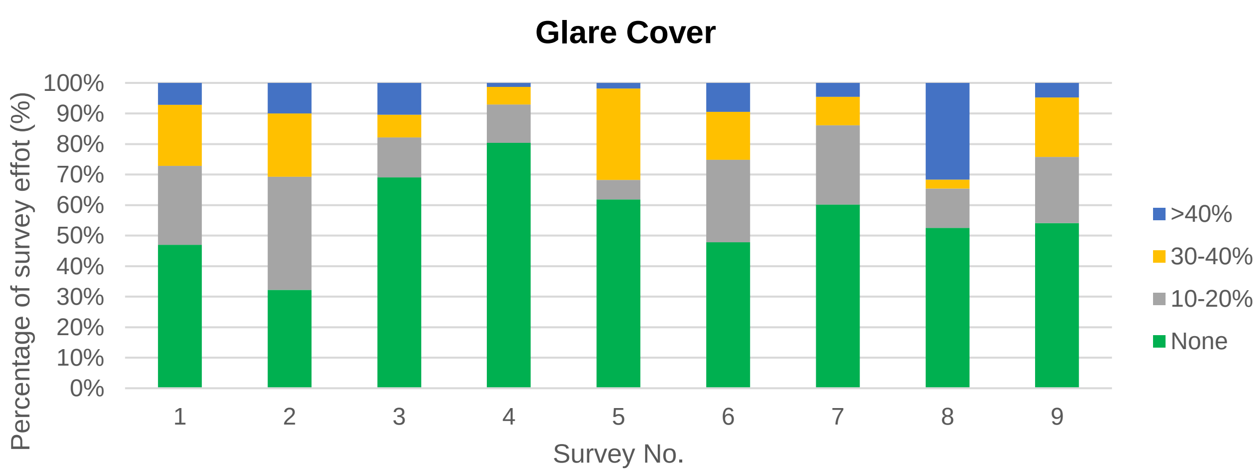


Figure 12: Glare Cover During Leg 1 of the 2020 MMASP.

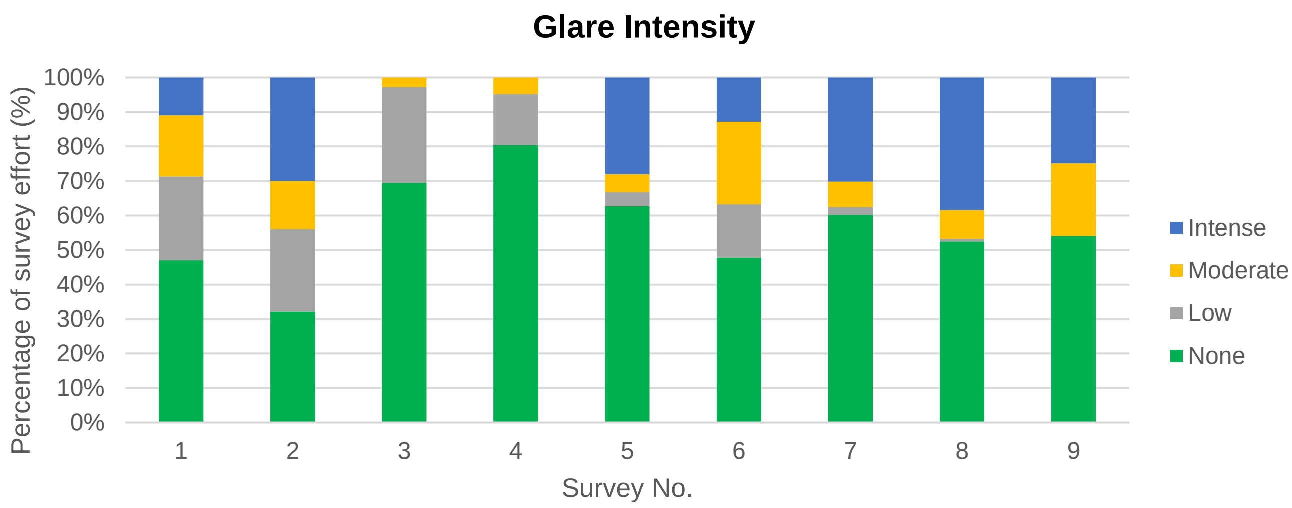


Figure 13: Glare Intensity During Leg 1 of the 2020 MMASP.

3.1.3 Survey Sightings

Eight different marine mammal species were observed during Leg 1 of the 2020 MMASP: narwhal, bowhead whale, beluga whale, ringed seal, harp seal, bearded seal, walrus, and polar bear. Unidentified whales and seals were also recorded during the surveys. Tables 4 and 5 summarize the number of marine mammal sightings and animals recorded during surveys for each species by survey number. A total of 3,942 sightings totalling 8,666 marine mammals were recorded during Leg 1 surveys.

Table 4: Number of sightings (including off-effort) in Eclipse Sound grid during Leg 1.

Survey #	Narwhal	Bowhead Whale	Beluga Whale	Unidentified Whale	Ringed Seal	Harp Seal	Bearded Seal	Walrus	Unidentified Seal	Polar Bear	Total
Survey 1	352	21	3	0	10	13	1	0	24	4	**428**
Survey 2	548	23	1	1	9	40	1	1	42	6	**672**
Survey 3	278	6	0	4	13	17	0	0	6	0	**324**
Survey 4	455	16	0	4	13	6	0	0	8	0	**502**
Survey 5	351	17	0	1	18	14	0	0	16	6	**423**
Survey 6	76	5	0	1	12	2	0	0	10	0	**106**
Survey 7	389	17	0	1	49	3	1	0	11	0	**471**
Survey 8	635	9	0	1	23	4	0	0	7	0	**679**
Survey 9	300	6	0	0	25	3	0	0	3	0	**337**
Total	**3,384**	**120**	**4**	**13**	**172**	**102**	**3**	**1**	**127**	**16**	**3,942**

Table 5: Number of animals (including off-effort) in Eclipse Sound grid during Leg 1.

Survey #	Narwhal	Bowhead Whale	Beluga Whale	Unidentified Whale	Ringed Seal	Harp Seal	Bearded Seal	Walrus	Unidentified Seal	Polar Bear	Total
Survey 1	914	26	3	0	15	129	1	0	25	4	**1,117**
Survey 2	1,219	27	1	1	12	230	1	1	59	8	**1,559**
Survey 3	573	6	0	4	15	91	0	0	7	0	**696**
Survey 4	966	23	0	4	14	59	0	0	8	0	**1,074**
Survey 5	698	20	0	1	20	219	0	0	18	12	**988**
Survey 6	165	7	0	1	12	2	0	0	11	0	**198**
Survey 7	843	20	0	1	59	26	1	0	12	0	**962**
Survey 8	1,337	10	0	2	30	18	0	0	7	0	**1,404**
Survey 9	600	6	0	0	30	29	0	0	3	0	**668**
Total	**7,315**	**145**	**4**	**14**	**207**	**803**	**3**	**1**	**150**	**24**	**8,666**

Narwhal

Narwhal were observed throughout the survey area during the Leg 1 surveys (Figure 14). A total of 3,384 sightings and 7,315 individual narwhal were recorded during the Leg 1 surveys (Tables 4 and 5). Narwhal group sizes ranged from single animals to a group size of 20, with mean and median group sizes of 2.1 and 1.0, respectively. A total of 265 mother/calf pairs and 17 lone calves were recorded during the surveys.

Bowhead whale

A total of 120 sightings and 145 individual bowhead whales were recorded during the Leg 1 surveys (Figure 14; Tables 4 and 5). Bowhead group sizes ranged from single animals to a group size of three, with mean and median group sizes of 1.2 and 1.0, respectively. Four mother/calf pairs were recorded during the surveys. The first two mother/calf pairs were observed in the Pond Inlet and Eclipse Sound strata on 13 July. The third mother/calf pair was observed in Eclipse Sound West stratum on 18 July. The fourth mother/calf pair was observed in Milne Inlet stratum on 20 July.

Beluga whale

During the Leg 1 surveys, there was a total of four beluga sightings (all single animals) (Figure 14; Tables 4 and 5). Three sightings were observed during Survey 1 (10 July) in the Pond Inlet stratum (Appendix B, Figure B-1). The fourth sighting was observed during Survey 2 (13 July), again in the Pond Inlet stratum (Appendix B, Figure B-2).

Unidentified whale

There were 13 sightings and 14 unidentified whales during the Leg 1 surveys (Figure 14; Tables 4 and 5).

Ringed seal

Ringed seals were observed throughout the survey area during the Leg 1 surveys (Figure 15). One hundred seventy-two sightings totalling 207 ringed seals were recorded during Leg 1 surveys (Tables 4 and 5). Ringed seal sightings in the water were primarily of single animals (127 of 143 sightings). The remaining ringed seal groups observed in the water consisted of groups of two or four animals. Ringed seals on the ice were observed with group sizes ranging from one to six seals, with mean and median group sizes of 1.5 and 1.0, respectively.

Harp seal

A total of 102 sightings of 803 individual harp seals were recorded during Leg 1 surveys (Tables 4 and 5). Most harp seals were observed either in the Pond Inlet, Baffin Bay or northern Navy Board Inlet strata during Leg 1 surveys (Figure 15). All harp seals were observed in the water with group sizes that ranged from one to 40 animals and with mean and median group sizes of 7.9 and 5.0, respectively.

Bearded seal

Three sightings of individual bearded seals were recorded during Leg 1 surveys (Tables 4 and 5). One was observed during Survey 1 in Eclipse Sound (Appendix B; Figure B-1). The second was observed during Survey 2 in the Navy Board Inlet stratum (Appendix B; Figure B-2). The third was observed during Survey 7 in the Milne Inlet North stratum (Appendix B; Figure B-7).

Walrus

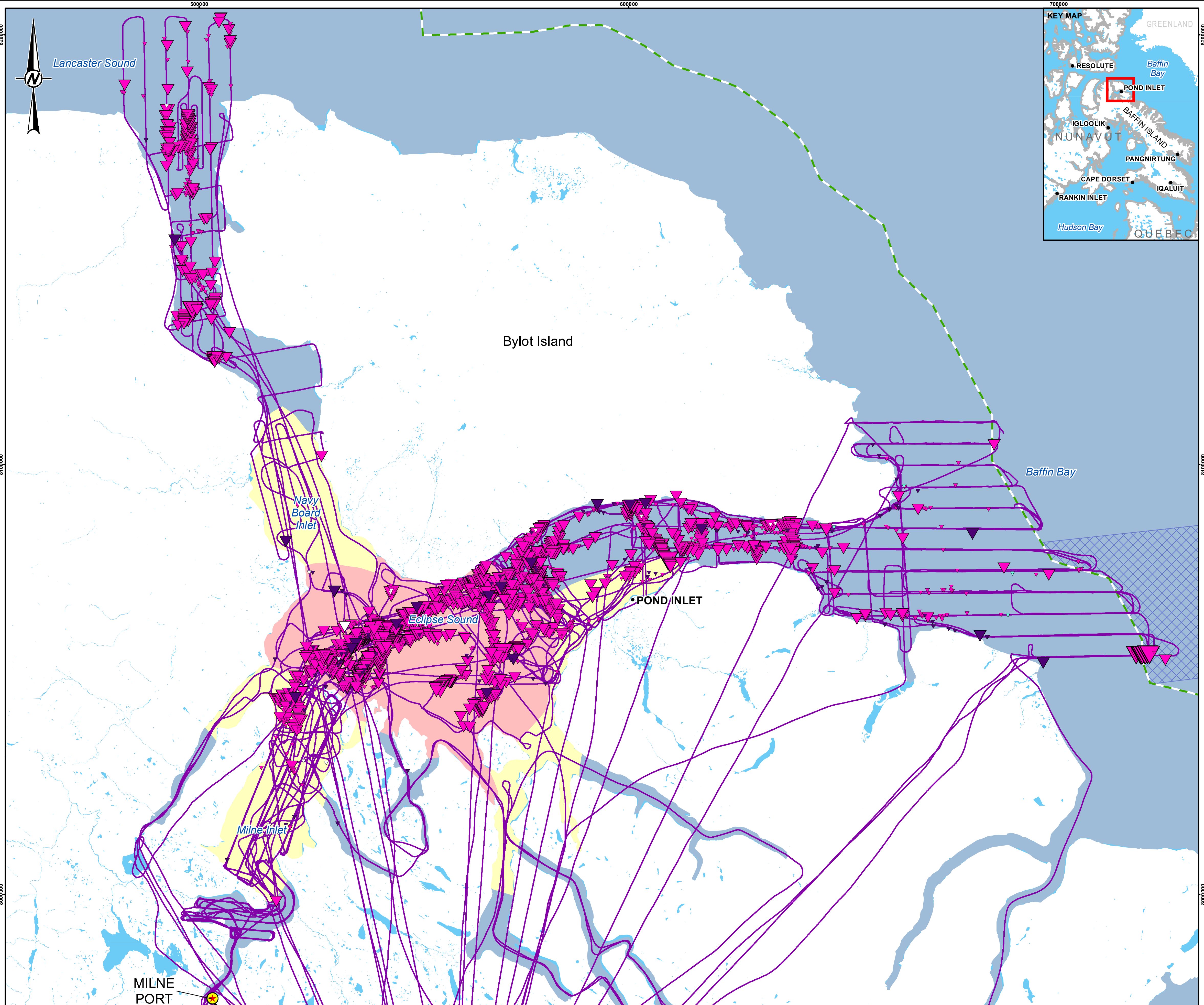
One sighting of an individual walrus was recorded during Leg 1 surveys (Figure 15; Tables 4 and 5). It was observed during Survey 2 in Eclipse Sound (Appendix B; Figure B-2).

Unidentified seal

Unidentified seals were observed throughout the survey area during Leg 1 surveys (Figure 15). There were 127 sightings totalling 150 animals (Tables 4 and 5).

Polar bear

Sixteen polar bear sightings of 24 individuals were recorded during Leg 1 surveys (Figure 15; Tables 4 and 5). Ten sightings were observed in Navy Board Inlet, five sightings in Pond Inlet Stratum and one sighting in Eclipse Sound stratum. Four mother with cubs sightings were recorded during Leg 1 surveys. The first sighting of a mother with two cubs was observed in Navy Board Inlet stratum on 12 July (Appendix B; Figure B-2). Two separate sightings of a mother with two cubs were observed in Navy Board Inlet stratum on 18 July. The last sighting of a mother with one cub was also observed in Navy Board Inlet stratum on 18 July (Appendix B; Figure B-5).



LEGEND

- COMMUNITY
- MILNE PORT

VISUAL SURVEY CETACEAN SPECIES OBSERVATIONS (GROUP SIZE)

BELUGA
- 1

BOWHEAD WHALE
- 1
- 2-10

NARWHAL
- 1
- 2-10
- 10+

UNIDENTIFIED CETACEAN
- 1
- 2-10

- MILNE INLET TOTE ROAD
- AERIAL SURVEY TRACK
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION (JULY 21, 2020)
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10

0 25 50
1:900,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

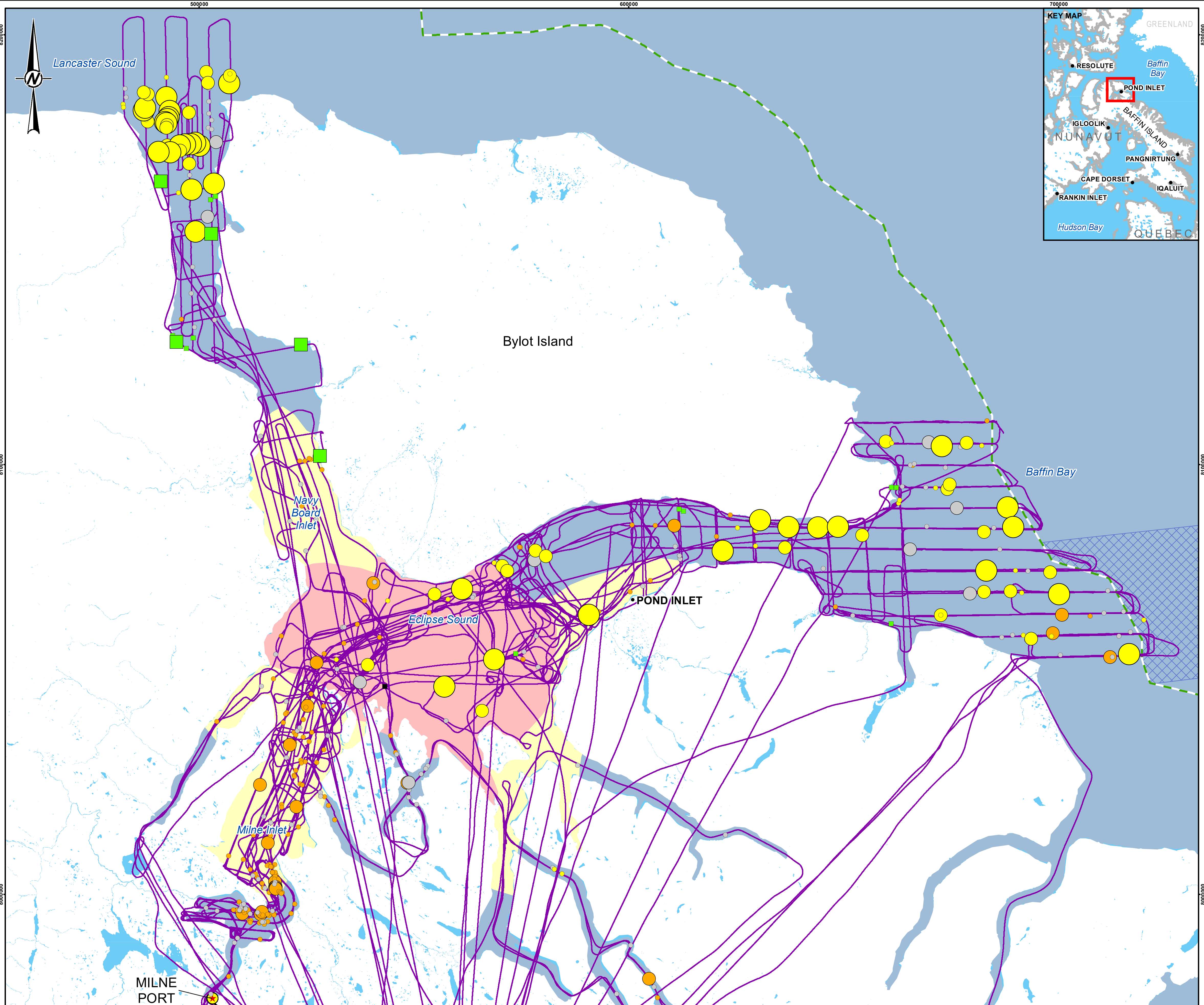
PROJECT
MARY RIVER PROJECT

TITLE
DISTRIBUTION OF CETACEANS DURING LEG 1 - JULY 2020 IN ECLIPSE SOUND GRID

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AJA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	14



LEGEND

- COMMUNITY
- MILNE PORT
- MILNE INLET TOTE ROAD
- AERIAL SURVEY TRACK
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

VISUAL SURVEY PINNIPEDS AND POLAR BEARS SPECIES OBSERVATIONS (GROUP SIZE)

HARP SEAL
- 1
- 2-10
- 10+

POLAR BEAR
- 1
- 2-10

RINGED SEAL
- 1
- 2-10

WALRUS
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

ICE CONCENTRATION (JULY 21, 2020)
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10

0 25 50
1:900,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
DISTRIBUTION OF PINNIPEDS AND POLAR BEARS DURING LEG 1 – JULY 2020 IN ECLIPSE SOUND GRID

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AJA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	15

3.1.4 Relative Abundance of Marine Mammals in RSA

In 2020, a total of 6,781.6 km of effort (4,292.9 km during systematic transects and 2,488.7 km during dedicated transects) was flown over nine surveys during Leg 1. The relative abundance of marine mammals in the RSA, expressed as the animal detection rate (no. of animals relative to survey effort in km) and sighting rate (no. of sightings relative to survey effort in km) were calculated. Table 6 provides a summary of sighting rates and animal detection rates by species and according to effort types (systematic transects vs. dedicated transects). Narwhal had the highest relative abundance both on the systematic transects and on dedicated transects (0.33 animals/km and 2.09 animals/km, respectively). Narwhal were more abundant on dedicated transects than in areas where systematic transects were flown (2.09 animals/km and 0.33 animals/km, respectively), whereas beluga whale, ringed seal, harp seal, and bearded seal were more abundant in the areas where systematic transects were flown compared to areas where dedicated transects were flown (Table 6). Bowhead were also more abundant on dedicated transects than in areas where systematic transects were flown (0.03 animals/km and 0.01 animals/km, respectively). Narwhal relative abundance varied between surveys from 0.00 to 0.35 animals/km along systematic transects and 1.40 to 4.25 animals/km along dedicated transects (leads/floe edge) (Table 7). During the first vessel passage, the MSV *Botnica* (escorting two carriers and two tugs) transited through a large, consolidated ice field in North Milne/West Eclipse on 21 July which included several narrow ice leads occupied by large numbers of narwhal. The following day, narwhal relative abundance increased from 2.21 animals/km (Survey 8 on 21 July) to 4.25 animals/km (Survey 9 on 22 July) in leads in Eclipse Sound (dedicated transects) and decreased from 0.16 animals/km (Survey 8 on 21 July) to 0.02 animals/km (Survey 9 on 22 July) in Milne Inlet (systematic transects) after the icebreaker transited the RSA (Table 7). Narwhal distribution also appeared to shift from the 4-6/10 ice area in north Milne Inlet on 21 July to the 9-10/10 ice in Eclipse Sound on 22 July (Appendix B, Figures B-8 and B-9).

Table 6: Sighting and Animal Detection Rate (Relative Abundance) of Marine Mammals in RSA during Leg 1

Species	No. of Sightings		Sighting Rate (sightings/km)			No. of Animals		Animal Detection Rate (animals/km)		
	Sys.[a] Tran.	Ded.[b] Tran.	Sys. Tran.	Ded. Tran.	Combined	Sys. Tran.	Ded. Tran.	Sys. Tran.	Ded. Tran.	Combined
Narwhal	664	2,468	0.1547	0.9917	0.4618	1,431	5,203	0.3333	2.0906	0.9782
Bowhead Whale	35	59	0.0082	0.0237	0.0139	39	75	0.0091	0.0301	0.0168
Beluga Whale	4	0	0.0009	0.0000	0.0006	4	0	0.0009	0.0000	0.0006
Unknown Whale	1	10	0.0002	0.0040	0.0016	1	11	0.0002	0.0044	0.0018
Ringed Seal	122	36	0.0284	0.0145	0.0233	154	38	0.0359	0.0153	0.0283
Harp Seal	85	13	0.0198	0.0052	0.0144	680	99	0.1584	0.0398	0.1149
Bearded Seal	2	0	0.0005	0.0000	0.0003	2	0	0.0005	0.0000	0.0003
Walrus	0	1	0.0000	0.0004	0.0001	0	1	0.0000	0.0004	0.0001
Unknown Seal	88	25	0.0205	0.0100	0.0166	107	29	0.0249	0.0117	0.0201
Polar Bear	1	2	0.0002	0.0008	0.0004	2	3	0.0005	0.0012	0.0007

[a] abbreviation for Systematic Transects
[b] abbreviation for Dedicated Transects

Table 7: Sighting and Animal Detection Rate (Relative Abundance) of Narwhal in RSA during each survey of Leg 1.

Survey	No. of Animals				Animal Detection Rate (animals/km)			
	Sys.[a] Tran.	Ded.[b] (Leads/Floe Edge)	Ded. Tran. (Ship Track in Ice)	Ded. Tran. (Ship Track in Open Water)	Sys. Tran.	Ded. Tran. (Leads/Floe Edge)	Ded. Tran. (Ship Track in Ice)	Ded. Tran. (Ship Track in Open Water)
1	440	453	—	—	0.4867	3.9289	—	—
2	669	299	—	—	0.7732	1.3985	—	—
3	147	389	—	—	0.2837	1.7297	—	—
4	23	852	—	—	0.0540	1.9267	—	—
5	111	583	—	—	0.4059	1.7107	—	—
6	0	161	—	—	0.0000	1.9031	—	—
7	6	759	—	—	0.0176	2.7381	—	—
8	27	781	289	47	0.1628	2.2078	1.6307	0.4831
9	8	528	62	—	0.0189	4.2457	1.6654	—
Total	**1,431**	**4,805**	**351**	**47**	**0.3333**	**2.2073**	**1.6367**	**0.4831**

[a] abbreviation for Systematic Transects
[b] abbreviation for Dedicated Transects

3.1.4.1 Comparison to 2019 MMASP

The relative abundance for this section considered only data collected during systematic transects because dedicated transect were not flown in 2019 due to the limited amount of ice present during that year. The relative abundance of marine mammals in the RSA was higher in 2020 (0.56 animals/km) than in 2019 (0.37 animals/km; Table 8). Much of this increase can be attributed to a greater relative abundance of seals observed in 2020. Seal species observed in greater relative abundance in 2020 included ringed seal, harp seal, and unidentified seal. It should be noted that the seal data should be interpreted with caution due to the difficulty of observing and identifying seals at survey altitudes of 305 m (1,000 ft) above sea level (ASL), especially as sea states increases.

Narwhal relative abundance in the RSA was similar in 2020 (0.33 animals per km) to that observed in 2019 (0.30 animals/km; Table 8). Bowhead whale relative abundance in the RSA was lower in 2020 (0.009 animals/km) to that observed in 2019 (0.023 animals/km; Table 8).

Table 8: Relative Abundance (animal detection rate) of Marine Mammals in RSA during Leg 1 in 2019 and 2020.

Species	2019		2020	
	No. of Animals	Relative Abundance (animals/km)	No. of Animals	Relative Abundance (animals/km)
Narwhal	1,187	0.2952	1,431	0.3333
Bowhead Whale	94	0.0234	39	0.0091
Beluga Whale	1	0.0002	4	0.0009
Killer Whale	10	0.0025	0	0.0000
Unknown Whale	4	0.0010	1	0.0002
Ringed Seal	71	0.0199	154	0.0359
Harp Seal	102	0.0286	680	0.1584
Bearded Seal	2	0.0006	2	0.0005
Unknown Seal	19	0.0053	107	0.0249
Polar Bear	1	0.0002	2	0.0005
Total	**1,491**	**0.3709**	**2,420**	**0.5637**

Note: Relative abundance = animals/km (corrected for survey effort in km)

3.2 Leg 2: Open-Water Surveys in Eclipse Sound and Admiralty Inlet

3.2.1 Survey Coverage

Four surveys over 13 days were attempted during the open-water season in the Eclipse Sound and Admiralty Inlet grids (Appendix B; Figures B-10 to B-15). Over the course of the four surveys, a total of 8,815.7 km of survey effort was conducted which included both visual and photographic surveys (Table 9).

Eclipse Sound Grid: Visual surveys totaled 4,843.0 km and photographic surveys totaled 1,447.6 km of survey effort (Table 9). Three of the four surveys achieved complete coverage of the survey grid (Appendix B; Figures B-10, B-14 and B-15). Surveys 1 and 3 were completed in a single day under good sighting conditions. Survey 2 missed the top half of Navy Board Inlet (Appendix B; Figure B-12) due to poor sighting conditions. Survey 4 was completed in two days due to high sea states encountered on the first day. Surveys 2 and 4 were not retained for the abundance analysis due to poor sightings conditions and incomplete coverage in a single day.

Admiralty Inlet Grid: Visual surveys totaled 2,336.3 km and photographic surveys totaled 188.8 km of survey effort (Table 9). Only two surveys (Surveys 1 and 3) were flown in Admiralty Inlet in 2020. Poor survey conditions during the time allotted for Surveys 2 and 4 did not allow for surveys to be conducted. Surveys 1 and 3 achieved complete coverage of the survey grid (Appendix B; Figures B-11 and B-13) in a single day under good sighting conditions.

Table 9: Visual (V) and photographic (P) surveys undertaken during Leg 2.

Survey Stratum	Survey 1 20–21 Aug	Survey 2 24–25 Aug	Survey 3 28–29 Aug	Survey 4 30 Aug–01 Sept
Pond Inlet (PI)	V	V	V	V
Eclipse Sound East (ESE)	V	V	V	V
Eclipse Sound West (ESW)	V	V	V	V
Milne Inlet North (MIN)	V	V&P	V	V
Milne Inlet South (MIS)	P	P	P	P
Tremblay Sound (TS)	P	P	P	P
Navy Board Inlet (NBI)	V	V	V	V
Eclipse Fjords	V	V	V	V
Eclipse Visual Effort (km)	**1,187.5**	**1,191.8**	**1,177.3**	**1,286.4**
Eclipse Photographic Effort (km)	**371.7**	**352.1**	**347.3**	**376.5**
Eclipse Total Effort (km)	**1,559.2**	**1,543.9**	**1,524.6**	**1,662.9**
Admiralty Inlet North (AIN)	V	—	V&P	—
Admiralty Inlet South (AIS)	V&P	—	V&P	—
Admiralty Fjords	V	—	V	—
Admiralty Visual Effort (km)	**1,231.0**	**0**	**1,105.3**	**0**
Admiralty Photographic Effort (km)	**22.7**	**0**	**166.1**	**0**
Admiralty Total Effort (km)	**1,253.7**	**0**	**1,271.4**	**0**
Combined Total Effort (km)	**2,812.9**	**1,543.9**	**2,796.0**	**1,662.9**

3.2.2 Sighting Conditions

MMOs recorded environmental sighting conditions during visual surveys at the beginning and end of each transect and anytime conditions changed along the track. All sighting conditions were recorded within the MMO field of view (1 km of the transect line). Sightings conditions were evaluated based on survey effort when each condition was observed. Sighting conditions are pooled for both Eclipse and Admiralty survey grids during Survey s 1 and 3. Surveys 2 and 4 represent sightings conditions for the Eclipse survey grid as Admiralty Inlet was not flown during Surveys 2 and 4. For calculating abundance estimates, distance analyses used the sighting conditions as covariates in the model.

Ice Cover

Ice was only present in Eclipse Sound Grid during Survey 1 of Leg 2 of the 2020 MMASP. Ice was recorded in the White Bay fjord and at the northern portion of Navy Board Inlet, accounting for <1% of the survey effort (Figure 16). In both areas, the ice observed was pieces of floating pack ice. No ice was present in Admiralty Inlet during Leg 2 surveys.

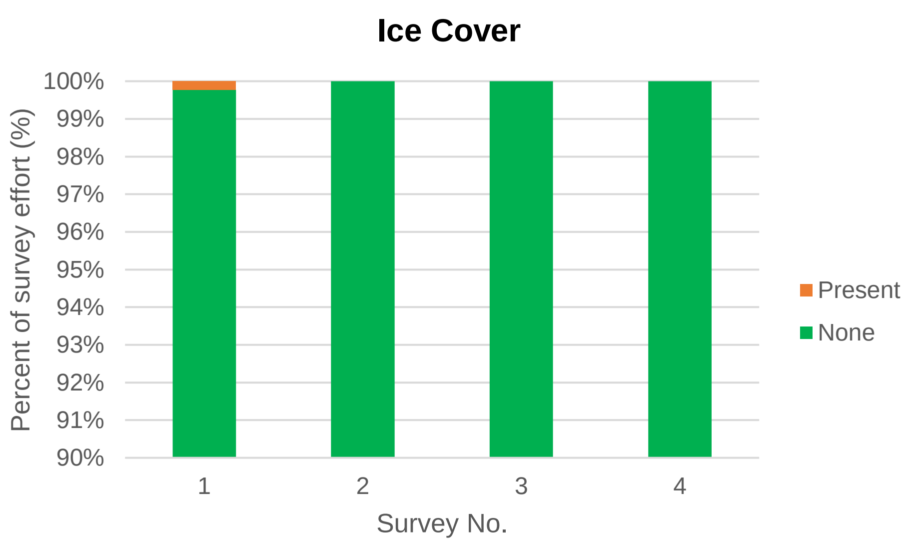


Figure 16: Ice Cover during Leg 2 of the 2020 MMASP.

Fog

Two measurements of fog were used as sighting conditions. Fog cover was assessed as the percent (0–100%) of fog obscuring the viewing area and fog intensity (four levels: “none” when there was no fog, “light” fog that animals were visible through, “moderate” when animals were likely missed in the fog, and “thick” when animals were certainly missed in the fog). Areas that were forecasted to be foggy were avoided when daily surveys were planned. Fog cover ranged from None to 100% cover during Leg 2 of the 2020 MMASP. Fog was only present during Surveys 3 and 4, and accounted for 2% and 10% of the effort of each survey, respectively (Figure 17). Most of the fog that was present on the survey was primarily of light and moderate thickness (Figure 18).

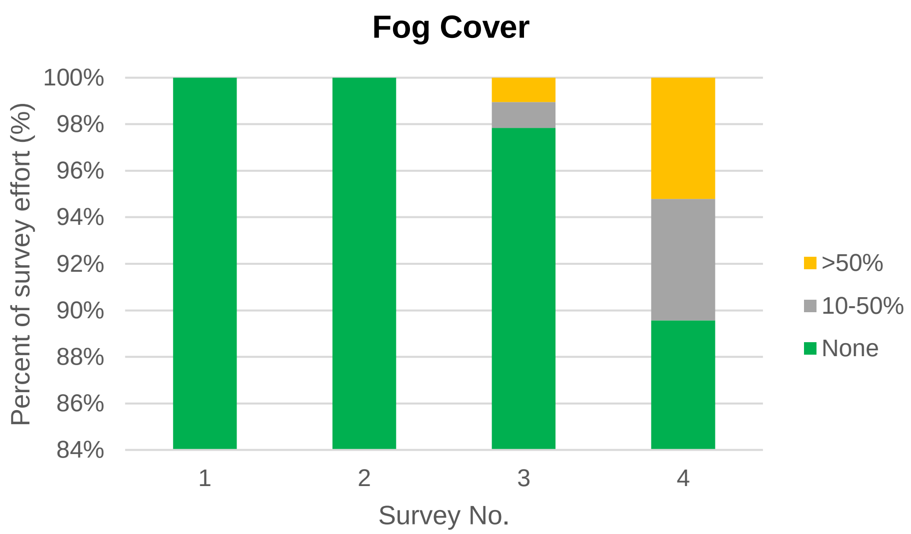


Figure 17: Fog Cover During Leg 2 of the 2020 MMASP.

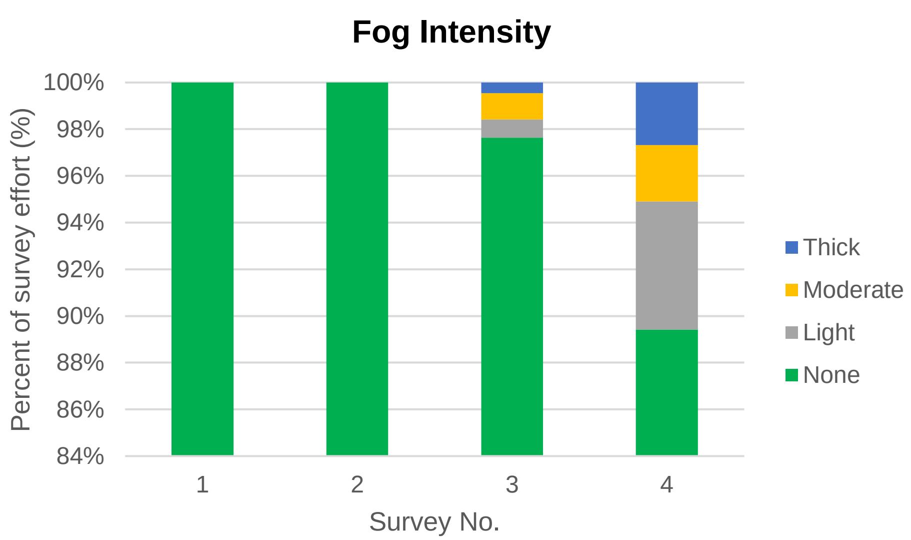


Figure 18: Fog Intensity During Leg 2 of the 2020 MMASP

Beaufort Sea State

On a scale of 0 to 12, the Beaufort Sea State (BF) ranged from BF 0 (glassy mirror) to BF 6 (large waves) during Leg 2 of the 2020 MMASP (Figure 19). Most sea state conditions were recorded between BF 0 (glassy mirror) and BF 3 (large wavelets, scattered whitecaps) for both survey grids. Areas that were forecasted to have high sea states (i.e., BF 5) were avoided when daily surveys were planned. If sea state conditions exceeded BF 4, the area was generally abandoned, and the survey was resumed in an area with more favorable environmental sighting conditions.

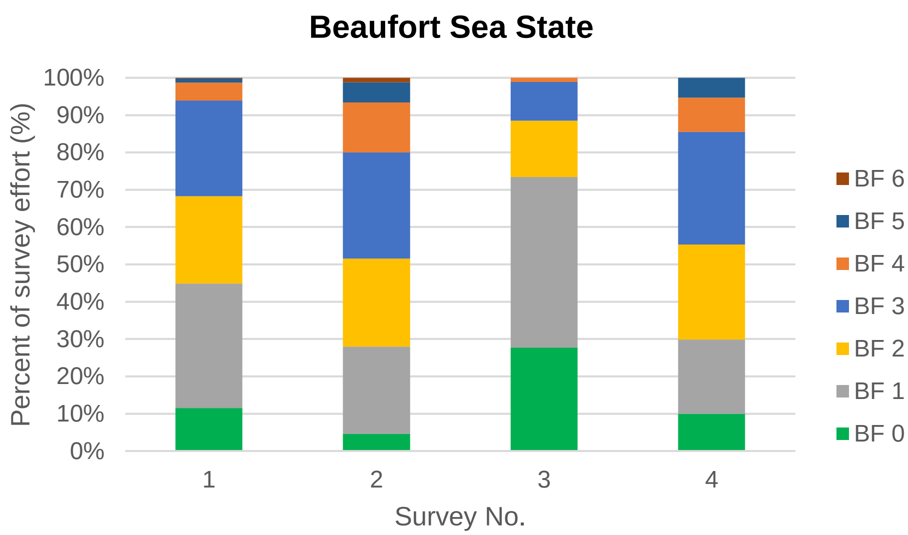


Figure 19: Beaufort Sea State During Leg 2 of the 2020 MMASP

Glare Cover and Intensity

Two measurements of glare were used as sighting conditions. Glare cover was assessed as the percent (0–100%) of the viewing area affected by sun reflection and glare intensity (four levels: “none” when there was no reflection, “low” when animals were likely detected in center of reflection angle, “moderate” when animals were likely missed in the center of reflection angle, and “intense” when animals were certainly missed in the center of reflection angle). All surveys were flown during partial cloudy conditions with glare recorded as “none” for 33% to 55% of the survey effort in each survey (Figures 20 and 21).

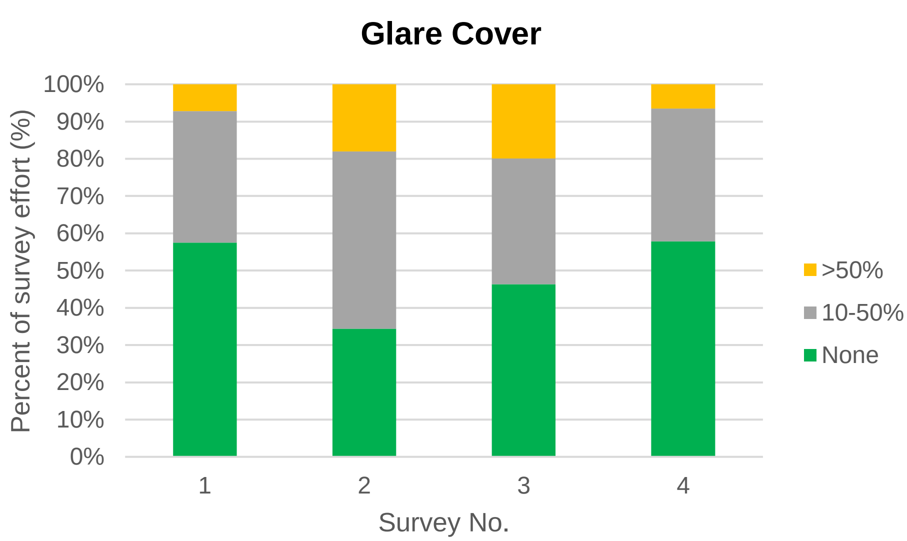


Figure 20: Glare Cover During Leg 2 of the 2020 MMASP

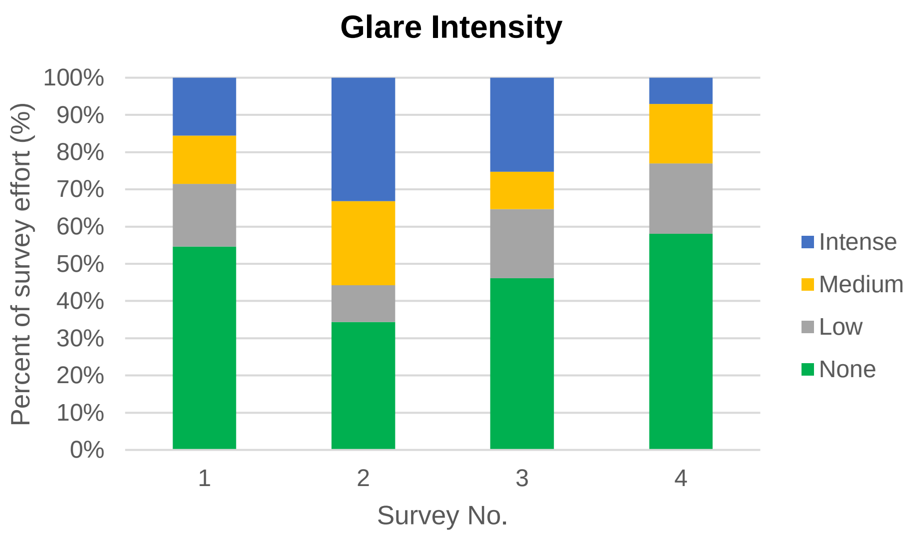


Figure 21: Glare Intensity During Leg 2 of the 2020 MMASP

3.2.3 Visual Survey Sightings

Eclipse Sound Grid: Eight different species of marine mammals were observed during Leg 2 visual surveys of the 2020 MMASP in the Eclipse Sound grid: narwhal, bowhead whale, beluga whale, killer whale, sperm whale (*Physeter macrocephalus*), ringed seal, harp seal, and polar bear. Unidentified whales and seals were also recorded during the visual surveys.

Table 10 summarizes the number of marine mammal sightings and animals recorded for each species in each of the four Leg 2 surveys. A total of 746 sightings and 1,134 animals were recorded during Leg 2 visual surveys in the Eclipse Sound grid. The most commonly sighted species was ringed seal (249 sightings totalling 277 animals), followed by narwhal (230 sightings totalling 405 animals), harp seal (27 sightings totalling 150 animals), polar bear (13 sightings totalling 25 animals), sperm whale (five sightings totalling six animals), killer whale (three sightings totalling 14 animals), bowhead whale (one sighting of single whale), and beluga whale (one sighting of a single whale). There were also 216 unidentified seal sightings totalling 253 animals and one sighting of two unidentified whales.

Table 10: Marine mammal sightings (including off-effort) in Eclipse Sound grid during Leg 2.

Species	Survey 1		Survey 2		Survey 3		Survey 4	
	No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals
Narwhal	86	102	92	235	26	34	26	34
Bowhead Whale	0	0	0	0	1	1	0	0
Beluga Whale	0	0	1	1	0	0	0	0
Killer Whale	0	0	0	0	3	14	0	0
Sperm Whale	1	1	0	0	4	5	0	0
Unidentified Whale	0	0	0	0	1	2	0	0
Ringed Seal	55	65	81	84	94	109	19	19
Harp Seal	7	17	6	14	11	112	3	7
Unidentified Seal	36	38	32	38	120	145	28	32
Polar Bear	3	5	5	11	2	2	3	7
Total	**188**	**228**	**217**	**383**	**262**	**424**	**79**	**99**

Admiralty Inlet Grid: Seven different species of marine mammals were observed during Leg 2 visual survey of the 2020 MMASP in the Admiralty Inlet grid: narwhal, bowhead whale, ringed seal, harp seal, bearded seal, hooded seal (*Cystophora cristata*), and polar bear. Unidentified whales and seals were also recorded during the surveys. Table 11 summarizes the number of marine mammal sightings and animals recorded for each species during each of the Leg 2 surveys. A total of 1,366 sightings and 2,934 animals were recorded during Leg 2 visual surveys in the Admiralty Inlet grid.

The most commonly identified species was narwhal (845 sightings totalling 1,390 animals), followed by ringed seal (170 sightings totalling 201 animals), harp seal (127 sightings totalling 1,028 animals), polar bear (25 sightings totalling 39 animals), bowhead whale (15 sightings totalling 34 animals), bearded seal (one sighting of a single seal) and hooded seal (one sighting of a single seal). There were also 180 sightings of unidentified seals totalling 238 animals and three sightings of individual unidentified whales.

Table 11: Marine mammal sightings (including off-effort) in Admiralty Inlet grid during Leg 2.

Species	Survey 1		Survey 3	
	No. Sightings	No. Animals	No. Sightings	No. Animals
Narwhal	326	536	519	854
Bowhead Whale	8	23	7	11
Unidentified Whale	0	0	3	3
Ringed Seal	25	28	145	173
Harp Seal	71	586	56	442
Bearded Seal	0	0	1	1
Hooded Seal	0	0	1	1
Unidentified Seal	80	100	100	138
Polar Bear	16	26	9	13
Total	**526**	**1,299**	**841**	**1,636**

Narwhal

Eclipse Sound Grid: During the open-water season (Leg 2) narwhal were primarily sighted in Milne Inlet South and Tremblay Sound strata as evident in the photographic coverage of the areas (Appendix B; Figures B-10, B-12, B-14 and B-15). Relatively few narwhal were recorded in Eclipse Sound, Navy Board Inlet or the Fjords during the four Leg 2 surveys conducted in August.

A total of 230 sightings and 405 individual narwhal were recorded during the Leg 2 visual survey of the Eclipse Sound grid (Table 10). Narwhal group sizes ranged from single animals to a group size of eight, with mean and median group sizes of 1.8 and 1.0, respectively. Eleven mother/calf pairs were recorded during the surveys. Nine mother/calf pairs were observed during Survey 2 (24 August) in Milne Inlet North strata. During Survey 3 (29 August), one mother/calf pair was observed in White Bay. During a reconnaissance flight on 23 August a mother/calf pair was observed in Milne Inlet North strata.

Admiralty Inlet Grid: Narwhal were observed throughout the central and southern portion of Admiralty Inlet. In Admiralty Inlet South stratum, narwhal were observed clumped close to shore on the western side of the inlet (as evident in the photographic coverage for Leg 2 Surveys 1 and 3; Appendix B; Figures B-11 and B-13). In Admiralty Inlet North stratum, narwhal were dispersed throughout the central portion of the stratum (Appendix B; Figures B-11 and B-13).

A total of 845 sightings and 1,390 individual narwhal were recorded during the Leg 2 visual surveys of the Admiralty Inlet grid (Table 11). Narwhal group sizes ranged from single animals to a group size of 16, with mean and median group sizes of 1.6 and 1.0, respectively. Ninety-six mother/calf pairs were recorded during the surveys. Thirty-two mother/calf pairs were observed during Survey 1 (21 August) in Admiralty Inlet North stratum. During Survey 3 (28 August), fourteen mother/calf pairs were observed in Admiralty Inlet South strata and 50 mother/calf pairs were observed in Admiralty Inlet North strata.

Bowhead Whale

Eclipse Sound Grid: One bowhead whale was observed in the RSA during the open-water surveys. It was sighted on August 29 at the top of Navy Board Inlet (Appendix B; Figure B-14).

Admiralty Inlet Grid: Bowhead whales were observed in Admiralty Inlet during Leg 2 surveys flown in August. Bowhead whale sightings were located throughout Admiralty Inlet, including one sighting in Moffet Inlet (Appendix B; Figures B-11 and B-13). A total of 15 sightings and 34 individual bowhead whales were recorded during the Leg 2 visual surveys of the Admiralty Inlet grid (Table 11). Bowhead group sizes ranged from single animals to a group size of seven, with mean and median group sizes of 2.3 and 1.0, respectively. No mother/calf pairs were observed.

Beluga Whale

Eclipse Sound Grid: During the open-water season there was one beluga sighting of a single animal observed during Leg 2 Survey 2 in Northern Milne Inlet stratum (Appendix B; Figure B-12).

Admiralty Inlet Grid: No beluga whales were observed in Admiralty Inlet during the Leg 2 visual surveys.

Killer Whale

Eclipse Sound Grid: Killer whales were observed on two days during Leg 2 visual surveys. During a reconnaissance flight on 27 August, multiple sightings of killer whales were observed in Eclipse Sound West, Milne Inlet North, and Milne Inlet South strata (Appendix C). The first sighting of approximately 27 killer whales was observed at 14:40 south of Stevens Island in Milne Inlet South stratum. The second sighting of approximately 16 to 20 killer whales was observed at 15:00 at the north end of Athole Point in Eclipse Sound West stratum. The third sighting of approximately 24 to 30 killer whales was observed at 16:05 west of Stevens Island in Milne Inlet North stratum. It is likely that this third sighting of killer whales was a resighting of the first sighting. The third sighting quickly evolved into a large predation event where killer whales were observed herding approximately 150 to 200 narwhal into Fairweather Bay and feeding on them. This event is described in more detail in Appendix C. During Survey 3 on the 29 August, three pods of killer whales in close proximity to each other (totalling 31 animals) were observed in the Pond Inlet stratum moving east (Appendix B; Figure B-14). They appeared to be leaving the RSA.

Admiralty Inlet Grid: No killer whales were observed in Admiralty Inlet during Leg 2 visual surveys.

Sperm Whale

Eclipse Sound Grid: Sperm whales were observed on two surveys flown in August. A total of five sightings and six sperm whales were recorded during the Leg 2 visual surveys of the Eclipse Sound grid (Table 10). The first sighting of a single sperm whale was observed on 20 August in the Eclipse Sound West stratum (Appendix B; Figure B-10). During Survey 3 on the 29 August, four sightings totalling five sperm whales were observed in the Pond Inlet strata (Appendix B; Figure B-14).

Admiralty Inlet Grid: No sperm whales were observed in Admiralty Inlet during Leg 2 visual surveys.

Unidentified Whale

Eclipse Sound Grid: A single unidentified whale was observed in Eclipse Sound West stratum during Leg 2 Survey 3 (Appendix B; Figure B-14).

Admiralty Inlet Grid: There were three sightings of individual unidentified whales observed during Leg 2 visual surveys in the Admiralty Inlet grid. All sightings occurred during Survey 3 in the Admiralty Inlet North stratum (Appendix B; Figure B-13).

Ringed Seal

Eclipse Sound Grid: Ringed seals were observed during all Leg 2 visual surveys throughout the Eclipse Sound grid (Appendix B; Figures B-10, B-12, B-14 and B-15). There was a total of 249 sightings totalling 277 individual ringed seals recorded during Leg 2 visual surveys (Table 10). Ringed seal sightings were primarily of single animals (228 of 249 sightings). The remaining ringed seal sightings observed consisted of groups of two, one sighting of four animals, and one sighting of seven animals.

Admiralty Inlet Grid: Ringed seals were observed during both Leg 2 visual surveys of the Admiralty Inlet grid (Appendix B; Figures B-11 and B-13). There was a total of 170 sightings totalling 201 individual ringed seals recorded during Leg 2 visual surveys (Table 11). Ringed seal sightings were primarily of single animals (150 of 170 sightings). The remaining ringed seal sightings observed consisted of groups of two, three, and four animals.

Harp Seal

Eclipse Sound Grid: Harp seals were observed on all Leg 2 visual surveys. They were observed primarily at the top of Navy Board Inlet and in the Pond Inlet stratum (Appendix B; Figures B-10, B-12, B-14 and B-15). A total of 27 sightings and 150 individual harp seals were recorded during Leg 2 visual surveys (Table 10). Harp seal were observed with group sizes that ranged from one to 60 animals with mean and median group sizes of 5.6 and 2.0, respectively.

Admiralty Inlet Grid: Harp seal were observed on both of the Leg 2 visual surveys in Admiralty Inlet grid (Appendix B; Figures B-11 and B-13). A total of 127 sightings and 1,028 individual harp seals were recorded during Leg 2 visual surveys (Table 11). Harp seals were observed throughout the survey area with group sizes ranging from 1 to 70 animals with mean and median group sizes of 8.1 and 1.0, respectively.

Bearded Seal

Eclipse Sound Grid: Bearded seal were not observed in Eclipse Sound grid during Leg 2 visual surveys.

Admiralty Inlet Grid: One sighting of an individual bearded seal was recorded in Admiralty Inlet South stratum during Leg 2 Survey 3 (Table 11; Appendix B; Figure B-13).

Hooded Seal

Eclipse Sound Grid: Hooded seals were not observed in Eclipse Sound grid during Leg 2 visual surveys.

Admiralty Inlet Grid: One sighting of a single hooded seal was recorded in Admiralty Inlet North stratum during Leg 2 Survey 3 (Table 11; Appendix B; Figure B-13).

Unidentified Seal

Eclipse Sound Grid: Unidentified seals were observed throughout the survey area during Leg 2 visual surveys (Appendix B; Figures B-10, B-12, B-14 and B-15). A total of 216 sightings and 253 seals were recorded with mean and median group sizes of 2.0 and 1.0, respectively (Table 10).

Admiralty Inlet Grid: Unidentified seals were observed during both Leg 2 visual surveys (Appendix B; Figures B-11 and B-13). A total of 180 sightings and 238 seals were recorded with mean and median group sizes of 1.3 and 1.0, respectively (Table 11).

Polar Bear

Eclipse Sound Grid: Thirteen polar bear sightings of 25 individuals were made during Leg 2 visual surveys in the Eclipse Sound grid (Table 10). All but one of these sightings occurred in Navy Board Inlet. During Survey 1, two sightings of single polar bear walking on the shore and a sighting of a mother with two cubs walking on the shore were observed in Navy Board Inlet (Appendix B; Figure B-10). During Survey 2, two sightings of individual polar bears walking on the shore and three sightings of a mother with two cubs were observed (Appendix B; Figure B-12). Two of the mother with two cubs sightings were observed running on shore and the third mother with two cubs sighting was of the mother on shore waiting for the cubs who were swimming towards her. Two sightings of individual polar bear were observed during Survey 3 (Appendix B; Figure B-14); one sighting was of a polar bear running down a hill and the other was of a polar bear swimming in the water. Both sightings were recorded in Navy Board Inlet. During Survey 4, one sighting of two juveniles running in a drainage basin toward the beach, one sighting of a mother with a cub underneath her, standing and looking at the plane, and a third sighting of a mother with two cubs looking up at the plane, were observed in Navy Board Inlet, all within close proximity of each other (Appendix B; Figure B-15).

Admiralty Inlet Grid: Twenty-five polar bear sightings of 39 individuals were made during Leg 2 visual surveys in the Admiralty Inlet grid (Table 11). Seventeen of the sightings were of single animals and the other eight sightings were of a mother with one or two cubs.

3.2.4 Photographic Survey Sightings

Photographic analyses were only completed for surveys with complete survey (transect) coverage and adequate sighting conditions. For the Eclipse Sound survey grid, this included Surveys 1 and 3 (Survey 2 was not fully completed and Survey 4 was conducted during by poor weather including higher sea states and fog cover). For the Admiralty Inlet survey grid, Surveys 2 and 4 were not flown due to poor weather. As such, analysis of the aerial photographic data for Admiralty (Leg 2) was limited to Surveys 1 and 3. All photographic surveys were flown at 610 m (2,000 ft).

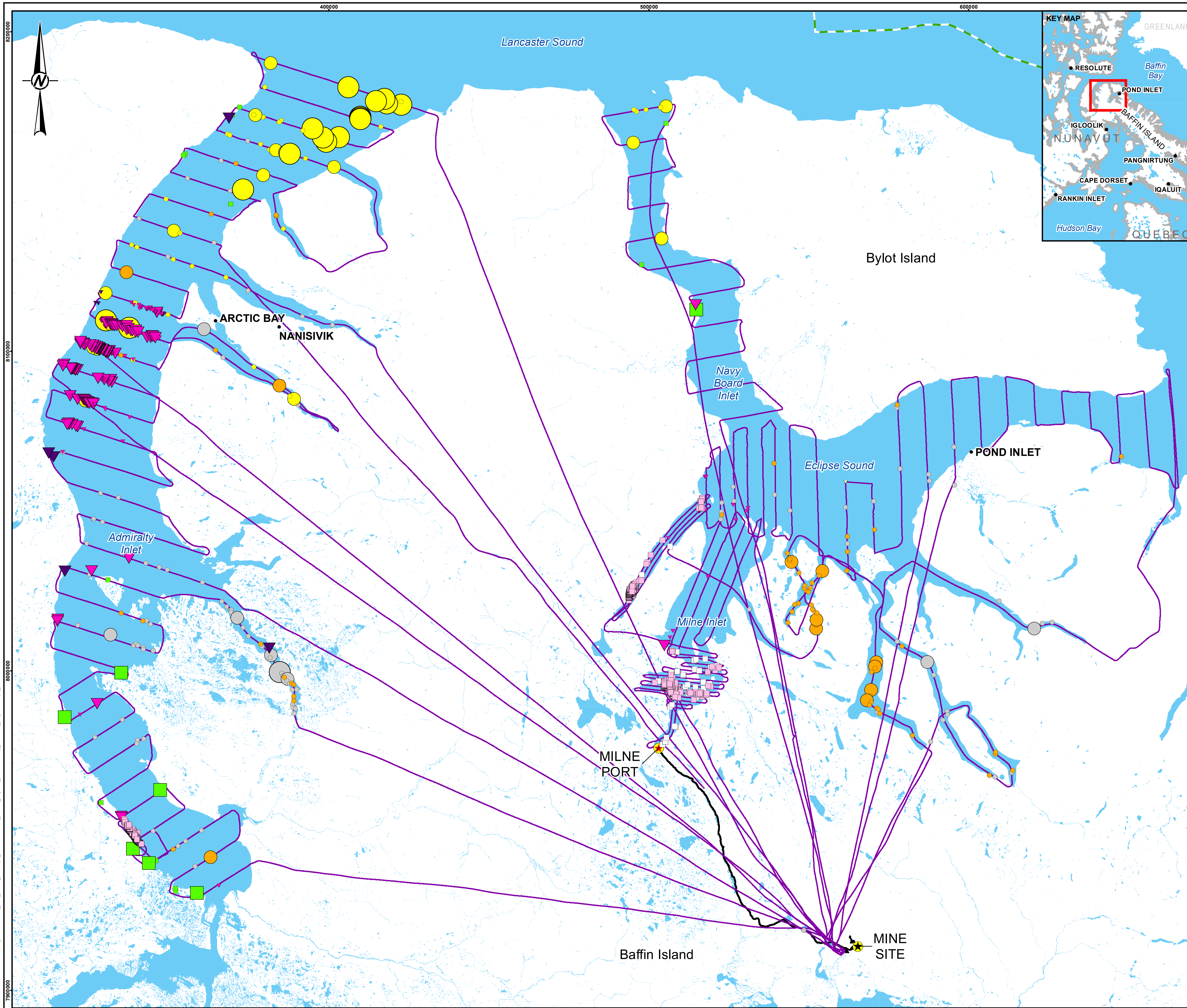
Eclipse Sound Grid: During the open-water season (Leg 2), narwhal were primarily sighted in Milne Inlet South and Tremblay Sound strata as evident in the photographic coverage of the areas (Figure 22 A–B and Figure 23 A–B). A total of 3,464 sightings and 5,916 narwhal were recorded during photographic surveys in Eclipse Sound grid (Table 12). Narwhal group sizes ranged from single animals to a group size of 18, with mean and median group sizes of 1.7 and 1.0, respectively. Unidentified seals were recorded on Surveys 1 and 3 of Leg 2 photographic surveys in the Eclipse Sound grid (Figure 22 A–B and Figure 23 A–B). There was a total of 854 sightings and 900 seals recorded during the Leg 2 photographic surveys (Table 12). Seal group sizes ranged from single animals to a group size of six, with mean and median group size of 1.1 and 1.0, respectively.

Admiralty Inlet Grid: In Admiralty Inlet, two of the three photographic surveys were conducted in the south stratum and one was conducted in the north stratum (Figure 22 A–B and Figure 23 A–B). A total of 8,315 sightings and 11,300 narwhal were recorded during the photographic surveys in the Admiralty Inlet grid (Table 12). Narwhal group sizes ranged from single animals to a group size of 19, with mean and median group sizes of 1.4 and 1.0, respectively. Six bowhead whale sightings were recorded on two of the Leg 2 photographic surveys in the Admiralty Inlet grid (Table 12). All six bowhead whale sightings in Admiralty Inlet were recorded during Survey 3; three sightings of single animals, two sightings of a pair of animals, and one sighting of a group of three animals (Figure 23 A–B). All animals were identified as adults. Unidentified seals were recorded on Surveys 1 and 3 of Leg 2 photographic surveys in the Admiralty Inlet grid (Figure 22 A–B and Figure 23 A–B). There was a total of 3,728 sightings and 5,837 seals recorded during the Leg 2 photographic surveys (Table 12). Seal group sizes ranged from single animals to a group size of 62, with mean and median group size of 1.6 and 1.0, respectively.

Table 12: Photographic survey sightings in the Eclipse Sound and Admiralty Inlet grids during Leg 2.

Grid	Survey	Stratum[a]	Narwhal		Bowhead[b]		Unidentified Seal	
			No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals
Eclipse	1	MIS	648	1,222	0	0	43	55
Eclipse	1	TS	416	900	0	0	8	8
Eclipse	3	MIS	1,525	2,359	0	0	590	604
Eclipse	3	TS	875	1,435	0	0	213	233
Admiralty	1	AIS	1,182	1,970	0	0	6	6
Admiralty	3	AIS	1,129	2,164	4	7	14	20
Admiralty	3	AIN	6,004	7,166	2	3	3,708	5,811

[a] MIN=Milne Inlet North, MIS=Milne Inlet South, TS=Tremblay Sound, AIN=Admiralty Inlet North, AIS=Admiralty Inlet South
[b] Not including re-sightings



LEGEND

- COMMUNITY
- MILNE PORT
- MINE SITE
- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- NARWHAL
- UNIDENTIFIED SEAL

VISUAL SURVEY MARINE MAMMALS SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10
- 10+

NARWHAL
- 1
- 2-10

POLAR BEAR
- 1
- 2-10

RINGED SEAL
- 1
- 2-10

SPERM WHALE
- 1

UNIDENTIFIED SEAL
- 1
- 2-10
- 10+

0 25 50
1:1,200,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

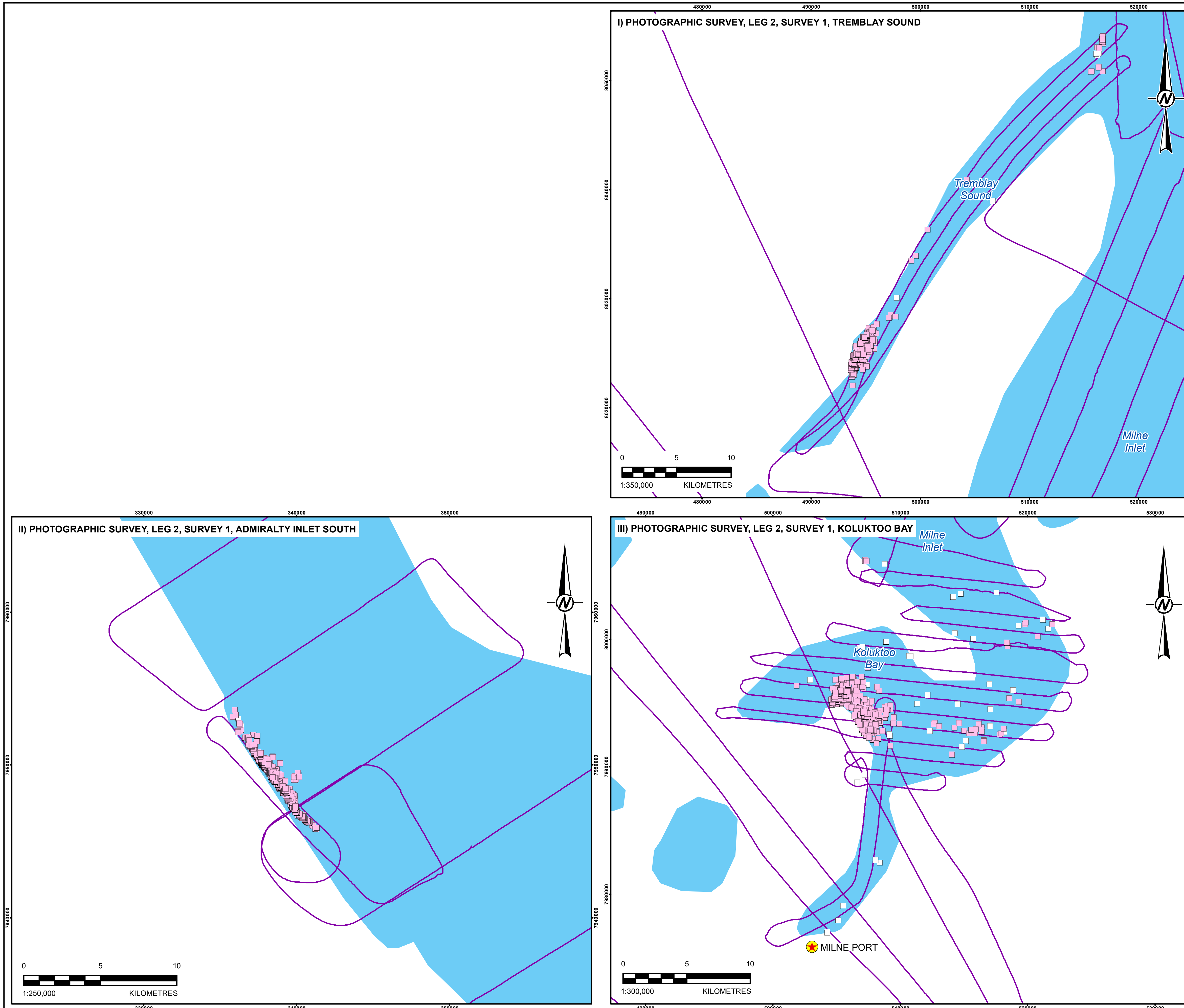
PROJECT
MARY RIVER PROJECT

TITLE
DISTRIBUTION OF MARINE MAMMALS RECORDED DURING LEG 2 - SURVEY 1 ON 20-21 AUGUST 2020 IN ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	22A



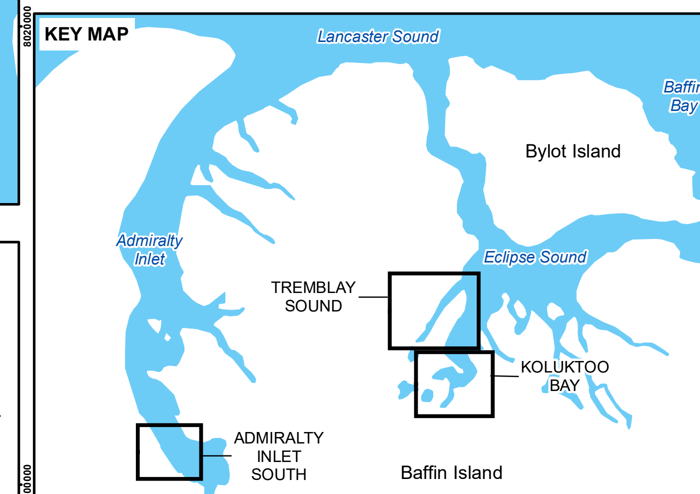
LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- WATERBODY

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- NARWHAL
- UNIDENTIFIED SEAL

KEY MAP



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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT

BAFFINLAND IRON MINES CORPORATION

PROJECT

MARY RIVER PROJECT

TITLE

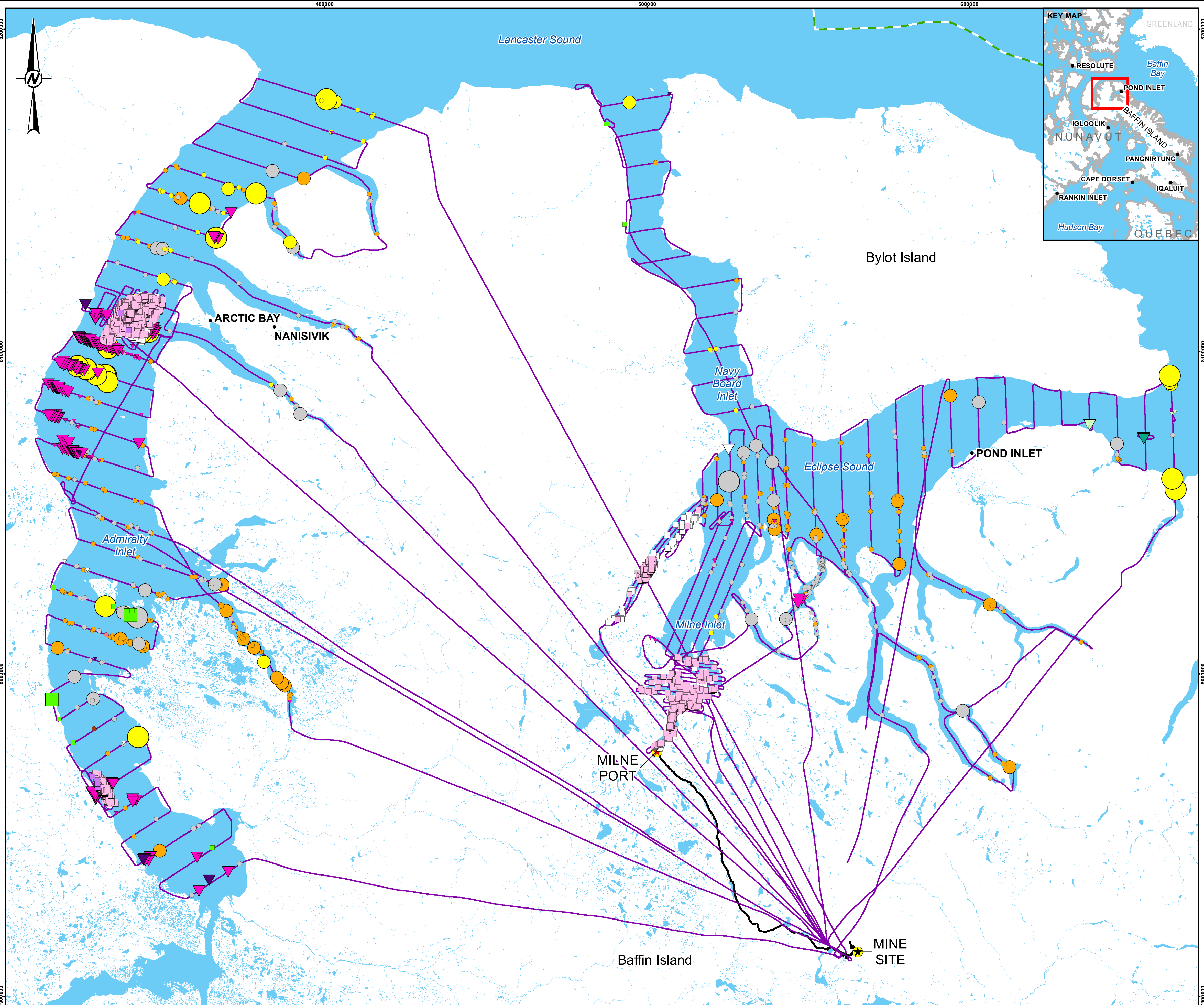
PHOTOGRAPHIC SURVEYS DURING LEG 2 -SURVEY 1 ON 20-21 AUGUST 2020 IN ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	22B



LEGEND

- COMMUNITY
- MILNE PORT
- MINE SITE

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BOWHEAD WHALE
- NARWHAL
- UNIDENTIFIED SEAL

VISUAL SURVEY MARINE MAMMALS SPECIES OBSERVATIONS (GROUP SIZE)

BEARDED SEAL
- 1

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10
- 10+

HOODED SEAL
- 1
- 2-10
- 10+

KILLER WHALE
- 1
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

POLAR BEAR
- 1
- 2-10

RINGED SEAL
- 1
- 2-10

SPERM WHALE
- 1
- 2-10

UNIDENTIFIED SEAL
- 1
- 2-10
- 10+

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50

1:1,200,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

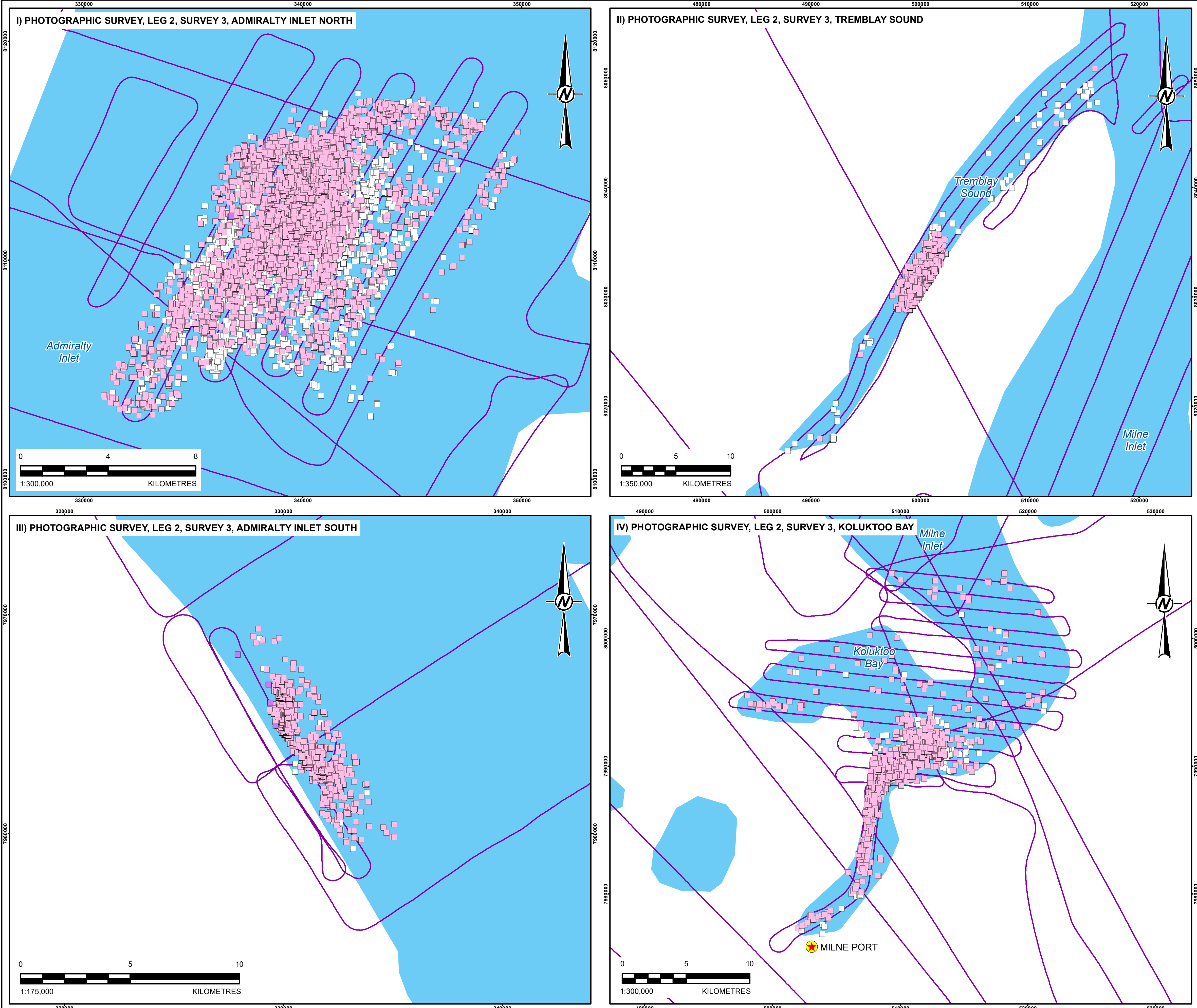
TITLE
DISTRIBUTION OF MARINE MAMMALS RECORDED DURING LEG 2 - SURVEY 3 ON 28-29 AUGUST 2020 IN ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	23A



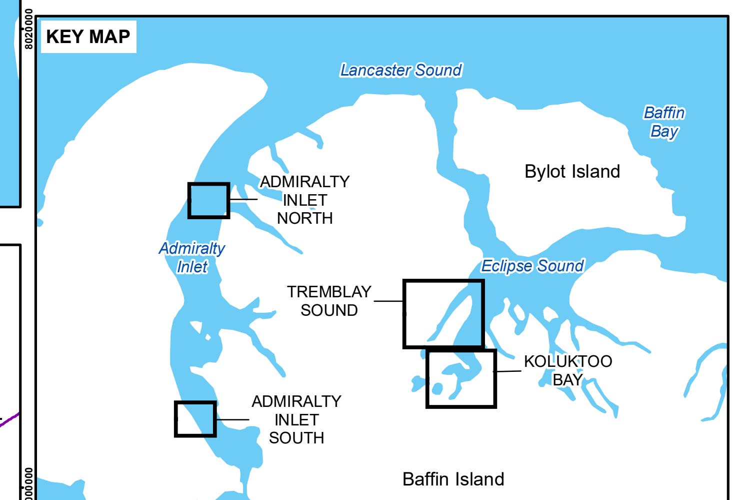
LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- WATERBODY

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BOWHEAD WHALE
- NARWHAL
- UNIDENTIFIED SEAL

KEY MAP



REFERENCE(S)
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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
PHOTOGRAPHIC SURVEYS DURING LEG 2 - SURVEY 3 ON 28-29 AUGUST 2020 IN ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-05
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	23B

3.2.5 Relative Abundance of Marine Mammals in Eclipse Sound and Admiralty Inlet Grids

In 2020 a total of 5,608.9 km of effort (4,701.1 km during visual surveys and 907.8 km during photographic surveys) was flown over two completed surveys in Eclipse Sound and Admiralty Inlet grids. The relative abundance of marine mammals in the Eclipse Sound and Admiralty Inlet grids for Surveys 1 and 3, expressed as the animal detection rate (no. of animals relative to survey effort in km), are shown in Tables 13 and 14.

Eclipse Sound Grid: Narwhal had the highest relative abundance (0.77 animals/km) of all the marine mammal species identified to the species level, followed by ringed seal, harp seal, killer whale, sperm whale, and then bowhead whale (Table 13). Unidentified seals had the second highest relative abundance of 0.18 animals/km in the RSA.

Admiralty Inlet Grid: Narwhal had the highest relative abundance (2.07 animals/km) of all the marine mammal species identified to the species level, followed by harp seal, ringed seal, bowhead whale, polar bear, bearded seal, and then hooded seal (Table 14). Unidentified seals had the second highest relative abundance of 0.94 animals/km in the Admiralty Inlet grid.

Table 13: Sighting and Animal Detection Rate (Relative Abundance) of Marine Mammals in Eclipse Sound Grid during Leg 2, Surveys 1 and 3.

Species	Visual Survey		Photographic Survey	Combined Visual and Photographic Survey
	No. of Sightings	No. of Animals	Surface Count	Animal Detection Rate (animals/km)
Narwhal	18	30	2339	0.7682
Bowhead Whale	1	1	0	0.0003
Killer Whale	3	14	0	0.0045
Sperm Whale	4	5	0	0.0016
Unidentified Whale	1	2	0	0.0006
Ringed Seal	149	174	–	0.0736
Harp Seal	15	106	–	0.0448
Unidentified Seal	151	237	327	0.1829

Table 14: Sighting and Animal Detection Rate (Relative Abundance) of Marine Mammals in Admiralty Inlet Grid during Leg 2, Surveys 1 and 3.

Species	Visual Survey		Photographic Survey	Combined Visual and Photographic Survey
	No. of Sightings	No. of Animals	Surface Count	Animal Detection Rate (animals/km)
Narwhal	725	1,207	4021	2.0704
Bowhead Whale	8	12	10	0.0087
Unidentified Whale	3	3	0	0.0012
Ringed Seal	164	194	–	0.0830
Harp Seal	116	861	–	0.3685
Bearded Seal	1	1	–	0.0004
Hooded Seal	1	1	–	0.0004
Unidentified Seal	182	347	1846	0.9386
Polar Bear	7	8	0	0.0032

3.2.5.1 Comparison with 2019 MMASP

The relative abundance for this section was calculated based on data collected for Surveys 1 and 3 in the 2020 MMASP and Surveys 3 and 4 in the 2019 MMASP because these surveys had complete grid coverage in good sighting conditions.

Eclipse Sound Grid: The relative abundance of marine mammals in the RSA was lower in 2020 (1.05 animals/km) compared to that observed in 2019 (1.74 animals/km; Table 15). Total effort was similar between 2019 and 2020 (2,942.1 km and 3,083.8 km, respectively). Narwhal relative abundance in 2020 was less than half the numbers seen in 2019 (0.77 animals/km and 1.64 animals/km, respectively). Ringed seals and unidentified seals were observed in higher relative abundance in 2020 compared to 2019 (Table 15). Harp seals were observed in lower relative abundance in 2020 compared to 2019. It should be noted that the seal data should be interpreted with caution due to the difficulty of observing and identifying seals at survey altitudes of 305 m (1,000 ft) above sea level (ASL), especially as sea states increase.

Admiralty Inlet Grid: The relative abundance of marine mammals in the Admiralty Inlet grid was lower in 2020 (3.37 animals/km) to that observed in 2019 (4.89 animals/km; Table 15). Total effort was higher in 2020 compared to 2019 (2,525.1 km and 1,534.2 km, respectively). Much of this decrease in abundance can be attributed to the increased effort flown in the fjords and in the northern portion of the inlet in 2020 which had relatively low numbers of animals. Narwhal relative abundance in 2020 was less than that observed in 2019 (2.07 animals/km and 3.44 animals/km, respectively). Ringed seals and harp seals were observed in higher relative abundance in 2020 compared to 2019 (Table 15). Unidentified seals were observed in lower relative abundance in 2020 compared to 2019.

Table 15: Relative Abundance of Marine Mammals in Eclipse Sound and Admiralty Inlet survey grids during Leg 2 in 2019 and 2020.

Species	Eclipse Sound Grid		Admiralty Inlet Grid	
	2019 (animals/km)	2020 (animals/km)	2019 (animals/km)	2020 (animals/km)
Narwhal	1.6396	0.7682	3.4363	2.0704
Bowhead Whale	0.0003	0.0003	0.0313	0.0087
Killer Whale	0.0010	0.0045	0.0000	0.0000
Sperm Whale	0.0000	0.0016	0.0000	0.0000
Unidentified Whale	0.0000	0.0006	0.0000	0.0012
Ringed Seal	0.0047	0.0736	0.0122	0.0830
Harp Seal	0.0527	0.0448	0.1495	0.3685
Bearded Seal	0.0000	0.0000	0.0000	0.0004
Hooded Seal	0.0000	0.0000	0.0000	0.0004
Unidentified Seal	0.0574	0.1829	1.2938	0.9286
Polar Bear	0.0000	0.0000	0.0000	0.0032
Total	**1.7396**	**1.0490**	**4.8911**	**3.3705**

3.2.6 Narwhal Abundance Estimate

Narwhal abundance estimates were only calculated for survey replicates with complete transect coverage and adequate sighting conditions. For the Eclipse Sound survey grid, this included Surveys 1 and 3. Survey 2 was not fully completed, and Survey 4 was affected by poor weather including high sea states and fog cover which resulted in the survey being extended over two days (all other surveys in the Eclipse survey grid were completed in a single day). For the Admiralty Inlet survey grid, Surveys 2 and 4 could not be flown due to poor weather, therefore narwhal abundance estimates were only calculated for Surveys 1 and 3.

3.2.6.1 Visual Survey Data Characteristics

Sightings data from both the Eclipse Sound and Admiralty Inlet survey grids supplemented one another to provide for a more robust model of probability detection function. The same marine mammal observers flew both the Eclipse Sound and Admiralty Inlet grids and were incorporated into the model as a covariate. Re-sightings were not used for the estimation of any variables.

One detection function was created for narwhal for the combined Eclipse Sound and Admiralty Inlet grids. Sightings data was pooled between dates to increase sample size to meet the assumptions of the detection probability model, but only if the spatial distribution of species detections (sightings) were similar between those days (i.e., the ability to detect animals at a distance did not change under the available sighting conditions, including altitude). Combining survey data for days with apparent variability in detectability can skew findings and result in either an over- or under-estimation of true animal density for a specific date. Environmental conditions were good for all the surveys chosen to calculate abundances. Location (i.e., Eclipse Sound vs Admiralty Inlet) was included as a covariate in the detection function model but it did not lower Akaike's Information Criterion (AIC) values and consequently, location specific models were not created.

The number of narwhal sightings during fjord transects was too small (n=5) to appropriately perform abundance estimations using the Density Surface Modelling technique (Doniol-Valcroze et al. 2015b). Individual fjord surveys were instead treated as separate transects within a fjord-based stratum and analyzed the same as transects within the other regional strata.

Analysis of sightings data was performed using the Mark-Recapture Distance Sampling (MRDS) analysis package (Laake et al. 2018) within R version 3.6.2 (R Core Team 2019). The shape of the histogram suggested that some animals were missed close to the trackline despite the bubble windows. There was a risk that hazard-rate and half-normal distributions would overestimate the probability of detection and the resulting effective strip width. The gamma key function does not assume a 100% detection on the track line ($g(0)=1$). A horizontal offset value can be applied to the gamma detection function data since that key function assumes zero detections at zero distance. However, offsetting the data for the gamma key function does bias the results, with larger offsets creating a greater bias. Since the decrease in detections near the trackline was not large for the data collected in 2020, a larger offset would be required to fit the gamma key function. Since AIC values were not a good indicator for the fit of the gamma function to the offset 2020 data, offset distances were not applied to assist the fit of the gamma key function for this year. Environmental and observer covariates were included for fitting the detection function and mark-recapture models. Models were selected using the minimum AIC.

The combined narwhal sightings (n=755) for the Eclipse Sound and Admiralty Inlet survey grids from the open-water season survey (Leg 2) were used for estimating the detection function and mark-recapture detection probabilities for narwhal in Eclipse Sound and Admiralty Inlet (Figure 24). This was because the same observers were used for both the Eclipse Sound and Admiralty Inlet grids and location (i.e., Eclipse Sound or Admiralty Inlet) did not affect the model. Examination of the histogram of the perpendicular distances of unique sightings suggested right-truncating the data at 1,000 m (i.e., discarding sightings beyond 1,000 m).

Model selection was performed on the three key functions and all the combinations of environmental covariates. A hazard rate key function and covariates for observer, 30 second rolling count of observations, and the interaction of glare intensity, side of aircraft and glare angle had the lowest AIC for detection function models: (g(x)=0.49 and CV=0.03%; Appendix D).

Selection among mark-recapture models was performed on all combinations of environmental covariates. The lowest AIC was a model with covariates for glare intensity, 60 second rolling count of observations, and the interaction of observer and distance (Appendix D). It resulted in a p(0) of 0.73 for observers 1 (Figure 25) and 0.73 for observers 2 (Figure 26), and a combined p(0) of 0.92 and (CV=0.02). The combined models resulted in a detection probability of 0.46 (CV=0.04).

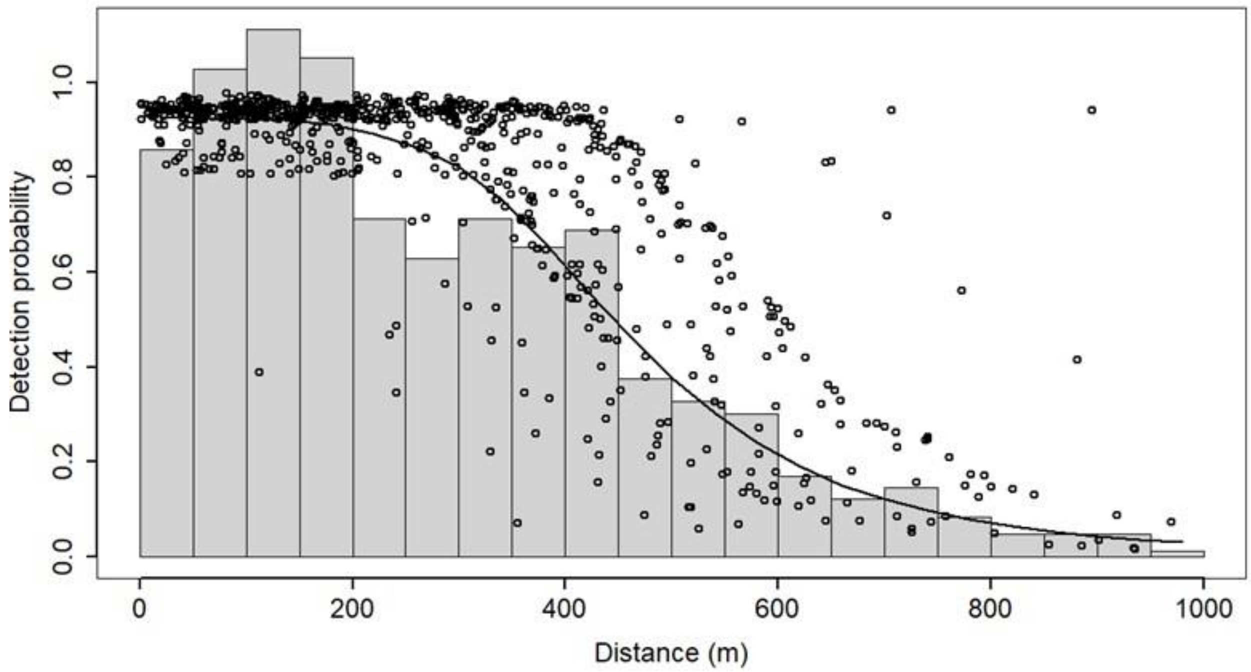

Figure 24: Histogram showing perpendicular distances of narwhal sightings in Eclipse Sound and Admiralty Inlet survey grids. Note: Fitted hazard rate key function is shown with right truncation at 1000 m (no left truncation). O = probability of detection for each sighting based on perpendicular distance and other covariates.

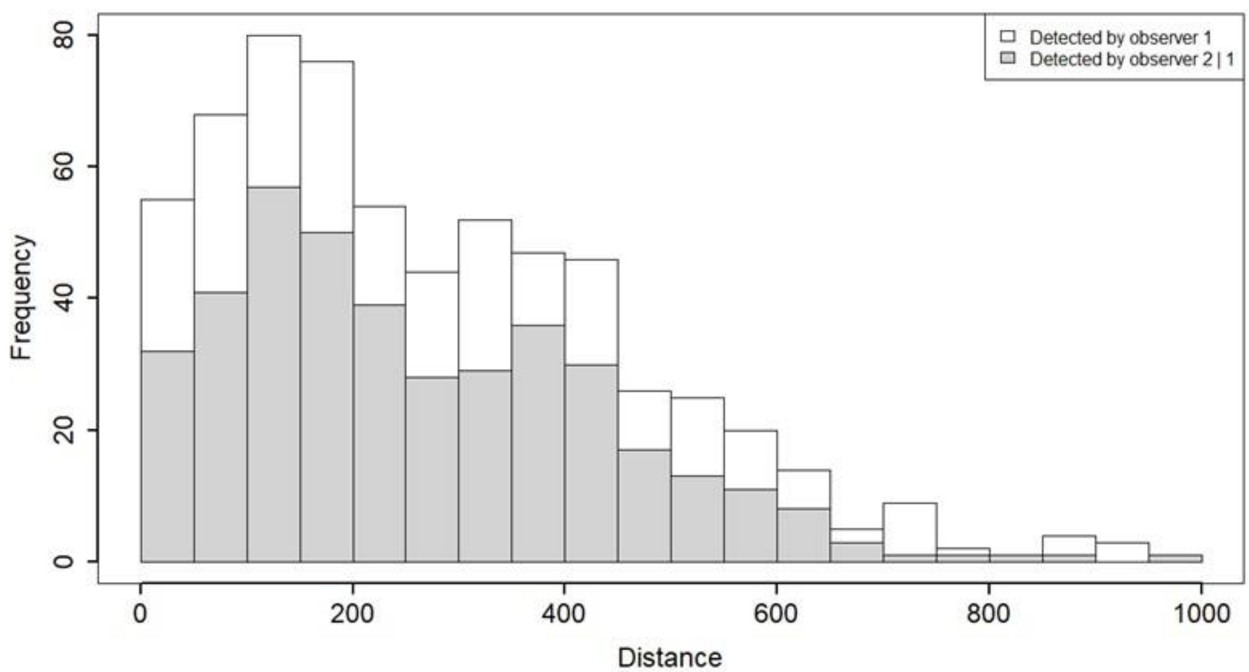

Figure 25: Distribution of narwhal sighting distances for Observer 1 and Combined (Observers 1 and 2) in Eclipse Sound and Admiralty Inlet survey grids.

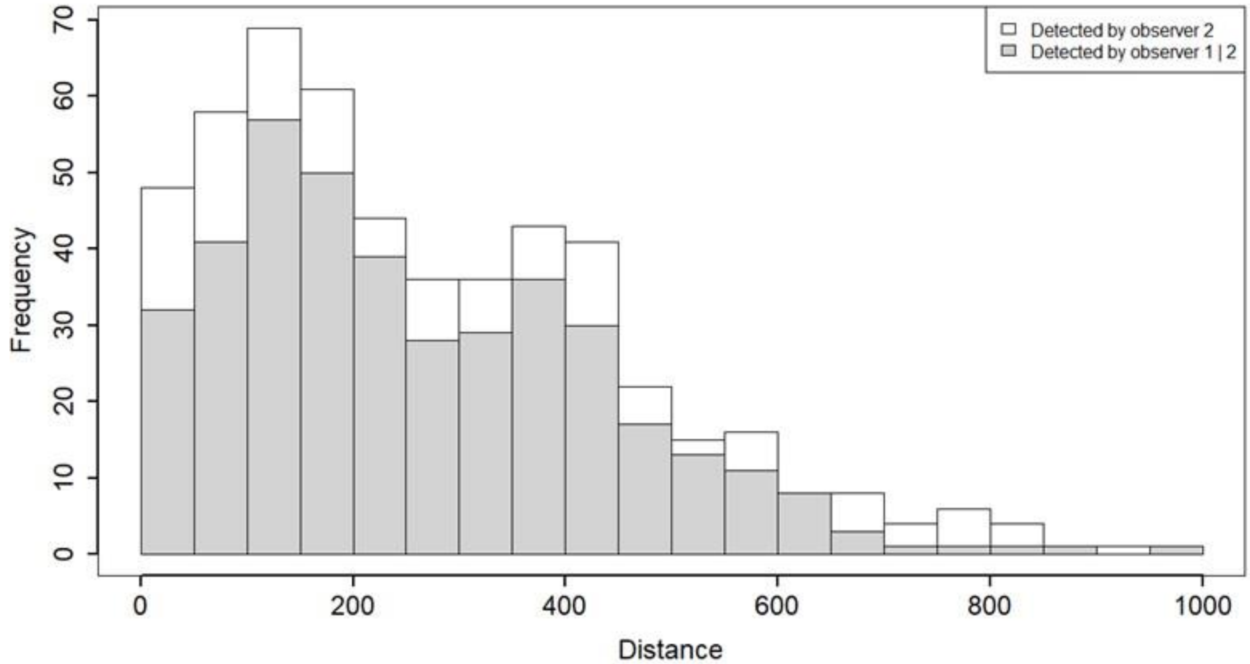

Figure 26: Distribution of narwhal sighting distances for Observer 2 and Combined (Observers 1 and 2) in Eclipse Sound and Admiralty Inlet survey grids.

The availability bias component of g(x), where an animal is diving and is thus out of visual range of the observers, requires species, and area-specific dive profile data to estimate proportion of time spent underwater (e.g., Barlow et al. 1988). A correction factor (2.94, CV=0.03 for mid-August and 2.92, CV=0.03 for late August) was applied to the data to account for potential availability bias for this species, adjusted for the specific observation platform. This correction factor is based on previously reported narwhal dive and aerial survey results (Doniol-Valcroze et al. 2015a; Watt et al. 2015a).

3.2.6.2 Photographic Survey Data Characteristics

For the assessment of reliability and repeatability of the photographic data, a simple linear regression of the comparison of two experienced photo readers was run. Repeat counts of 504 photos were highly correlated (simple linear regression; R^2 = 0.974, $F_{1,501}$ = 18.499 x 10^3, p < 0.0001). Counts for the first and repeat reads were the same for 239 of the 504 photos, differed by one for 146 photos, and by two for 52 photos, by three for 32 photos, by four for 16 photos, by five for 11 photos, and by six for eight photos. The original counts were kept for the abundance analysis.

On average, 0.8 % of the photos had murky water (see Tables 17 and 20 in Section 3.2.6.3 later), and 13.2 % of the photos had glare (see Tables 17 and 20 in Section 3.2.6.3 later). Photographs overlapped by an average of 65%.

With ideal sightings conditions for photographic data, one would expect a slight decrease in animal detectability with increasing distance from the track line. The data showed a slight decrease in sightings with increased distance from the track line (Figure 27). Possible factors affecting the detectability bias include camera angle, aircraft crab angle (cross wind), imprecise aircraft altitudes, obscurity of subsurface animals, observer bias, and animal behaviour. A detection function was created for narwhal in the photographic surveys. Surveys were selected for the analysis that had no land or glare which would skew the results. Environmental conditions were appropriate for all the surveys chosen to calculate abundances.

A detection model fitted to the photographic data for one survey flown at 610 m (2000 ft) resulted in a probability of detection of 0.8986 ($C_d =$ detectability bias correction factor of 1.11, n=2,914), CV=0.02 (Figure 27). A hazard rate key function with no adjustments had the lowest AIC of 39225.11 for the detection function model.

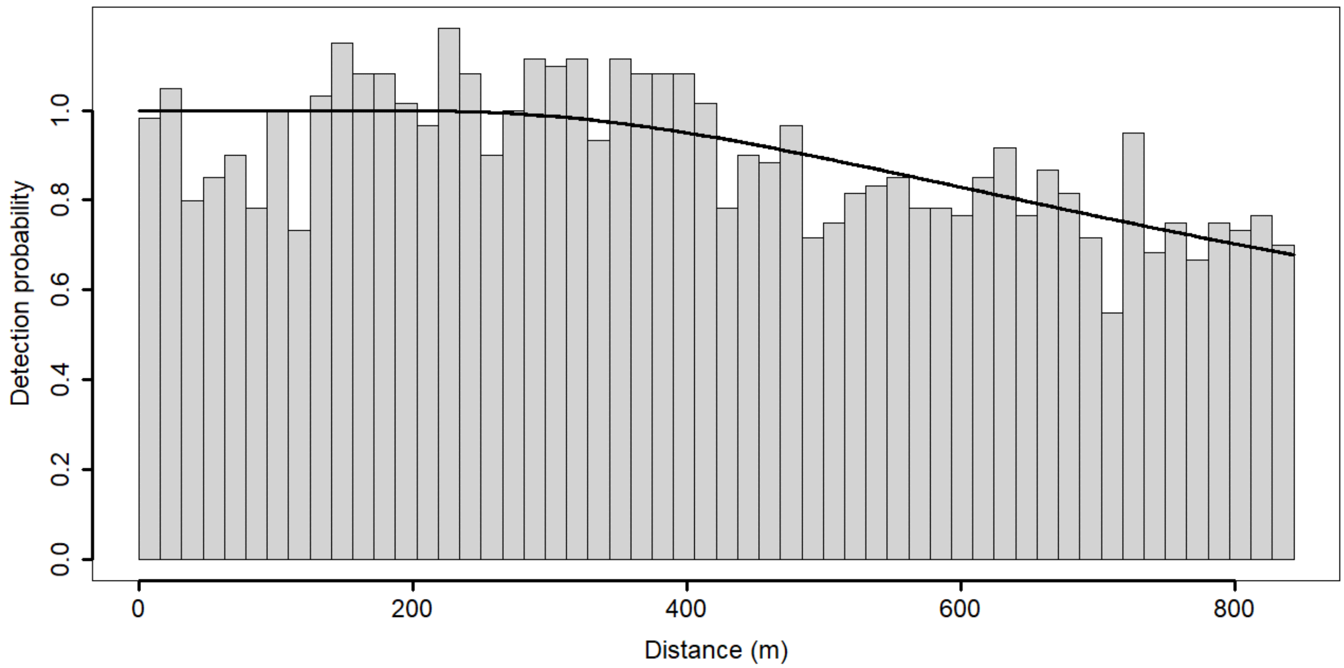

Figure 27: Detection Function for Photographic Survey Data at 610 m (2000 ft).

3.2.6.3 Narwhal Abundance

3.2.6.3.1 Eclipse Sound Stock

Overall, there were 18 narwhal visual sightings for Surveys 1 and 3 combined (Table 16). All sightings had perpendicular distances recorded during flight.

During Survey 1 (20 August), a total of 1,187.5 km of transects were visually surveyed (Table 16). The total count of narwhal sightings observed on-effort in the visual survey area was ten sightings before and nine after truncation (Table 16). Although variation of the abundance estimate was a combination of the variation from detection function, encounter rate, cluster size and availability bias, the overall variation in abundance estimates came primarily from the encounter rate component (Table 16). The total narwhal abundance for Survey 1 visual surveys was estimated at 130 narwhal (CV=0.34) (Table 16).

The total length of transect lines visually surveyed during Survey 3 (29 August) was 1,177.3 km (Table 16). The total count of narwhal sightings observed on-effort in the visual survey area was eight sightings before and after truncation (Table 16). For this survey, the overall variation in abundance estimates came primarily from the encounter rate and the cluster size component. The total narwhal abundance for Survey 3 visual surveys was estimated at 181 narwhal (CV=0.39) (Table 16).

Table 16: Narwhal abundance estimates from visual surveys in Eclipse Sound grid during Leg 2.

Survey	Stratum[a]	Area (km^2)	Effort (km)	No. Sight. Before Trunc.	No. Sight. After Trunc.	Corrected Abundance	CV	% CV contributed by Encounter Rate	% CV contributed by Cluster Size
1	PI	1381.3	149.9	0	0	–	–	–	–
1	ESE	2066.5	221.4	0	0	–	–	–	–
1	ESW	841.0	183.9	6	6	88	0.46	99.5	0
1	MIN	681.3	156.9	4	3	42	0.40	99.3	0
1	NBI	2007.8	167.7	0	0	–	–	–	–
1	Fjords	957.5	307.6	0	0	–	–	–	–
1	***Total***	**7935.5**	**1187.5**	**10**	**9**	**130**	**0.34**	–	–
3	PI	1381.3	153.8	0	0	–	–	–	–
3	ESE	2066.5	228.4	0	0	–	–	–	–
3	ESW	841.0	180.0	1	1	15	1.11	99.9	
3	MIN	681.3	159.9	3	3	41	1.11	99.9	
3	NBI	2007.8	160.7	0	0	–	–	–	–
3	Fjords	957.5	294.5	4	4	125	0.41	66.8	32.6
3	***Total***	**7935.5**	**1177.3**	**8**	**8**	**181**	**0.39**	–	–

[a] PI=Pond Inlet, ESE= Eclipse Sound East, ESW=Eclipse Sound West, MIN=Milne Inlet North, NBI=Navy Board Inlet.

During Survey 1 (20 August), two photographic surveys were undertaken, one in Milne Inlet South (MIS) stratum and one in the Tremblay Sound (TS) stratum (Figure 22). A total of 2,763 photographs were taken to capture the narwhal aggregations in the two areas. The total area photographed was 425.9 km^2 (272.1 km^2 in MIS and 153.8 km^2 in TS; Table 17). The total count of narwhal in the photographed areas was 2,122 narwhal (1,222 in MIS and 900 in TS; see Table 12). The sum of the area of the individual photographs totaled 696.9 km^2 in MIS and 286.8 km^2 in TS, resulting in an average density of 1.8 narwhal/km^2 in MIS and 3.1 narwhal/km^2 in TS. Multiplying the average density by the total area photographed resulted in a surface estimate of 477 narwhal in MIS and 483 narwhal in TS. The surface estimate was then corrected for availability bias using C_α=3.18 (correction from Watt et al. 2015a), and detectability bias of 1.11, resulting in a total narwhal estimate for the photographed areas for Survey 1 of 1,684 narwhal (CV=0.04) in MIS and 1,705 narwhal (CV=0.04) in TS (Table 17).

During Survey 3 (29 August), two photographic surveys were undertaken in the Eclipse Sound study area, one in MIS stratum and one in the TS stratum (Figure 23). A total of 2,855 photographs were taken to capture the narwhal aggregations in the two areas. The total area photographed was 425.9 km^2 (272.1 km^2 in MIS and 153.8 km^2 in TS; Table 17). The total count of narwhal in the photographed areas was 3,794 narwhal (2,359 narwhal in MIS and 1,435 narwhal in TS; see Table 12). The sum of the area of the individual photographs totaled 771.2 km^2 in the MIS and 403.4 km^2 in TS, resulting in an average density of 3.1 narwhal/km^2 in MIS and 3.6 narwhal/km^2 in TS. Multiplying the average density by the total area photographed resulted in a surface estimate of 832 narwhal in MIS and 547 narwhal in TS. The surface estimate was then corrected for availability bias using C_α = 3.16 (correction from Watt et al. 2015a), and detectability bias of 1.11, resulting in a total narwhal estimate for the photographed areas for Survey 3 of 2,918 narwhal (CV=0.04) in MIS and 1,919 narwhal (CV=0.04) in TS (Table 17).

Table 17: Narwhal abundance estimates from photographic survey in Eclipse Sound grid during Leg 2.

Survey	Stratum[a]	# Photos	# Photos with Murky Water	# Photos with Glare	Photo Area (km^2)	Surface Count	Corrected Abundance	CV
1	MIS	1,740	15	129	272.10	477	1,684	0.04
1	TS	1,023	0	475	153.84	483	1,705	0.04
3	MIS	1,857	38	181	272.10	832	2,918	0.04
3	TS	998	0	86	153.84	547	1,919	0.04

[a] MIN=Milne Inlet North, MIS=Milne Inlet South, TS=Tremblay Sound.

For the Eclipse Sound stock, the narwhal abundance estimates calculated for the two survey replicates (Survey 1 and 3) ranged from 3,519 to 5,018 narwhal (Table 18). The abundance estimate for Survey 3 (5,018 narwhal, CV = 0.03, 95% CI of 4,736–5,317) was statistically significantly higher than the abundance estimate for Survey 1 (3,519 narwhal, CV = 0.03, 95% CI of 3,308–3,743) (Z-test = -8.10, $p < 0.0001$). The majority of the sightings were based on photographic data for both surveys. Given the higher confidence of animal detection associated with the photographic survey data, the Survey 3 results were considered to reflect a more accurate representation of the actual narwhal abundance in the RSA and were therefore retained as the best 2020 abundance estimate for the Eclipse Sound stock. The difference in abundance estimates between Surveys 1 and 3 was likely attributed to less narwhal being present in the dedicated photographic survey areas during Survey 1 compared to Survey 3. This may have been due to natural movement patterns of narwhal in and out of the photographic survey areas, or may reflect non-random narwhal distribution / movement patterns in the RSA due to influences of killer whales (Survey 3 was the only survey replicate in 2020 when killer whale were observed during active surveying). Other potential contributing factors may have included weather, as sighting conditions were poorer during Survey 1 due to higher sea state conditions. Table 18: Narwhal abundance estimates from combined visual and photographic surveys in Eclipse Sound grid during Leg 2.

Survey	Survey Type	Estimate	CV	95% CI
1	Visual	130	0.34	68 – 247
1	Photographic	3,389	0.03	3,195 – 3,594
1	Combined	3,519	0.03	3,308 – 3,743
3	Visual	181	0.39	87 – 378
3	Photographic	4,837	0.03	4,588 – 5,099
3	Combined	5,018	0.03	4,736 – 5,317

3.2.6.3.2 Admiralty Inlet Stock

Overall, there were 725 narwhal sightings while on-effort for Surveys 1 and 3 (Table 19). Initially, 90 of the sightings were missing perpendicular distances. After photo-verification of sightings with missing measurements, 47 perpendicular distances were recovered from the photographs, with the remaining 43 left as missing values.

During Survey 1 (21 August), a total of 1,231.0 km of transects were visually surveyed (Table 19). The total count of narwhal sightings observed on-effort in the visual survey area was 318 sightings before truncation and 317 after truncation (Table 19). Variation of the abundance estimate was a combination of the variation of detection function, encounter rate, cluster size, and availability bias. For Survey 1 the variation in abundance estimates came primarily from the encounter rate and the detection function component. The total narwhal abundance for Survey 1 visual surveys was estimated at 14,427 narwhal (CV=0.22) (Table 19).

The total length of transect lines visually surveyed during Survey 3 (28 August) was 1,105.3 km (Table 19). The total count of narwhal sightings observed on-effort in the visual survey area was 407 sightings before truncation and 401 after truncation (Table 19). The overall variation in abundance estimates came primarily from the encounter rate and the cluster size component. The total narwhal abundance for Survey 3 visual surveys was estimated at 19,721 narwhal (CV=0.23) (Table 19).

Table 19: Narwhal abundance estimates from visual surveys in Admiralty Inlet grid during Leg 2.

Survey	Stratum[a]	Area (km^2)	Effort (km)	No. Sight. Before Trunc.	No. Sight. After Trunc.	Corrected Abundance	CV	% CV contributed by Encounter Rate	% CV contributed by Cluster Size
1	AIN	6835.4	795.1	315	314	13,955	0.23	94.2	3.6
1	AIS	1626.3	177.5	3	3	472	0.70	65.9	33.9
1	Fjords	756.2	258.5	0	0	–	–	–	–
1	***Total***	***9217.9***	***1231.0***	***318***	***317***	***14,427***	***0.22***	–	–
3	AIN	6662.2	727.0	375	369	17,734	0.25	96.3	1.9
3	AIS	1619.1	178.3	31	31	1,975	0.49	89.8	9.7
3	Fjords	756.2	200.0	1	1	12	1.09	99.9	0
3	***Total***	***9037.5***	***1105.3***	***407***	***401***	***19,721***	***0.23***	–	–

[a] AIN=Admiralty Inlet North, AIS=Admiralty Inlet South.

During Survey 1 (21 August), one photographic survey was undertaken in the Admiralty Inlet South (AIS) stratum (see Figure 22). A total of 157 photographs were taken to capture the narwhal aggregations in the area. The total area photographed was 25.4 km^2 (Table 20). The total count of narwhal in the photographed areas was 1,970 narwhal (see Table 12). The sum of the area of the individual photographs totaled 62.7 km^2, resulting in an average density of 31.4 narwhal/km^2. Multiplying the average density by the total area photographed resulted in a surface estimate of 798 narwhal. The surface estimate was then corrected for availability bias using C_α=3.18 (correction from Watt et al. 2015a), and detectability bias of 1.11, resulting in a total narwhal estimate for the photographed area for Survey 1 of 2,817 narwhal (CV=0.05) in AIS (Table 20).

During Survey 3 (28 August), two photographic surveys were undertaken in the Admiralty Inlet study area, one in AIS stratum and one in AIN stratum (Figure 23). A total of 1,206 photographs were taken to capture the narwhal aggregations in the two areas, with a total area photographed of 205.9 km^2 (32.6 km^2 in AIS and 173.3 km^2 in AIN; Table 20). The total count of narwhal in the photographed areas was 9,330 narwhal (2,164 in AIS and

7,166 in AIN; see Table 12). The sum of the area of the individual photographs totaled 73.5 km^2 in AIS and 548.7 km^2 in AIN, resulting in an average density of 29.4 narwhal/km^2 in AIS and 13.1 narwhal/km^2 in AIN. Multiplying the average density by the total area resulted in a surface estimate of 960 narwhal in AIS and 2,263 narwhal in AIN. The surface estimate was then corrected for availability bias using C_α=3.16 (correction from Watt et al. 2015a), and detectability bias of 1.11, resulting in a total narwhal estimate for the photographed areas for Survey 3 of 3,367 narwhal (CV=0.05) in AIS and 7,938 narwhal (CV=0.04) in AIN (Table 20).

Table 20: Narwhal abundance estimates from photographic surveys in Admiralty Inlet grid during Leg 2.

Survey	Stratum[a]	# Photos	# Photos Murky Water	# Photos with Glare	Area (km2)	Surface Count	Corrected Abundance	CV
1	AIS	157	0	0	25.42	798	2,817	0.05
3	AIS	178	0	52	32.59	960	3,367	0.05
3	AIN	1,028	0	0	173.27	2,263	7,938	0.04

[a] AIN=Admiralty Inlet North, AIS=Admiralty Inlet South.

For the Admiralty Inlet stock, the narwhal abundance estimates calculated for the two survey replicates (Surveys 1 and 3) ranged from 17,244 to 31,026 (Table 21). The abundance estimate for Survey 3 (31,026 narwhal, CV = 0.14, 95% CI of 23,406–41,126) was statistically significantly higher than the abundance estimate for Survey 1 (17,244 narwhal, CV = 0.18, 95% CI of 12,056–24,664) (Z-test = -2.51, p = 0.0061). The majority of the sightings were based on photographic data for both surveys. Given the higher confidence of animal detection associated with the photographic survey data, the Survey 3 results were considered to reflect a more accurate representation of actual narwhal abundance in Admiralty Inlet and were therefore retained as the best 2020 abundance estimate for the Admiralty Inlet summer stock. The difference in abundance estimates between Survey 1 and 3 was likely attributed to less narwhal being present in the photographic survey areas during Survey 1 compared to Survey 3. This may have been due to natural movement patterns of narwhal in and out of the photographic survey areas. Other potential contributing factors include weather, as sighting conditions were poorer during Survey 1 due to higher sea state conditions.

Table 21: Narwhal abundance estimates from combined visual and photographic surveys in Admiralty Inlet grid during Leg 2.

Survey	Survey Type	Estimate	CV	95% CI
1	Visual	14,427	0.22	9,425 – 22,084
1	Photographic	2,817	0.05	2,533 – 3,133
1	*Combined*	*17,244*	*0.18*	*12,056 – 24,664*
3	Visual	19,721	0.23	12,715 – 30,588
3	Photographic	11,305	0.03	10,677 – 11,970
3	*Combined*	*31,026*	*0.14*	*23,406 – 41,126*

3.2.6.3.3 Combined Eclipse Sound and Admiralty Inlet Stocks

For the combined Eclipse Sound and Admiralty Inlet stock, the narwhal abundance estimates calculated for the two survey replicates (Surveys 1 and 3) ranged from 20,763 to 36,044 (Table 22). The abundance estimate for Survey 3 (36,044, CV = 0.12, 95% CI of 28,267–45,961) was statistically significantly higher than the abundance estimate for Survey 1 (20,763, CV = 0.15, 95% CI of 15,410–27,976) (Z-test = -2.78, p = 0.0027). The majority of the sightings were based on photographic data for both surveys. Given the higher confidence of animal detection associated with the photographic survey data, the Survey 3 results were considered to reflect a more accurate representation of actual narwhal abundance in these areas and were therefore retained as the best 2020 abundance estimate for the combined Eclipse Sound / Admiralty stock. The difference in abundance estimates between Survey 1 and 3 was likely attributed to less narwhal being present in the photographic survey areas during Survey 1 compared to Survey 3. This may have been due to natural movement patterns of narwhal in and out of the photographic survey areas, or may reflect non-random narwhal distribution / movement patterns in the RSA due to influences of killer whales (Survey 3 was the only survey replicate in 2020 when killer whale were observed during active surveying). Other potential contributing factors may have included weather, as sighting conditions were poorer during Survey 1 due to higher sea state conditions.

Table 22: Narwhal abundance estimates for the combined Eclipse Sound and Admiralty Inlet stocks during Leg 2.

Survey #	Stock	Estimate	CV	95% CI
1	Eclipse Sound	3,519	0.03	3,308 – 3,743
1	Admiralty Inlet	17,244	0.18	12,056 – 24,664
1	*Combined*	20,763	0.15	15,410 – 27,976
3	Eclipse Sound	5,018	0.03	4,736 – 5,317
3	Admiralty Inlet	31,026	0.14	23,406 – 41,126
3	*Combined*	36,044	0.12	28,267 – 45,961

4.0 DISCUSSION

Two different marine mammal aerial surveys were performed in 2020. A reconnaissance survey was initially run during the early shoulder season (Leg 1) to collect data on the presence/absence and distribution of marine mammals in the RSA specific to available ice conditions at that time of year. A systematic aerial-based transect survey was then conducted during the open-water season (Leg 2) to obtain abundance estimates of the Eclipse Sound and Admiralty Inlet narwhal summer stocks.

4.1 Narwhal

4.1.1 Leg 1 – Early Shoulder Season

High-level Summary: *Results from the Leg 1 survey indicated that prior to the start of icebreaking in 2020, few narwhal had progressed into Milne Inlet due to a large consolidated ice field present in Western Eclipse which appeared to impede southbound access. Narwhal were largely concentrated within this ice field amongst several prominent ice leads when icebreaking began. This differed from 2019, when more narwhal had progressed into Milne Inlet prior to the start of icebreaking due to lighter ice conditions that year. In both years, narwhal were also present in northern Navy Board Inlet and east of Pond Inlet prior to the start of icebreaking.*

By the time surveys began on 10 July, the floe edge had begun to break apart and the new ice edge was situated close to the town of Pond Inlet (see Figure 7). The focus of the early shoulder season survey was shifted to obtain relative abundance estimates and distribution of marine mammals in the open water areas and in the ice leads throughout the Eclipse Sound survey grid prior to and during ice breaking activities. The first Baffinland vessel to enter the RSA in 2020 was the icebreaker MSV Botnica on 21 July 2020, which escorted two bulk carriers and two tugs along the Northern Shipping Route to Milne Port.

During Survey 1 of Leg 1 (10 July), narwhal were distributed throughout the 1-3/10 ice and open water area east of Pond Inlet, along the floe edge and in the three prominent ice leads located west of the floe edge (Appendix B, Figure B-1). Within the three ice leads the concentration of narwhal was highest in the most easterly ice lead with decreasing numbers in the leads moving westerly. Fast ice was present west of the most westerly ice lead, so it is unlikely narwhal had moved into Eclipse Sound any further than what was observed on the first survey. A reconnaissance flight was also flown during Survey 1 of Leg 1 in Milne Inlet and Koluktoo Bay and no narwhal were observed. As the days progressed more leads formed in Eclipse Sound and narwhal continued to push westerly into the leads (Appendix B, Figures B-2 to B-9). Narwhal were first observed in Northern Milne Inlet on 20 July. One Narwhal was observed in South Milne Inlet on the 21 July. No narwhal were observed in Koluktoo Bay during the Leg 1 surveys.

Narwhal distribution differed between 2019 and 2020 due to the different ice conditions in the study area. When aerial surveys began in July of 2019 and 2020, the floe edge had already largely broken up with most of the ice situated in Eclipse Sound, Milne Inlet North, and the lower part of Navy Board Inlet. The difference in narwhal distribution occurred in the ice-covered portions of the RSA. In 2019, the remaining sea ice present in the RSA when icebreaking started was fragmented into a loose pack ice formation allowing narwhal to disperse throughout the area somewhat evenly. In 2020, sea ice present in the RSA at the start of icebreaking was largely intact (i.e., large, consolidated ice field) with a few ice leads running through it. As a result, narwhal were highly concentrated in the ice leads in Eclipse Sound, forming a more clumped distribution compared to 2019. Narwhal distribution in the Baffin Bay and Pond Inlet strata was similar between 2019 and 2020 with narwhal dispersed throughout the open water areas.

When the first ice breaker convoy entered the RSA on 21 July, large concentrations of narwhal were observed in two large ice leads north of Ragged Island and in the 4-6/10 ice area west of Ragged Island (Appendix B, Figure B-8). The day following the first ice breaker convoy (22 July), narwhal were still observed north of Ragged Island but fewer were seen in the 4-6/10 ice area west of Ragged Island.

Nine aerial surveys were conducted during the early shoulder season (see Table 3). Relative abundance estimates were calculated for all marine mammals observed during the early shoulder season for both the systematic transects and the dedicated transects (i.e., leads and floe edge). Narwhal had the highest relative abundance both during systematic transects and dedicated transects (0.33 animals/km and 2.08 animals/km, respectively). Narwhal relative abundance increased on the dedicated transects (in leads/floe edge) and decreased on the systematic transects (in Milne Inlet) after the icebreaker transited the RSA (Survey 9, 4.25 animals/km and 0.02 animals/km, respectively) (Table 7). This is further supported by the noticeable shift in narwhal distribution from Survey 8 to 9 (Appendix B, Figures B-8 and B-9) where narwhal moved from the 4-6/10 ice area in north Milne Inlet to the 9-10/10 ice in Eclipse Sound. Narwhal relative abundance during systematic transects in 2020 was similar to what was observed in 2019 in the open water areas (0.33 animals/km and 0.30 animals/km, respectively) (Table 8).

4.1.2 Leg 2 – Open-water Season

High-level Summary: *Results from the Leg 2 survey indicated that: i) narwhal abundance in Eclipse Sound was statistically lower in 2020 than observed in previous years when aerial surveys were conducted (i.e., 2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to what was observed in previous years (2013 and 2019). These results suggest either a potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020, a potential displacement of these animals to another area (e.g., Eastern Baffin Bay summering ground), or a potential decrease in the Eclipse Sound summer stock.*

During Leg 2, two complete aerial surveys were flown in the Eclipse Sound and Admiralty Inlet grids. Because narwhal were distributed in a relatively small area (mostly in Milne Inlet and Tremblay Sound where most sightings were captured by photographic surveys), low CVs were achieved in the August surveys that provided good abundance estimates. The two surveys flown were statistically different from each other in both Eclipse Sound and Admiralty Inlet (Eclipse Sound Survey 3 was statistically higher than Survey 1, Z-test = -8.10, $p < 0.0001$; Admiralty Inlet Survey 3 was statistically higher than Survey 1, Z-test = -2.51, $p = 0.0061$; Combined Survey 3 was significantly higher than Survey 1, Z-test = -2.78, $p = 0.0027$). The survey with the lowest CV and highest count was selected as the best abundance estimate for the stocks, thus Survey 3 was selected as the best estimate for the Eclipse Sound stock of 5,018 narwhal (CV = 0.03, 95% CI of 4,736–5,317), for the Admiralty Inlet stock of 31,026 narwhal (CV = 0.14, 95% CI of 23,406–41,126), and for the combined Eclipse Sound and Admiralty Inlet stocks of 36,044 (CV = 0.12, 95% CI of 28,267–45,961) (Table 23).

Table 23: Comparison of narwhal abundance estimates for Eclipse Sound, Admiralty Inlet, and combined stocks.

Stock	Year	Survey Dates (Survey #)	Abundance	CV	95% CI	Source
Eclipse Sound	2004	August	20,225	0.36	9,471–37,096	Richard et al. 2010
Eclipse Sound	2013	18–19 Aug	10,489	0.24	6,342–17,347[b]	Doniol-Valcroze et al. 2015a
Eclipse Sound	**2016**	**7–10 Aug**	**12,039**	**0.23**	**7,768–18,660**	**Marcoux et al. 2019**
Eclipse Sound	2016	15 Aug	20,093	0.57	6,449–104,339	Golder 2018b
Eclipse Sound	2016	21 Aug	12,955	0.16	7,245–23,166	Golder 2018b
Eclipse Sound	2019	21–22 Aug (#3)	7,765	0.04	7,182–8,396	Golder 2020a
Eclipse Sound	2019	25–27 Aug (#4)	12,088	0.08	10,388–14,066	Golder 2020a
Eclipse Sound	**2019**	**21–27 Aug (#3&4)**	**9,931**	**0.05**	**9,009–10,946**	**Golder 2020a**
Eclipse Sound	2019	29–30 Aug (#5)	4,879[a]	0.06	4,322–5,507	Golder 2020a
Eclipse Sound	2020	20 Aug (#1)	3,519	0.03	3,308 – 3,743	Golder 2021
Eclipse Sound	**2020**	**29 Aug (#3)**	**5,018**	**0.03**	**4,736 – 5,317**	**Golder 2021**
Admiralty Inlet	2003	August	5,362	0.50	1,920–12,199	Richard et al. 2010
Admiralty Inlet	2010	7–11 Aug	18,049	0.23	11,613–28,053	Asselin and Richard 2011
Admiralty Inlet	2013	12–17 Aug	35,043	0.42	14,188–86,553[b]	Doniol-Valcroze et al. 2015a
Admiralty Inlet	2019	21–22 Aug (#3)	27,436	0.14	20,860–36,084	Golder 2020a
Admiralty Inlet	2019	25–26 Aug (#4)	30,638	0.29	17,668–53,129	Golder 2020a
Admiralty Inlet	**2019**	**21–26 Aug (#3&4)**	**28,746**	**0.15**	**21,545–38,354**	**Golder 2020a**
Admiralty Inlet	2019	29–30 Aug (#5)	18,976	0.20	12,963–27,779	Golder 2020a
Admiralty Inlet	2020	21 Aug (#1)	17,244	0.18	12,056–24,664	Golder 2021
Admiralty Inlet	**2020**	**28 Aug (#3)**	**31,026**	**0.14**	**23,406–41,126**	**Golder 2021**
Combined	**2013**	**12–19 Aug**	**45,532**	**0.33**	**22,440–92,384[b]**	**Doniol-Valcroze et al. 2015a**
Combined	2019	21–22 Aug (#3)	35,201	0.11	28,401–43,629	Golder 2020a
Combined	2019	25–27 Aug (#4)	42,726	0.21	28,620–63,786	Golder 2020a
Combined	**2019**	**21–27 Aug (#3&4)**	**38,677**	**0.11**	**31,155–48,015**	**Golder 2020a[c]**
Combined	2019	29–30 Aug (#5)	23,855	0.16	17,581–32,368	Golder 2020a
Combined	2020	20–21 Aug (#1)	20,763	0.15	15,410–27,976	Golder 2021
Combined	**2020**	**28–29 Aug (#3)**	**36,044**	**0.12**	**28,267–45,961**	**Golder 2021**

[a] Possible narwhal aggregation missed during survey personal comms. local hunters.
[b] T. Doniol-Valcroze, Pers. Comm. 2020.
[c] T. Number has been revised from the Golder 2020a report to correct an error.

The abundance estimate for the combined Eclipse Sound and Admiralty Inlet stocks was 36,044 narwhal (CV = 0.12, 95% CI of 28,267–45,961; Table 23) based on aerial surveys conducted on 28–29 August 2020. This estimate is within the range of the 2013 Fisheries and Oceans Canada (DFO) estimate for the combined Eclipse and Admiralty stocks of 45,532 narwhal (CV = 0.33, 95% CI of 22,440–92,384; Doniol-Valcroze et al. 2015) (Z-test = 0.61, p = 0.2726) and the 2019 Baffinland estimate for the combined Eclipse and Admiralty stocks of 38,677 (CV = 0.11, 95% CI of 31,155–48,105; Golder 2020) (Z-test = 0.44, p = 0.3302) (Table 23). The sample sizes used to generate narwhal abundance estimates for DFO's previous surveys (Doniol-Valcroze et al. 2015a; Marcoux et al. 2019) were not reported. The use of the Z-statistic may represent a higher precision than is warranted by the DFO data.

For Eclipse Sound stock alone, the abundance estimate was 5,018 narwhal (CV = 0.03, 95% CI of 4,736–5,317; Table 23) based on the aerial survey conducted on 29 August 2020. This estimate is statistically lower than the 2016 DFO estimate of 12,039 narwhal (CV = 0.23, 95% CI of 7,768–18,660; Marcoux et al. 2019) (Z-test = 2.53, p = 0.0057), the 2013 DFO estimate of 10,489 narwhal (CV = 0.24, 95% CI of 6,342–17,347; Doniol-Valcroze et al. 2015) (Z-test = 2.17, p = 0.0150), and the 2019 Baffinland estimate of 9,931 narwhal (CV = 0.05, 95% CI of 9,009–10,946; Golder 2020) (Z-test = 9.53, p < 0.0001) (Table 23).

For the Admiralty Inlet stock alone, the abundance estimate was 31,026 narwhal (CV = 0.14, 95% CI of 23,406-41,126; Table 23) based on the aerial survey conducted on 28 August 2020. This estimate is within the range of the 2013 DFO estimate of 35,043 narwhal (CV = 0.42, 95% CI of 14,188-86,553; Doniol-Valcroze et al. 2015) (Z-test = 0.26 p = 0.39) and the 2019 Baffinland estimate of 28,746 narwhal (CV = 0.15, 95% CI of 21,545-38,354; Golder 2020) (Z-test = 0.37, p =0.36) (Table 23).

In 2013–2016 and 2019, aerial surveys conducted in mid to late August found narwhal distributed in Milne Inlet, Tremblay Sound and Koluktoo Bay (Elliott et al. 2015; Thomas et al. 2015; Thomas et al. 2016; Golder 2018b, 2020a). Similarly, during Leg 2 of the 2020 MMASP (mid to late August), narwhal were observed primarily in Milne Inlet, Tremblay Sound and Koluktoo Bay. Results from the 2017 Tremblay Sound tagging program indicated that tagged narwhal concentrated in Milne Inlet, Tremblay Sound, and Koluktoo Bay during the second half of August (Golder 2018a). IQ also indicated that narwhal were concentrated in Tremblay Sound, western Eclipse Sound, Milne Inlet, and Koluktoo Bay in August (JPCS 2017).

Narwhal were observed in two of the five fjords flown in Eclipse Sound grid. One sighting of a single narwhal was observed in White Bay on 27 August. On 29 August, three sightings totalling eleven narwhal were observed in White Bay and one sighting of a single narwhal was observed in Tay Sound. A killer whale herding event occurred in Milne Inlet on 27 August (see Appendix C) which may have elicited the movement of some narwhal into the fjords on the days that followed. Breed et al. (2017) indicated that the presence of killer whales can strongly alter the distribution and behaviour of narwhal. When killer whales are present, narwhal move closer to shore and into the fjords. Breed et al. (2017) also found that the effects extended beyond predatory events and persisted for the duration that killer whales remained in the area. This is consistent with Inuit IQ (JPCS 2017; ERM 2019).

Summary

Results from the 2020 aerial survey indicated: i) narwhal abundance in Eclipse Sound was statistically lower in 2020 than in previous aerial survey years carried out in the RSA (2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to that observed in previous years (2013 and 2019). These results suggest a potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020 but cannot discount the possibility of a potential displacement of these animals to another area (e.g., Eastern Baffin Bay summering ground) or a potential decrease in the Eclipse Sound summer stock.

In consideration of the above findings, it is evident that a lower number of narwhal were observed in the Eclipse Sound summer stock area during 2020 that requires further investigation. Consequently, Baffinland has committed to applying adaptive management and implementing additional mitigation measures to its 2021 shipping operations while the potential cause of the decline is being investigated. The following section discusses the potential contribution of the Project relative to the observed findings in balance with other potential contributing factors.

4.2 Potential Contributing Factors to 2020 Findings

The activities summarized below are considered potential contributors to the lower observed number of narwhal in Eclipse Sound in 2020. These are further discussed in Golder (2021a) (see Appendix E). At present, it is understood that these may have acted independently, or in a cumulative or additive manner. The information presented herein is considered preliminary and further desktop analysis and information collection is required to appropriately determine potential causes of the 2020 narwhal abundance observation. Baffinland proposes to undertake the development of this material, as per the Adaptive Management Plan (Baffinland 2021), in collaboration with applicable parties through the MEWG and dedicated discussions with DFO and other responsible parties related to the authorization of works associated with the Pond Inlet Small Craft Harbour construction project.

4.2.1 Icebreaking Activities

Project icebreaking is considered a possible contributing factor to the observed decrease in Eclipse Sound narwhal summer stock in 2020. In 2020, narwhal numbers in the RSA were significantly lower than what was observed in 2019 and compared to previous survey estimates. Ice conditions in 2020 were more concentrated in the RSA compared to 2019, but less concentrated compared to 2018. Similarly, more icebreaking took place in the RSA in 2020 (22 h) than 2019 (11 h), but substantially less than 2018 (56 h). In 2020, narwhal were largely concentrated in several prominent ice leads present within a large, consolidated ice field in western Eclipse Sound during the first day of icebreaking, and therefore occurred in a more clumped distribution when they were first exposed to icebreaking compared to 2019 when animals were more widely distributed in the RSA during their initial icebreaking exposure. During its first transit in the RSA in 2020, the MSV *Botnica* (escorting two carriers and two tugs) transited in close proximity to the leads where narwhal were confirmed to be holding.

4.2.2 Construction Noise from Small Craft Harbour in Pond Inlet

Preliminary analysis of underwater noise recordings collected by JASCO Applied Sciences (JASCO), on behalf of Baffinland, in Eclipse Sound during the 2020 early shoulder and open-water seasons identified anomalous sounds, similar in nature to sounds generated by pile driving (and different than sounds generated by vessels). These impulsive sounds are not thought to be natural in origin and according to available construction monitoring reports (Advisian 2021), they correspond in time with impact pile driving that occurred in Pond Inlet as part of the 2020 Small Craft Harbour construction project. A preliminary review of available construction monitoring reports by Golder indicated that the pile driving emitted high-energy impulsive noise to the marine environment during a 52-day period (8 July to 28 August) that corresponded with the typical timing of narwhal spring migratory movements into Eclipse Sound. The construction monitoring report from 2020 (Advisian 2021) indicated that impact driving methods were employed for pile installation instead of vibratory methods originally proposed by the proponent, that underwater noise/overpressure thresholds were exceeded during active impact pile driving, and that mitigation measures were not implemented to minimize adverse effects of impact pile driving noise on marine mammals in the RSA.

4.2.3 Increased Killer Whale Presence

Increased killer whale presence in the RSA is considered a possible contributing factor to the observed decrease in Eclipse Sound narwhal summer stock in 2020 given the potential of increased narwhal mortality, narwhal population decline, or a range contraction as suggested by Lefort et al. (2020). Killer whales were observed in the RSA in 2020 in higher numbers than in 2019. In 2020, the highest count of killer whales recorded at one time was 67 animals on 26 August from the Bruce Head observation platform, compared to 15 killer whales on 29 August in 2019 (Golder 2021b). The earliest record of killer whale presence in the RSA in 2019 was ten whales reported on 22 July based on aerial surveys conducted in Baffin Bay (Golder 2020). In 2020, the earliest record of killer whale presence in the RSA was ten whales reported on 18 August in Eclipse Sound by a Pond Inlet community member (Golder 2021a). Golder's aerial survey confirmed sightings of killer whales on 26, 27, and 29 August 2020. The sighting on 27 August included a narwhal herding event where over 200 narwhal were chased by a group of ~30 killer whales into Fairweather Bay (along the western shore of Milne Inlet North) with confirmation of at least four narwhal kills including two calves, one adult female and one adult male.

4.2.4 Other Potential Factors to 2020 Findings

Other potential factors that may have contributed to the lower observed number of narwhal in Eclipse Sound in 2020 include direct or indirect effects of climate change on narwhal including, but not limited to, associated changes in predator/prey dynamics and subsequent effects on narwhal fitness or energy reserves prior to their arrival on the summer grounds.

4.3 Other Marine Mammal Sightings

Although calculating abundance estimates for narwhal were the main focus of the 2020 MMASP, other marine mammals were also observed in the RSA. Their distribution and abundance are discussed below.

Bowhead Whale

Leg 1: Bowhead whales were observed throughout the RSA in 2020 with a similar distribution as observed in 2019. In 2020, bowhead whales were observed in every strata in the Eclipse Sound grid except the Tremblay Sound and South Milne Inlet strata (see Figure 14). Bowhead whales were most commonly observed in Baffin Bay, Pond Inlet, Eclipse Sound East, Eclipse Sound West, and Navy Board Inlet strata.

Bowhead relative abundance in the RSA was lower in 2020 (0.009 animals/km) than in 2019 (0.023 animals/km). The lower number of bowhead observed in 2020 may be indicative of a more regular occurrence, as it was noted by many local residents in Pond Inlet that bowhead numbers observed in 2019 were higher than those observed in recent years.

Leg 2: Bowhead whale observations declined substantially prior to the start of the open-water season (Leg 2), suggesting that most bowhead seen during Leg 1 had migrated out of the area prior to 20 August (start of Leg 2). One bowhead whale was observed in the RSA during the open-water surveys on August 29 at the top of Navy Board Inlet. During previous aerial surveys flown in August in the RSA, four bowhead whales were observed in 2019 (Golder 2020a), six were observed in 2014 (Thomas et al. 2015) and none were observed in 2013 or 2015 (Elliott et al. 2015; Thomas et al. 2016). The decline in relative abundance of bowhead during Leg 2 was consistent with baseline conditions, and did not suggest that Project shipping activities resulted in displacement of bowhead from their summering ground. Bowhead relative abundance in the Eclipse Sound grid was similar in

2020 (0.0003 animals/km) and 2019 (0.0003 animals/km). Bowhead whales appeared to use Eclipse Sound and Navy Board Inlet as a migration corridor during the early shoulder season, with numbers in the RSA dropping dramatically during the open water season. This was consistent with IQ (JPCS 2017) which included observations of bowhead migrating through the RSA in Aujaq (end of July to September).

In Admiralty Inlet, bowhead whales were observed during both surveys flown in August. Bowhead sightings were dispersed throughout the Admiralty Inlet grid, including one sighting in a fjord. The Canadian High Arctic Cetacean Survey conducted by DFO in August 2013 calculated a bowhead abundance in Admiralty Inlet of 82 whales (CV=0.97; DFO 2015b). Bowhead whale abundance estimates calculated in 2019 were higher than previous estimates in Admiralty Inlet. The highest estimate for the 2019 MMASP was obtained from the 25–27 August survey with an estimate of 834 bowhead whales (CV=0.50, 95% CI of 334–2,080). The lowest estimate for the 2019 MMASP was obtained two days later from the 29–30 August survey with an estimate of 472 bowhead whales (CV=0.35, 95% CI of 240–926). In the Admiralty Inlet grid, bowhead relative abundance was higher in 2019 (0.0313 animals/km) than in 2020 (0.0087 animals/km).

Killer Whale

In 2020, killer whales were only seen during the open water season in the Eclipse Sound grid. There appeared to be more killer whales present in Eclipse Sound this year compared to the previous year. In 2020 the highest count of killer whales observed in one day was 67 animals on 26 August from the Bruce Head observation platform, compared to 15 animals on 29 August in 2019 from the MMASP. Relative abundance estimates were 4.5 times greater in 2020 (0.0045 animals/km) than in 2019 (0.0010 animals/km).

Killer whales were first reported in the RSA on 18 August by a Pond Inlet community member (see Section 4.2). Killer whales were observed in the RSA by the Bruce Head Shore-based Monitoring Program on 26 August (Golder 2021). During this observation, 67 killer whales were observed entering the Bruce Head study area from the north. The following day (27 August) killer whales were still being observed in the Bruce Head study area, but they appeared to be leaving the study area, returning north. A killer whale/narwhal herding event was observed on 27 August (see Appendix C for details) by the aerial survey team and it is highly probable that it was the same group of killer whales that were observed on 26 and 27 August by the Bruce Head Shore-based Monitoring Program. During this event killer whales were observed actively herding hundreds of narwhal into Fairweather Bay, where they proceeded to attack and kill numerous narwhal. A narwhal carcass was observed in Fairweather bay on 29 August. Killer whales were last observed in the RSA on 29 August, where three groups of killer whales (31 whales) were observed travelling eastbound in the Pond Inlet stratum and appeared to be leaving the RSA.

The presence of killer whales in the Eclipse Sound grid during aerials surveys may have influenced survey results as discussed in Section 4.2.3.

Beluga Whale

Beluga whale numbers have been consistently low during the present and previous surveys in the RSA. A total of five beluga whales were observed in the RSA during the 2020 MMASP. Four were sighted during Leg 1 and one was sighted during Leg 2. Four beluga whales were observed in the RSA during the 2019 MMASP (Golder 2020a). Beluga whales were not observed during Baffinland surveys from 2013 to 2015 (Elliott et al. 2015; Thomas et al. 2015; Thomas et al. 2016), suggesting their numbers have always been low in the RSA. In 2007 and 2008, beluga whales were observed in the RSA in small numbers (three animals in 2007 and 59 animals in 2008; Baffinland 2012). Beluga whale were not observed in the Admiralty Inlet grid during the 2019 or 2020 MMASP.

Sperm Whale

Sperm whale have never been seen during any of the previous Baffinland surveys. In 2020, five sightings totalling six sperm whales were recorded during the Leg 2 visual surveys of the Eclipse Sound grid (see Table 10). The first sighting of a single sperm whale was observed on 20 August in the Eclipse Sound West stratum (Appendix B, Figure B-10). During Leg 2 Survey 3 on 29 August, four sightings of five sperm whales were observed in the Pond Inlet strata (Appendix B, Figure B-14). In 2018, two sperm whales were spotted near Pond Inlet from a boat by Brandon Laforest, a World Wildlife Fund scientist while working in the area (CBC News 2018). Mr. Laforest also noted in the CBC article, that back in 2014 local hunters had spotted sperm whale in the area. IQ collected by Jason Prno Consulting (2017) indicated that sperm whale were historically observed in the RSA, though these anecdotal observations are scarce. The more regular occurrence of sperm whale in the area may be a sign of underlying shifts in the ecosystem.

Pinnipeds

Pinniped data collected in 2019 and 2020 should be interpreted with caution due to the relative difficulty in observing seals at survey altitudes of 305 m (1,000 ft) ASL. Apparent differences in sighting data may result from changes in survey conditions and ability of MMOs to identify species rather than actual changes in pinniped numbers or distribution.

Ringed Seal: Ringed seals were sporadically distributed throughout the survey area during the 2020 MMASP, similar to what was observed in previous years (Elliott et al. 2015; Thomas et al. 2015, 2016; Golder 2020a). During Leg 1, ringed seal relative abundance was higher in 2020 (0.036 animals/km) than in 2019 (0.020 animals/km). This may be attributable to the different environmental conditions observed between the two years, where 2019 had much less ice in the survey area compared to 2020 when Leg 1 surveys were flown. During Leg 2, ringed seal relative abundance in the Eclipse Sound grid was also higher in 2020 (0.0736 animals/km) than in 2019 (0.0047 animals/km). A similar pattern was observed in the Admiralty Inlet grid where ringed seal relative abundance was higher in 2020 (0.0830 animals/km) than in 2019 (0.0122 animals/km). Ringed seal observations provide relative abundance and distribution information. However, this information cannot be used to reliably assess the effects of Project shipping or obtain accurate abundance estimates.

Harp Seal: Harp seals were distributed primarily in northern Navy Board Inlet and Pond Inlet strata in the Eclipse Sound grid during Legs 1 and 2 of the 2020 MMASP, similar to what had been observed in previous years (Elliott et al. 2015; Thomas et al. 2015, 2016; Golder 2020a). In Admiralty Inlet, harp seals were primarily observed in Admiralty Inlet North stratum during the 2020 MMASP, similar to what was observed in the 2019 MMASP.

During Leg 1, harp seal relative abundance was much higher in 2020 (0.158 animals/km) than in 2019 (0.029 animals/km). This may be attributable to the different environmental conditions observed between the two years, where 2019 had much less ice in the survey area compared to 2020, or to a greater number of harp seals in the RSA in July 2020. Harp seal numbers in the RSA have been variable during aerial surveys from 2013 to 2020. The highest count of harp seals recorded on one survey was 80 sightings totalling 1,005 individuals on 16–17 September 2014 (Thomas et al. 2015). During Leg 2, harp seal relative abundance in the Eclipse Sound grid was similar in 2020 (0.0448 animals/km) to 2019 (0.0527 animals/km). In the Admiralty Inlet grid, harp seal relative abundance was higher in 2020 (0.3685 animals/km) compared to 2019 (0.1495 animals/km). Harp seal observations provide relative abundance and distribution information. However, this information cannot be used to reliably assess the effects of Project shipping or obtain accurate abundance estimates.

Bearded Seal: Similar to previous years, only a few bearded seals were observed during the 2020 MMASP. Three sightings were recorded during Leg 1 in the Eclipse Sound Grid, and one sighting was recorded in the Admiralty Inlet grid during Leg 2. Limited IQ has been collected regarding the overall abundance of bearded seal. Some Elders in the Baffin region have observed a decrease in bearded seal abundance since the advent of firearms and motorized transportation (Baffinland 2010). In contrast, one Elder noted that bearded seal were rare near Pond Inlet in the past but are now more frequently observed.

Hooded Seal: One hooded seal was recorded during Leg 2 surveys in Admiralty Inlet in 2020. This was the first sighting of a hooded seal observed during the Baffinland aerial survey programs. Small numbers of hooded seals appear in Lancaster Sound and northwest Baffin Bay during July and August and they are occasionally sighted along the northeast coast of Bylot Island during the fall. Hooded seals were rare in Eclipse Sound (Koski and Davis 1979) and generally remained in northwest Baffin Bay until October (Koski and Davis 1979; Koski 1980). Limited IQ has been collected regarding the numbers of hooded seals in the RSA. It was noted during the 2015 workshops that hooded seals were rare in the RSA but sometimes hunted (JPCS 2017).

Walrus: One walrus was recorded during the Leg 1 surveys in Eclipse Sound in 2020. Walrus have rarely been observed during the Baffinland aerial survey programs. In 2014, three sightings totalling four individuals were recorded during a survey on 3-4 August (Thomas et al. 2015). In 2015, one walrus was recorded during one survey on 31 August (Thomas et al. 2016). IQ indicates that small numbers of walrus occur near the mouth of Navy Board Inlet and in Lancaster Sound to the west of Admiralty Inlet (Baffinland 2010). During the 2015 workshops, IQ indicated the Navy Board Inlet floe edge had more walrus present than at the Pond Inlet floe edge (JPCS 2017).

Polar Bear

Polar bear sightings have been regularly recorded during the Baffinland aerial survey programs. The distribution of polar bears in 2020 was similar to what was observed during previous aerial surveys. In the Eclipse Sound grid polar bears were more likely to be recorded in the Navy Board Inlet and Pond Inlet strata. In the Admiralty Inlet grid, polar bears were recorded throughout the study area, although in 2020 most sightings were recorded in the Admiralty Inlet South stratum. Because most polar bear sightings are of polar bears on shore (i.e., when in transit), they are not included in the relative abundance estimates. Relative abundance estimates include only sightings seen on transect. Polar bear observations provide relative distribution information but cannot be used to assess effects of Project shipping or reliable abundance estimates.

5.0 SUMMARY

The 2020 MMASP addressed Project Certificate No. 005 Terms and Conditions 101, 107, 108, 109, 111, and 126. Table 24 demonstrates how Project Certificate Terms and Conditions were met through the 2020 MMASP.

Table 24: NIRB Project Certificate No. 005 Terms and Conditions relevant to the 2020 MMASP.

Project Certificate Terms and Conditions	Condition / Evidence of Conditions Met
101	Efforts to involve Inuit in monitoring studies at all levels: ■ Inuit involvement was not possible for the 2020 season due to the COVID-19 global pandemic and operational restrictions. Monitoring protocols that are responsive to Inuit concerns: ■ Aerial surveys allow for evaluation of narwhal large-scale displacement effects, abandonment of the RSA, moderate to large changes in stock size. ■ Although not designed to assess ringed seal abundance in the RSA, the MMASP reports on values of relative abundance for ringed seals. Schedule for periodic aerial surveys as recommended by the MEWG: ■ Aerial surveys were conducted in 2019 and 2020.
107	Surveillance monitoring to improve the likelihood of detecting strong marine mammal responses occurring ahead of the ship. ■ Leg 1 aerial surveys flown during the early shoulder season prior to and during icebreaking operations can detect changes is distribution and relative abundance.
108	Data produced is analysed rigorously by experienced analysts.
109	Conduct a monitoring program to confirm the prediction in the FEIS: ■ Aerial survey can measure effects at the narwhal population and/or stock level including evaluation of large-scale displacement effects or abandonment of the RSA.
111	Develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring: ■ Conducted statistical analyses to compare the values of the current aerial survey to past aerial surveys.
126	Design monitoring program to ensure that local users can assist with monitoring and evaluating potential impacts: ■ Inuit involvement was not possible for the 2020 season due to the COVID-19 global pandemic and operational restrictions.

Results from the 2020 aerial survey indicated: i) narwhal abundance in Eclipse Sound was statistically lower in 2020 than in previous aerial survey years carried out in the RSA (2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to that observed in previous years (2013 and 2019). These results suggest a potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020 but cannot discount the possibility of a potential displacement of these animals to another area (e.g., Eastern Baffin Bay summering ground) or a potential decrease in the Eclipse Sound summer stock.

These findings are not consistent with impact predictions made in the FEIS Addendum for the ERP, which stated that the Project is unlikely to result in significant residual adverse effects on narwhal in the RSA (defined as effects that would compromise the integrity of the population either through mortality or via large-scale displacement or abandonment of the RSA). However, the addition of new stressors in 2020, including the Small Craft Harbour Construction in Pond Inlet, have made the causal-relationship between the Project and the results indeterminate. Nevertheless, based on the results of the 2020 MMASP, further investigation regarding the cause(s) of the observed decrease in Eclipse Sound narwhal stock is warranted (Golder 2021a; see Appendix E).

6.0 RECOMMENDATIONS

The following recommendations should be considered with respect to future aerial survey monitoring program:

- To better understand potential short-term, long-term and cumulative effects of icebreaker noise on narwhal during the early shoulder season, Golder recommends that Baffinland implement follow-up monitoring programs in 2021, including the MMASP. However, if pile driving for the Small Craft Harbour Construction at Pond Inlet continues under similar conditions in 2021, results of the 2021 MMASP may, again, not be a reliable indicator of Project-related effects.
- Despite the existence of uncertainty with respect to the cause of the observed effect in 2020, it is recommended for Baffinland to implement additional mitigation actions during shoulder season shipping in 2021 to lower the potential for additive effects of icebreaking alongside other potential contributors to changes in the narwhal population (see Appendix E for mitigation options).
- To address the uncertainty that exists as to the cause of the 2020 decline in abundance of the Eclipse Sound narwhal summer stock abundance, Golder recommends that a 'High Action Development Plan' be developed by Baffinland in consultation with relevant parties (see Appendix E for elements to be included in 'High Action Development Plan').
- Given the regional nature of some of the potential causes of the 2020 abundance change, Golder recommends that additional desktop investigation be developed with oversight and input from the responsible parties and include IQ and community involvement (see Appendix E for potential desktop investigation).

7.0 CLOSURE

We trust that this report meets your immediate requirements. If you have any questions regarding the content of this report, please do not hesitate to contact the undersigned.

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APPENDIX A

MMO Training Manual

REPORT

2020 Marine Mammal Aerial Survey Program

Training Manual

Submitted by:

Golder Associates Ltd.

102, 2535 - 3rd Avenue S.E., Calgary, Alberta, T2A 7W5, Canada

1663724-219-R-Rev0-39000

2 July 2020

Distribution List

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1.0 INTRODUCTION

The Marine Mammal Aerial Survey Program (MMASP) represents one of several programs that were developed to support the Mary River Project (the Project). The MMASP is part of the Marine Monitoring Program (MMP) for marine mammals, in accordance with Project Certificate (PC) terms and conditions issued for the Project. This manual was developed by experienced marine mammal observers to help train other biologists who may or may not have aerial survey experience.

A marine mammal observer (MMO) is a person with training in marine mammal survey techniques. These survey techniques include spotting and identifying marine mammals, determining location of sightings and their movement, and recording environmental variables.

This MMASP training manual will cover the following:

- objectives of the MMASP
- health and safety
- field program overview and procedures
- survey equipment
- data collection, management, and backup

2.0 PROGRAM OBJECTIVES AND OVERVIEW

The 2020 MMASP is proposed to occur during three separate survey legs: Leg 1 (early shoulder season), Leg 2 (open-water season) and Leg 3 (late shoulder season). The Leg 1 surveys are proposed to occur over a 14-day window in mid-July, during the staging period when narwhal and other marine mammals await ice break-out prior to their entry into Eclipse Sound and Milne Inlet. The objective of the Leg 1 surveys is to determine the relative abundance and distribution of narwhal near the Pond Inlet floe edge prior to and during initial shipping and icebreaking operations. These surveys aim to address identified data gaps for marine mammals along the floe edge during the early shoulder season. Leg 2 surveys are proposed to occur over a 14-day window in mid-August corresponding with the peak open-water period. The objective of Leg 2 surveys is to obtain an updated (2020) abundance estimate for the Eclipse Sound and Admiralty Inlet narwhal summer stocks, as well as for other marine mammal species in the Regional Study Area (RSA). Survey design and data collection methodology previously developed by Fisheries and Oceans Canada (DFO) (Matthews et al. 2017; Marcoux et al. 2016; Doniol-Valcroze et al. 2015; Asselin and Richard 2011; Golder 2020) will be used to allow for a comparison to previously reported abundance estimates. Leg 3 surveys are proposed to occur over a 2-day period in late October corresponding with the end of the shipping season. The objective of the Leg 3 surveys is to conduct a visual clearance survey to confirm that no narwhal entrapment events have occurred in the RSA following completion of Baffinland's 2020 shipping operations along the Northern Shipping Route.

3.0 HEALTH AND SAFETY

3.1 Aircraft

Leg 1 and 2 surveys will be flown in a de Havilland Canada DHC-6 Twin Otter aircraft operated by Kenn Borek Air Ltd. (Ken Borek; Figure 1). This short takeoff and landing utility aircraft seats 19 passengers, has a maximum range of approximately 4.5 hours or 1207 km (750 miles) and a cruise speed of 265 km/h (165 mph).

Kenn Borek's safety management system is consistent and aligned with Transport Canada's highest airline standard complete with Emergency Response Plan and Quality Assurance Program. Kenn Borek continuously monitors and develops the following safety objectives:

- Non-punitive Policy
- Proactive Reporting
- Annual Goal Setting
- Management of Change / Risk Management Program
- Corrective Action Planning and Quality Assurance Oversight
- Continuous promotion of a safe and just culture by all Kenn Borek Air management

Figure 1. Aircraft de Havilland Canada DHC-6 Twin Otter operated by Kenn Borek Air Ltd.

Leg 3 surveys may be flown in a de Havilland Canada DHC-6 Twin Otter aircraft operated by Kenn Borek or in a Dornier Do 228 twin-turboprop STOL utility aircraft operated by Summit Air (Figure 2). The Dornier is a short takeoff and landing utility aircraft that seats 19 passengers, has a maximum range of approximately 10 hours and has cruise speed of 413 km/h (257 mph).

In addition to Summit Air's 360-degree safety management system, they use audits by Transport Canada and existing or potential clients to improve their processes and practices.

Summit Air has developed a Safety Management System (SMS) capable of:

- Identifying or trapping unsafe actions
- Initiating corrective actions
- Continuously monitoring and evaluating operations

The components of our SMS system include:

- Reactive Reporting
- Proactive Reporting
- Investigation & Analysis
- Risk Management & Assessment
- Corrective Action Plan Review
- Trend Analysis

Figure 2: Aircraft Dornier Do 228 twin-turboprop operated by Summit Air.

3.2 Personnel

MMOs are expected to familiarize themselves with aircraft exit locations and safety equipment on-board the aircraft. This information will be reviewed during the safety briefing prior to each flight. In addition to aircraft safety, all MMOs must read and understand the MMASP program-specific Health, Safety, Security and Environment (HSSE) Plan which will be reviewed prior to the start of MMASP related work. A major component of the HSSE Plan is the identification of potential health and safety hazards associated with the MMASP including environmental conditions and MMO activities and the implementation of the controls necessary to minimize the risk to people. The program-specific HSSE Plan is based on the assessment of previous worksites and similar activities, and is a dynamic document that can be modified if things change during the MMASP. The HSSE plan will typically cover the following information:

- personnel contact information
- emergency contact information
- Safe Work Practices and Procedures
- toolbox meetings (to be completed at the start of every day)
- incident reporting

4.0 FIELD PROGRAM

4.1 Survey Area

Two survey grids (Eclipse Sound and Admiralty Inlet) encompass the survey area for the 2020 MMASP. Eclipse Sound Grid is divided into nine strata (Baffin Bay, Pond Inlet, Eclipse Sound East, Eclipse Sound West, Navy Board Inlet, Tremblay Sound, Milne Inlet North, Milne Inlet South, and Fjords; Figure 3). Admiralty Inlet Grid is divided into three strata (Admiralty Inlet North, Admiralty Inlet South, and Fjords; Figure 3).

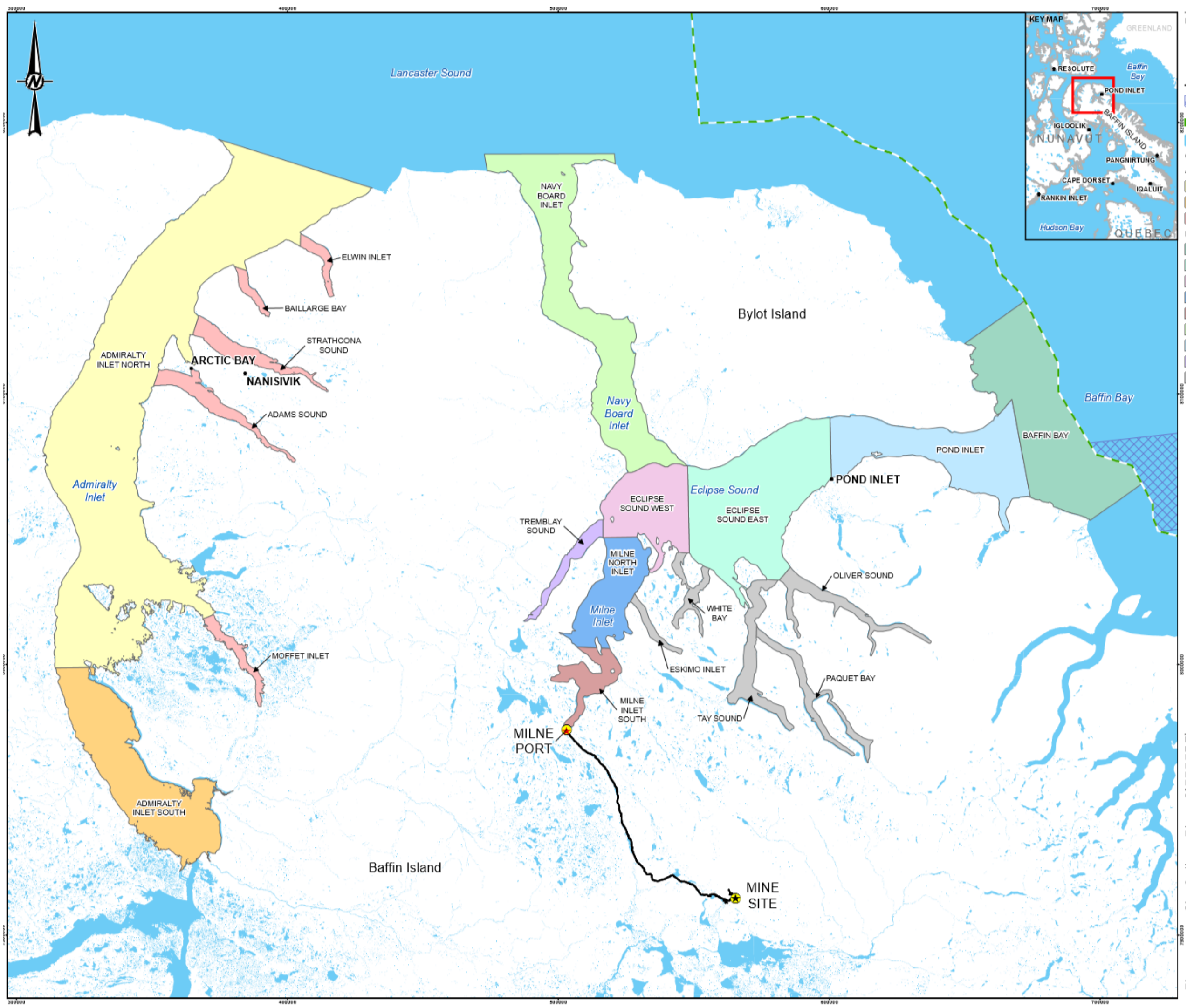


Figure 3. Geographic strata for Eclipse Sound Grid (on the right) and Admiralty Inlet Grid (on the left).

Leg 1 study area encompasses the Eclipse Sound Grid and is based on the boundaries flown in previous surveys from 2013–2016 (DFO 2017; Golder 2017), with the addition of a Baffin Bay stratum (Figure 3). Leg 1 is designed to focus in the open-water area around the floe edge (blue and yellow/orange lines in Figure 4) in the Baffin Bay or eastern Pond Inlet strata where narwhal are known to stage prior to entering Eclipse Sound. Reconnaissance flights will be flown periodically in Tremblay Sound, Eclipse Sound and Milne Inlet to verify narwhal presence/absence. If narwhal are observed in these strata, the entire survey grid will be flown, including all strata (switching from yellow/orange floe edge line and blue transect lines to red transect lines in Figure 4).

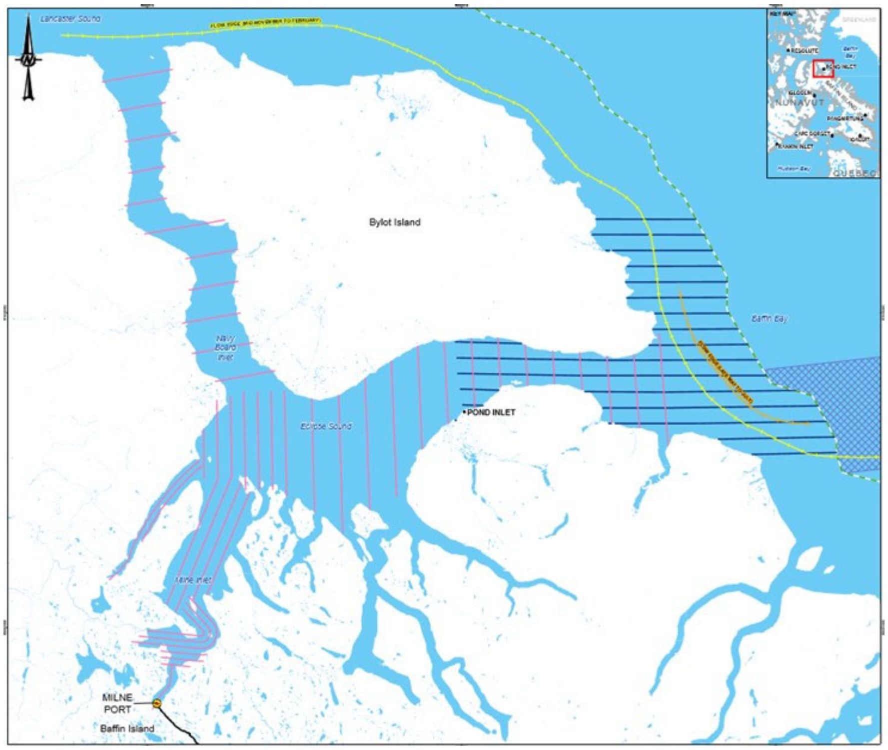


Figure 4. Leg 1 transect lines for the Eclipse Sound study area.

Leg 2 will survey Eclipse Sound Grid and Admiralty Inlet Grid within a two- to three-day period to obtain an estimate of narwhal abundance in the combined areas. The boundaries for the Eclipse Sound Grid are the same as those for Leg 1 with the exclusion of the Baffin Bay stratum (see Figure 3). As during Leg 1, systematic random visual line-transect surveys will be flown for all strata (except Tremblay Sound and Milne Inlet South where photographic surveys will be conducted) with the location of the first line chosen at random (Figure 5). A photographic survey with complete coverage will be flown for the Tremblay Sound and Milne Inlet South strata. Reconnaissance flights in Eclipse Fjords will be flown when time and weather permits.

The boundaries for Admiralty Inlet are divided into three strata (see Figure 5). Systematic random visual line-transect surveys will be flown for the North and South strata with the location of the first line chosen at random (Figure 5). Reconnaissance flights in the fjords will be flown when time and weather permits.

During visual line-transect surveys, if large aggregations (e.g., >50 narwhals or when observers indicated that they could not accurately keep up with narwhal counts) are identified, a photographic survey will be flown with complete coverage over the group to allow for accurate counts of animals. To identify aggregations observed during visual surveys, all personnel on board the aircraft were instructed to look out for herds of narwhals and alert everyone when one was sighted. When such an aggregation was located, lines would be flown in a cross pattern over the group, to determine its spatial extent. Using pre-planned survey grids, the aggregation will be photographed using a systematic grid with complete coverage as seen in Figure 5 for the Milne Inlet South and Tremblay Sound strata.

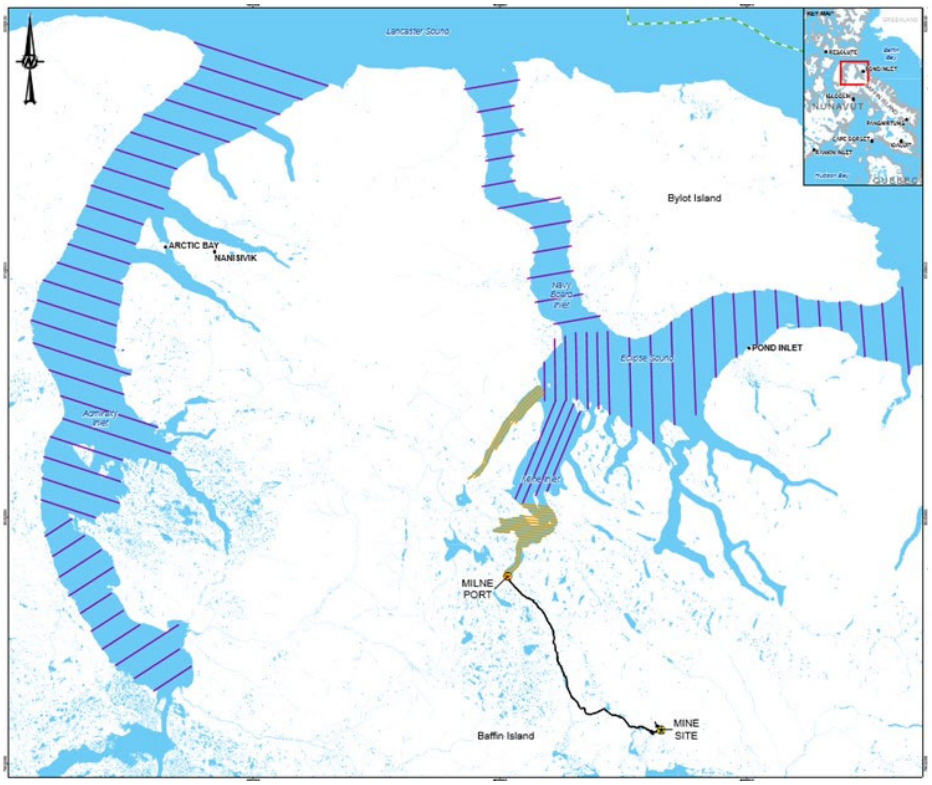


Figure 5. Leg 2 transect lines for the Eclipse Sound and Admiralty Inlet study areas.

Leg 3 study area will focus on the Eclipse Sound Grid with the exclusion of the Baffin Bay stratum. Leg 3 will be flown as a visual clearance survey to confirm that no narwhal entrapment events have occurred in the RSA following completion of Baffinland's 2020 shipping operations along the Northern Shipping Route. Areas flown in this survey will include areas of high ice concentrations along the shipping corridor and areas of known past entrapments.

4.2 Flight and Observational Procedures

Each survey will be flown along the transect lines at a target altitude of 305 m (1,000 feet) with a target speed of 185 km/h (100 knots). The survey aircraft for Legs 1 and 2 will consist of a de Havilland Twin Otter 300 equipped with four bubble windows on the sides and a large belly window used for cameras. MMOs will be stationed at the front and rear bubble windows that provide a view of the track line directly below the aircraft. Visual surveys will be conducted as a double-platform experiment with independent observation platforms at the front (primary) and rear (secondary) of the survey plane. The two observers stationed on the same side of the aircraft will be separated visually and acoustically to achieve independence of their conditional detections. A fifth member of the survey team will be responsible for overseeing camera operations, data entry, and navigation along the survey grid.

Observers will focus on the area closest to the track line and use their peripheral vision for sightings farther afield. Primary observers will record every marine mammal sighting by speaking into a hand-held audio recorder to supplement the data being collected in real time in Mysticetus. Secondary observer will also record every marine mammal sighting in a hand-held audio recorder, as well as enter partial observation records in Mysticetus. Each sighting record will include information on time, species type, group size, group composition (presence of calves, mother/calf pairs, adults, number of tusks, etc.), direction of travel (heading), speed of travel, sighting cue, behaviour, and activity. A group is defined as animals within one to a few body lengths of each other and oriented or moving in a similar direction. Observers will give priority to estimating group size, especially when densities are high, followed by other variables (direction of movement, presence of young, number of tusks) if time permits. Geometers will automatically assign the perpendicular declination angle of each sighting in the Mysticetus program for the primary and secondary observers. Position and altitude of the plane will be recorded every second using a GPS connected to a laptop running Mysticetus. A dedicated Bluetooth GPS unit and iPad will also be used to track the aircraft location using specialized navigational mapping software (Foreflight pre-programmed with the survey transect grid).

Observational conditions (environmental data) will be recorded onto the audio recorders by the primary observers at the start of each transect and re-stated at any time a change was detected throughout the survey. Conditions will include sea state (Beaufort scale), ice concentration (in tenths), fog (% cover in field of view and intensity), and glare (% of forward field of view and intensity). Environmental data will be entered into Mysticetus after each flight.

4.3 Photographic Data

To supplement visual observations, the aircraft will collect continuous photographic records below the aircraft using dual oblique cameras pointing downwards towards either side of the track line. A three-second interval between photographs will allow for a target overlap of 20% between successive photographs along the direction of the aircraft at the survey altitude of 1000 ft above sea level. The aircraft will be fitted with a camera belly port hatch to accommodate a custom camera frame and two Canon EOS 5DS R Digital Single Lens Reflex (DSLR) still cameras.

Each camera will be connected to a laptop and controlled remotely (settings, start and stop). Photographs will be stored in high-resolution RAW format. At the end of each survey photos will be transferred to an external hard drive.

4.4 Photographic Surveys

During visual line-transect surveys, if large aggregations (>50 narwhals or when observers indicate that they cannot accurately keep up with narwhal counts) are identified, a photographic survey will be flown with complete coverage over the group to allow for accurate counts of animals. To better quantify large narwhal aggregations observed on the visual surveys, all personnel on board the aircraft will be instructed to look out for herds of narwhal and alert everyone when one was sighted. When such an aggregation is located, two lines will be flown in a cross pattern over the group to determine its spatial extent. Using the pre-planned survey grid, the aggregation will be photographed using a systematic grid with complete coverage. A five-second interval between photographs will allow for a target overlap of ~25% between successive photographs along the direction of the aircraft at the survey altitude of 2000 ft above sea level. During Leg 2 a dedicated photographic survey will be flown in the Milne Inlet South and Tremblay Sound strata where narwhal are known to concentrate at that time of the year.

5.0 DAILY ROUTINES

Every morning the aerial crew will meet at a designated area to take the bus to the Weather Haven where they will remain for the duration of the day awaiting a weather window for a survey. Once arriving at the Weather Haven a toolbox session will be initiated with the aerial crew and a plan put into motion to either prepare for a survey or to check back in an allotted time if weather conditions are not favorable for a survey. Weather requirements for surveying include a ceiling of greater than 333 m (1,000 ft) and sea states of less than Beaufort level five.

Flight days — If the weather permits a flight, the lead MMO will set up a time for departure. *Punctuality is required*. Delays or missing crew members can force the survey to be canceled. Bring water and food for the flight, keeping in mind that the plane has no toilet. A small bag including toiletries and a coat are also good to bring, as sometimes poor weather may require the use of an alternate landing site. Each MMO will be supplied with a dry suit to wear while working on the aircraft. After a flight, it is important to enter and validate the data as soon as possible. Depending on the landing time, this could be either that evening or the next morning.

Non-flight days — Typical workdays range in length from 8-10 hours depending upon the number of trained staff members available, the weather, and how much data needs processing from the previous day. When no surveys are flown MMO's will be expected to do data entry and validation.

6.0 EQUIPMENT

Clinometer

Depression angle from the horizon to the sighting as determined using a clinometer, when the marine mammal is perpendicular to the aircraft. Use only one clinometer reading for the center of a group (no angle ranges). See Appendix B for instructions of use.

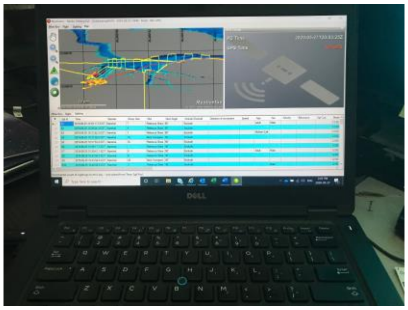
Geometer

When the marine mammal is perpendicular to the aircraft, sight the animal in the center of the scope and press the button on the front of the geometer. This will automatically record sighting time and declination angles of the sighting in the Mysticetus program. This devise can be used instead of the clinometer.

Digital Recorder

Digital recorders will be used to record sighting data and environmental data to be transcribed to the Mysticetus database at the end of each flight.

Laptop with Mysticetus program



The Mysticetus program will be used to record GPS tracks and waypoints (transect start and stop, sightings, and environmental data) during each survey. After each survey, additional data will be entered on a laptop computer into the Mysticetus database. The database is programmed with data forms (drop-down menus) and data entry fields that are specific to the type of data being collected.

Bad Elf GPS

A Bad Elf GPS Pro device will be used to track the aircraft during marine mammal surveys at one second intervals.

Each GPS device should be turned on at the start of the flight by pressing the “ON” button located on the left side of the device. It may take a few minutes for the device to acquire satellites.

The MMO should check the GPS device regularly during the flight to ensure that it has not lost signal and is working properly.

Camera Equipment

Each aircraft will be equipped with two identical camera systems, using Canon EOS 5DS DSLR cameras fitted with 35 mm lens. The cameras will be connected to a laptop computer to control exposure settings and photo interval. The cameras will be installed within the camera hatch on a custom-made mount. Images will be saved directly to the internal camera cards. The cameras will be oriented widthwise (long side perpendicular to the track line) and angled obliquely: one to the port side and the other to the starboard side. See Appendix A for detailed camera setup.

Personal Protective Equipment

Observers will be provided with a dry suit and a headset prior to each flight.

7.0 DATA COLLECTION

Each aerial survey crew consists of five positions: two primary observers (front observer), two secondary observers (rear observers), and the navigator/data manager (Figure 6). The positions are assigned prior to take-off and have different responsibilities, however during long flights positions can be rotated during transit and refuelling to reduce fatigue.

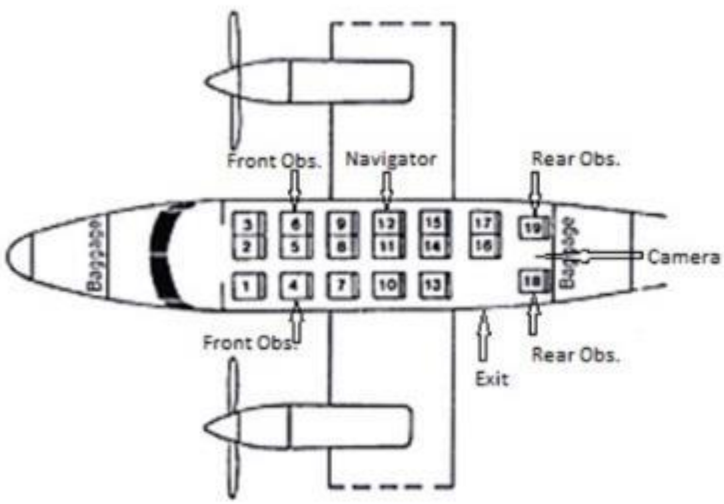


Figure 6: Twin Otter aircraft configuration with aerial crew locations

7.1 Navigator/Data Manager

The navigator/data manager is responsible for setting up the cameras and computer system for surveying. A specially designed electronic database (Mysticetus) with mapping software will be downloaded with the survey track lines so the observers can be notified by the navigator the start and stop point of the transects. Geometers will automatically populate Mysticetus with the date, time, location (i.e. GPS coordinates), observer and declination angle of the primary and secondary observer sightings. Data manager will supplement the sighting data for the primary observer sightings in real time with species and group size along with any additional data verbalized by the primary observers. A drop-down menu is available to facilitate recording data collected during the survey, but some data will be transcribed from the audio recorders into the database after the flight. Supplemental sighting data for the secondary observers will be entered after completion of the survey. Primary and secondary observers are connected to separate computers each running their own version of Mysticetus. A portable GPS unit is plugged into each computer to record GPS positions and waypoints during each flight with the Mysticetus program. The date, time, and GPS coordinates are automatically recorded with each one-second point on the track line.

The data manager will be responsible for keeping a flight log in the Mysticetus database connected to the primary observers. The flight log should have the date, flight number, start (aircraft starts moving) and stop (aircraft stops moving) times, and the survey number for each time the aircraft is flown.

7.2 Primary and Secondary Observers

At the start of the flight, each observer is issued a geometer, synchronized wristwatch, and digital voice recorder. Primary observers sit in the forward right and left seats and collect environmental and sightings data used for analyses. The two most experienced MMOs on the aircraft should be occupying the primary observer positions. Secondary observers sit in the rear right and left seats and are collecting sightings data to be used in the double-platform experiment. The double-platform experiment requires independent observation platforms at the front (primary) and rear (secondary) of the survey plane. The two observers stationed on the same side of the aircraft will be separated visually and acoustically to achieve independence of their conditional detections.

7.2.1 Environmental Data

Environmental conditions are recorded at the start and end of each transect and whenever conditions change within the viewing area (Table 1). The viewing area is estimated out to approximately 1 km from the aircraft (see Appendix B). Four environmental conditions are recorded:

- **Ice tenths cover**: Tenths of the viewing area covered in ice.
- **Beaufort wind force (Beaufort Sea State)**: Visual conditions of the wave height and froth.
- **Glare**: Angle of searching area affected by sun reflection and intensity.
- **Fog**: Percentage of the viewing area obscured due to fog and what intensity.

See Appendix B for examples of the various environmental conditions.

Table 1. Environmental codes.

Environmental Type	Code	Description
Ice Cover	0/10 – 10/10	Ice cover within viewing area
Beaufort Wind Force	0	Sea like a mirror
	1	Ripples with the appearance of scales are formed, but without foam crests
	2	Small wavelets, short but more pronounced. Crests have glassy appearance and don't break.
	3	Large wavelets. Crests begin to break. Scattered whitecaps.
	4	Small waves, becoming longer. Fairly frequent whitecaps.
	5	Moderate waves, taking a pronounced long form. Many whitecaps.
	6	Large waves forming, white foam crests more extensive everywhere. Probably spray.
	7-12	Ranges from a gale to a hurricane.
Glare Angle	0-90 degrees	Angle of viewing area affected by sun reflection

Environmental Type	Code	Description
Glare Intensity	Intense	When animals were certainly missed in the center of reflection angle
	Medium	When animals were likely missed in the center of reflection angle
	Low	When animals were likely detected in center of reflection angle
	None	No glare
Fog Cover	0-100%	Percent fog obscuring viewing area
Fog Intensity	Thick	Dense thick fog that you can't see through
	Moderate	Thick and light fog interspersed, can see through at times
	Light	Light fog that you can see through
	None	No fog

7.2.2 Sighting Data

Sighting data is recorded every time a marine mammal is sighted (Table 2). For examples with descriptions of each sighting type see Appendix B.

Observers will trigger the geometer when a marine mammal is spotted **perpendicular** to the aircraft so the sighting along with the date, time, location, observer and declination angle is automatically entered in the Mysticetus program. Primary observers will notify the Mysticetus operator (i.e. data manager) of the species and group size.

Both primary and secondary observers will record the following additional information about the sighting on their digital voice recorder in order of importance:

- **Time:** hour, minute and second
- **Species**: name of species observed
- **Group size**: number of individuals in group
- **Included/excluded:** on transect or on transit
- **Direction of movement:** clockface direction of movement in relation to the aircraft.
- **Speed:** relative speed of animal's movement.
- **Age/sex:** apparent age of the animal and if tusk present.
- **Behavior:** movements or biological processes in which animal is engaged.
- **Activity:** a collection of behaviors that indicate the animal is working toward an overall goal (e.g., feeding, migrating).
- **Sighting cue:** What alerted you to the sighting?

Table 2: Sighting data codes

Sighting Type	Code	Description
Species	Species (e.g. narwhal)	Narwhal, bowhead, beluga, ringed seal, harp seal, walrus, etc.
Group Size	#	Number of individuals in group (group is defined as animals that are within one body length of each other and oriented or moving in a similar direction).
Clinometer angle	# degrees	Depression angle from the horizon to the sighting as determined using a clinometer, when the marine mammal is perpendicular to the aircraft. Use only one clinometer reading for the center of a group (no angle ranges). If using a geometer, sighting time and depression angle are automatically stored on a laptop with the press of the button. Clinometers will only be used if needed.
Include/Exclude	Include	A sighting seen within the field of view on transect, at the surface or clearly visible just below surface, and at survey altitude.
	Exclude	If the sighting is seen on transit, or outside the field of view (i.e. behind the aircraft or well beyond 1 km), or barely visible below surface, or seen when flying above normal survey altitude (i.e. on transit flights).
Direction of movement	Clockface 1-12	Clockface direction of movement in relation to the aircraft. 12 o'clock means animal is moving in same direction as aircraft.
Speed	Fast	When animal is swimming rapidly through the water, often associated with splashes.
	Moderate	When animal is swimming moderately through water, often associated with trail behind animal.
	Slow	When animal is swimming slowly through water, but trail barely visible in water.
	Not moving	Animal is stationary, no movement.
Age	# adults	Large whitish animals should be assumed to be adults. Dark animals that are 85% or larger than the length of whitish adults should be assumed to be adults. Code unknown if not sure.
	# juvenilles	Dark in color and 15% smaller than adult. May have short tusk present. Code unknown if not sure.
	# calves	Whitish to grey in appearance and slightly less than half of the length of the adult female. Code unknown if not sure.
Sex	# males	If tusk visible code as male. Code unknown if not sure.
	# females # mother	If no tusk visible and not accompanied by a calf. Code as female. Code as mother if seen with a calf. Code unknown if not sure.

Sighting Type	Code	Description
Activity	Feeding	Animal seen feeding or evidence of prey observed.
	Resting	Animal lying motionless at the surface of the water or on the ice/land.
	Milling	Moving but net movement is near zero, e.g. swimming in circles.
	Socializing	Engaged in social activity (involving more than one animal).
	Traveling	Moving in a distinct direction with a moderate to fast pace.
	Unknown	Nothing recorded.
Behaviour	Hauled out	Hauled out on ice or land (pinnipeds).
	Diving	Animal descends below the surface.
	Swimming	Animal is swimming at the surface.
	Surface activity	Splashing, jumping, flipper or tail slapping, implies social interaction.
	Looking	When animal is in an upright position with its head out of the water and is actively looking at something (pinniped or polar bear).
	Walking	Polar bear walking on ice or land.
	Breaching	When a whale leaps with its entire body out of the water.
	Spyhopping	When a whale raises its head vertically out of the water so that its eyes are clear of the surface.
	Fluking	When a whale raises its fluke as it dives beneath the water.
	Blow	When whale releases air from its lungs at the surface of the water, observed as clouds of moist air. Can be visible at far distances.
	Surfacing	When a marine mammal is observed coming to the surface of the water.
	Unknown	Nothing recorded.
Sighting cue	Blow	Whale exhales breath at surface of water seen as a watery mist
	Body	Body or marine mammal
	Footprint	Surface of the water looks disturbed and are made when a marine mammal has just been on or near the surface of the water.
	Splash	Splashes may be a sign that a marine mammal is present
	Birds	Aggregation of birds may be attracted to marine mammal when they are feeding
	Unknown	Nothing recorded

8.0 DATA MANAGEMENT

One of the most important parts of the work is to carefully record information on all sightings/observations during the survey onto the audio recorders and transcribe that data into the database after every flight. This information is critical to the success of the MMASP Program. A lot of time and mentorship will be spent on training to properly, efficiently and consistently record information.

8.1 Data Transcription

Once the survey is complete, data from the voice recorders must be transcribed into the Mysticetus database for the primary observes or on data sheets for the secondary observers as soon as possible so that people may be able to accurately fill in any data not recorded during the survey. There will be prompts to enable the MMO to enter data efficiently and out-of-range error checking to ensure that only plausible values can be entered into the database. The Mysticetus database includes three types of data: flight data, environmental/effort data, and marine mammal sightings data.

8.1.1 Flight Data

Flight data is recorded by the data recorder during the flight and is assigned waypoints in the tracking program. Flight data includes the following data:

- Date
- Location (Eclipse Sound or Admiralty Inlet)
- Survey number
- Flight number (can take up to four flights to complete a survey)
- Observers and their locations on the aircraft

8.1.2 Environmental/Effort Data

Environmental/effort data are assigned waypoints in the database by the data recorder during the flight. Primary observers will fill in specific information associated with the waypoints after the flight from their audio recordings. Environmental/effort data include the following data:

- Start and stop transects (assigned a waypoint by data recorder during flight)
- Environmental record (assigned a waypoint by data recorder during flight)
- Ice cover for environmental record (filled in by primary observer audio recordings after flight)
- Beaufort wind force for environmental record (filled in by primary observer audio recordings after flight)
- Glare angle and intensity for environmental record (filled in by primary observer audio recordings after flight)
- Fog cover and intensity for environmental record (filled in by primary observer audio recordings after flight)

8.1.3 Sighting Data

Marine mammal sightings are assigned waypoints in the database by the data recorder during the flight. Primary and secondary observers will fill in specific information associated with the waypoints after the flight from their audio recorders. Sighting data include the following waypoints:

- Marine mammal sighting (assigned a waypoint by geometer during flight)
- Species (filled in by data recorder in real time for primary observer or by primary/secondary observer audio recordings after flight)
- Group size (filled in by data recorder in real time for primary observer or by primary/secondary observer audio recordings after flight)
- Clinometer angle (automatically entered by geometer)
- Observer (automatically entered by geometer)
- Include/exclude (filled in by primary/secondary observer audio recordings after flight)
- Direction of movement (filled in by primary/secondary observer audio recordings after flight)
- Speed (filled in by primary/secondary observer audio recordings after flight)
- Age (filled in by primary/secondary observer audio recordings after flight)
- Sex (filled in by primary/secondary observer audio recordings after flight)
- Activity (filled in by primary/secondary observer audio recordings after flight)
- Behaviour (filled in by primary/secondary observer audio recordings after flight)
- Sighting cue (filled in by primary/secondary observer audio recordings after flight)

Once all data have been entered, all electronic entries should be compared to digital recordings again, by a different observer, to check for errors. Backups of the database should be made regularly and stored on an external hard drive and another computer.

8.2 Data Editing

Check your own work at the end of each survey to ensure accuracy. If you note a mistake, and can remember the details, correct it and initial the changes. If you cannot remember, do not make a guess. Missing data are preferable to incorrect data. All columns should be filled out to the best of your ability; there should be no blank spaces in the spreadsheet. Additionally, if you note a mistake by another MMO, bring it to their attention as soon as possible, so it can be corrected.

8.3 Data Storage and Backup

MMOs are required to do the following measures after each survey is complete to help prevent collected data from being lost:

- Data recorded onto the digital recorders must be backed up onto the field computer.
- Mysticetus data should be backed up regularly in several places: external hard drive, lead MMO’s laptop and on the field computer, as coordinated by the lead MMO. Backups should be double-checked to ensure that data were successfully transferred.

The photographic images will be backed up after every flight and a copy made for duplicates.

APPENDIX A

Camera Setup

Camera Setup

Camera Settings

- Mark each camera left or right (small piece of electrical tape with a "L" or "R" in silver permanent marker), mark media cards left or right
- In playback menu, turn rotate tall and image review off.
- In shooting menu set image quality to RAW size large, 14 bit, image area to FX (36X24) 1.0 x with auto DX crop off, color space to RGB, and turn active D-lighting to off.
- In setup menu format both the SD and CF cards and set camera to write to one card then overflow to the next card. Set camera date and time to the precise GPS date and time, do this at the start of every day, check the date-time at the end of every flight when you're back in the hotel to see if there is any drift. If there is drift record it so that true camera times can be estimated to get an accurate match with GPS time.
- Connect cameras to a laptop running the camera control software. Using the camera control software, set cameras to shoot in manual settings, shutter priority of at least 1/1600 s, the aperture can be set on automatic if you expect a large variability in the brightness of the photos, particularly when ice in present in the survey area. Try to balance to keep an f stop that is not wide open as there is some clutter introduced to the pixels when shooting at wide open but do not close the aperture too much either. You can increase the ISO to increase shutter speed but there is some noise introduced to the pixels at the highest ISOs. Setting the ISO at 400 to 800 should be acceptable if you need to go that high to get 1/1600 sec shutter speed. We should do some tests in the aircraft when we get the chance to evaluate the tradeoff between ISO and shutter speed.
- Be careful with AF buttons, make sure they are set manual, if need be tape with electrical tape, remove tape after each flight so that glues do not adhere too much.

Inverter

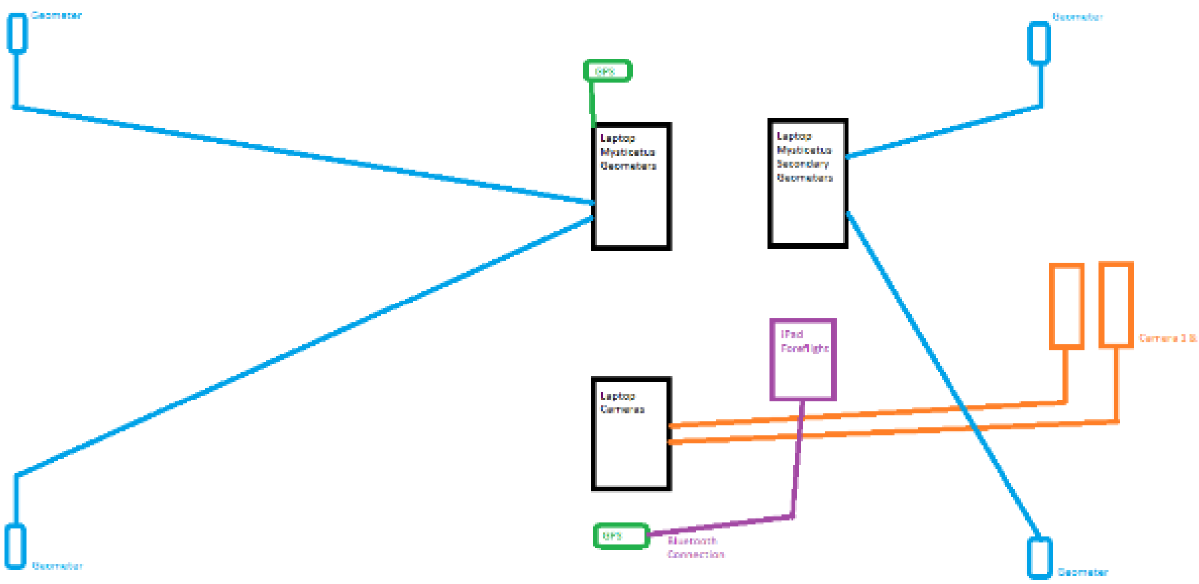
- bring plenty of extension cords, plan layout before flight
- careful with cords draped over seats and along floors, there are pinch points that can cut or damage cables (electrical, antenna, GPS, serial)
- duct tape cords to the walls to keep them from getting in way or being tripped over
- turned on inverter at start of flight before action starts, may have to ask pilot, they usually turn it off when starting aircraft, best to indicate when they look back to check on passengers before beginning taxiing, or after take-off during level flight

Mounting cameras on the frames

- frame, aircraft floor, camera port opening may have sharp edges, be careful
- setup frame, set camera angles depending on how many cameras you intend on using (eg 2, 3 or 4), 2 is usually one looking left and one looking right. If using a 35 mm lens, adjust angles to 27 degrees from centerline using a digital protractor.

- camera image long axis is usually perpendicular to the flight direction to get the maximum strip width
- fit camera to frame before first flight, make sure that lenses are not touching camera port glass and that frame is setup for least vibration, set camera mount delimiters if they are available so that the camera will not touch parts of the aircraft when they are shooting (airframe vibration transferred to camera, damage to glass, damage to camera). Prevent the edges of the camera port from being included in the photos taken.
- connect electrical
- tape connections if you can, especially between AC/DC power supply and dummy battery lead of camera
- carefully mount camera taking care to avoid stretching cables to prevent connectors from coming loose
- fire test shots to verify the centerline is covered in the images

For connecting all equipment in the aircraft refer to image below.



APPENDIX B

Examples of Environmental and Sighting Data

This appendix contains examples of environmental and sighitng data used in the data collection of the MMASP:

Environmental data includes:

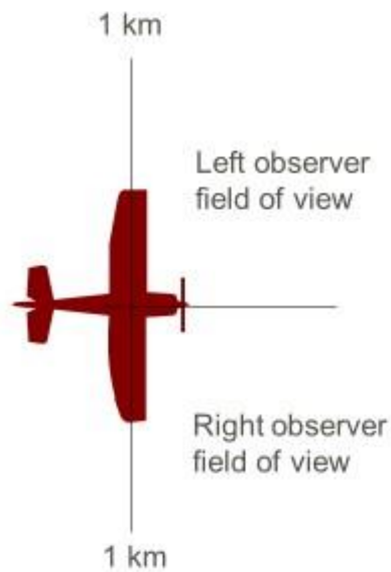
- Ice cover
- Wind force
- Glare
- Fog

Sighitng data contains:

- Species
- Number
- Clinometer
- Include/exclude
- Heading
- Speed
- Age
- Sighting cue
- Behavior
- Activity

Field of View

- Looking forward and to out to the side of the aircraft
- 90 degrees and out to 1 km

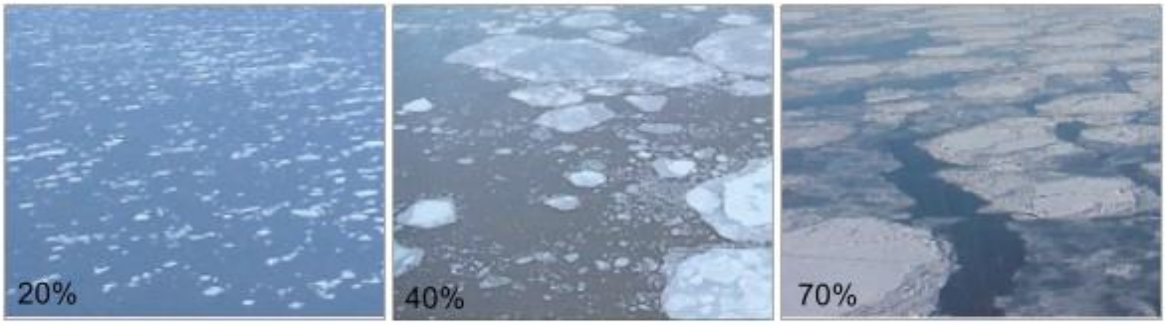


Environmental Data

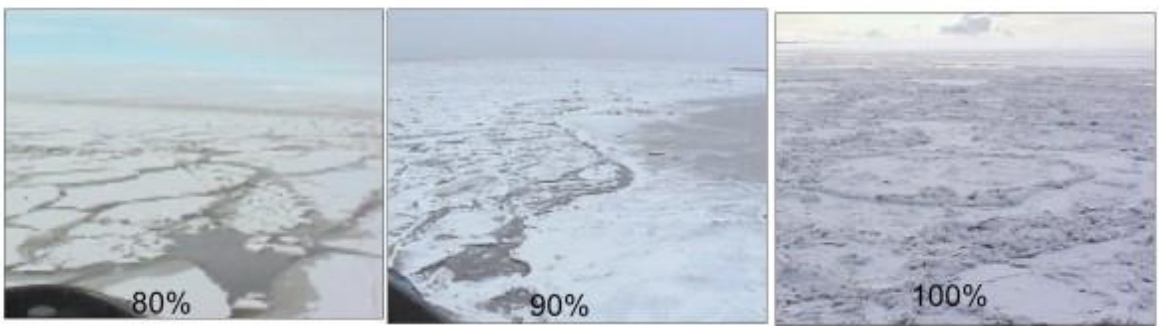
- **Ice cover**
- Wind force
- Glare
- Fog

Subjective

Based on average of conditions



Percent ice cover

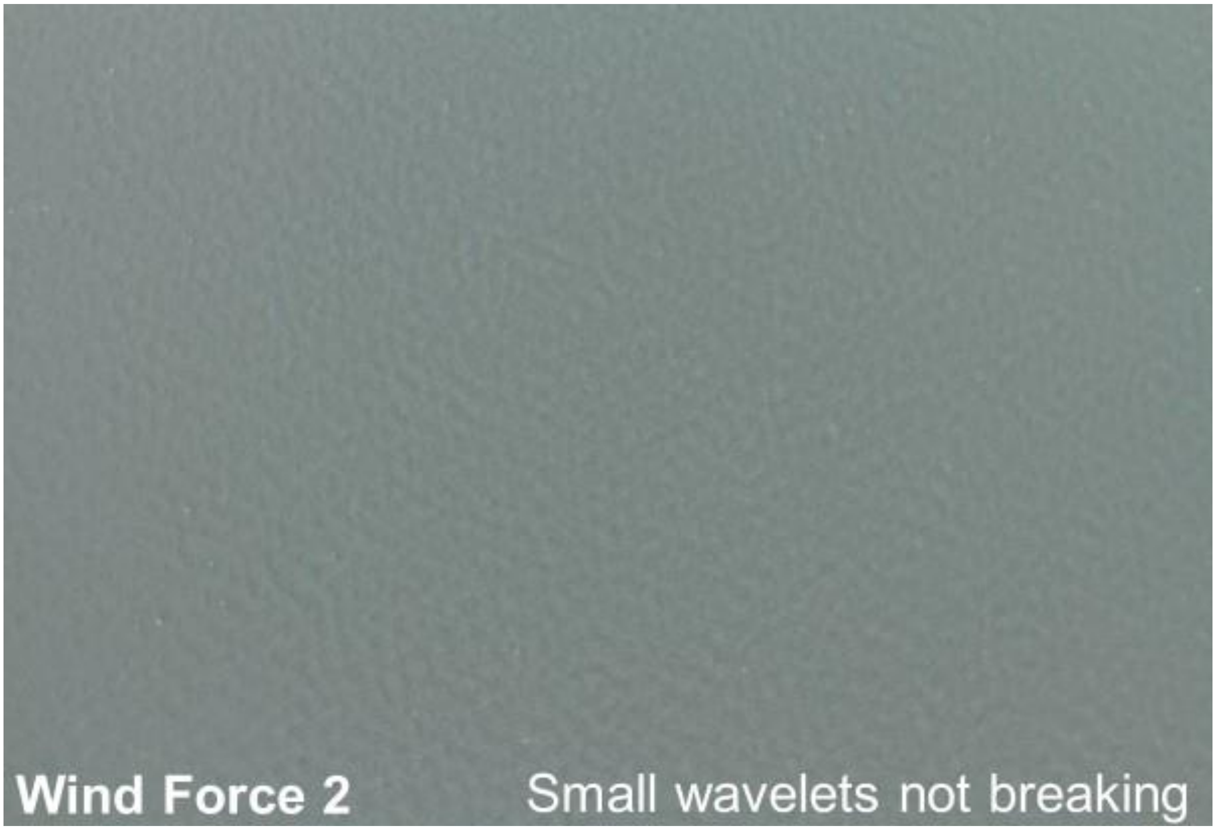


Beaufort Wind Force Chart

Wind Speed Knots	Wind Speed m/s	Beaufort Wind Force	World Meteorological Organization Terms	Wave Height (m)	Description
<1	<0.5	0	Calm	0	Glassy like a mirror
1-3	0.5-1.5	1	Light air	<0.1	Ripples with the appearance of scales but no whitecaps or foam crests
4-6	2.1-3.1	2	Light breeze	0-0.1	Small wavelets, crests have a glassy appearance but do not break (no whitecaps)
7-10	3.6-5.1	3	Gentle breeze	0.1-0.5	Smooth large wavelets, crests begin to break, occasional/scattered whitecaps
11-16	5.7-8.2	4	Moderate breeze	0.5-1.2	Slight; small fairly frequent whitecaps
17-21	8.7-10.8	5	Fresh breeze	1.2-2.4	Moderate waves becoming longer, some spray, frequent moderate whitecaps
22-27	11.3-13.9	6	Strong breeze	2.4-4	Rough, larger waves, longer-formed waves, many large whitecaps
28-33	14.4-17.0	7	Near gale	4-6	Very rough, large waves forming, white foam crests everywhere, spray is present
34-40	17.5-20.6	8	Gale		
41-47	21.1-24.2	9	Strong gale		
48-55	24.7-28.3	10	Storm	6-9	High
56-63	28.8-32.4	11	Violent storm	9-14	Very high


Wind Force 0
Glassy


Wind Force 1
Ripples

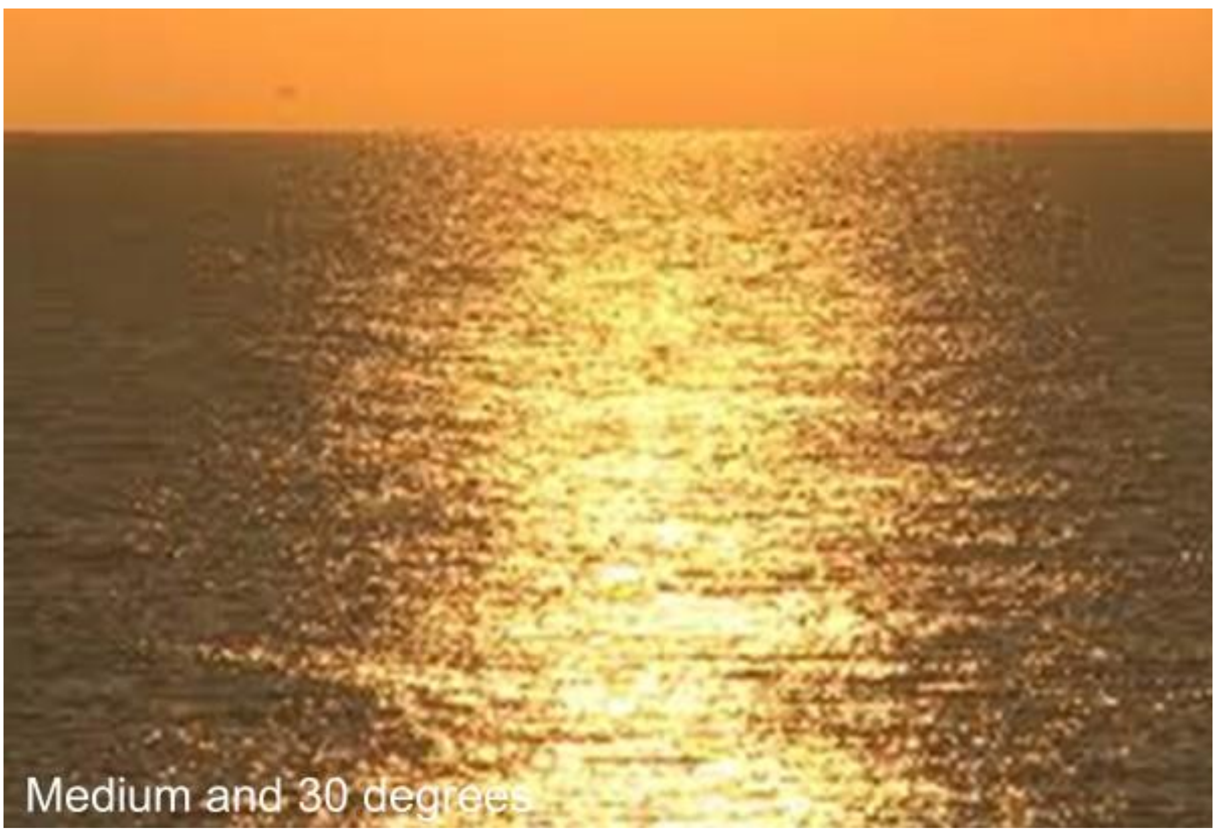

Wind Force 2
Small wavelets not breaking


Wind Force 3
Scattered white-caps


Wind Force 4
Frequent white-caps


Glare
Two measurements:
• Degree - angle of viewing area affected by sun reflection (0-90 degrees)
• Intensity – intense, medium, low, or none


Intense and 10 degrees


Medium and 30 degrees

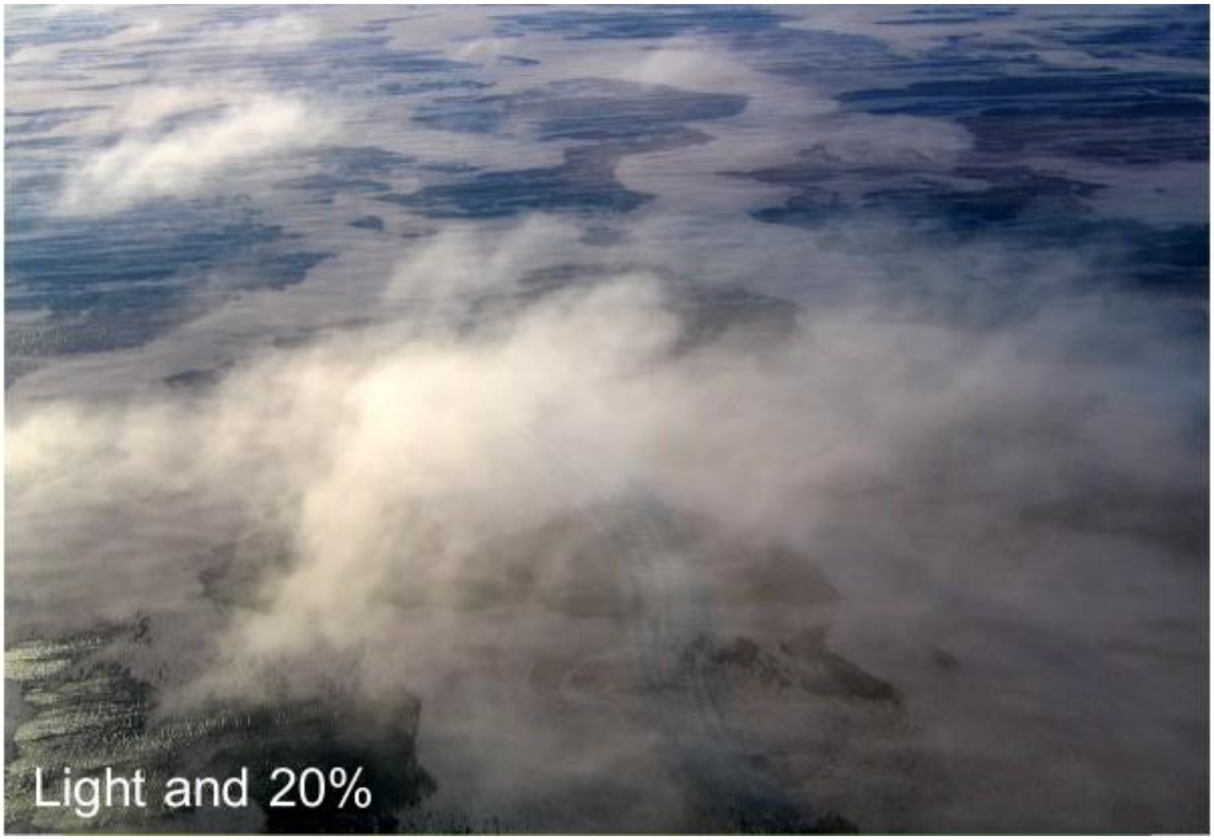
Fog

Two measurements:

- Percent - percent fog obscuring viewing area (0 - 100 %)
- Intensity – thick, moderate, light, or none

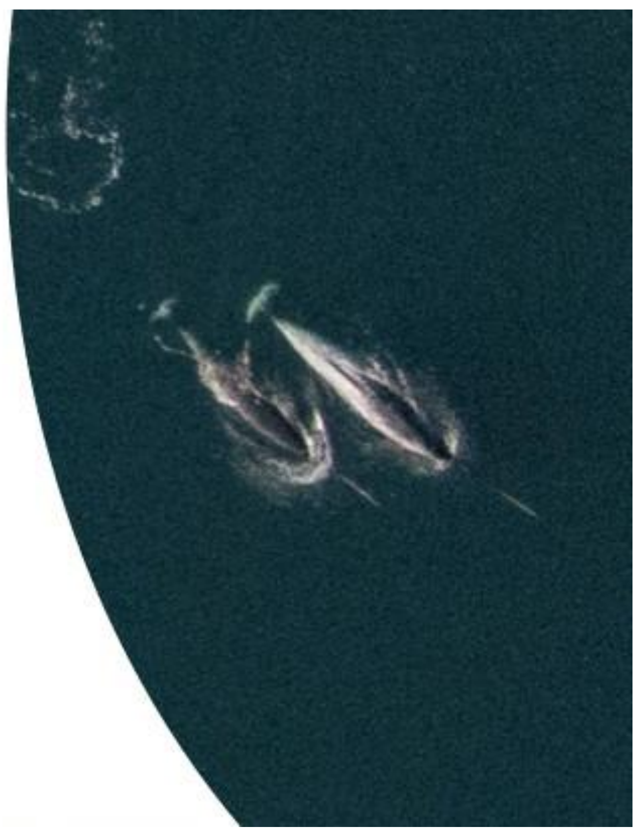

Thick and 100%

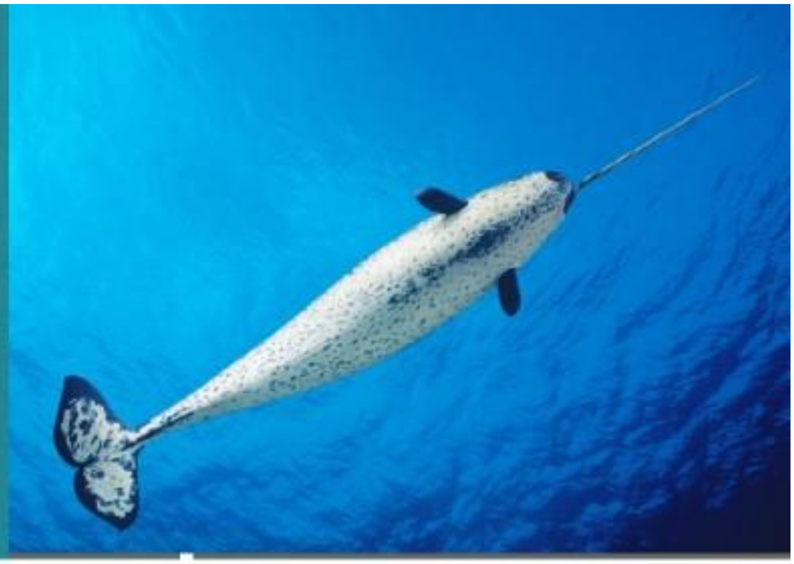

Moderate and 100%



Sighting Data

- Collected for each sighting:
  - **Species**
  - Number (group size)
  - Clinometer angle
  - Include/exclude
- Collected if time:
  - Heading
  - Speed
  - Age
  - Sighting Cue
  - Activity/Behavior





Narwhal

- small whale 4.2 to 4.7 m
- low bushy blow
- spotted black and white coloration
- males have a tusk
- tail convex on trailing edge

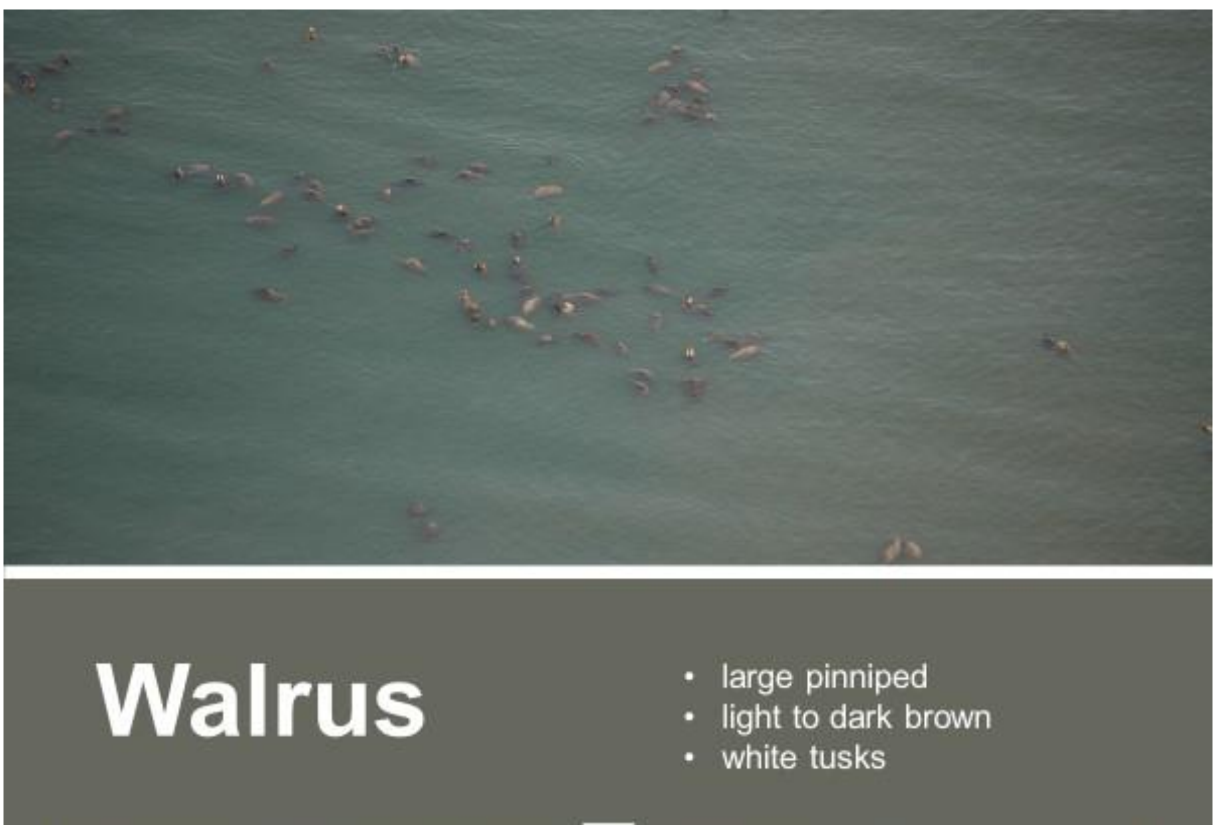
Beluga

- small whale 2.7 to 4.2 m
- low bushy blow
- adults white and calves are gray


Bowhead
• large whale
• hump near blowhole
• can have white on chin and tail
• blows are v-shaped


Killer Whale
• mid-sized whale 9 m
• dorsal fin
• black with white patches


Seals
• Ringed Seal
• Harp Seal
• Bearded Seal


Walrus
• large pinniped
• light to dark brown
• white tusks

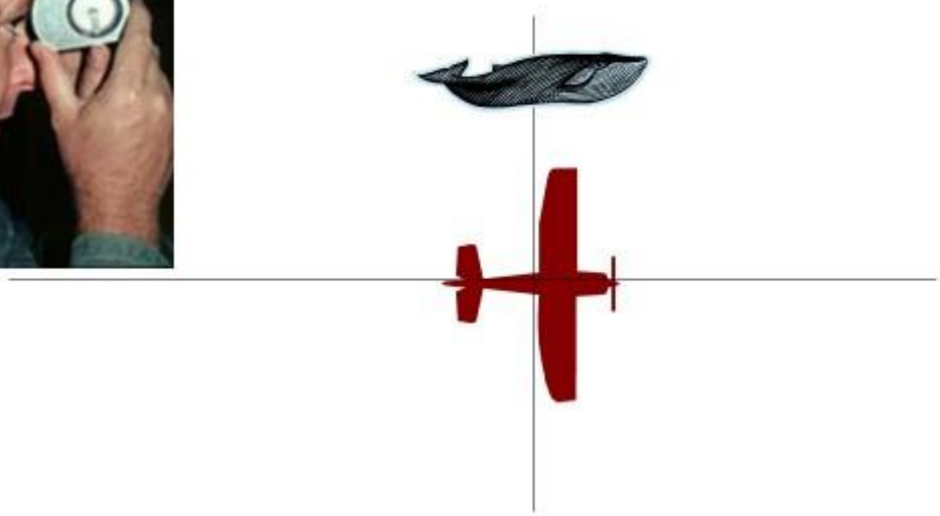
Polar Bear

Group Size

- Number of individuals in group (group is defined as animals that are within one or a few body lengths of each other and oriented or moving in a similar direction)

Using Clinometers

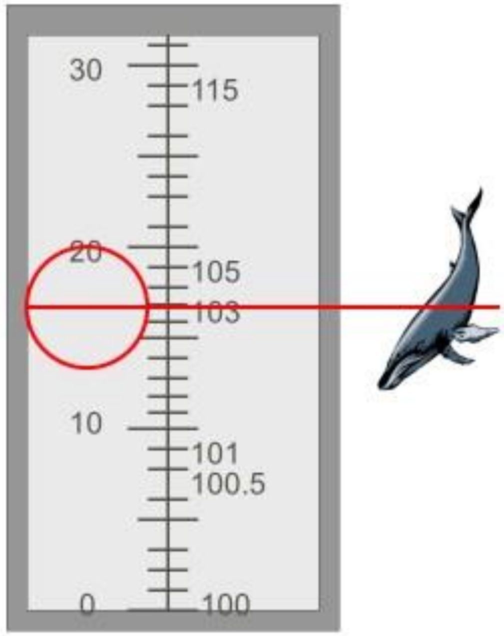
- Wait until the plane is perpendicular to the sighting. Then keep both eyes open and, looking though the inclinometer, line up the horizontal line with the center portion of the animal.
- Record the number on the **left** that the horizontal line passes through.
- If a group of several animals is sighted, measure from the center of the group.



•**Keep both eyes open!**

•Line up mammal with horizontal line (use middle of mammal)

•Use scale on left = **17**



Include / Exclude

Include

- Sighting is on transect, within the field of view, at the surface or clearly visible just below surface, and at survey altitude

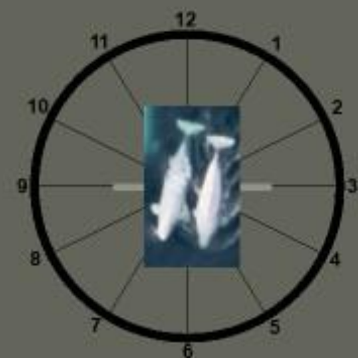
Exclude

- Sighting is on transit or outside of the field of view (i.e. behind the aircraft or well beyond 1 km distance), or barely visible below surface, or seen when flying above normal survey altitude (i.e. on transit flights above 1000 ft).

Heading

- Assume aircraft is always pointing to 12:00
- Record clock face direction of animal (1 to 12)

Belugas heading towards 6:00



Speed

Fast

- White water streaming off bodies, wake left behind

Moderate

- Definite heading, steady motion, small amount of white water

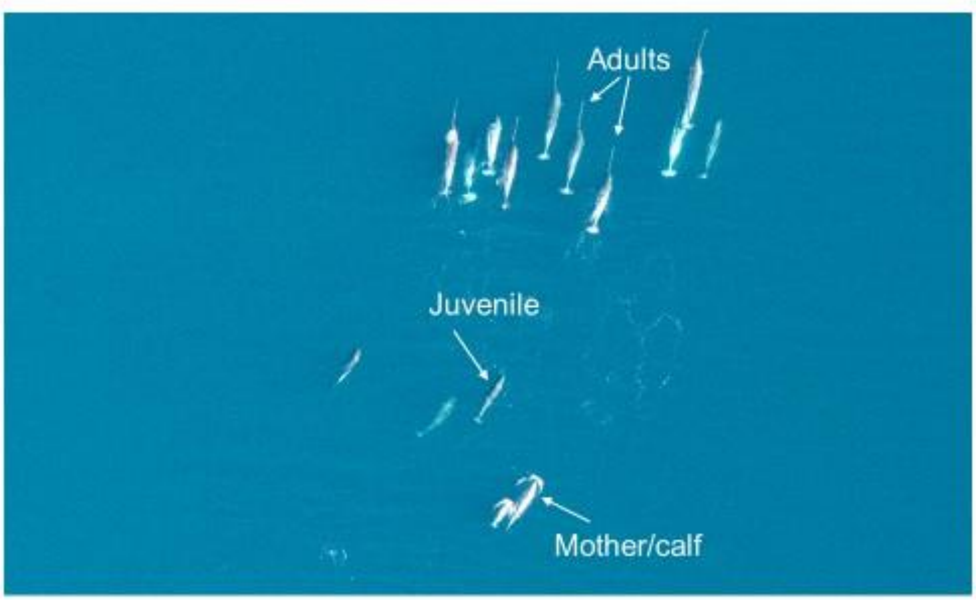
Slow

- Definite heading, forward motion observable, no white water visible

Not Moving

- Marine mammal is stationary, no movement

Narwhal age classes



Sighting Cue

- Body
- Blow
- Footprint
- Splash
- Birds


Footprint


Splash


Blow


Birds


Behaviour
• Hauled Out
• Diving
• Fluke
• Surfacing
• Swimming
• Surface Activity
• Looking
• Blow
• Breaching/spyhopping
• Walking

Hauled Out

Hauled out on ice or land (pinnipeds)

Diving

Marine mammal descends below the surface.

Fluke

Whale shows its fluke as it dives beneath the water.

Surfacing

Marine mammal observed coming to the surface of the water.

Swimming

Marine mammal swimming at the surface of the water

Surface Activity

Marine mammal splashing, jumping, flipper or tail slapping, implies social interaction

Looking

When animal is in an upright position with its head out of the water and is actively looking at something (pinniped or polar bear)

Blow

Marine mammal releases air from its lungs at the surface of the water, observed as clouds of moist air. Can be visible at far distances.

Breach

When a whale leaps with its entire body out of the water.

Spyhop

Marine mammal raises its head vertically out of the water so that its eyes are clear of the surface.

Walk

Polar bear walking on ice or land.

Activity

An activity is composed of several behaviors and cannot always be determined

- Feeding
- Traveling
- Resting
- Milling
- Socializing
- Unknown

Feeding

Marine mammal seen feeding or evidence of prey observed.

Travelling

Moving in a distinct direction with a moderate to fast pace

Resting

Marine mammal lying motionless at the surface of the water or on the ice/land

Milling

Moving but net movement is near zero, eg. swimming in circles.

Socializing

Engaged in social activity (involving more than one animal)

APPENDIX C

Hard Copy Datasheets for Secondary Observers

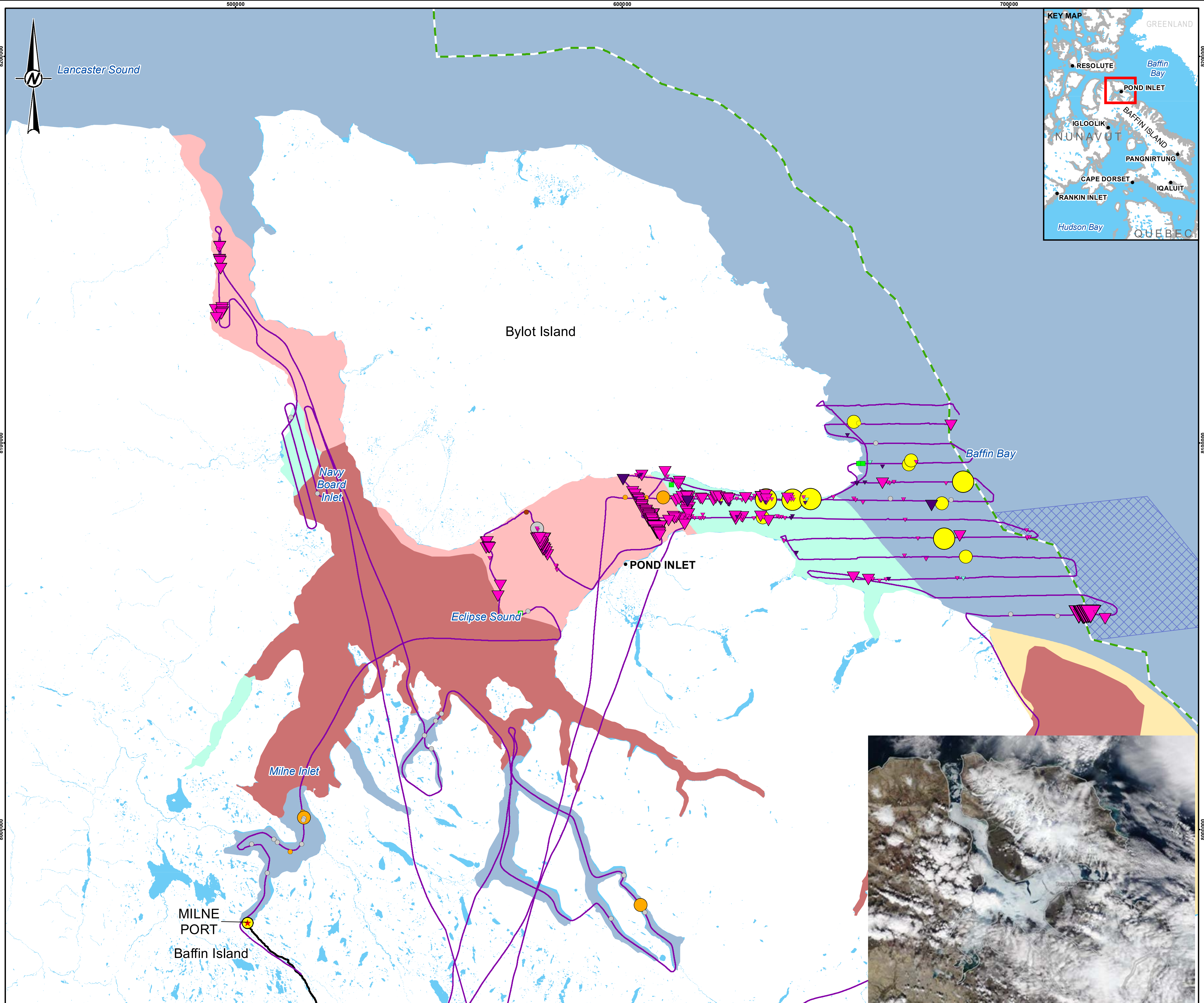
Date: ____________________ Observer name: ___________________________

Time	Species	Group size	Dec. angle	Include/ exclude	Dir. of Travel	Speed	Age	Sex	Activity	Beh.	Sigh. cue

golder.com

APPENDIX B

Mapbook



LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BEARDED SEAL
- 1

BELUGA
- 1

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

POLAR BEAR
- 1

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED SEAL
- 1
- 2-10

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50
1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 1 - JULY 10-11, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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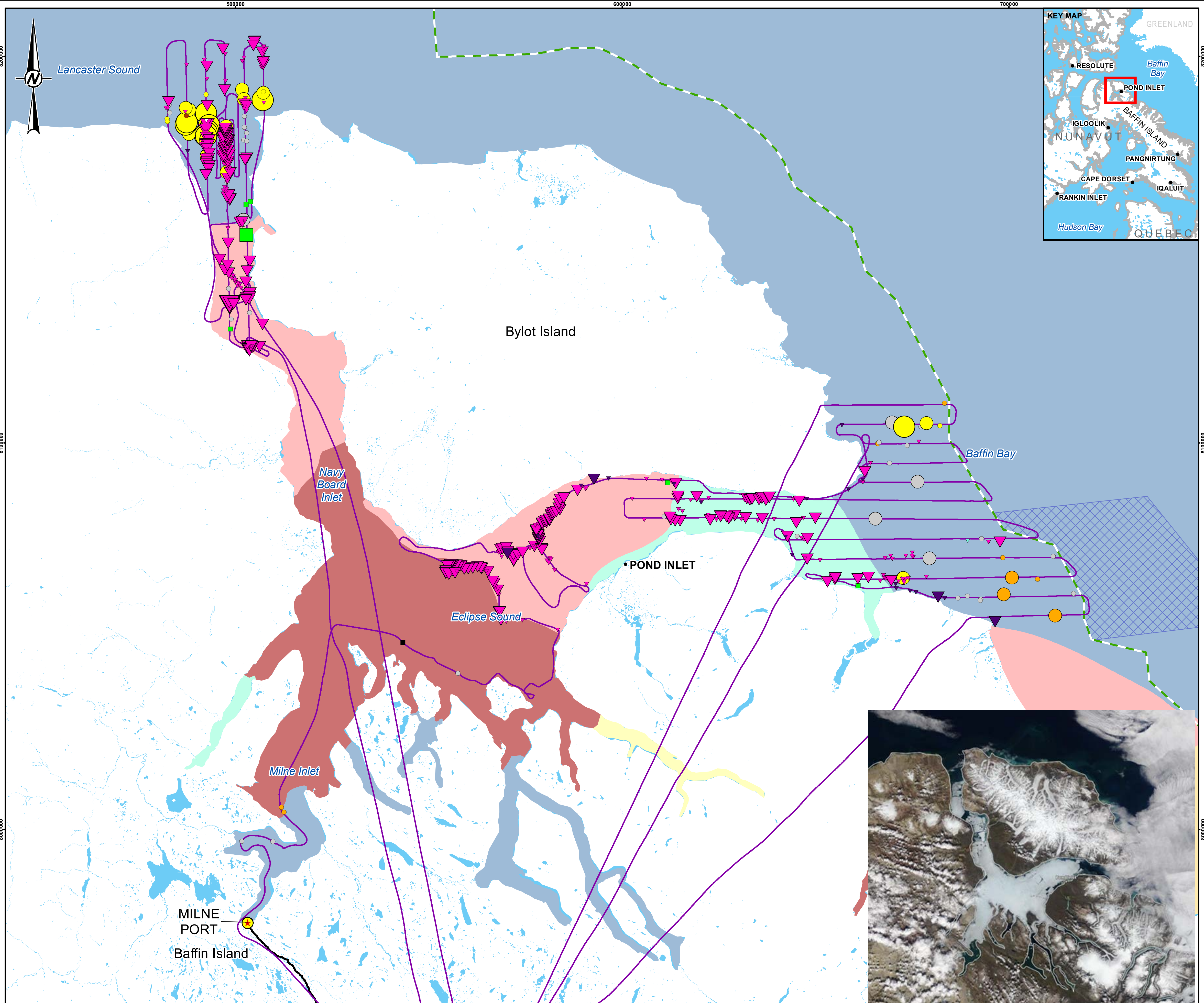

LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BEARDED SEAL: 1

BELUGA: 1

BOWHEAD WHALE: 1; 2-10

HARP SEAL: 1; 2-10; 10+

NARWHAL: 1; 2-10; 10+

POLAR BEAR: 1; 2-10

RINGED SEAL: 1; 2-10

WALRUS: 1

UNIDENTIFIED CETACEAN: 1

UNIDENTIFIED SEAL: 1; 2-10

ICE CONCENTRATION

- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

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BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 2 - JULY 12-13, 2020

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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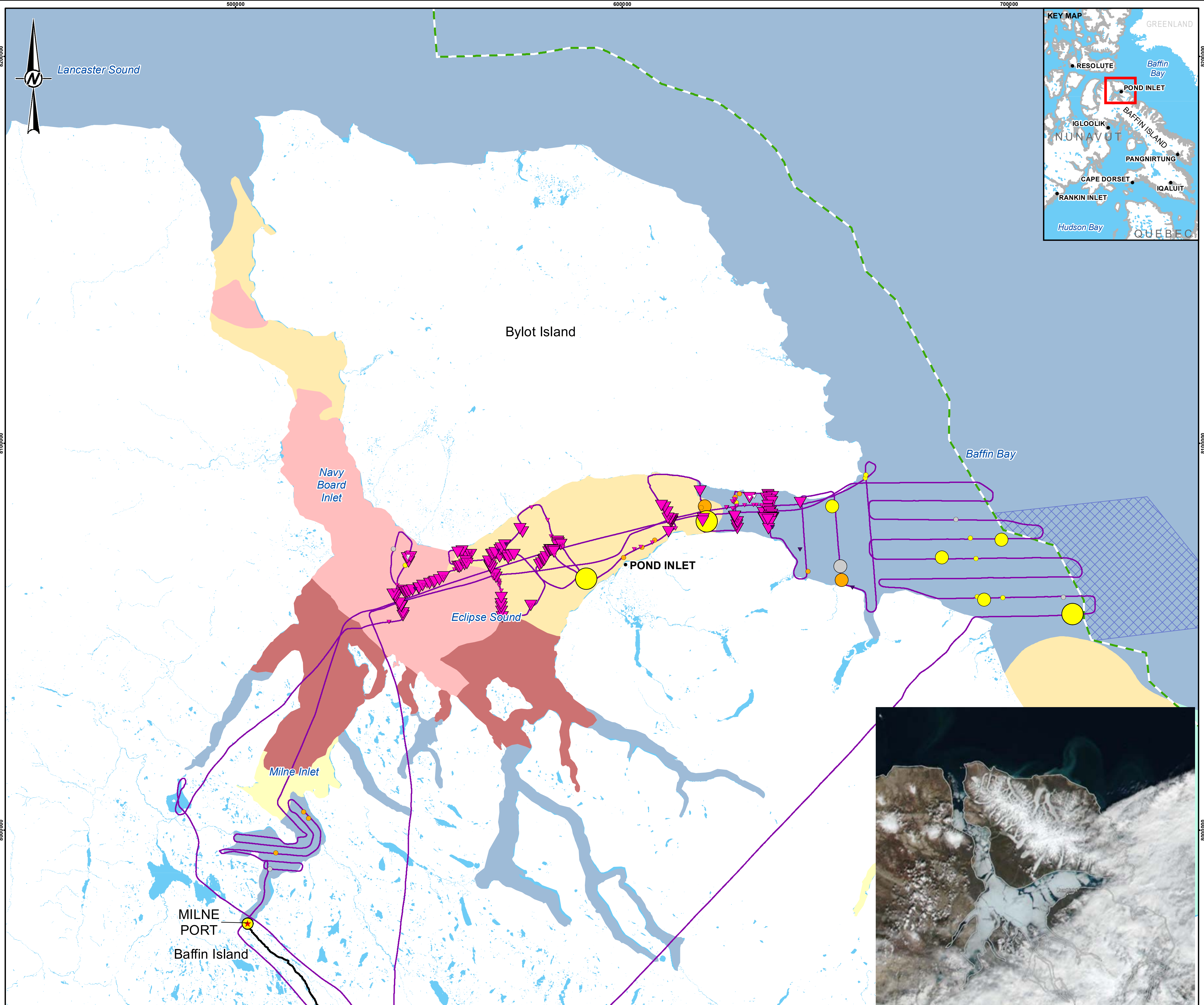

LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1

HARP SEAL
- 1
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50
1:1,000,000 KILOMETRES

REFERENCE(S)
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PROJECTION: UTM ZONE 17 DATUM: NAD 83

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PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 3 - JULY 15, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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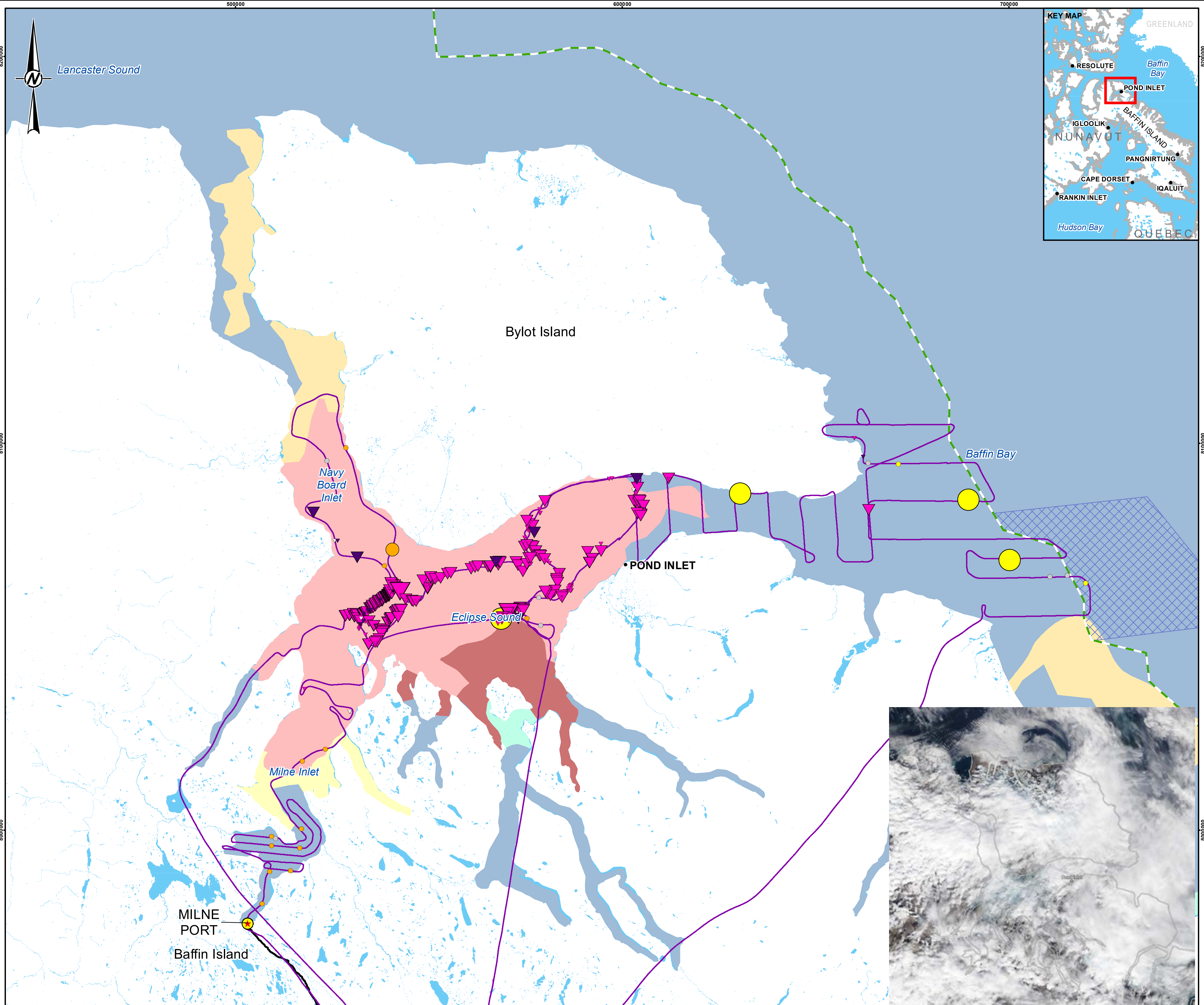

LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 10+

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

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PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 4 - JULY 16-17, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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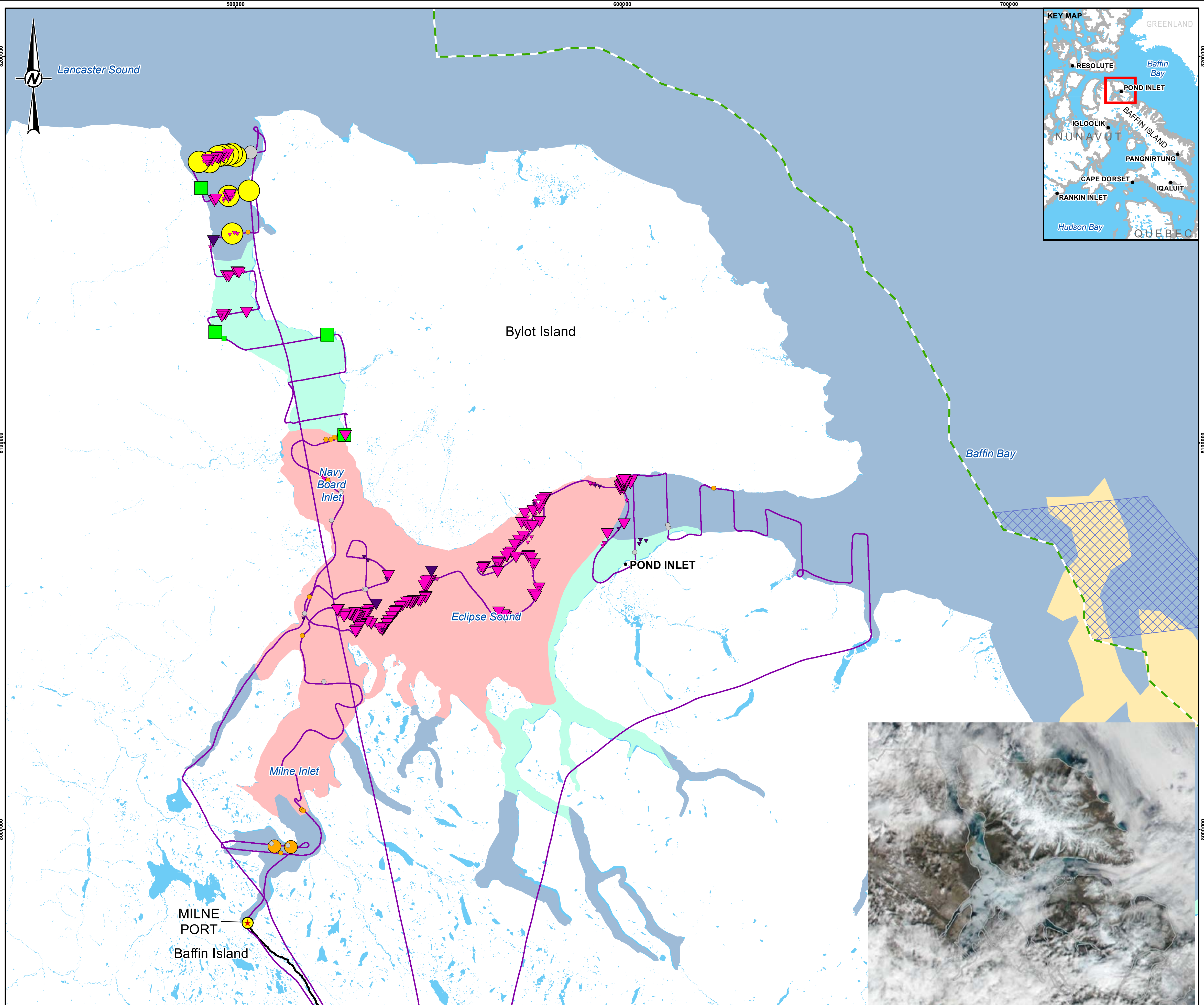

LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10
- 10+

NARWHAL
- 1
- 2-10

POLAR BEAR
- 1
- 2-10

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

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PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 5 - JULY 18, 2020

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-5

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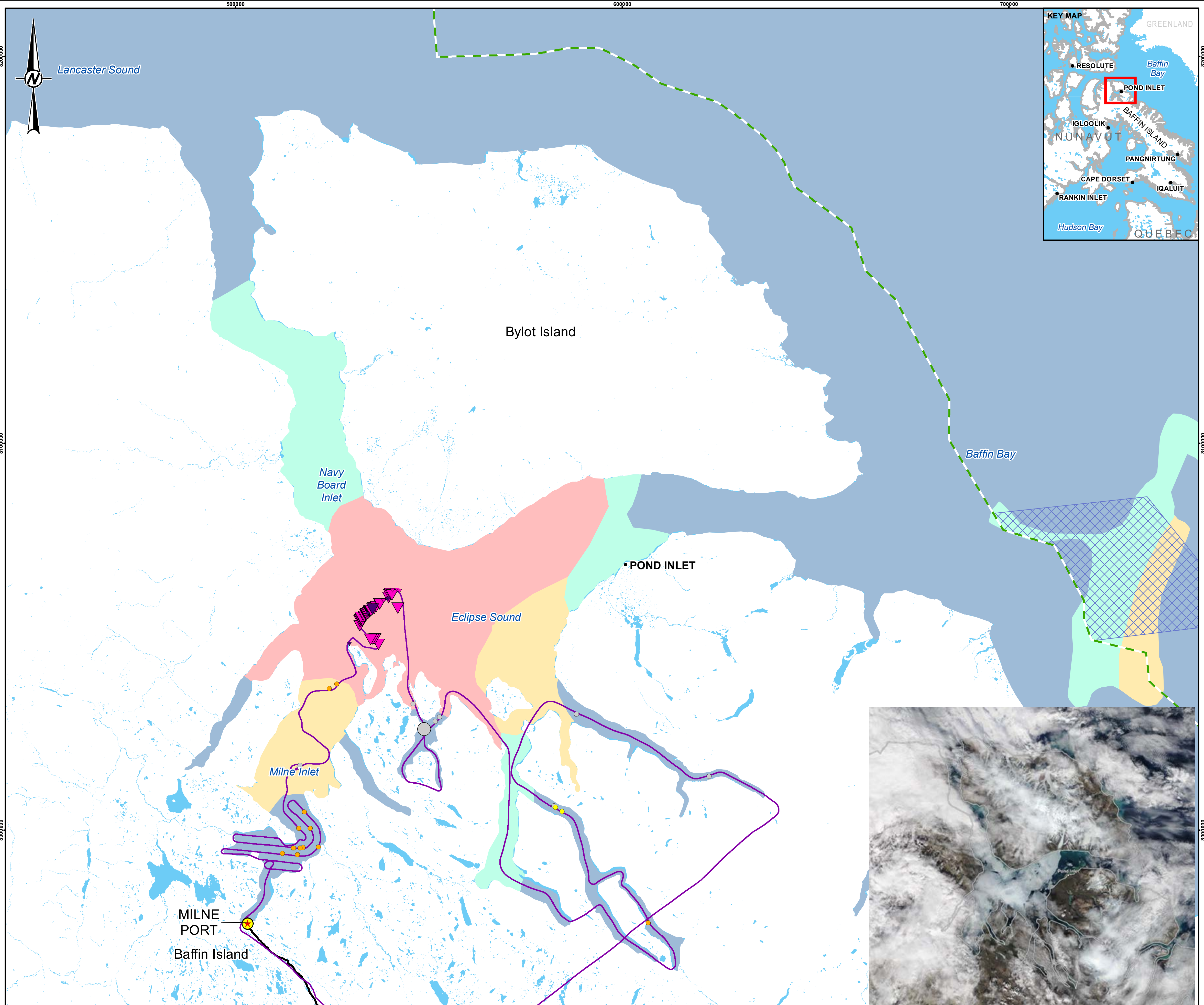

LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1

NARWHAL
- 1
- 2-10

RINGED SEAL
- 1

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50
1:1,000,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

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PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 6 - JULY 19, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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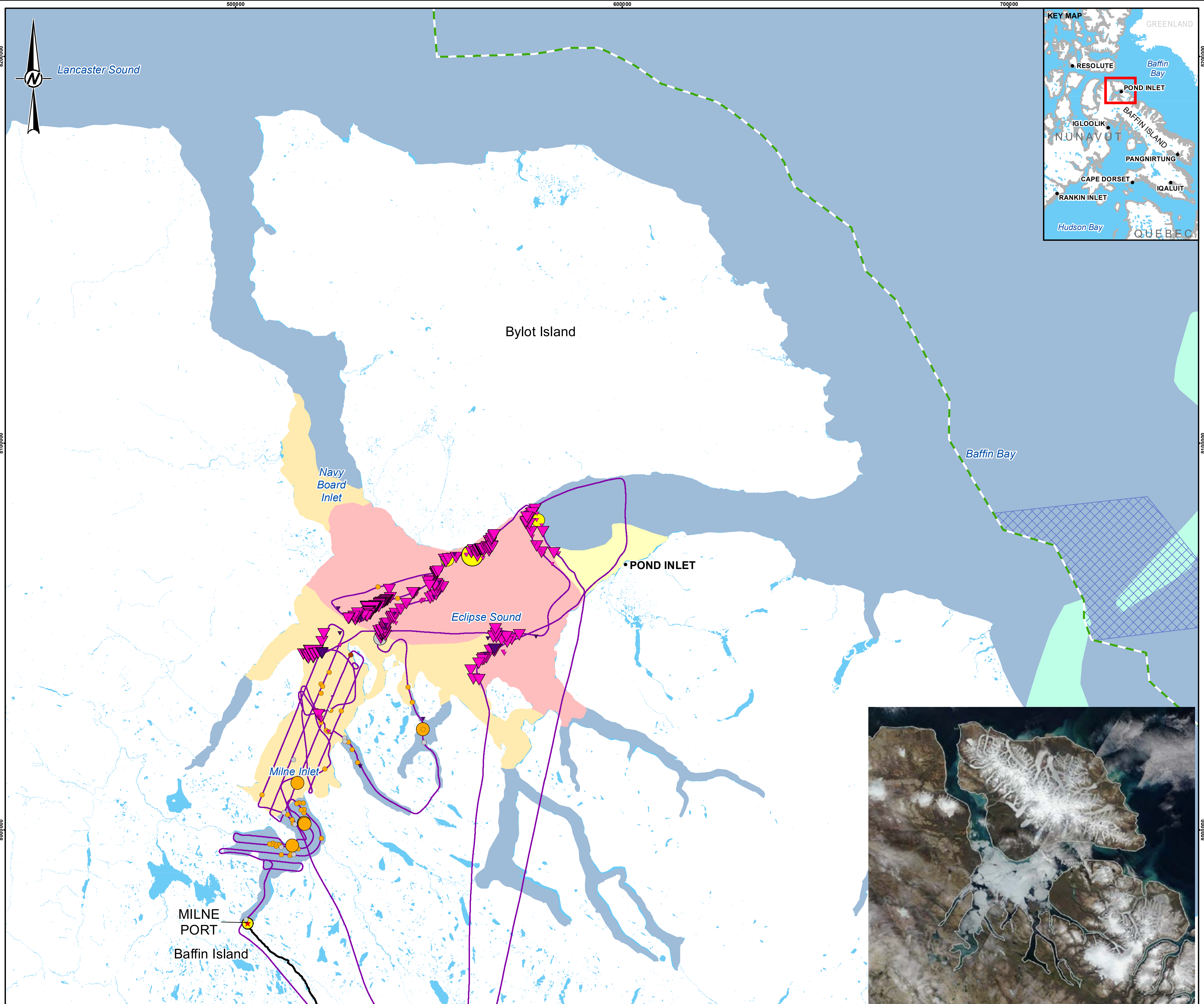

LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BEARDED SEAL
- 1

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10
- LANDFAST ICE

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
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PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

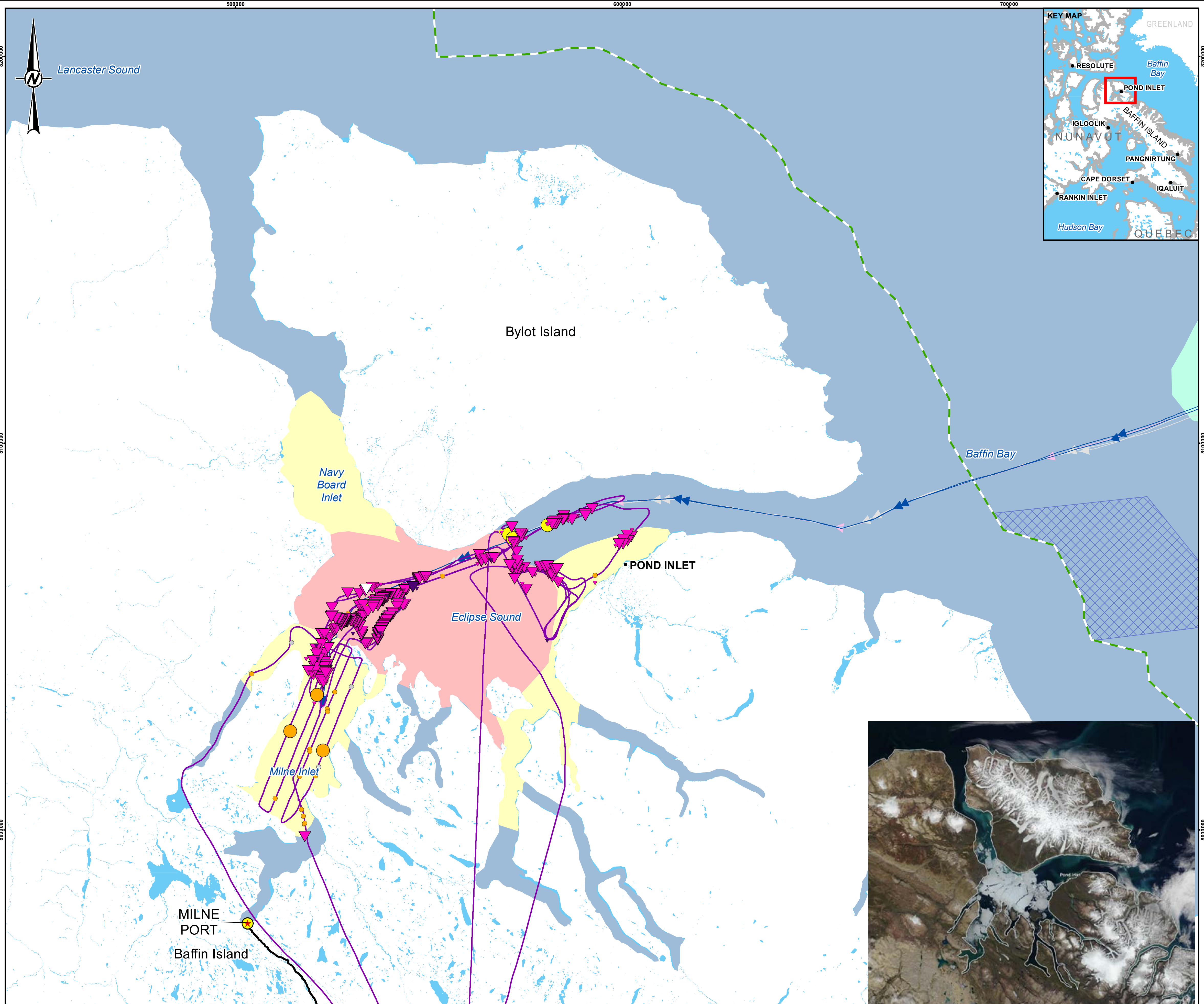
TITLE
ECLIPSE SOUND LEG 1 SURVEY 7 - JULY 20, 2020

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-7



LEGEND

- COMMUNITY
- MILNE PORT
- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 2-10

UNIDENTIFIED SEAL
- 1

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 9-10/10

0 25 50
1:1,000,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 8 - JULY 21, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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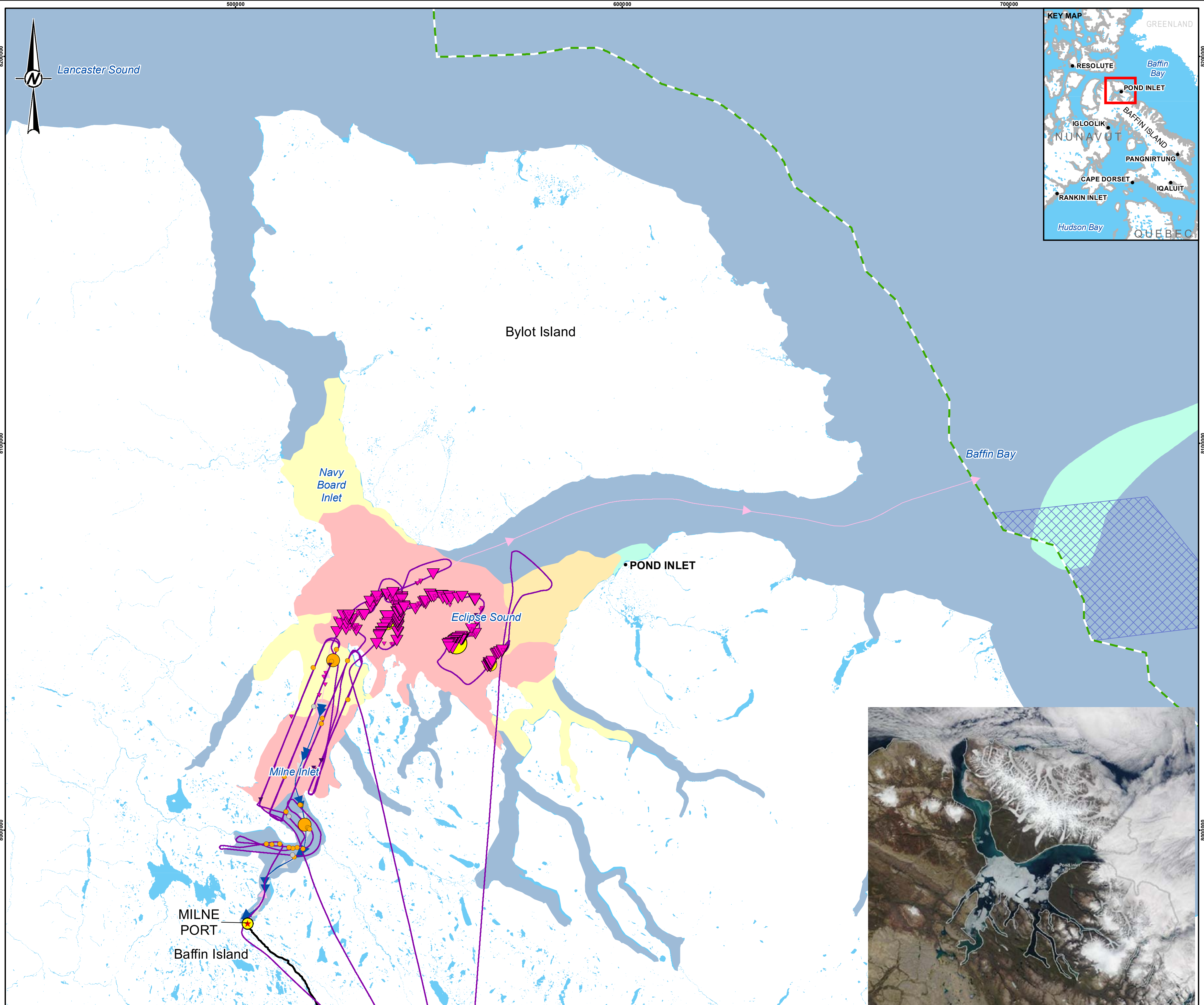


LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1

HARP SEAL
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED SEAL
- 1

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

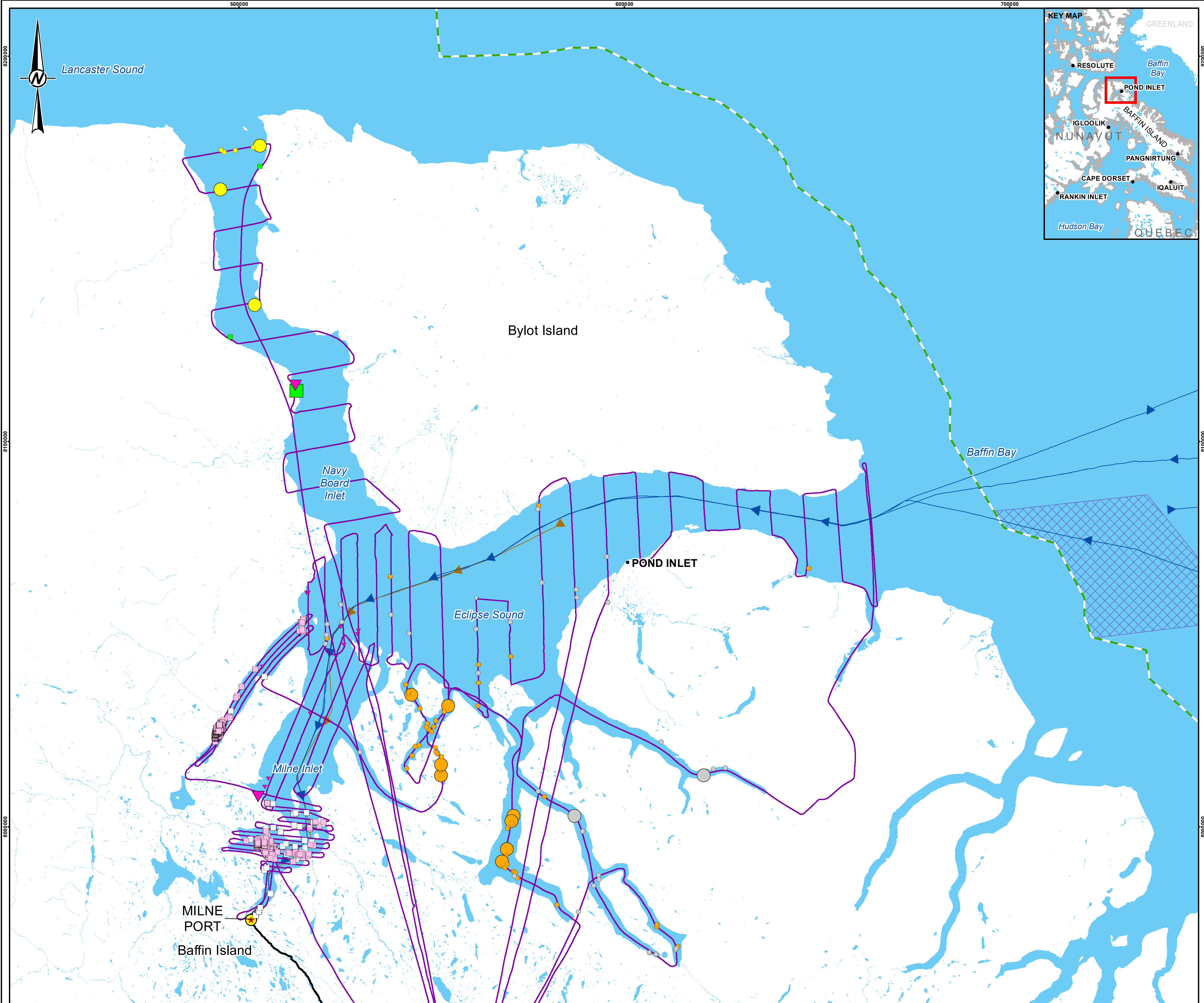
TITLE
ECLIPSE SOUND LEG 1 SURVEY 9 - JULY 22, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm



LEGEND

- COMMUNITY
- MILNE PORT

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- NARWHAL
- UNIDENTIFIED SEAL

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

HARP SEAL

- 1
- 2-10

NARWHAL

- 1
- 2-10

POLAR BEAR

- 1
- 2-10

RINGED SEAL

- 1
- 2-10

SPERM WHALE

- 1

UNIDENTIFIED SEAL

- 1
- 2-10

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS

- BULK (ORE) CARRIER
- GENERAL CARGO VESSEL
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL

NON-PROJECT VESSEL SHIP TRACKS

- OTHER
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

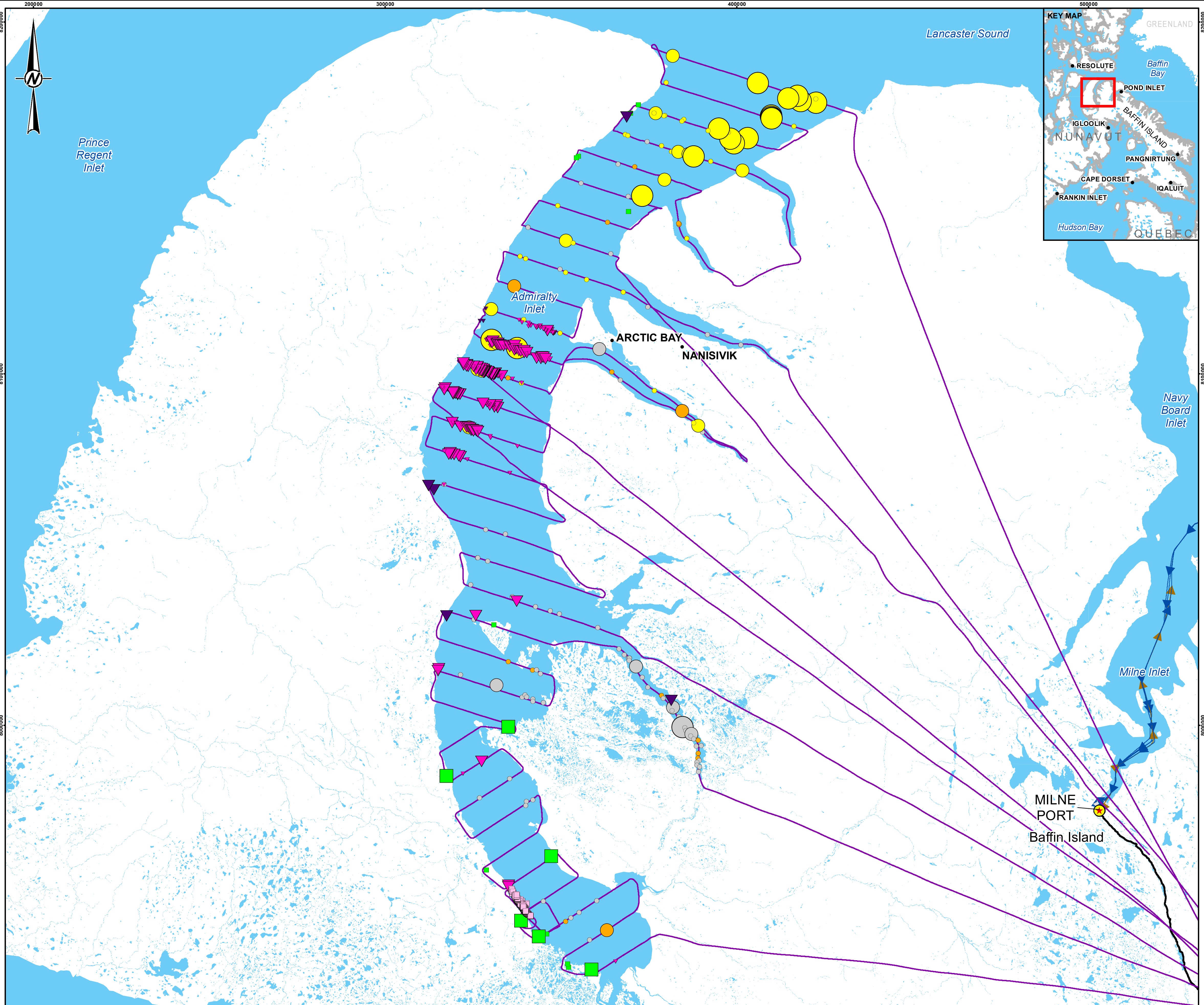
PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 2 SURVEY 1 - AUGUST 20, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-10



LEGEND

- COMMUNITY
- MILNE PORT

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- NARWHAL
- UNIDENTIFIED SEAL

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE

- 1
- 2-10

HARP SEAL

- 1
- 2-10
- 10+

NARWHAL

- 1
- 2-10

POLAR BEAR

- 1
- 2-10

RINGED SEAL

- 1
- 2-10

UNIDENTIFIED SEAL

- 1
- 2-10
- 10+

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS

- BULK (ORE) CARRIER
- GENERAL CARGO VESSEL
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL

NON-PROJECT VESSEL SHIP TRACKS

- OTHER
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 30 60

1:1,100,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ADMIRALTY INLET LEG 2 SURVEY 1 - AUGUST 21, 2020

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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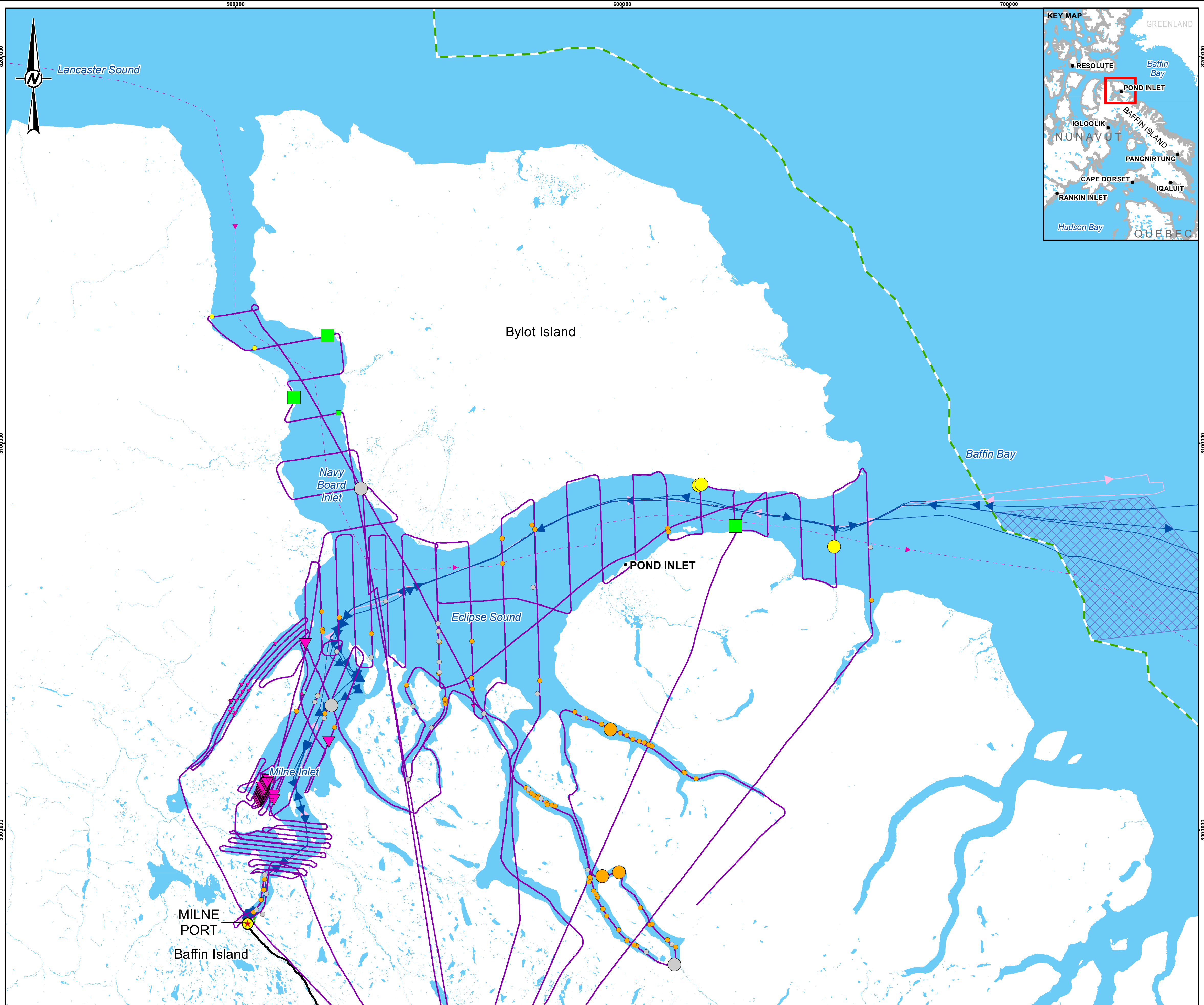


LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BELUGA
- 1

HARP SEAL
- 1
- 2-10

NARWHAL
- 1
- 2-10

POLAR BEAR
- 1
- 2-10

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED SEAL
- 1
- 2-10

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- OIL TANKER
- SERVICE VESSEL

NON-PROJECT VESSEL SHIP TRACKS
- ICEBREAKER (LOUIS S ST LAURENT)
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

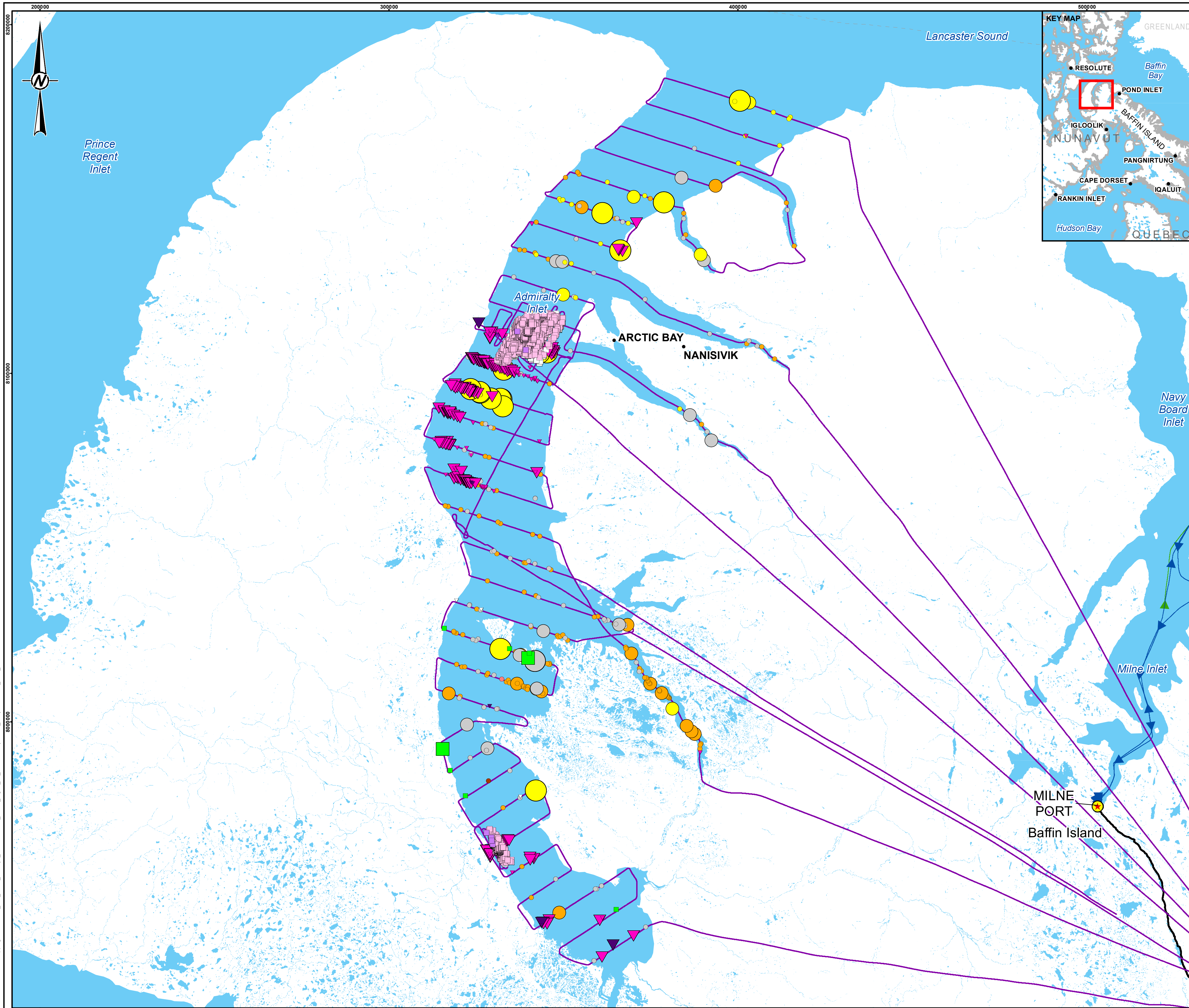
TITLE
ECLIPSE SOUND LEG 2 SURVEY 2 - AUGUST 24-25, 2020

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-12



LEGEND

- COMMUNITY
- MILNE PORT

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BOWHEAD WHALE
- NARWHAL
- UNIDENTIFIED SEAL

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BEARDED SEAL
- 1

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10
- 10+

HOODED SEAL
- 1

NARWHAL
- 1
- 2-10
- 10+

POLAR BEAR
- 1
- 2-10

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1
- 2-10
- 10+

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- OIL TANKER
- SERVICE VESSEL

NON-PROJECT VESSEL SHIP TRACKS
- OTHER
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 30 60

1:1,100,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ADMIRALTY INLET LEG 2 SURVEY 3 - AUGUST 28, 2020

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
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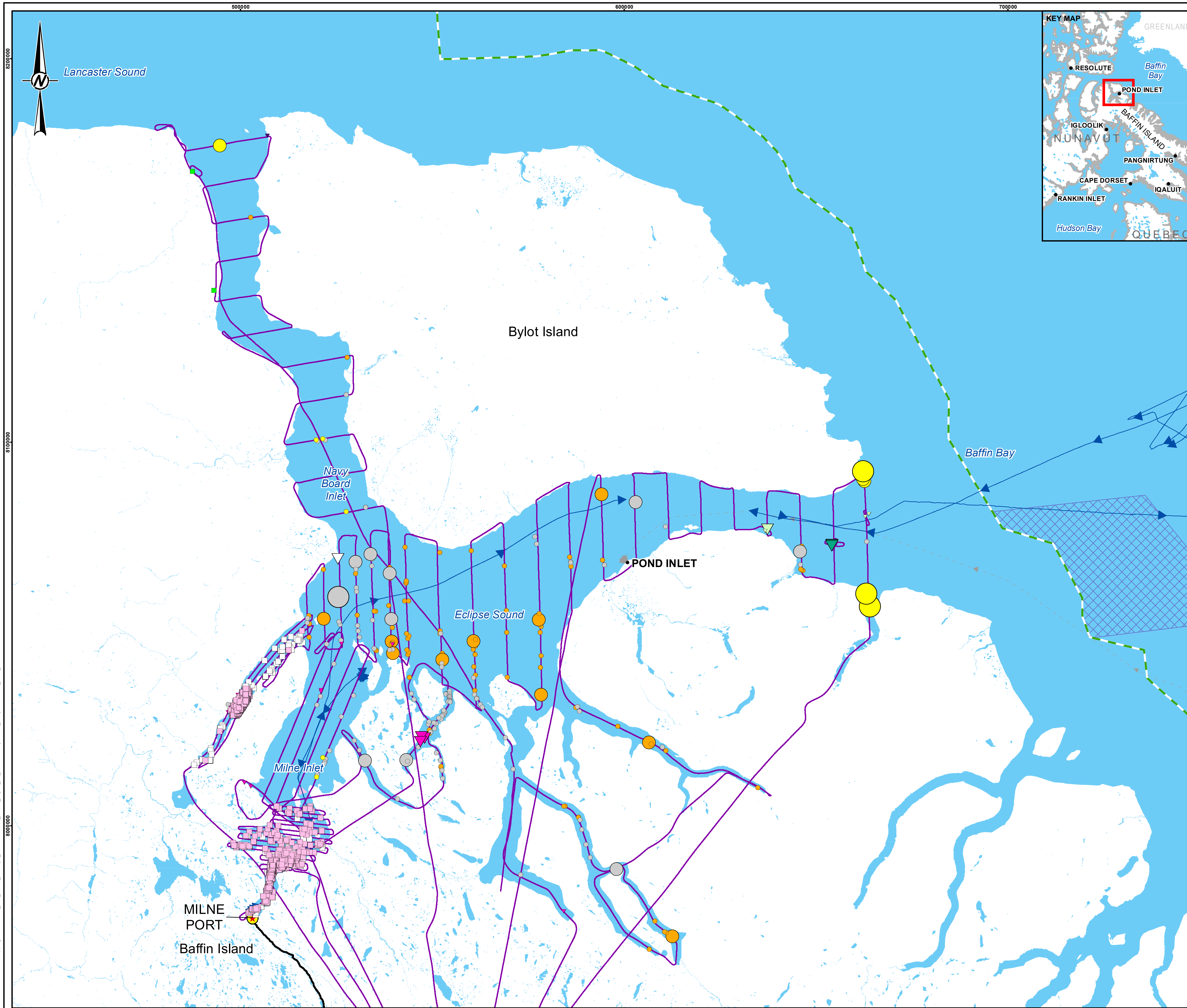


LEGEND

- COMMUNITY
- MILNE PORT

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- NARWHAL
- UNIDENTIFIED SEAL

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1

HARP SEAL
- 1
- 2-10
- 10+

KILLER WHALE
- 2-10

NARWHAL
- 1
- 2-10

POLAR BEAR
- 1

RINGED SEAL
- 1
- 2-10

SPERM WHALE
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 2-10

UNIDENTIFIED SEAL
- 1
- 2-10
- 10+

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL

NON-PROJECT VESSEL SHIP TRACKS
- OTHER
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

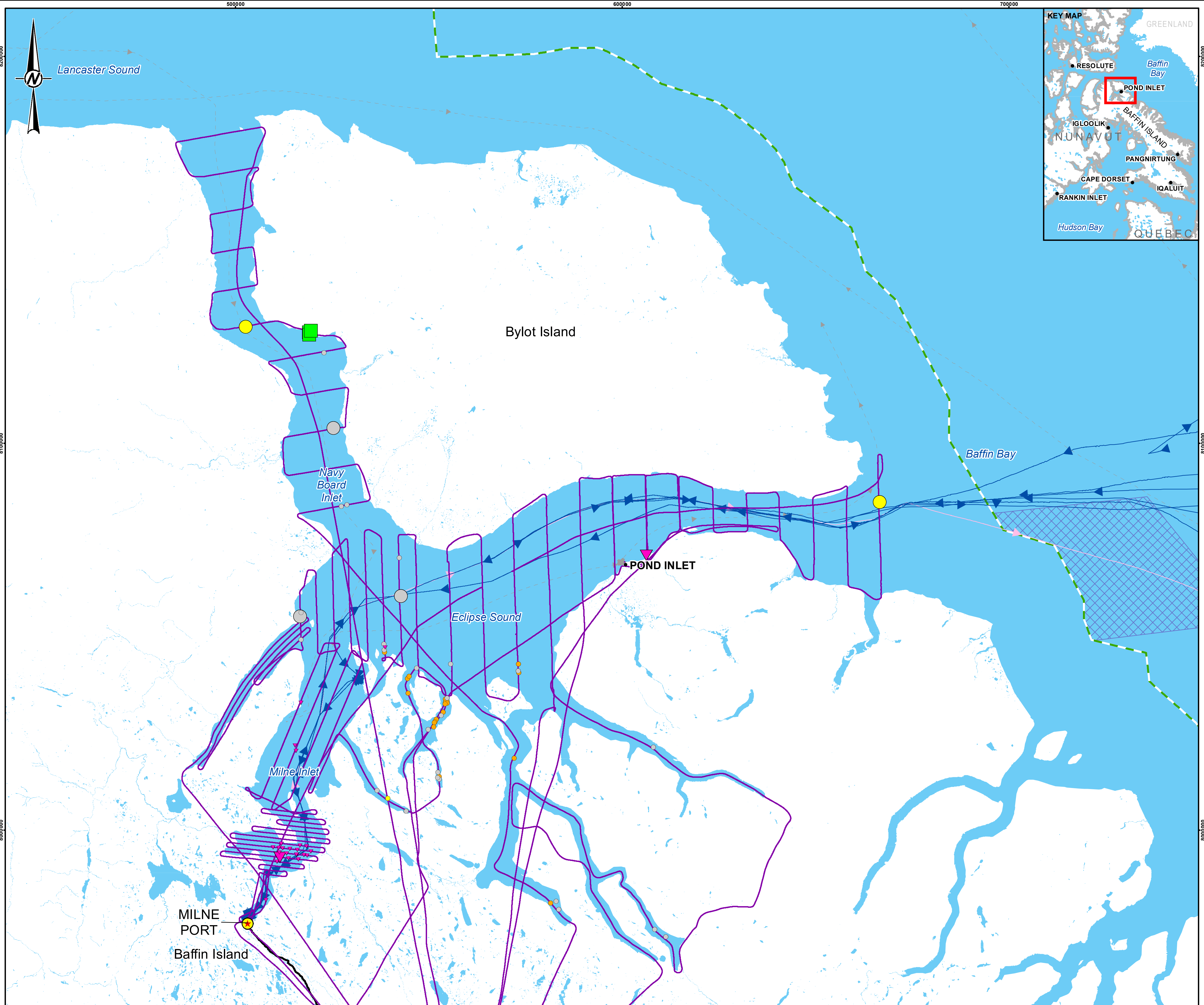
TITLE
ECLIPSE SOUND LEG 2 SURVEY 3 - AUGUST 29, 2020

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-14



LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

HARP SEAL
- 1
- 2-10

NARWHAL
- 1
- 2-10

POLAR BEAR
- 2-10

RINGED SEAL
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL

NON-PROJECT VESSEL SHIP TRACKS
- OTHER
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 2 SURVEY 4 - AUGUST 30-SEPTEMBER 1, 2020

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-17
DESIGNED	TT
PREPARED	AA
REVIEWED	PA
APPROVED	PA

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	0	B-15

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

APPENDIX C

Killer Whale and Narwhal Herding Event

In late August of 2020, multiple killer whale groups were observed throughout Milne Inlet during two of Baffinland's 2020 marine mammal monitoring programs, the Bruce Head Shore Based Monitoring Program (Bruce Head Program) and the Marine Mammal Aerial Survey Program (MMASP) (Figure C-1).

Pre-herding event observations of killer whale and narwhal from Bruce Head Program

On 26 and 27 August, daily visual survey data was collected from Bruce Head between 06:00 and 22:00. Visibility was moderate to poor throughout the day of 26 August, due to strong winds, resulting in partial to no coverage during some surveys. On 26 August at 18:00, approximately 67 killer whales (Orcinus orca) were observed entering the BH survey area from the north and travelling fast southward from south of Stephen's Island to southeast of Bruce Head. At 17:22, before the killer whales were observed, three groups of narwhal were traveling fast, southbound, hugging the shoreline within 50 m of Bruce Head, in a tight group (~21 individuals in total, group size ranged from 2 to 12). At 18:39 some of the killer whales were still traveling southwest of Poirier Island while another group continued toward Koluktoo Bay (Figures C-2 and C-3), eventually turning north again. From 19:46 to 20:34 the northerly group was observed circling and tail slapping, possibly hunting and feeding on a narwhal, between Stephens and Poirier Islands. At the same time, from 19:46 to 20:01, sixteen groups of narwhal (~120 individuals in total, group size ranged from 1 to 40) were traveling fast and southbound, in tight groups, within 300 m of Bruce Head. Due to the distance to the killer whale observations and fading light it was no longer possible to continue observations. The last observation of killer whales was at 21:20 when they were still between Stephens and Poirier Island and had possibly made another kill.

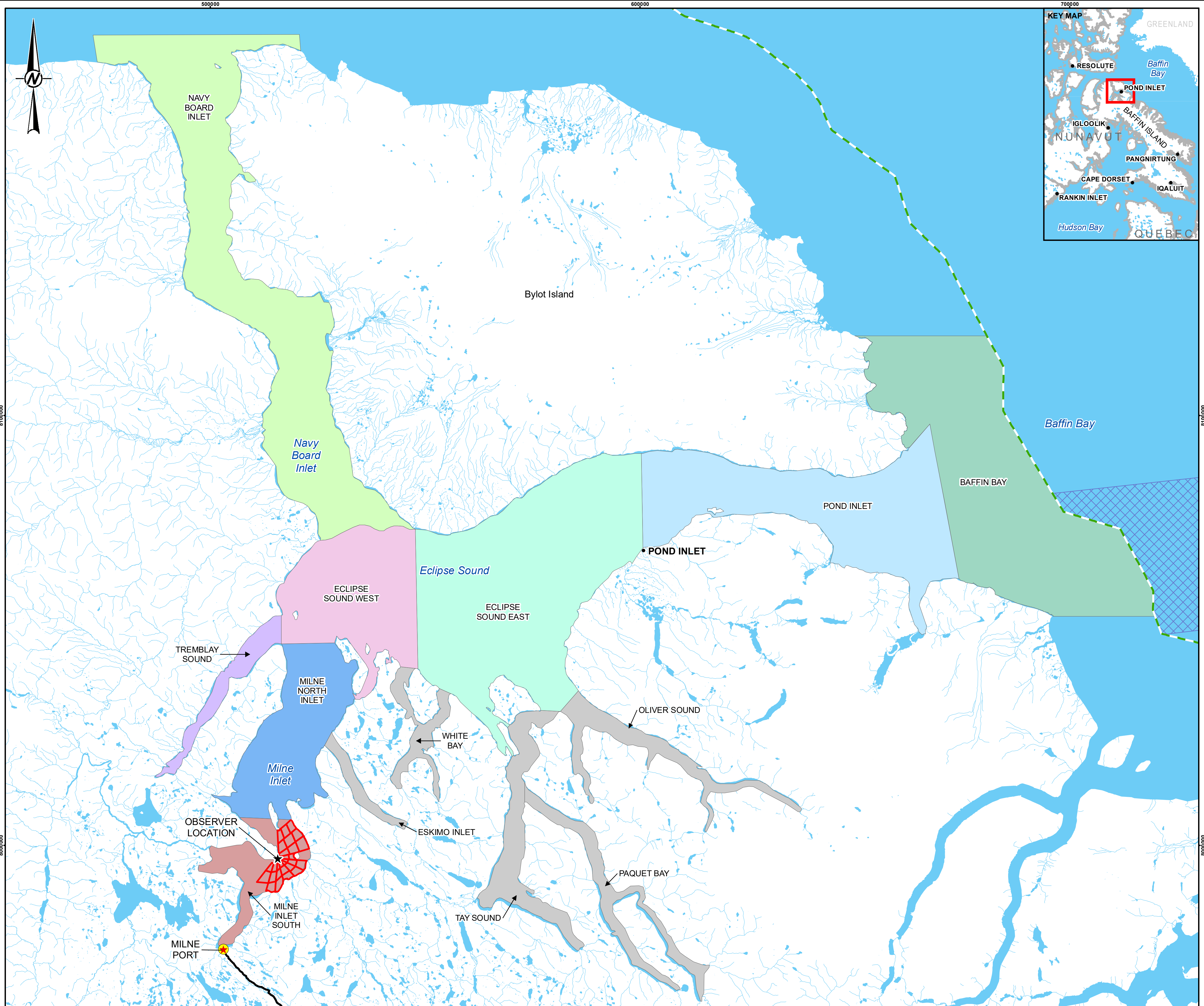
On 27 August visibility was poor due to strong winds, precipitation, and low cloud most of the day. In the morning, 20 narwhal groups were observed during visual observations from Bruce Head between 06:19 and 09:19 (~56 individuals in total, group size ranged from 1 to 9). All narwhal groups were observed traveling south except for a single narwhal observed traveling north at 09:19. Most narwhal were traveling at medium to fast speeds in tight groups within 300 m of the Bruce Head shoreline. Later on the morning of 27 August, multiple killer whale groups were observed in the Bruce Head survey area. The first observation of 12 killer whales was recorded at 10:08 south of Bruce Head, mid-inlet, off Koluktoo Bay. At 11:08 the killer whales had moved further south in Milne Inlet reaching the far shore of the inlet, opposite to Bruce Head, where they were milling and slowly traveling north at 11:50. At 13:30 the three pods were still traveling north along the far shore near the south end of Poirier Island. They were last observed from Bruce head at 14:05 when they were still traveling northbound along the far shoreline, north of Poirier Island. They were not observed again until 14:40 when an aerial survey aircraft saw them traveling north at 14:40 near Stephens Island (Figure C-2). A few hours after the killer whale/narwhal herding event was observed by the aerial survey team, from 16:13 to 16:36, a narwhal herding event was also observed from Bruce Head from 19:03 to 20:50. All of the ~130 narwhal were traveling south at medium to fast speeds and in either loose or tight groups.

Observations of killer whales during aerial surveys

Three killer whale groups were observed from both aerial survey aircraft on 27 August. Prior to departing for reconnaissance flights, the aerial survey crew was notified by Bruce Head that killer whales had been observed that morning throughout Milne Inlet, from 10:08 to 14:05. Due to poor weather conditions, the aerial survey team was unable to fly until 13:30. A reconnaissance flight was flown in Milne Inlet South and Milne Inlet North. During the reconnaissance flight in Milne Inlet South two groups of killer whales, comprised of ~14 individuals each, were observed from 14:40 to 14:45 off the south end of Stephens Island (Figure C-2) traveling in a northerly direction. The groups were composed of animals of mixed ages including at least one large adult male.

Shortly after completing a photographic survey in Tremblay Sound, the second aerial survey aircraft observed two male killer whales at 15:18, a few km northeast of Athole Point (Figure C-2). A few minutes later multiple groups of at least 16 killer whales were confirmed milling and spread out over half a mile radius. The aircraft circled over the killer whales from 15:18 to 15:29 to collect photos and data on killer whale group size, composition and behaviour. One group of four killer whales was observed feeding on a small kill. The kill could not be identified but many birds were observed flying over the location. Traces of what appeared to be remains of a kill were also observed floating at the surface (Figure C-4). The remaining killer whale groups were traveling north toward the feeding location. There were 3–4 adult males in the group, otherwise classification of age and sex of all individuals was not possible.

After collecting data on the killer whales near Athole Point, the aircraft flew a southbound reconnaissance flight along the most westerly transect line, paralleling the shoreline of Milne Inlet, completing the line at 15:43. No narwhal or killer whales were observed along this survey line. The aircraft then started flying north again at 15:45, observing 6–7 narwhal at the start of the next line. The narwhal were resting in shallow water ~200 m from shore and ~6.8 km southeast of Fairweather Bay (Figure C-2). Immediately after observing the narwhal, the aerial survey crew observed a group of five killer whales milling and a group of 10+ killer whales traveling at a moderate speed in a southwesterly direction, paralleling the shoreline, ~2 km from the location of the narwhal (Figure C-5). The aerial survey crew left the killer whales to continue flying the aerial survey, finishing the survey lines at 16:00. The aircraft then flew over the killer whale groups in north Milne Inlet one more time, to briefly check their location and behaviour and they were in approximately the same location northeast of Athole Point traveling southwest (Figures C-2 and C-6). The aircraft then returned south to collect detailed behavioural and photo data on the narwhal and killer whales observed at 15:45.



LEGEND

- ★ BRUCE HEAD SHORE-BASED MONITORING PROGRAM OBSERVER LOCATION
- • COMMUNITY
- MILNE PORT
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- BRUCE HEAD SHORE-BASED MONITORING PROGRAM STRATIFIED STUDY AREA (SSA) SUBSTRATA
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

GEOGRPHIC STRATA

ECLIPSE SOUND GRID

- BAFFIN BAY
- ECLIPSE SOUND EAST
- ECLIPSE SOUND WEST
- MILNE INLET NORTH
- MILNE INLET SOUTH
- NAVY BOARD INLET
- POND INLET
- TREMBLAY SOUND
- ECLIPSE FJORDS

DRAFT

0 25 50

1:900,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

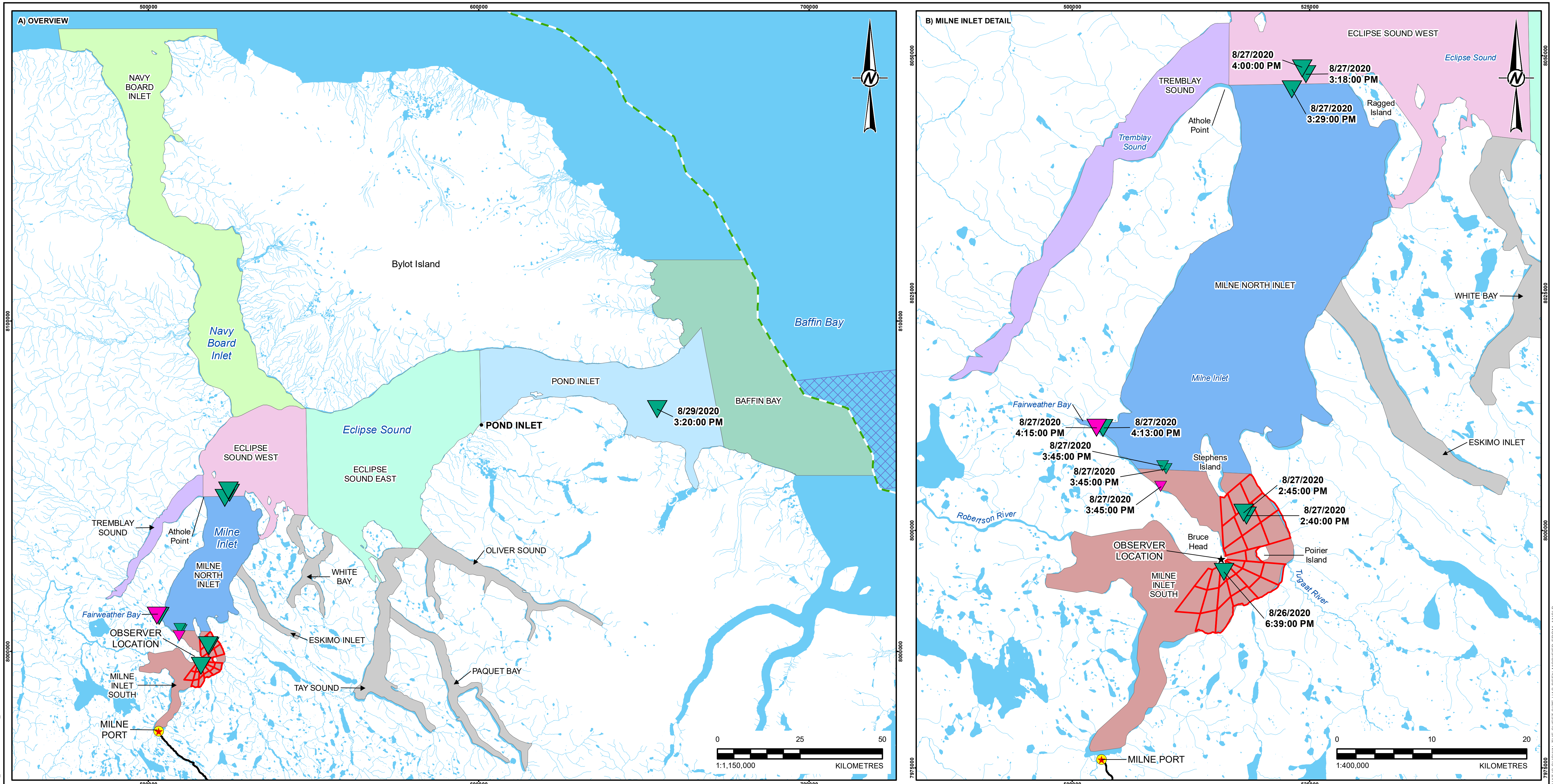
TITLE
LOCATION OF THE BRUCE HEAD SHORE-BASED MONITORING PROGRAM IN RELATION TO AERIAL SURVEY STRATA

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-04-15
DESIGNED	KG
PREPARED	AJA
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	A	C-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- ★ BRUCE HEAD SHORE-BASED MONITORING PROGRAM OBSERVER LOCATION
- MILNE PORT
- • COMMUNITY

CETACEAN SPECIES OBSERVATIONS (GROUP SIZE)

KILLER WHALE
- 2-10
- 10+

NARWHAL
- 2-10
- 10+

- MILNE INLET TOTE ROAD
- WATERCOURSE
- 40 km BUFFER ZONE
- BRUCE HEAD SHORE-BASED MONITORING PROGRAM STRATIFIED STUDY AREA (SSA) SUBSTRATA
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ECLIPSE SOUND GRID
- BAFFIN BAY
- ECLIPSE SOUND EAST
- ECLIPSE SOUND WEST
- MILNE INLET NORTH
- MILNE INLET SOUTH
- NAVY BOARD INLET
- POND INLET
- TREMBLAY SOUND
- ECLIPSE FJORDS

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

DRAFT

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-04-15
DESIGNED	KG
PREPARED	AJA
REVIEWED	
APPROVED	

TITLE
LOCATION OF KILLER WHALES OBSERVED BY THE BRUCE HEAD PROGRAM AND MMASP, 26 AND 27 AUGUST 2020

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	39000	A	C-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

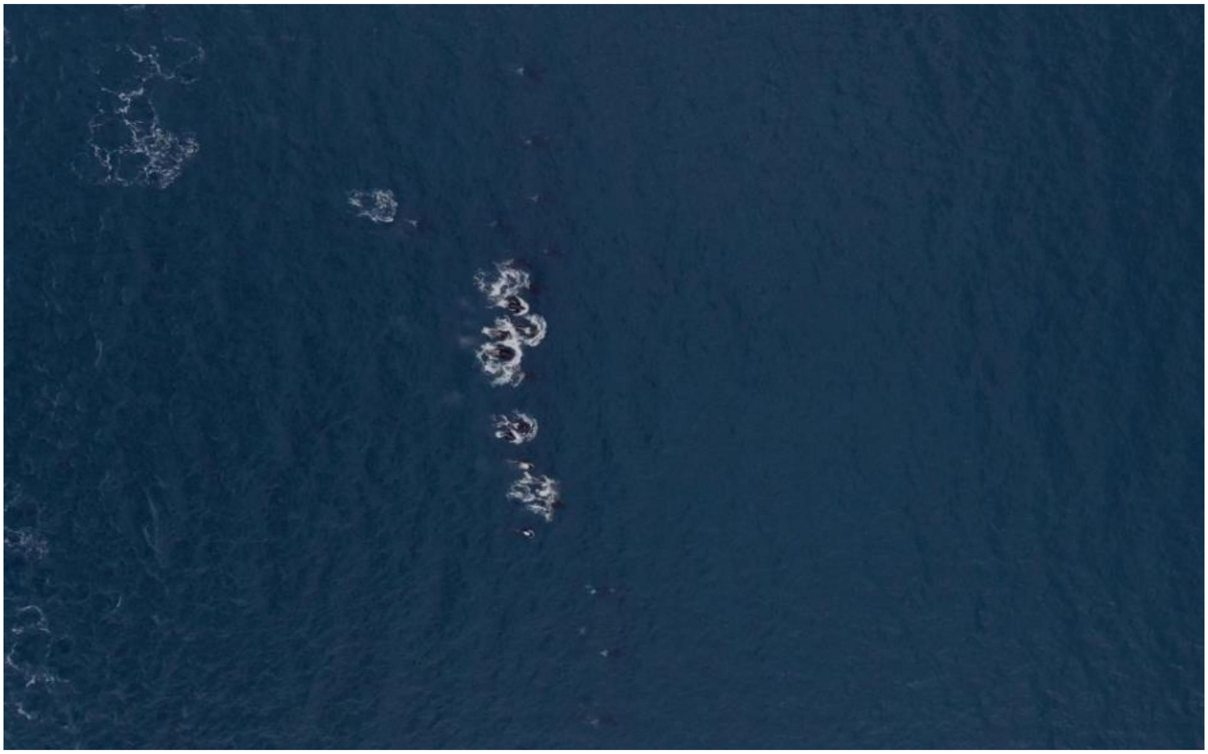


Figure C-3: Drone image of killer whale group observed at 18:36 from Bruce Head on 26 August 2020.

Figure C-4: Killer whales with kill remains and birds circling above in Milne Inlet North at 15:18 on 27 August 2020.

Figure C-5: Killer whales observed southeast of Fairweather Bay traveling southwest at 15:45 on 27 August 2020.

Figure C-6: Re-sighting of killer whales observed from 15:18 to 15:29, including two adult males (top and bottom whales), in north Milne Inlet northeast of Athole Point at 16:00 on 27 August 2020.

Observations of a killer whale/narwhal herding event in Fairweather Bay, Baffin Island

At 16:00 on 27 August, after completing a northbound transect in the north end of Milne Inlet, the aerial survey team flew south to return to the narwhal and killer whale groups observed at 15:45. As the aircraft approached the north shore of Fairweather Bay at 16:13, two groups of killer whales, containing 12-15 individuals each, were observed traveling southwest into Fairweather bay. Both groups of killer whales were traveling fast, swimming abreast of each other, in two lines into the middle of the bay. At the same time, ~150–200 narwhal were traveling quickly, in dispersed but tight groups, into Fairweather Bay. Narwhal groups consisted of adults with tusks, without tusks, juveniles and calves. The aircraft circled over Fairweather Bay from 16:13 to 16:36 to collect photos and record details of the herding event (Figures C-2 and C-7).

As the two lines of killer whales entered the bay, they spread out into smaller groups (Figures C-8 to C-12). Meanwhile, the narwhal entered the bay and were forced along the shoreline by the killer whales (Figures C-13 and C-14). Some of the narwhal attempted to swim back out of the bay along the shoreline. One group of 10 killer whales split into two groups of five whales with one group of five remaining in a tight group near the entrance to the bay, while the others spread out near the shoreline blocking ~50–100 narwhal from exiting the bay. The killer whales started to isolate individual narwhal from the narwhal groups. At least four narwhal kills were confirmed including two calves, one adult female (probable mother of one of the calves) and one adult male. When the killer whales spread out an adult or sub-adult male killer whale was observed killing a female narwhal by grabbing her in the mid-section while another killer whale grabbed the calf. At the same time, on the other side of the aircraft, another calf was observed being killed by another group of killer whales; they were pushing the calf around and appeared to be feeding on it. Another adult, presumably the mother of the killed narwhal calf, appeared to be injured, barely moving, as the killer whales circled in the vicinity. The killer whales were also observed throwing one of the carcasses around. One adult male narwhal was observed floating along the shoreline and appeared to be dead. During a flight over the area the following day, two narwhal carcasses were observed in Fairweather Bay including one stranded in the river mouth.

After observing the feeding events, the aircraft continued circling over Fairweather Bay to observe the movement and behaviour of the narwhal and killer whale groups. The narwhal continued traveling fast in tight groups hugging both shorelines and heading deeper into the bay into shallower water. Due to fuel constraints, the aircraft left Fairweather Bay at 16:36 to return to Mary River. The narwhal were last seen swimming in tight, but dispersed groups away from the killer whales, deeper into the bay toward the shallow waters of the river mouth funneling into the bay (Figures C-7 and C-14). The killer whales were still spread-out hunting narwhal in approximately the same location the narwhal kills were observed.

Killer whales were last observed in the RSA on 29 August, during an afternoon survey flight conducted. Three groups of killer whales were observed traveling eastbound (31 whales) in the Pond Inlet stratum and appeared to be leaving the RSA. Given the timing and location of this observation, it is likely these killer whales were members of the same groups observed on 26 and 27 August and during the killer whale/narwhal herding event described here (Figure C-2).

Figure C-7: Fairweather Bay and the location of the observed calf kill and feeding event (in orange).

Figure C-8: Killer whales swimming abreast into Fairweather Bay on 27 August 2020.

Figure C-9: Killer whales swimming abreast and starting to disperse into smaller groups in Fairweather Bay on 27 August 2020.

Figure C-10: Killer whales travelling parallel the south shore entering Fairweather Bay on 27 August 2020.

Figure C-11: Killer whales (bottom) traveling toward the narwhal groups (top) near the Fairweather Bay shoreline (top) on 27 August 2020.

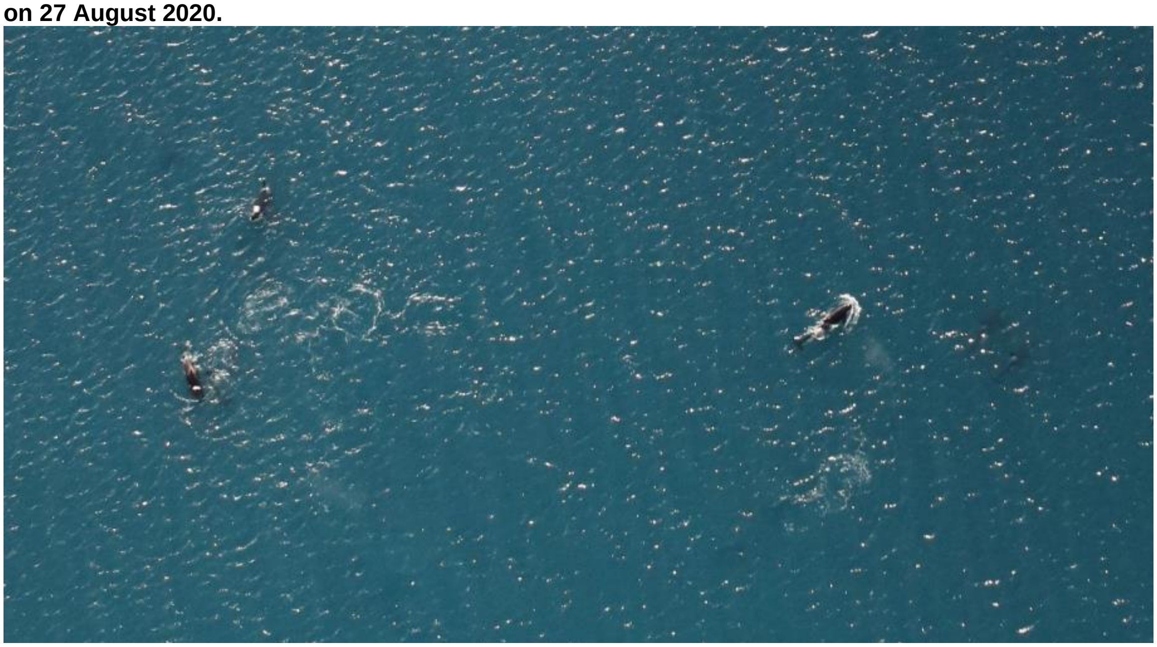


Figure C-12: Killer whale groups traveling and circling in Fairweather Bay during the herding event on 27 August 2020.

Figure C-13: Narwhal groups clustering along the shoreline and traveling fast into Fairweather Bay on 27 August 2020.

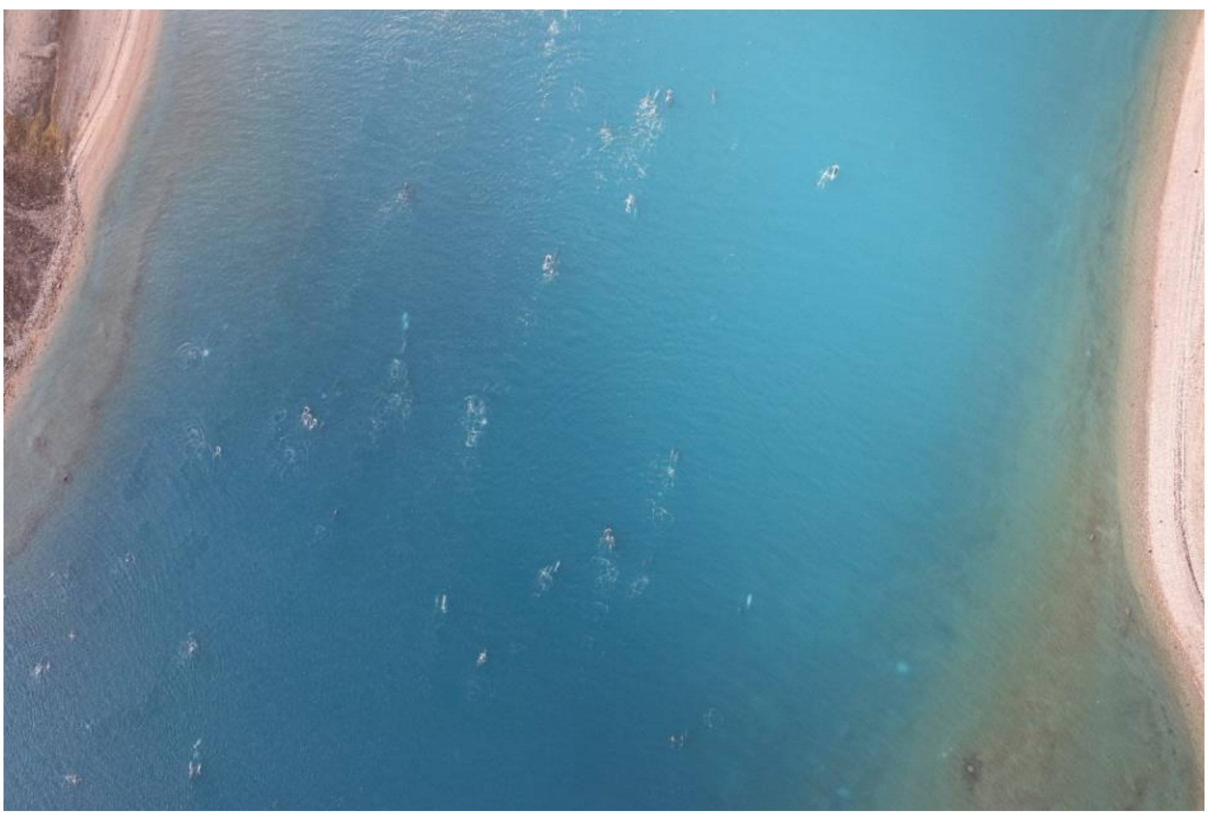


Figure C-14: Narwhal groups funneling into Fairweather Bay at 16:33 on 27 August 2020.

APPENDIX D

Distance Sampling and Mark-Recapture Models

Table 1: Narwhal Distance Sampling and Mark-Recapture Models

Distance Sampling			Mark-Recapture	
AIC	Key Function[1]	Model[2]	AIC	Model[2]
9851.33	HR	~Glare : Side : GlrAngle + ObsName + 30Sec	1468.252	~distance : ObsName + Glare + 60Sec
9851.38	HR	~Glare : Side : GlrAngle + ObsName	1468.272	~distance : ObsName + Glare + 60Sec + Bft
9860.15	HN	~Glare : Side : GlrAngle + ObsName + 30Sec	1468.472	~distance : ObsName + GlrRank + 60Sec
9861.11	HN	~Glare : Side : GlrAngle + ObsName	1469.582	~distance : ObsName + GlrAngle + 60Sec
9864.09	HR	~Glare : Side : GlrAngle + ObsName : 30Sec	1469.592	~distance : ObsName + Glare
9868.41	HR	~Glare + GlrAngle : ObsName + Side	1470.172	~distance : ObsName + Glare + 60Sec + Location
9868.42	HR	~Glare + GlrAngle : ObsName + Side + 30Sec	1470.372	~distance : ObsName + GlrRank
9869.03	Gamma	~Glare : Side : GlrAngle + ObsName	1471.242	~distance : ObsName + 60Sec + Side : GlrAngle
9869.37	Gamma	~Glare : Side : GlrAngle + ObsName + 30Sec	1471.672	~distance : ObsName + GlrAngle
9869.52	HR	~Glare + GlrAngle * ObsName + Side	1473.072	~distance : ObsName + 60Sec: Side"
9869.53	HR	~Glare * Side + 30Sec + ObsName	1473.372	~distance : ObsName + 60Sec + Bft
9869.77	HN	~Glare : Side : GlrAngle + ObsName : 30Sec	1473.422	~distance : ObsName + Bft + 60Sec
9870.48	HR	~Glare * Side + 30Sec + ObsName + GlrAngle	1473.472	~distance : ObsName + Glare : 60Sec
9870.48	Gamma	~Glare : Side + 30Sec + ObsName + GlrAngle	1473.922	~distance : ObsName + 60Sec + Glare : GlrAngle
9873.82	HN	~Glare * Side + 30Sec + ObsName	1474.272	~distance : ObsName + 60Sec
9874.1	HN	~Glare + ObsName + Side + 30Sec	1474.672	~distance : ObsName + Bft
9874.21	HR	~Glare * Side + 30Sec * ObsName	1475.552	~distance : ObsName + Side + 60Sec
9875.3	HN	~Glare + ObsName + Side + 30Sec + GlrAngle	1475.592	~distance : ObsName
9875.37	HR	~Glare + ObsName + Side + 30Sec + GlrAngle	1476.302	~distance : ObsName + 60Sec : Bft
9875.65	HR	~Glare + ObsName + Side * GlrAngle	1477.072	~distance : ObsName + Side

1) HR = Hazard Rate, HN = Half Normal.

2) distance = horizontal distance, Bft = Beaufort sea state, Side = aircraft side, Glare = glare intensity, GlrRank = glare intensity ranking, ObsName = observer name, GlrAngle = area of visual field covered by glare, 30Sec = 30 second rolling total of observations, 60Sec = 60 second rolling total of observations, Location = Eclipse Sound or Admiralty Inlet.

APPENDIX E

Preliminary Summary of 2020 Narwhal Monitoring Programs

GOLDER

TECHNICAL MEMORANDUM

DATE 7 April 2021 **Reference No.** 1663724-285-TM-Rev1-48000

TO Lou Kamermans, Senior Director of Sustainable Development
Baffinland Iron Mines Corporation

CC

FROM Phil Rouget **EMAIL prouget@golder.com**

PRELIMINARY SUMMARY OF 2020 NARWHAL MONITORING PROGRAMS

This technical memorandum has been prepared to provide preliminary results of the 2020 narwhal monitoring programs undertaken in support of the Mary River Project (the Project). Detailed monitoring results, including methodologies, will be provided to the NIRB and the Marine Environment Working Group (MEWG) as part of Baffinland's annual reporting process. Possible influencing factors on the 2020 results are discussed herein and potential adaptive management measures have been proposed for consideration.

1.0 INTRODUCTION

Key interim 2020 monitoring results indicate: i) narwhal abundance in Eclipse Sound was statistically lower than previous years; ii) recorded sounds from Baffinland icebreaking were 10-20 dB lower than modelled, which results in 120 dB exposure durations that are 60-90% lower than predicted; and iii) noise emissions of a non-vessel based, anthropogenic, impulsive sound source were detected in the RSA during the 2020 early shoulder and open-water season, which was consistent with the type of noise generated by impact pile driving. Consistent with Baffinland's approach towards adaptive management as described in the draft Adaptive Management Plan (June 2020), the following actions are recommended:

1) A review of potential causal factors of the decreased narwhal abundance in Eclipse Sound observed in 2020
2) Identification of follow-up monitoring programs for narwhal at the Project level (for implementation in 2021)
3) Identification of additional follow-up monitoring programs for narwhal at a regional level

Despite the limited information available to reliably attribute the primary causal factors, recognizing the value of the Eclipse Sound narwhal stock to the residents of Pond Inlet, the following precautionary approach is advisable for the 2021 shipping season:

4) Identification and implementation of precautionary Project-based operational mitigations for shoulder season shipping in light of unknown and/or unmitigated cumulative activities continuing to occur in 2021

This memo also includes preliminary investigations related to the four actions above, and Golder recommends these be developed further in collaboration with relevant parties.

Based on a preliminary review, potential causal factors of the 2020 decreased narwhal abundance in Eclipse Sound include acoustic disturbance from 2020 icebreaking operations, acoustic disturbance from impact pile driving in Pond Inlet associated with the Small Craft Harbour (SCH) construction project, and increased killer whale presence in the Regional Study Area (RSA).

Golder recommends additional Project-related monitoring be undertaken by Baffinland; in particular, aerial based surveys in 2021 to obtain an abundance estimate for the Eclipse Sound summer stock, as well as instrumentation of narwhal with satellite tags during early season ice conditions to fill data gaps associated with narwhal interactions with icebreaking.

Potential longer-term regional-based narwhal monitoring studies, which could inform how narwhal use of Eclipse Sound is influenced by regional factors, are also recommended to investigate potential non-Project influences on Eclipse Sound narwhal (e.g., abundance surveys of the Baffin Bay regional narwhal population, drone-based aerial photogrammetry to estimate body condition). These would be founded on local Inuit knowledge and implemented collaboratively between Baffinland, the community of Pond Inlet and respective regulatory agencies.

2.0 BACKGROUND

The Mary River Project is an operating iron ore mine located in the Qikiqtani Region of North Baffin Island, Nunavut, owned and operated by Baffinland Iron Mines Corporation (Baffinland). Baffinland is currently operating in the Early Revenue Phase (ERP) of the Project and is authorized to transport 4.2 Mtpa of ore by truck to Milne Port for shipping through the Northern Shipping Route using chartered ore carrier vessels. A Production Increase Proposal (PIP) to ship 6.0 Mtpa from Milne Port was approved twice, for two two-year periods spanning 2018–2021.

In 2020, Baffinland's shipping operations occurred over an 88-day period. The first Project vessel to enter the Regional Study Area (RSA) in 2020 was the icebreaker MSV *Botnica* on 21 July while escorting two ore carriers and two tugs to Milne Port. The last vessel to exit the RSA in 2020 was the MSV *Botnica* on 16 October while escorting one ore carrier and two tugs out of the RSA. In 2020, a total of 5.5 million tonnes of ore was shipped via 72 return ore carrier voyages and cargo/fuel was delivered to port via eight vessels, for a total of 80 vessels calling to Milne Port in 2020. This is 22 less vessels than the total of 102 vessels (82 ore carriers, 20 freight ships and fuel tankers) that called to Milne Port in 2019. The shipping activities that occurred in 2020 were within those described in the PIP Extension Request (2019), including shipping between July 15 and October 15, approximately.

To better understand potential short-term, long-term and cumulative effects of vessel noise on narwhal and other marine mammals in the RSA, Baffinland has implemented a number of follow-up monitoring programs since 2013 aimed at evaluating the potential effects of Project vessel noise on marine mammals (Table 1).

Table 1: Baffinland Marine Mammal Monitoring Programs Undertaken in RSA (2006--2020)

Marine Mammal Monitoring Program	Baseline						ERP (4.2 MPTA)			ERP (6 MPTA)		
	2006	2007	2008	2010	2013	2014[1]	2015[1]	2016	2017	2018	2019	2020
Bruce Head shore-based study	-	-	-	-	X	X	X	X	X	-	X	X
Passive acoustic monitoring	-	-	-	-	-	X	X	-	-	X	X	X
Ship-based Observer (SBO) program	-	-	-	-	X	X	X	-	-	X	X	-
Aerial surveys – cetaceans	X	X	X	-	X	X	X	X[2]	-	-	X	X
Aerial surveys - pinnipeds	X	X	X	-	-	X	-	-	-	-	-	-
Narwhal tagging study	-	-	-	-	-	-	-	X	X	-	-	-

1. 2014 included baseline data collection and initial evaluation of EEM protocol. 2015 was first year of EEM post dock construction (ERP)
2. DFO 2016 aerial survey data analyzed by Baffinland.

Hyphen (-) = no monitoring data collected that year

3.0 2020 MARINE MAMMAL MONITORING PROGRAMS – PRELIMINARY RESULTS

In 2020, the following marine mammal monitoring programs were undertaken by Baffinland between July and September:

- Marine Mammal Aerial Survey Program (MMASP)
- Bruce Head Shore-based Monitoring Program
- Passive Acoustic Monitoring (PAM) Program

3.1 Marine Mammal Aerial Survey Program

High-level Summary: *Two different marine mammal aerial surveys were performed in 2020. A reconnaissance survey was initially run during the early shoulder season (Leg 1) to collect data on the presence/absence and distribution of marine mammals in the RSA specific to available ice conditions at that time of year. A systematic aerial-based transect survey was then conducted during the open-water season (Leg 2) to obtain abundance estimates of the Eclipse Sound and Admiralty Inlet narwhal summer stocks. Results from the Leg 1 survey indicated that prior to the start of icebreaking in 2020, few narwhal had progressed into Milne Inlet due to a large consolidated ice field present in Western Eclipse which appeared to impede southbound access. Narwhal were largely concentrated within this ice field amongst several prominent ice leads when icebreaking began. This differed from 2019, when more narwhal had progressed into Milne Inlet prior to the start of icebreaking due to lighter ice conditions that year. In both years, narwhal were also present in northern Navy Board Inlet and east of Pond Inlet prior to the start of icebreaking. Results from the Leg 2 survey indicated that: i) narwhal abundance in*

Eclipse Sound was statistically lower in 2020 than observed in previous years when aerial surveys were conducted (i.e., 2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to that observed in previous years (2013 and 2019). These results suggest either a potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020, a potential displacement of these animals to another area (e.g., Eastern Baffin Bay summering ground), or a potential decrease in the Eclipse Sound summer stock.

The following section provides additional details on both aerial surveys undertaken by Baffinland in 2020.

In 2020, marine mammal aerial surveys were conducted in the North Baffin region during the early shoulder season from 10 to 22 July (Leg 1) and during the open-water season from 20 August to 1 September (Leg 2). The objectives of the Leg 1 surveys were to better understand the relative abundance and distribution of narwhal in the RSA prior to and during initial shipping and icebreaking operations in the RSA. The objectives of the Leg 2 surveys were to obtain abundance and density estimates of marine mammals in the RSA during the open-water season including an annual abundance estimate for the Eclipse Sound and Admiralty Inlet narwhal summer stocks. The aerial survey design combined visual line-transect sampling (i.e., conventional distance sampling methods) with high-resolution aerial photographic surveys. The photographic surveys were flown in high density areas of marine mammals which would otherwise be too difficult for the visual observers to get an accurate count. This method results in a greater degree of survey accuracy compared to visual line-transect sampling alone because a more robust estimate can be obtained through the photographic survey component.

Leg 1 (Early Shoulder Season)

During Leg 1, narwhal were primarily concentrated in Baffin Bay, Pond Inlet, Eclipse Sound and Navy Board Inlet. Prior to the icebreaker's first entry in the RSA, open water was present throughout Baffin Bay, Pond Inlet, and the central and northern portions of Navy Board Inlet; while Eclipse Sound was covered by extensive sea ice including a large, consolidated ice field that extended from the bottom of Navy Board Inlet to approximately 25 km east of Pond Inlet (Figure 1). Several prominent leads in the consolidated ice field were occupied by large numbers of narwhal, including many mother/calf pairs. Prior to the start of icebreaking, few narwhal had progressed into Milne Inlet, presumably due to impeded southbound access created by the consolidated ice field. This differed from 2019, when more narwhal had progressed into Milne Inlet prior to the start of icebreaking due to lighter ice conditions that year. In both years, narwhal were also present in northern Navy Board Inlet and east of Pond Inlet prior to the start of icebreaking

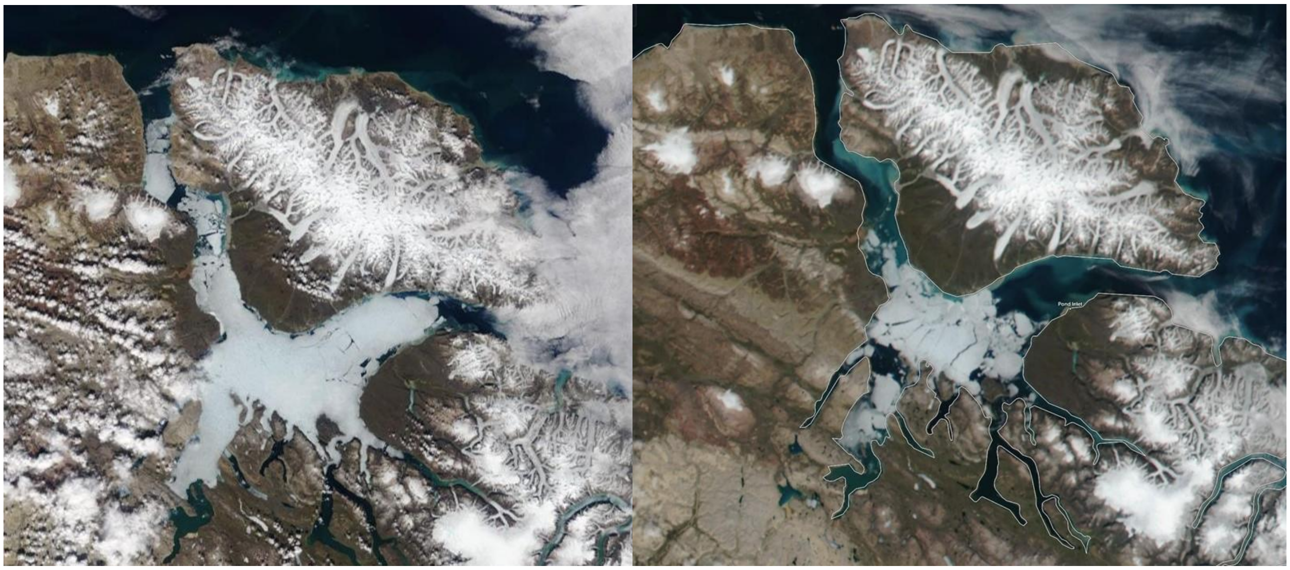


Figure 1: Satellite image of RSA on 12 July 2020 (left) and 21 July 2020 (right) showing changing ice conditions in the RSA between the start of aerial surveys and the first day of shipping (Source: Zoom Earth; https://zoom.earth).

Leg 2 (Open Water Season)

During Leg 2, narwhal in the RSA were primarily concentrated in Milne Inlet South / Koluktoo Bay and Tremblay Sound. The abundance estimate for the combined Eclipse Sound and Admiralty Inlet stocks was 36,044 narwhal (Coefficient of Variation (CV) = 0.12, 95% confidence interval (CI) of 28,267–45,961; Table 2) based on aerial surveys conducted on 28–29 August 2020. This estimate is within the range of the 2013 Fisheries and Oceans Canada (DFO) estimate for the combined Eclipse and Admiralty stocks of 45,532 narwhal (CV = 0.33, 95% CI of 22,440–92,384; Doniol-Valcroze et al. 2015) (Z-test = 0.61, p = 0.2726) and the 2019 Baffinland estimate for the combined Eclipse and Admiralty stocks of 38,771 (CV = 0.12, 95% CI of 30,667–49,016; Golder 2020) (Z-test = 0.42, p = 0.3366) (Table 2).

For Eclipse Sound stock alone, the abundance estimate was 5,018 narwhal (CV = 0.03, 95% CI of 4,736–5,317; Table 2) based on the aerial survey conducted on 29 August 2020. This estimate is statistically lower than the 2016 DFO estimate of 12,039 narwhal (CV = 0.23, 95% CI of 7,768–18,660; Marcoux et al. 2019) (Z-test = 2.53, p = 0.0057), the 2013 DFO estimate of 10,489 narwhal (CV = 0.24, 95% CI of 6,342–17,347; Doniol-Valcroze et al. 2015) (Z-test = 2.17, p = 0.0150), and the 2019 Baffinland estimate of 9,931 narwhal (CV = 0.05, 95% CI of 9,009–10,946; Golder 2020) (Z-test = 9.53, p < 0.0001) (Table 2).

For the Admiralty Inlet stock alone, the abundance estimate was 31,026 narwhal (CV = 0.14, 95% CI of 23,406-41,126; Table 2) based on the aerial survey conducted on 28 August 2020. This estimate is within the range of the 2013 DFO estimate of 35,043 narwhal (CV = 0.42, 95% CI of 14,188-86,553; Doniol-Valcroze et al. 2015) (Z-test = 0.26 p = 0.39) and the 2019 Baffinland estimate of 28,746 narwhal (CV = 0.15, 95% CI of 21,545-38,354; Golder 2020) (Z-test = 0.37, p =0.36) (Table 2).

Table 2: Historical Abundance Estimates for Eclipse Sound and Admiralty Inlet Narwhal Summer Stocks

Stock	Year	Abundance	CV	95% CI	Source
Eclipse Sound	2013	10,489	0.24	6,342–17,347	Doniol-Valcroze et al. 2015
Eclipse Sound	2016	12,039	0.23	7,768–18,660	Marcoux et al. 2019
Eclipse Sound	2019	9,931	0.05	9,009–10,946	Golder 2020
Eclipse Sound	2020	5,018	0.03	4,736 – 5,317	Golder 2021a
Admiralty Inlet	2013	35,043	0.42	14,188-86,553	Doniol-Valcroze et al. 2015
Admiralty Inlet	2019	28,746	0.15	21,545-38,354	Golder 2020
Admiralty Inlet	2020	31,026	0.14	23,406-41,126	Golder 2021a
Eclipse & Admiralty	2013	45,532	0.33	22,440–92,384	Doniol-Valcroze et al. 2015
Eclipse & Admiralty	2019	38,771	0.12	30,667–49,016	Golder 2020
Eclipse & Admiralty	2020	36,044	0.12	28,267–45,961	Golder 2021a

3.2 Bruce Head Shore-based Monitoring Program

***High-level Summary:** 2020 shore-based monitoring at Bruce Head detected fewer narwhal than previous years and this aligns with aerial survey findings of a statistically lower abundance of narwhal in Eclipse Sound in 2020 than previous years (i.e., 2013, 2016 and 2019). The narwhal calf ratio observed at Bruce Head in 2020 was consistent with pre-shipping levels, despite year-over-year increases in shipping from 2014 to 2019. Multiple observations of nursing in the Bruce Head area in 2020 offers some evidence that females with dependent young continue to carry out critical life functions in the presence of vessel traffic during the open-water season. The following provides additional details on the Bruce Head Shore-based Monitoring Program.*

Shore-based monitoring of narwhal along the Northern Shipping Route has been undertaken over a six-year period at Baffinland's Bruce Head field station (2014–2017; 2019–2020). The objective of the Bruce Head Shore-based Monitoring Program is to investigate narwhal response to shipping activities in Milne Inlet. During the open-water season, visual survey data were systematically collected on the relative abundance and distribution (RAD) and the group composition and behaviour of narwhal. Additional data were collected on environmental conditions and anthropogenic activities (e.g., shipping and hunting activities) to distinguish between the potential effects of Project-related shipping activities and confounding factors that may also affect narwhal behaviour. In 2020, data were also collected via Unmanned Aerial Vehicles (UAVs or drones) to evaluate observer detection performance and to further assess narwhal response to vessel traffic.

Relative abundance of narwhal in the Bruce Head study area, inferred from sighting rate (no. of narwhal per hour - corrected for effort), was shown to be relatively constant between 2014 and 2019, despite a gradual increase in iron ore shipping during this period (Golder 2021b, in press). In 2020, relative abundance of narwhal in the Bruce Head study area was lower compared to previous monitoring years. Based on an integrated analysis of all survey years combined, the effect of year was shown to be marginally significant ($p = 0.058$), largely due to the influence of the 2020 results. Of note, the number of narwhal observed in the study area, standardized by effort (narwhal/hour), were 101.4 narwhal/hour in 2014, 98.2 narwhal/hour in 2015, 178.0 narwhal/hour in 2016, 121.8 narwhal/hour in 2017, 126.7 narwhal/hour in 2019, and 47.5 narwhal/hour in 2020 (Table 3).

The lower relative abundance of narwhal observed in 2020 in the Bruce Head study area is consistent with findings from the 2020 aerial survey (significant decrease in 2020 Eclipse Sound abundance estimate). Results from the 2020 behavioural and group composition study components are consistent with existing impact predictions in the FEIS in that ship noise effects on narwhal will be limited to temporary, localized avoidance behaviour.

Table 3: Annual Comparison of Narwhal Relative Abundance at Bruce Head

Survey component	Survey year					
	2014	2015	2016	2017	2019	2020
Extent of shipping season	08 Aug– 03 Sep	03 Aug– 04 Sep	28 Jul– 03 Sep	02 Aug– 17 Oct	18 Jul– 30 Oct	05 Jul– 15 Oct
Survey period	03 Aug– 05 Sep	29 July– 05 Sep	30 July– 30 Aug	31 July– 29 Aug	06 Aug– 01 Sep	07 Aug– 01 Sep
No. of active survey days	23	29	27	26	26	26
No. of observer hours (total)	103.2	148.7	159.3	97.3	151.5	193.0
Average daily survey effort (h)	7.8	10.8	11.9	6.2	11.1	13.6
No. of completed RAD surveys	166	313	311	109	169	206
No. of vessel transits recorded during RAD	7	13	24	22	41	42
No. of RAD surveys with >1 vessel transiting	2	0	3	4	11	3
No. of vessel transits during survey period	13	22	47	59	75	56
No. of vessel transits during shipping season	13	22	56	154	240	188
No. of narwhal (total) recorded during RAD	10,463	14,599	28,309	11,831	19,200	9,047
No. of narwhal standardized by effort (narwhal/h)	101.4	98.2	178.0	121.8	126.7	47.5

Note: RAD = relative abundance and distribution

Similar to previous years, calves were observed during most sampling days and mean annual proportion of calves observed in 2020 (11.3%) was higher than three of the previous years (2014 = 10.7%, 2016 = 10.5%, 2017 = 9.5%), but lower than 2015 and 2019 when a mean annual proportion of 12.9% and 11.6% was recorded, respectively. This suggests that calf presence (calving success) at Bruce Head is still occurring at a rate that is consistent with pre-shipping conditions, despite year-over-year increases in shipping in the RSA.

Focal follow surveys undertaken during the Bruce Head program observed nursing by a calf or yearling during two of the 16 surveys conducted in the presence of vessels. This finding offers some evidence that females with dependent young continue to carry out critical life functions such as nursing in the presence of vessel traffic. The two nursing events occurred at distances of 4.25 km and 9.08 km from the vessel, respectively.

3.3 Passive Acoustic Monitoring During Icebreaking Operations

High-level Summary: *Underwater sounds from active Project-related icebreaking were successfully obtained in Eclipse Sound in 2020. To facilitate collection of this information, the captain of the icebreaker was requested to travel a pre-determined route directly over the underwater recording stations, which would allow for the collection of icebreaking related underwater sound in close proximity to underwater noise recorders. Results indicate sound levels from active icebreaking are 10 to 20 dB lower than what was predicted (using analogous sound sources from other regions), and per-transit exposure durations at a level of 120 dB re 1 µPa are thus 60-90% lower than predicted. The 2020 PAM program also detected sequences of impulsive sound in July and August 2020 that is consistent with the type of impulsive noise generated by impact pile driving (see further details in Section 4.2). Additional relevant details on the passive acoustic monitoring program during icebreaking operations are provided below.*

Two underwater acoustic recorders were deployed along the Northern Shipping Route on 29 Sep 2019 to record sound generated from the icebreaker MSV *Botnica* during the late shoulder season (Figure 2). One acoustic recorder was deployed in Eclipse Sound, near the southwest end of Bylot Island, and the other was deployed in northern Milne Inlet near Ragged Island. To extend their battery life, the recorders were programmed to stop recording through the winter, from 12 Oct 2019 to 17 Jul 2020, so they could continue to record noise from icebreaker transits during the 2020 ‘early shoulder’ season. Underwater noise was analyzed for a total of 17 one-way transits of the MSV *Botnica* in Eclipse Sound (8 in the 2019 late shoulder season and 9 in the 2020 early shoulder season) and 18 one-way transits in northern Milne Inlet (7 in the 2019 late shoulder season and 11 in the 2020 early shoulder season). All transits recorded during the 2019 fall shoulder season occurred in open-water (0/10 ice concentration). Transits recorded during the 2020 early shoulder season included both open-water and ice-covered conditions, with ice concentrations ranging between 0/10 and 9/10. During the analyzed transits, the MSV *Botnica* either transited alone or with 1 to 4 other vessels in escort (including ore carriers and tugs).

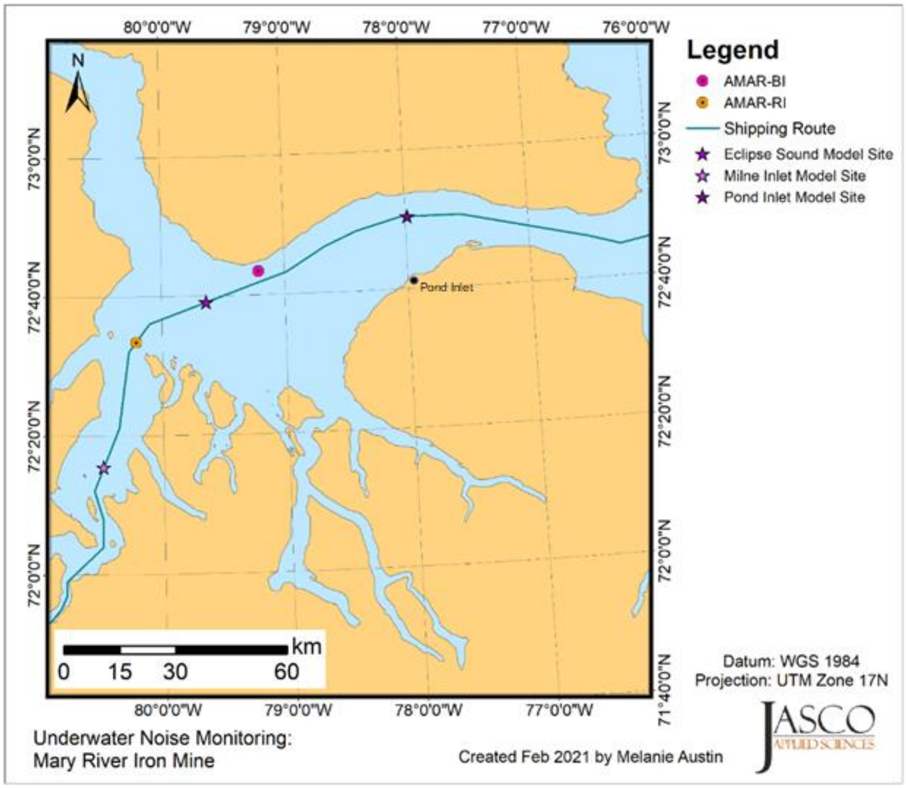


Figure 2: Location of acoustic recorder stations (AMAR-BI and AMAR-RI) deployed along the Northern Shipping Route during the 2019 late shoulder season and 2020 early shoulder season. Also shown are the acoustic modelling location selected for the marine mammal effects assessment.

Sound pressure levels (SPLs) were recorded during each of the analyzed icebreaker transits, both with and without vessels under escort. Two standard metrics of vessel noise emissions, radiated noise levels and monopole source levels, were estimated for each transit of the MSV *Botnica.* Also computed was the 90th percentile distance between the MSV *Botnica* and the recorder at which sound levels exceeded the 120 dB re 1 µPa disturbance threshold, and the corresponding exposure duration. Although the MSV *Botnica* was shown to periodically generate high intensity sound while transiting through ice, findings suggest that these periods are brief and intermittent (i.e., on the order of minutes or less). Furthermore, the spatial extent of the noise field and the duration of exposure associated with disturbance effects (>120 dB re 1 uPa RMS) was shown to increase by only a small amount when additional vessels were added to the convoy, and when ice concentration increased, but by no more than the variability observed of the MSV *Botnica* in varying conditions on its own.

The results of this analysis were also compared with modelling estimates that were calculated as part of the icebreaking assessment (Golder 2019a) and confirmed that the assumptions used in the acoustic modeling led to overestimates of the real sound levels experienced by narwhal, as the modelling was intentionally conservative. Results demonstrated that the measured per-transit noise exposure periods exceeding 120 dB re 1 µPa were approximately 80-90% lower than modelling estimates when the icebreaker was actively breaking ice (3/10 to 9/10), and > 60% lower than modelled estimates when the icebreaker was traveling in open water. Based on the acoustic modelling results of shoulder season shipping, a stationary narwhal in Eclipse Sound was predicted to experience sounds ≥ 120 dB re 1 µPa for between 0.7 and 9.5 hours per vessel transit, dependent on transit scenario and ice concentration (Quijano et al. 2019), while measured exposure durations have since been shown to range between only 0.17 and 1.08 hours (Austin and Dofher 2021, in press). The maximum exposure duration calculated ≥ 120 dB re 1 µPa (i.e., 1.08 hours) occurred on 22 July 2020 during which time the MSV *Botnica* was transiting at 7.3 knots through 9/10 ice concentration with no vessels in escort.

3.4 Discussion of Results

Results from the 2020 aerial survey indicated: i) narwhal abundance in Eclipse Sound was statistically lower in 2020 than in previous aerial survey years carried out in the RSA (2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to that observed in previous years. These results suggest either potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020, a potential displacement of these animals to another area (e.g., Eastern Baffin Bay summering ground), or a potential decrease in the Eclipse Sound summer stock.

Results from the 2020 shore-based monitoring at Bruce Head detected fewer narwhal than previous years and this aligns with aerial survey findings of a statistically lower abundance of narwhal in Eclipse Sound in 2020 compared to previous survey years (i.e., 2013, 2016 and 2019). The narwhal calf ratio observed at Bruce Head in 2020 was consistent with pre-shipping levels, despite year-over-year increases in shipping from 2014 to 2019. Multiple observations of nursing in the Bruce Head area in 2020 offers some evidence that females with dependent young continue to carry out critical life functions in the presence of vessel traffic.

Results from the 2020 PAM program indicated that underwater sounds from active Project-related icebreaking are lower than what was predicted, demonstrating that the acoustic modelling undertaken in the effects assessment was conservative. The 2020 PAM program also detected sequences of impulsive sound in July and August 2020 consistent with the type of impulsive noise generated by impact pile driving (see further details in Section 4.2).

In consideration of the above findings, it is evident that a lower number of narwhal were observed in the Eclipse Sound summer stock area during 2020 that requires further investigation. Consequently, Baffinland has committed to applying adaptive management and implementing additional mitigation measures to its 2021 shipping operations while the potential cause of the decline is being investigated. The following sections discuss the potential contribution of the Project relative to the observed findings in balance with other potential contributing factors.

4.0 POTENTIAL CONTRIBUTING FACTORS TO 2020 FINDINGS

The activities summarized below are considered potential contributors to the lower observed number of narwhal in Eclipse Sound in 2020. At present, it is understood that these may have acted independently, or in a cumulative or additive manner. The information presented herein is considered preliminary and further desktop analysis and information collection is required to appropriately determine potential causes of the 2020 narwhal abundance observation. Baffinland proposes to undertake the development of this material, as per the AMP (see Section 5.0), in collaboration with applicable parties through the MEWG and dedicated discussions with DFO and other responsible parties related to the authorization of works associated with the Pond Inlet SCH construction project.

4.1 Icebreaking Activities

***High-level Summary**: Project icebreaking is considered a possible contributing factor to the observed decrease in Eclipse Sound narwhal summer stock in 2020. In 2020, narwhal numbers in the RSA were significantly lower than that observed in 2019 and compared to previous survey estimates. Ice conditions in 2020 were more concentrated in the RSA compared to 2019, but less concentrated compared to 2018. Similarly, more icebreaking took place in the RSA in 2020 (22 h) than 2019 (11 h), but substantially less than 2018 (56 h). In 2020, narwhal were largely concentrated in several prominent ice leads present within a large, consolidated ice field in western Eclipse Sound during the first day of icebreaking, and therefore occurred in a more clumped distribution when they were first exposed to icebreaking compared to 2019 when animals were more widely distributed in the RSA during their initial icebreaking exposure. During its first transit in the RSA in 2020, the MSV Botnica (escorting two carriers and two tugs) transited in close proximity to the leads where narwhal were confirmed to be holding.*

Baffinland has undertaken icebreaking operations during the shipping shoulder seasons since 2018. In 2018, the MSV *Botnica* (icebreaker) first entered the RSA on 21 July (the last day land-fast ice remained in the RSA was 19 July). Regional ice conditions on 21 July included 9-10/10 ice concentrations throughout Milne Inlet North and Eclipse Sound, with 7-8/10 concentrations in Navy Board Inlet and east of Pond Inlet (Figure 3). A consolidated ice field of 9-10/10 ice concentrations persisted in Eclipse Sound / Milne Inlet North until 28 July, resulting in a total of eight days in which Project icebreaking took place in heavy ice conditions (≥9/10) along a portion of the Northern Shipping Route, with no restrictions in place in 2018 on the number of icebreaker transits allowed per day. Overall, sea ice was highly concentrated in the RSA when icebreaking began in 2018 compared to the 2019 and 2020 seasons (see Attachment 1 for yearly comparison of daily ice charts from 12 to 22 July).

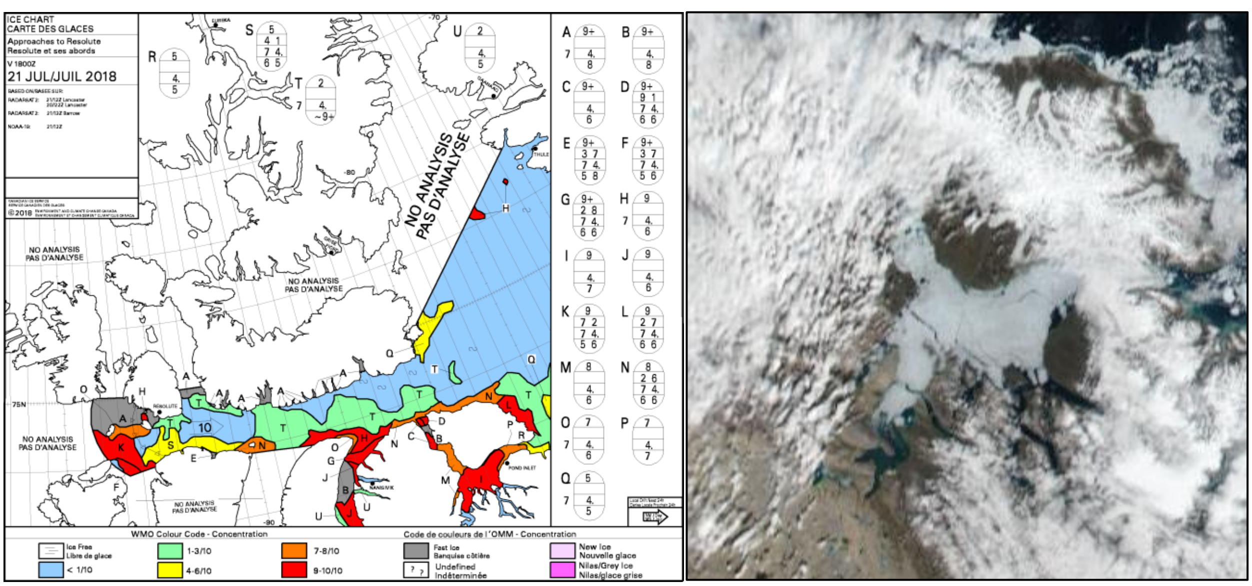


Figure 3: Ice chart for 21 July 2018 (left; Canadian Ice Service) and satellite image for 20 July 2018 (right; Zoom Earth) showing ice concentrations in Eclipse Sound on the first day of icebreaking in RSA.

In 2019, the first MSV *Botnica* transit in the RSA was on 17 July (the last day land-fast ice remained in the RSA was 11 July). Regional ice conditions on 17 July included 4-6/10 ice concentrations throughout Milne Inlet North and the majority of Eclipse Sound, with open water in Milne Inlet South and Pond Inlet (Figure 4). A consolidated ice field of 9-10/10 ice concentrations persisted in Western Eclipse Sound, south Navy Board Inlet and north Tremblay Sound until 20 July, resulting in a total of 3 days in which part of the Northern Shipping Route was transited through heavy ice conditions (≥9/10) (limited to one transit per day in these areas). Overall, sea ice in the RSA was in an advanced stage of break-up when icebreaking began in 2019 compared to the 2018 and 2020 seasons (Attachment 1).

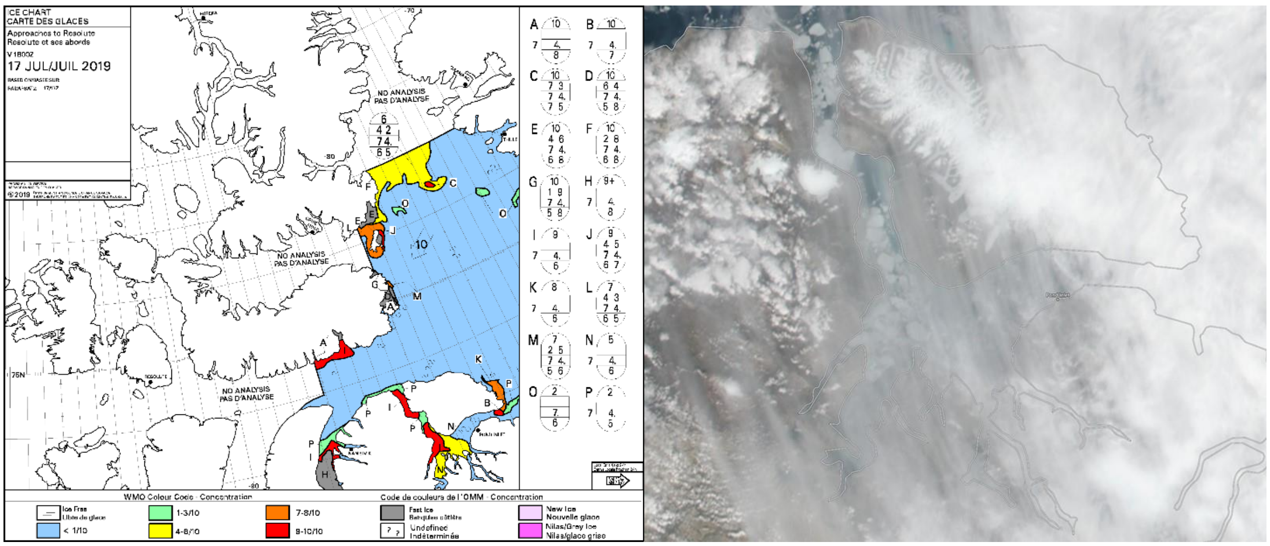


Figure 4: Ice chart for 17 July 2019 (left; Canadian Ice Service) and satellite image for 16 July 2019 (right; Zoom Earth) showing ice concentrations in Eclipse Sound on the first day of icebreaking in RSA.

In 2020, the first icebreaker transit in the RSA was on 21 July (the last day land-fast ice remained in the RSA was 17 July). Regional ice conditions on 21 July included 9-10/10 ice concentrations throughout Eclipse Sound, with 4-6/10 ice concentrations in Milne Inlet North, Tremblay Sound, and southern portion of Navy Board Inlet (Figure 5). A consolidated ice field of 9-10/10 concentrations persisted in Eclipse Sound until 26 July, resulting in a total of six days in which part of the Northern Shipping Route was transited through heavy ice conditions (≥9/10) (limited to one transit per day in these areas). Overall, sea ice was more concentrated in the RSA in 2020 compared to 2019 when icebreaking began, and less concentrated compared to 2018 ice conditions during initial icebreaker operations (Attachment 1). Slightly more icebreaking occurred in 2020 than 2019, primarily because the icebreaker was required to transit through more extensive heavy ice conditions in order to pass directly over the two JASCO hydrophone stations at Bylot Island and Ragged Island for the purpose of acquiring acoustic recordings of active icebreaking in 9-10/10 ice. Normally, the MSV Botnica would adhere to its standard practice of actively avoiding heavy ice conditions during transits along the shipping corridor unless these areas could not be safely avoided. This is therefore considered a one-off event for the purpose of filling an imperative data gap related to icebreaker and icebreaking escort operational noise in the RSA.

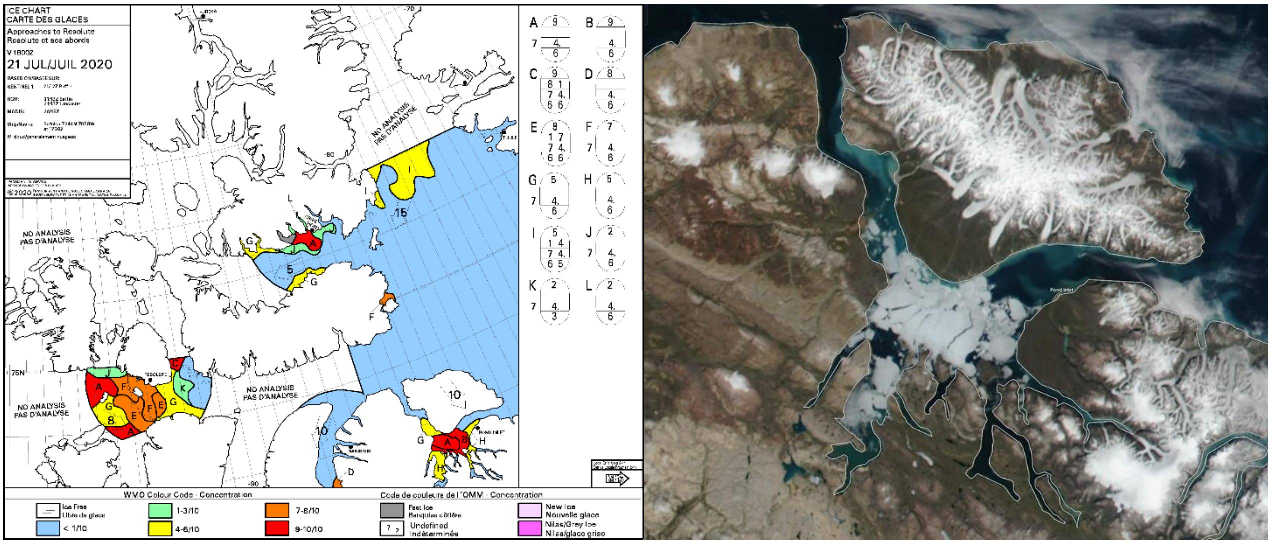


Figure 5: Canadian Ice Service chart for 21 July 2020 (left) and satellite image for 21 July 2020 (right) showing ice concentrations in Eclipse Sound on first day of icebreaking in RSA.

Narwhal distribution differed between 2019 and 2020 due to the different ice conditions in the study area. When aerial surveys began in July of 2019 and 2020, the floe edge had already largely broken up with most of the ice situated in Eclipse Sound, Milne Inlet North, and the lower part of Navy Board Inlet. The difference in narwhal distribution occurred in the ice-covered portions of the RSA. In 2019, the remaining sea ice present in the RSA when icebreaking started was fragmented into a loose pack ice formation allowing narwhal to disperse throughout the area somewhat evenly. In 2020, sea ice present in the RSA at the start of icebreaking was largely intact (i.e., large, consolidated ice field) with a few ice leads running through it. As a result, narwhal were highly concentrated in the ice leads in Eclipse Sound, forming a more clumped distribution compared to 2019. Narwhal distribution in the Baffin Bay and Pond Inlet strata was similar between 2019 and 2020 with narwhal dispersed throughout the open water areas.

Icebreaking was quantified to allow for a comparison between years. As noted above, icebreaking in heavy ice conditions (≥9/10 ice cover) occurred over eight days in 2018, three days in 2019, and six days in 2020 (Figure 6). The longest duration of heavy icebreaking in a single day was 18 h and 14 min in 2018, 4 h and 32 min in 2019, and 7 h and 16 min in 2020 (Figure 6). The total duration of icebreaking for the combined days in heavy ice conditions was double in 2020 compared to 2019 (~22 and 11 hours, respectively; Figure 6), and five times greater in 2018 compared to 2019 (~56 and 11 hours, respectively; Figure 6). The total distance travelled by the MSV *Botnica* in heavy ice conditions was 764.8 km in 2018, 131.4 km in 2019, and 226.5 km in 2020. A reduction in the level of icebreaking in 2019 and 2020 was, in part, due to changes in ice conditions in those years, but also a result of the introduction of icebreaker transit restriction mitigations following the 2018 shipping season. Some of the icebreaking that occurred in 2020 was also to satisfy the monitoring requirements to record icebreaker sound levels over the JASCO acoustic recorders.

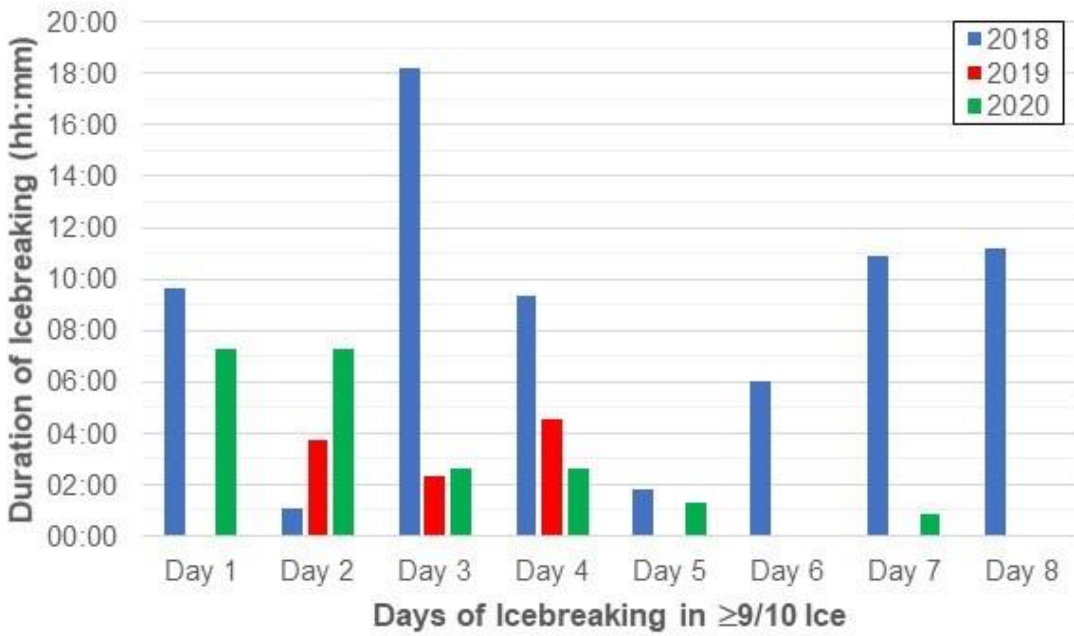
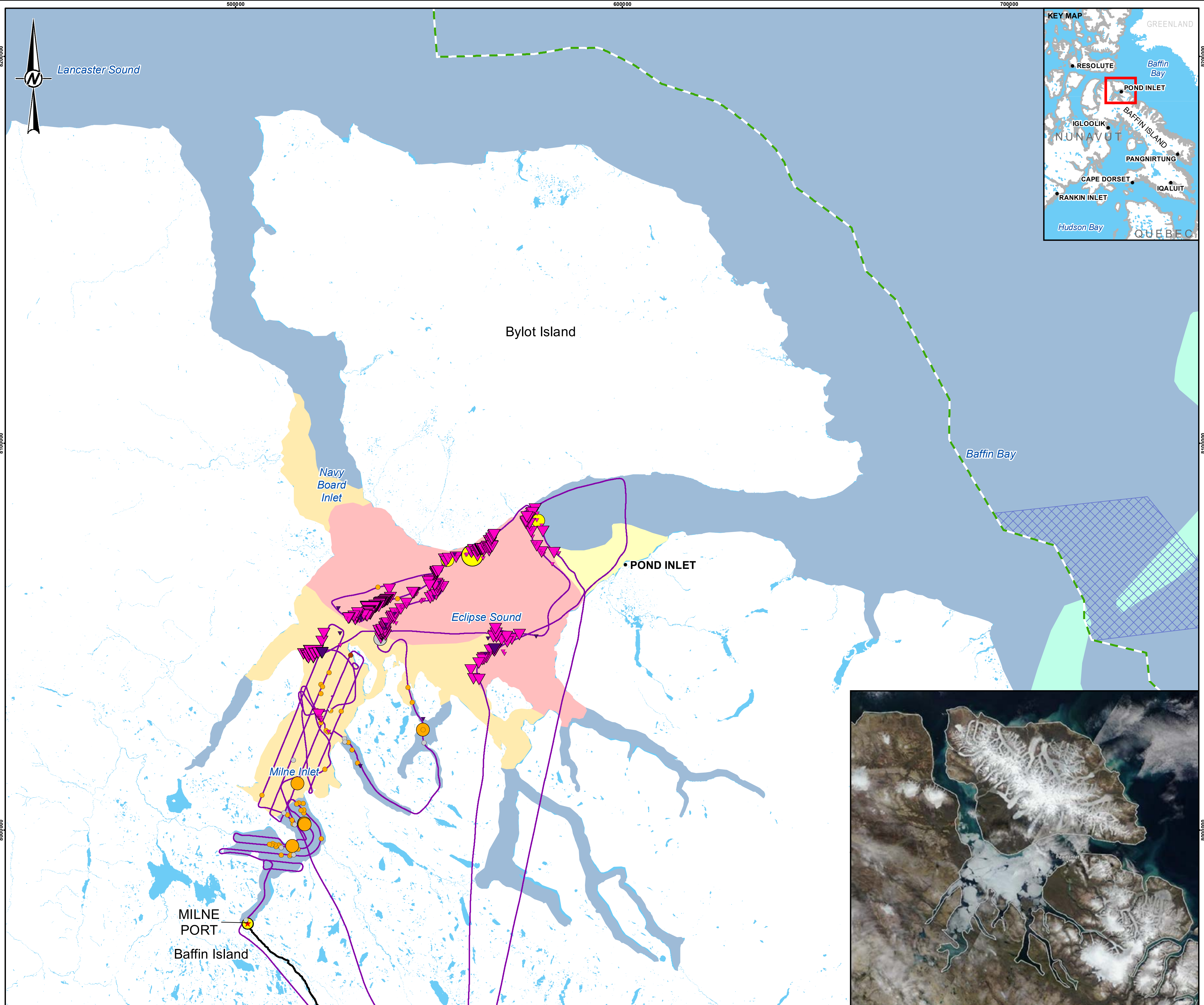


Figure 6: Daily duration of icebreaking in ≥9/10 ice concentrations presented by year (2018-2020).
Note: Day 1 represents the first day of icebreaking in the RSA each year.

Narwhal response to icebreaking during the late spring was studied in Lancaster Sound during the 1980s (Finley et al. 1990). This involved an icebreaker approaching and breaking landfast ice enroute to the Nanisivik mine in Admiralty Inlet. Narwhal response to this activity included their initial displacement from the floe edge in response to the approaching ship (at estimated received levels of 94–105 dB re 1µPa in the 20–1,000 Hz band), with some narwhal returning to the floe edge 1–2 days later and engaging in normal diving and foraging behaviour in the presence of the icebreaker and while being exposed to louder noise levels than the initial exposure (as high as 120 dB in the same band (Finley et al. 1990). Possible explanations to the overt response included 1) animals might have felt trapped along the ice edge as the ships approached, 2) a lack of familiarity or experience with icebreaker noise in the High Arctic during late spring, and/or 3) long-range sound propagation conditions in surface waters at that time of year. The fact that narwhal later returned to the area of disturbance when noise levels were higher than those to which they initially reacted suggests this initial reaction may have been a startle response and that some level of habituation or tolerance may have occurred (LGL and Greeneridge 1986). This type of response was not observed during icebreaking for the 2019 MMASP. In 2019 narwhal abundance increased after icebreaking activities were underway with an initial abundance of 5,793 narwhal (CV=0.23) on 15–16 2019 July prior to Baffinland vessel in the RSA to 15,591 narwhal (CV=0.19) on 21–22 July 2019 after Baffinland vessels entered the RSA (Golder 2020).

In 2020, the MSV *Botnica* (escorting two carriers and two tugs) transited through a large, consolidated ice field in North Milne/West Eclipse on 21 July which included several narrow ice leads occupied by large numbers of narwhal (including mother/calf pairs). Narwhal were confirmed to be ‘holding’ in these leads prior to the first icebreaker transit in the RSA (Figure 7). Based on the AIS vessel tracking data, the icebreaker appeared to have transited in close proximity to one of the leads upon its initial entry through the ice field (Figure 8). The following day, narwhal relative abundance increased from 2.21 animals/km (from 21 July 2020) to 4.25 animals/km in leads in Eclipse Sound (on non-systematic transects) and decreased from 0.16 animals/km (on 21 July 2020) to 0.02 animals/km in Milne Inlet (systematic transects) after the icebreaker transited the RSA. This is further supported by the noticeable shift in narwhal distribution from 21 to 22 July 2020 where narwhal appeared to move from the 4-6/10 ice area in north Milne Inlet to the 9-10/10 ice in Eclipse Sound (Figures 8 and 9).



LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BEARDED SEAL
- 1

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 1

UNIDENTIFIED SEAL
- 1
- 2-10

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10

0 25 50

1:1,000,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 7 - JULY 20, 2020

CONSULTANT

GOLDER

YYYY-MM-DD	2021-04-01
DESIGNED	TT
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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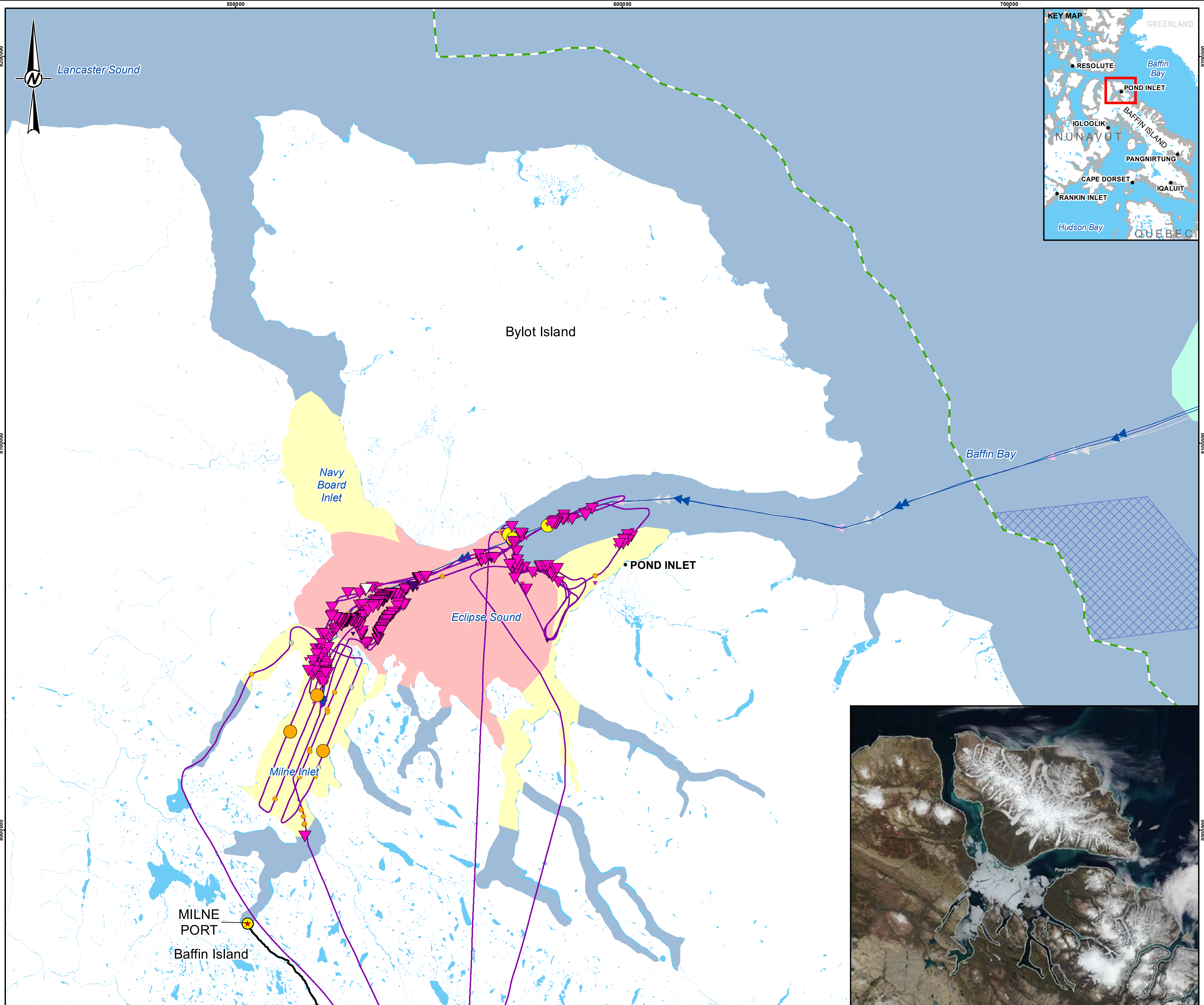

LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2-10

HARP SEAL
- 1
- 2-10

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED CETACEAN
- 2-10

UNIDENTIFIED SEAL
- 1

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 9-10/10

0 25 50
1:1,000,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 8 - JULY 21, 2020

CONSULTANT
GOLDER

YYYY-MM-DD	2021-04-01
DESIGNED	TT
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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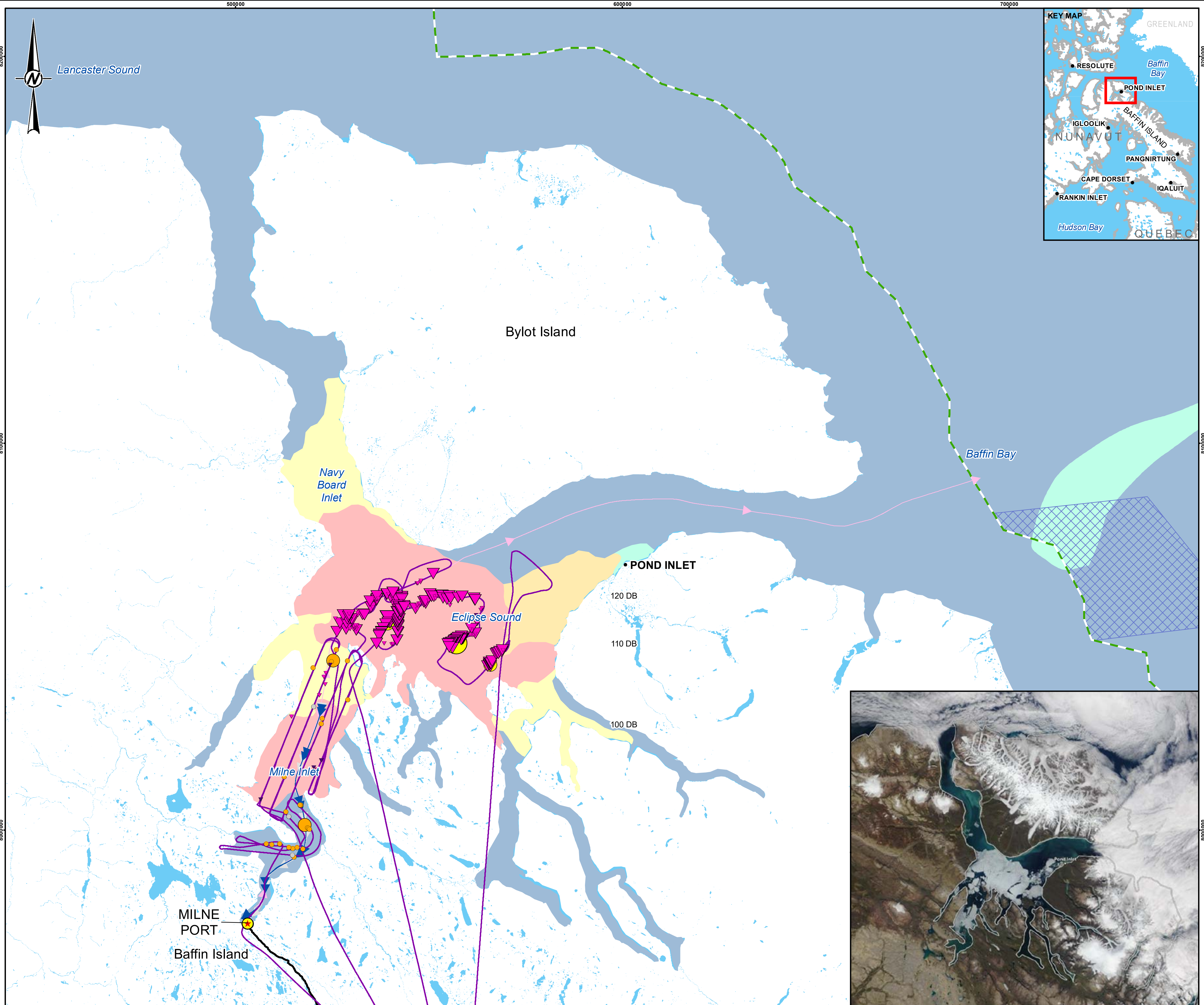


LEGEND

- COMMUNITY
- MILNE PORT

MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1

HARP SEAL
- 2-10
- 10+

NARWHAL
- 1
- 2-10
- 10+

RINGED SEAL
- 1
- 2-10

UNIDENTIFIED SEAL
- 1

- AERIAL SURVEY TRACK
- MILNE INLET TOTE ROAD

PROJECT VESSEL SHIP TRACKS
- BULK (ORE) CARRIER
- ICEBREAKER (BOTNICA)
- SERVICE VESSEL
- 40 km BUFFER ZONE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

ICE CONCENTRATION
- < 1/10
- 1-3/10
- 4-6/10
- 7-8/10
- 9-10/10

0 25 50
KILOMETRES
1:1,000,000

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. SOUND CONTOURS OBTAINED FROM JASCO APPLIED SCIENCES (30 MARCH 2021) BASED ON SOUND LEVELS REPORTED IN ADVISIAN (2021) FOR PILE DRIVING ON 22 JULY 2020.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 9 - JULY 22, 2020

CONSULTANT
GOLDER

YYYY-MM-DD	2021-04-01
DESIGNED	TT
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	48000	0	9

Additional information regarding narwhal behavioural responses to icebreaking has been yielded from Baffinland's 2018 tagging study (Golder 2020b). In August 2018, two narwhal (NW21 and NW22) were live captured in the RSA, instrumented with satellite telemetry tags and high-resolution dive tags, and released back to the ocean for the purpose of monitoring their daily movements in relation to fluctuating ice conditions in the RSA and in response to icebreaking operations and ship traffic along the Northern Shipping Route during the shipping season. Both NW21 and NW22 were shown to remain in the vicinity of the Northern Shipping Route for extended periods during the 2018 fall shoulder season, despite being exposed to thickening ice conditions and regular icebreaking activities during the late shoulder season. Although the location data associated with NW21 were not of sufficient resolution to assess fine scale movements of this animal in relation to icebreaker movements, it was evident from the daily narwhal tracks that exposure to icebreaker and ship traffic during this time did not result in any large-scale displacement of either narwhal from the RSA. In general, NW22 had multiple close encounters with the icebreaker and all vessel types throughout the fall shoulder season and did not appear to actively avoid icebreaking operations and associated vessel traffic as the season progressed. Of the total narwhal-vessel interaction events recorded for NW22 in 2019, 25 of these events occurred in relation to icebreaking transits undertaken by the MSV *Botnica* and one event occurred in relation to icebreaking transits by the CCGS *Terry Fox*. The distance between NW22 and an icebreaker during active transits (CPA < 54.4 km) ranged between 0.84 km and 52.97 km. Throughout the 19-day study period, NW22 remained within the modelled '120 dB disturbance' zone of the icebreaker (54.4 km) for 47.4% of the time.

NW22 interacted more closely with the MSV *Botnica* (with vessels in escort) toward the latter part of the late shoulder season (see Figure 13 in Golder 2019b). This finding may indicate possible habituation of the animal to icebreaking operations. It may also indicate that both the icebreaking vessel and animal were utilizing the path of least resistance (i.e., area with the least ice present) as the ice becomes increasingly dense later in the fall shoulder season. It is also possible that increasing ice concentration restricts movements by the animal, causing it to rely more heavily on the path created by icebreaking operations.

NW22 made regular crossings across the bow and the stern of all vessel types during the 2018 fall shoulder season (see Figure 14 in Golder 2019b). However, NW22 did not cross behind the stern of the *Botnica* (with vessels in escort) for a period of 4.5 hours following an active transit. As sound generated from vessels is known to radiate asymmetrically, with sound levels from the stern aspect typically being highest (Arveson and Vendittis 2000; McKenna et al. 2012), this finding may signify the animal's attempt to avoid the noisiest aspect of the vessel. However, the gap may also be due to data scarcity during the 2018 fall shoulder season (limited to one tagged animal). In addition, given the characteristics of sound that are generated from icebreaking operations and the way in which sound propagates under ice, the interpretation of the 4.5 h gap of crossing behind the stern of the vessel is not straightforward. It is also important to note that this result is based on a very limited dataset (a single animal over the course of 19 days), and further data collection and analysis is required to further evaluate this potential avoidance response.

Although this study does offer some preliminary evidence of narwhal behavioural responses to icebreaking; it is important to note that the results are based exclusively on narwhal behaviour to icebreaking during the late shoulder season, when ice conditions are considerably lighter than ice conditions present during the early shoulder season (i.e., when icebreaking would involve thick, first year ice). Results should thus be interpreted with caution.

Available IQ regarding the effects of icebreaking on narwhal is primarily based on historical observations of narwhal near the now decommissioned Nanisivik Mine in Arctic Bay which involved icebreaking operations between May and November.

"The ship track was used by narwhal to migrate in because the ship was opening up the ice. But when the ice breaker came in the narwhals would scatter. After the ice breaker came in and things calmed down, the narwhal came back in. It had a very temporary impact." [p.216 of JPCS 2019]

"We didn't see any decrease year to year. We didn't notice any changes in the population or abundance of narwhal. There were no drastic changes to the numbers." [p.216 of JPCS 2019]

"Ice breaking was always a concern. Early on we thought it was scaring away the narwhal. It turned out the ship was creating access for narwhal, and we used more than our quota. Real problems? No." [p. 215 of JPCS 2017]

"In the past, with Nanisivik, animals would flee to shore when the ship came. Eventually they got used to the ship and wouldn't flee." [p. 223 of JPCS 2019]

4.2 Construction Noise from Small Craft Harbour in Pond Inlet

High-level Summary*: Preliminary analysis of underwater noise recordings collected by JASCO Applied Sciences (JASCO), on behalf of Baffinland, in Eclipse Sound during the 2020 early shoulder and open-water seasons has identified anomalous sounds, similar in nature to sounds generated by pile driving (and different than sounds generated by vessels). These impulsive sounds are not thought to be natural in origin and according to available construction monitoring reports (Advisian 2021), they correspond in time with impact pile driving that occurred in Pond Inlet as part of the 2020 Small Craft Harbour (SCH) construction project. A preliminary review of available construction monitoring reports by Golder indicates that the pile driving emitted high-energy impulsive noise to the marine environment during a 52-day period (8 July to 28 August) that corresponded with the typical timing of narwhal spring migratory movements into Eclipse Sound. The construction monitoring report from 2020 (Advisian 2021) indicates that impact driving methods were employed for pile installation instead of vibratory methods originally proposed by the proponent, that underwater noise/overpressure thresholds were exceeded during active impact pile driving, and that mitigation measures were not implemented to minimize adverse effects of impact pile driving noise on marine mammals in the RSA.*

Construction of the SCH project in Pond Inlet has occurred during each open-water season since 2018, with construction anticipated to be completed in 2021 (Advisian 2021). The SCH project is permitted under DFO Fisheries Authorization (FAA) No. 17-HCAA-00551 (DFO 2020a) and No. 19-HCAA-01020 (DFO 2020b), issued to the Government of Nunavut – Community and Government Services (GN-CGS) as lead proponent of the SCH Project. The lead contractor for the project is Tower Arctic Ltd. (Tower Arctic). Construction activities for the project in 2020 took place during the open-water and shoulder season periods (10 June through 25 October). Advisian's 2020 construction monitoring report is included herein as Attachment 2 (Advisian 2021). In-water construction works undertaken in 2020 included impact pile driving, vibratory pile driving, dredging and placement of rock/fill in the marine environment. Pile driving occurred from 8 July through 7 October 2020 (Advisian 2021), over a 12-hour daily period. The location of the pile driving undertaken at the SCH site in 2020 is depicted in Figure 10.

Figure 10: Aerial imagery of Pond Inlet shoreline showing location of pile driving in 2020 (extracted from Advisian 2021).

Marine construction activities generate both impulsive and non-impulsive (continuous) noise underwater that have the potential to result in adverse effects on marine mammals, ranging from hearing impairment to acoustic disturbance effects including avoidance behaviour, displacement and/or acoustic masking. Impact pile driving in particular can introduce high-energy impulsive noise to the underwater acoustic environment, in which low-frequency components of the emitted noise can be transmitted over long distances with potential to disrupt the behavior of marine mammals at ranges of many kilometers (Tougaard et al. 2009; Brandt et al. 2011) and have the potential to induce hearing impairment at close range (Madsen et al. 2006). As part of the FAA for the SCH construction in Pond Inlet, a Construction Environment Management Plan (CEMP) was developed by Tower Arctic which included a number of mitigation commitments to manage adverse impacts from the planned pile driving activities on marine mammals and fish (Tower Arctic 2020). This included the following:

- Both pile types proposed for installation in 2020 (39 x 760 mm circular piles and 600 sheet piles) will be driven with a vibratory pile driver (ex. 44B model) and exceptionally a conventional hammer or a diesel hammer will be used. Systematically, if a hammer is used to pile a 760 mm circular pile, a bubble curtain will be put in place around the pile to reduce the overpressure and the activity will occur during daylight conditions only (to allow for visual monitoring of marine mammals).
- A soft start for pile driving will be implemented slowly over a 10 min period to ensure mammals and fish have sufficient time to leave the area. Soft start procedures will be implemented at the start of every piling event and every time piling has been interrupted for at least 30 min.
- A 500-m marine mammal exclusion zone (EZ) will be set up around the pile driving activity. Marine Mammal Observers (MMOs) will be employed to monitor the presence of marine mammals in the defined EZ for pile driving where there is potential for pile driving noise to exceed the underwater noise auditory threshold for marine mammals of 160 dB re 1µPa. The exclusion zone will be initially set at 500 m, with in-situ underwater

noise monitoring to be conducted at the onset of the construction activity to verify the exclusion zone based on the underwater noise auditory threshold. The construction activity will be suspended if a marine mammal enters the exclusion zone and will not restart until 30 minutes after it is last observed or it is seen leaving the exclusion zone.

- Ensuring underwater pressure and noise levels will not exceed 30 kPa at 10 m and 160 dB re 1 μPa for vibratory pile driving, which also defines the outer limit of the exclusion zone. The monitoring of the underwater noise will begin right after the soft start period. The purpose is to confirm the size of the exclusion zone initially set at 500-m in compliance with the CEMP. Measurements will be carried out starting at a 500 m mark offshore from the work site. Depending on the SPL_{RMS} dB (re 1μPa) results, subsequent measurements will be made either further offshore or inshore in order to define the location of the 160 dB (re 1μPa) threshold.
- Acoustic compliance monitoring will be implemented during the following pile driving activities:
  - Impact driving of 760 mm circular piles
  - Vibratory driving of 760 mm circular piles
  - Impact driving of sheet piles
  - Vibratory driving of sheet piles
- Acoustic measurements will be taken at the beginning of each new activity listed above. Additional measurements will be taken if the work method changes or if conditions such as weather and tide stage change significantly with respect to the initial measurements. A follow up measurement will be taken once a week at the perimeter of the exclusion zone.
- If construction is to occur during the iced-season, in-air sound levels shall not exceed the in-air acoustic threshold of 100 dB re 20μPa when pinnipeds are observed on the ice during construction activities.

Typically, in order to avoid and/or minimize adverse effects of high-energy pile driving noise on marine mammals, marine piling projects optimize the use of a vibratory hammer for pile installation[1], as this generates lower energy, non-impulsive noise unlike impact pile driving. Although a vibratory hammer was to be used as the primary method for pile installation during the SCH project (Tower Arctic 2020), based on follow-up reporting by Advisian (2021), a vibratory hammer was not mobilized to site until 28 August 2020, seven weeks after the start of the piling program. Piles were therefore installed using an impact hammer for the initial 52-days of the 2020 SCH construction project (8 July to 28 August).

Several non-compliance events occurred during the 2020 SCH pile driving program and were reported to DFO (Advisian 2021). This included exceedances of underwater noise/overpressure thresholds during active pile driving, absence of real-time acoustic monitoring during pile driving[2], failure to deploy bubble curtains during

[1] Noting however that piles installed with a vibratory hammer are typically still driven in the final stage with an impact hammer to seat the pile into the overburden and to determine the pile's load-bearing capacity.

[2] Acoustic monitoring of pile driving in 2020 was limited to a total of four days out of 23 days of pile driving based on information presented in Advisian (2021)

impact pile driving, failed application of soft-start procedure during pile driving, failure to implement adaptive management for pile driving, and failure to meet general monitoring requirements as prescribed in the CEMP (Tower Arctic 2020) and the FAA (DFO 2020).

One example of a non-compliance event during active pile driving was described as follows. On July 22, measured overpressure readings during active impact pile driving were shown to exceed the 30 kPa threshold a total of five times (Advisian 2021). This was noted as a potential underestimate, as hydrophone monitoring was not undertaken during all pile driving events that day because the EM was also having to undertake active marine mammal monitoring duties (acoustic monitoring was discharged to an on-site engineer that did not have the appropriate noise monitoring experience). This was identified as a non-compliance event for not performing real-time monitoring of the applicable thresholds during active pile driving, and a non-compliance event for not meeting the Environmental Procedure construction specification (Advisian 2018), which states that an EM must have no other roles on the Project and must be appropriately qualified to undertake the prescribed monitoring. On July 23, Tower Arctic attempted to set up a bubble curtain around the wetted pile to mitigate for the observed overpressure exceedances the previous day. However, the bubble curtain was determined to be not functional and therefore could not be used as a mitigation tool on that day (or on any subsequent day in 2021). In the absence of a bubble curtain, Tower Arctic subsequently made the decision to reduce the drop height of the impact hammer by 50% at the start of pile driving. In theory, reduction of the hammer height would generate lower overpressure. However, on-site Advisian Engineers reported that the contractor returned to a full height drop following initial application of this soft-start procedure (after confirming overpressure levels were no longer being exceeded during the half-height drop) (Advisian 2021). Soft-start procedures are intended to displace animals from the sound source area to avoid potential for acoustic injury. Advisian submitted a letter to DFO on 05 August 2020 summarizing details of this non-compliance event under the ‘Duty to Notify’ permit requirement (Advisian 2021).

JASCO’s 2020 passive acoustic monitoring program detected sequences of impulsive sound in acoustic data collected during July and August 2020 near Bylot Island (M. Austin, pers. comm., March 22, 2021). While the origin of this impulsive noise has not yet been confirmed, these sounds are not thought to be natural in origin and they correspond in time with impact pile driving that occurred at the SCH site in Pond Inlet. The nature of the sound is consistent with the type of impulsive noise that is generated by impact pile driving or by seismic acquisition surveys (i.e., air gun surveys). The recorded impulses occurred at a regular rate of repetition and were within the frequency range of impact pile driving noise; however they did not contain the high frequency energy (> 600 Hz) that pile driving impulses typically exhibit when recorded at close range. This finding may indicate that the impulses originated at a long distance from the recorder, given that higher sound frequencies are quickly attenuated over long distances. The Bylot Island acoustic recorder is approximately 42 km from Pond Inlet. If the impulses did originate at Pond Inlet, this would indicate that pile driving noise from the construction of the SCH traveled over distances of tens of kilometers, and that the resulting noise field generated by this activity likely extended across Eclipse Sound during the narwhal migratory period in Eclipse Sound and in areas overlapping with established calving/nursing grounds for the Eclipse Sound narwhal stock.

The 2020 Construction Season Annual Report (Advisian 2021) presents only one day of acoustic monitoring results for an impact pile driving event on 13 July 2020 (Figure 11). This event was also detected at JASCO’s acoustic recorder at Bylot Island on 13 July 2020 (Figure 12). Overpressure monitoring undertaken by the contractor indicated that impact pile driving resulted in a peak pressure that extended up to 37 kPa (measured at

10 m from the pile), equivalent to a peak Sound Pressure Level (SPL_{peak}) of 211 dB re 1 µPa[3], noting that the report does not specify actual SPL_{peak} or root-mean-square SPL (SPL_{rms}) values at 10m from the pile (Advisian 2021). Assuming a 10 dB offset between SPL_{peak} and SPL_{rms}, which is a reasonable assumption for impact pile driving impulses, sound level "contours" were approximated using a simple spreading loss assumption with range-dependent propagation loss coefficients that yielded an SPL_{rms} at 42 km that matched JASCO's measured value of 100 dB re 1 µPa (SPL_{rms}) for the pile driving noise recorded at Bylot Island. The estimation also accounted for sound absorption using an in-water attenuation coefficient calculated at 1 kHz. The resulting sound level contours (which are circular due to this simplified and rough approximation) are presented in Figure 13 in relation to ice conditions and narwhal sightings recorded on 13 July 2020.

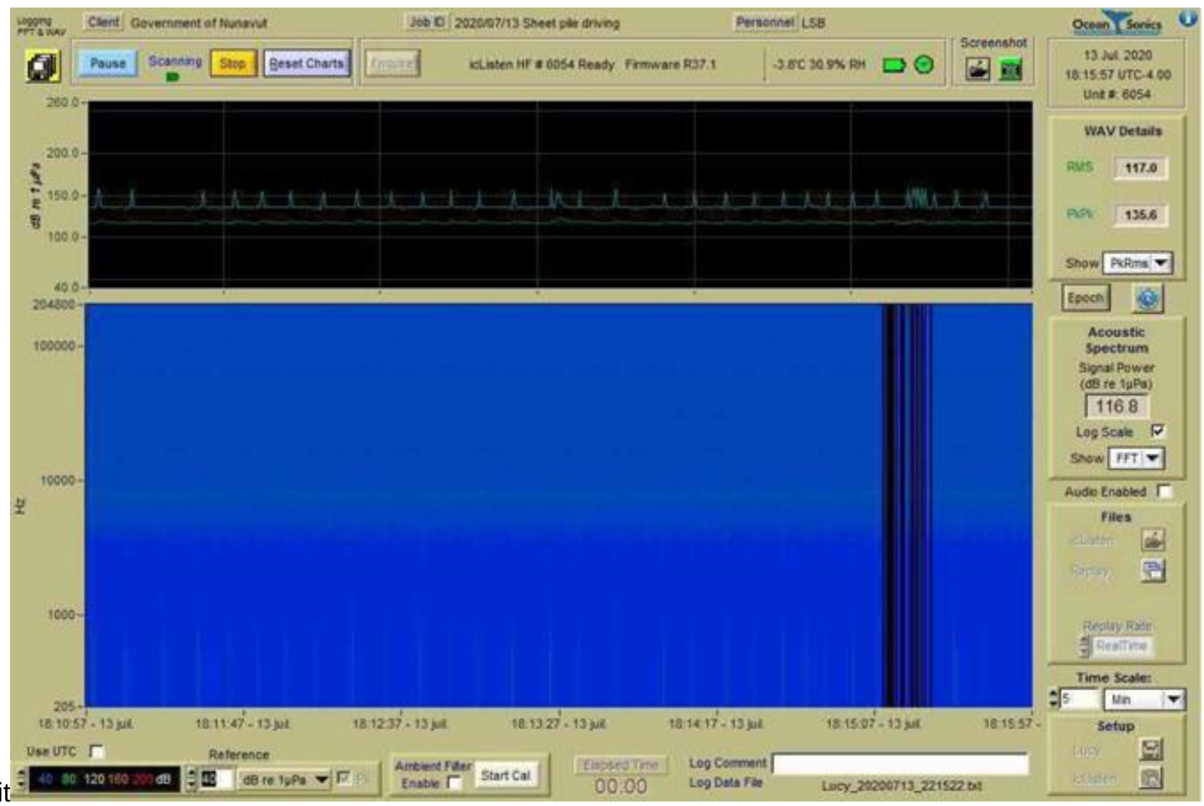
it 

Figure 11: Spectrogram of impact pile driving of sheet piles on 13 July 2020 recorded at 400 m from source (extracted from Advisian 2021).

[3] We note that 37 kPa exceeds the permitted threshold of 30 kPa at 10m, and that no mitigation was put into place to mitigate these impact pile driving sounds and exceedances.

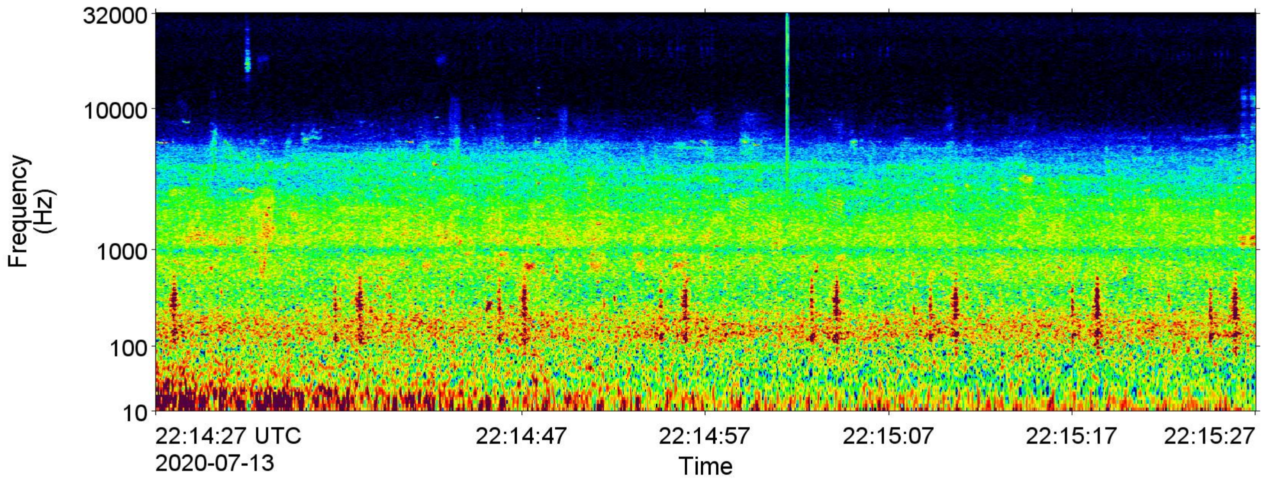
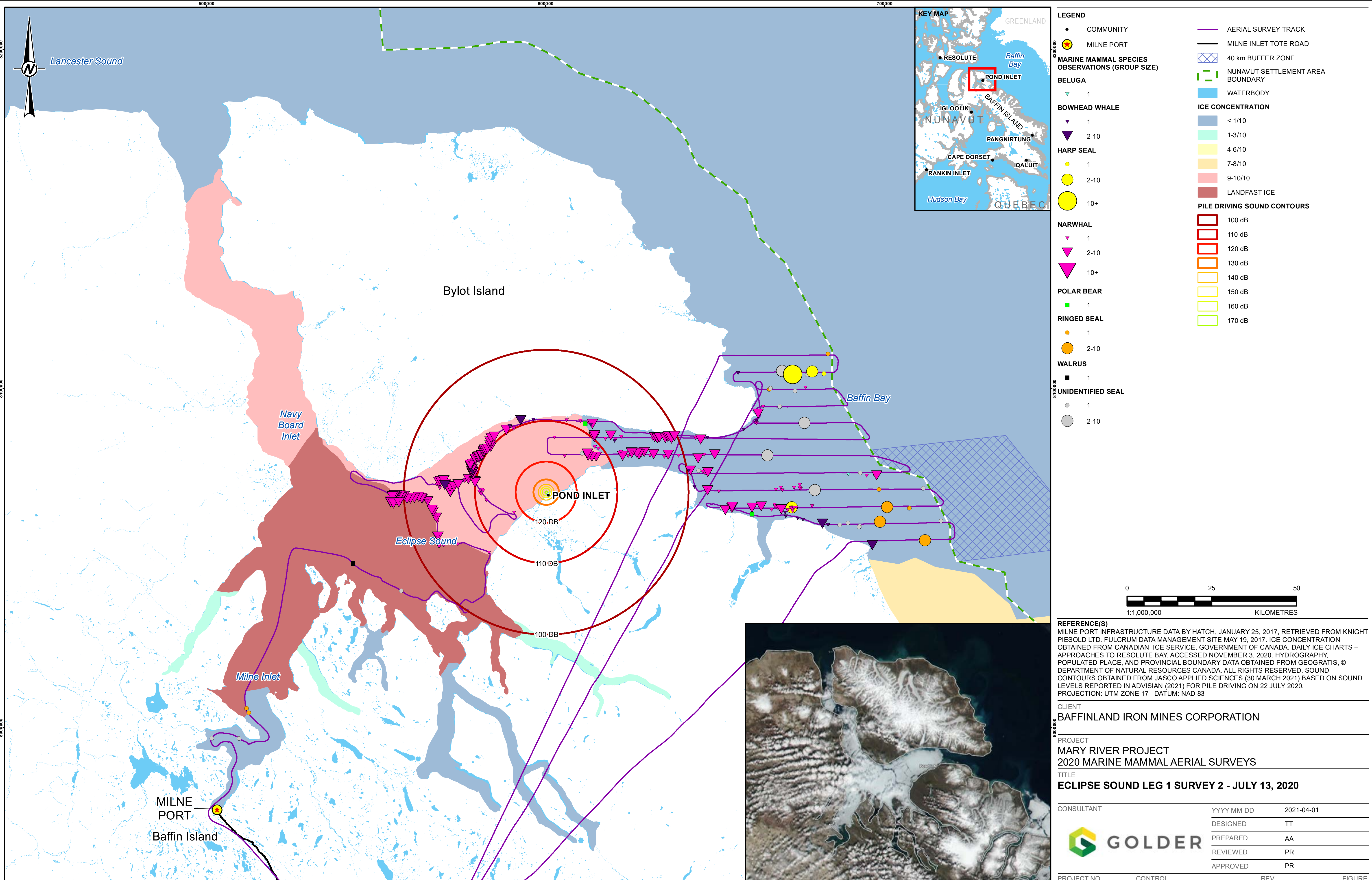


Figure 12: Spectrogram of impact pile driving of sheet piles on 13 July 2020 recorded at JASCO acoustic recorder station located off southwest corner of Bylot Island (42 km from source).



REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. ICE CONCENTRATION OBTAINED FROM CANADIAN ICE SERVICE, GOVERNMENT OF CANADA. DAILY ICE CHARTS – APPROACHES TO RESOLUTE BAY. ACCESSED NOVEMBER 3, 2020. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. SOUND CONTOURS OBTAINED FROM JASCO APPLIED SCIENCES (30 MARCH 2021) BASED ON SOUND LEVELS REPORTED IN ADVISIAN (2021) FOR PILE DRIVING ON 22 JULY 2020.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT
2020 MARINE MAMMAL AERIAL SURVEYS

TITLE
ECLIPSE SOUND LEG 1 SURVEY 2 - JULY 13, 2020

CONSULTANT
GOLDER

YYYY-MM-DD	2021-04-01
DESIGNED	TT
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	48000	0	13

The closest distance between the SCH site in Pond Inlet and the opposing shoreline on Bylot Island is approximately 22 km. As per Figure 13, it appears that the noise field generated by impact pile driving in 2020 extended across Eclipse Sound at sound levels likely audible to narwhal. Monitoring results at JASCO's Bylot Island acoustic recorder suggest that the range of audibility of the pile driving noise might have extended beyond this distance. Based on the timing of impact pile driving in 2020 in relation to the narwhal migratory period, and the assumption that Eclipse Sound narwhal are likely naïve to this type of noise source due to the rare occurrence of impulsive noise in the RSA (from pile driving or otherwise), it is possible that a portion of the exposed stock may have been experienced disturbance to the point of large-scale displacement from the RSA.

No direct studies have been conducted on the effects of impulsive noise sources on narwhal, but there are several examples in the literature where this has been reported for other arctic marine mammal species. Significantly lower number of beluga were observed at distances up to 20 km from active seismic operations (Miller et al. 2005; Southall et al. 2007). This corresponded with an unexpectedly higher number of belugas observed at distances in the 30 to 40 km range from the source, suggesting behavioral avoidance of the seismic pulsive noise at distances up to 20 km and displacement of these animals to further distances (Miller et al. 2005). Several reports have reported strong behavioral responses by bowhead whales to airgun pulses (Richardson et al. 1995; Blackwell et al. 2010). High-energy impulsive noise generated by seismic surveys undertaken in Baffin Bay in 2008 and 2009 were linked to narwhal entrapment events in Greenland and Canada in these years (Heide-Jørgensen et al. 2013) with the authors postulating that long-range noise emissions from the impulsive noise may have interrupted the outmigration of narwhal in Eclipse Sound, prompting the animals to remain on their summering grounds later in the season than they would normally, and resulting in entrapment events due to the rapid onset of land-fast ice formation at that time of year.

Avoidance behaviour from impulsive noise exposure has also been reported in several temperate toothed whale species. For example, harbour porpoise are known to demonstrate strong avoidance responses to pile driving up to distances of 20 km from the source (Dähne et al. 2013). Bailey et al. (2010) reported behavioural disturbance in bottlenose dolphin up to 50 km from pile driving activities, as well as auditory injury at distances up to 100 m from the source.

Evidence from the literature demonstrates that ringed seal appear to be fairly tolerant of pile driving noise, with little to no reaction observed in this species following repeated exposure (Blackwell et al. 2004). Ringed seals in the Prudhoe Bay region often tolerated exposure to high received levels (180–190 dB re 1µPa rms) of low-frequency sound pulses from airgun arrays, with little evidence of changes in behavior and no more than localized avoidance (Harris et al. 2001; Moulton and Lawson 2002).

Available IQ indicates that narwhal movement and distribution in the RSA may have been affected by nearshore construction activities. One interview participant of the Tusaqtavut Study (QIA 2019) described construction works at the SCH in Pond Inlet as a potential reason why narwhal are observed less in the area.

> *"In the summer we do work on our new offshore thing out there {Pond Inlet harbour expansion}, and since there was construction there, the narwhal could hear the rocks being dumped in the ocean from the dock, and for that reason, the narwhal didn't come by the community."* (P08-05-Feb19, interpreted from Inuktitut) (QIA 2019).

4.3 Increased Killer Whale Presence

***High-level Summary**: Increased killer whale presence in the RSA is considered a possible contributing factor to the observed decrease in Eclipse Sound narwhal summer stock in 2020 given the potential of increased narwhal mortality, narwhal population decline, or a range contraction as suggested by Lefort et al. (2020).*

Understanding confounding effects such as the presence of predators in a system is important when assessing movement behaviour of cetaceans in relation to vessel traffic. Killer whales (*Orcinus orca*), for example, are well known to prey on narwhal and may affect narwhal space use patterns (Campbell et al. 1988; Cosens and Dueck 1991; Golder 2021a). In one report by Laidre et al. (2006), an attack was observed in which multiple narwhal were killed by a pod of killer whales over six hours. In the immediate presence of killer whales, narwhal moved slowly, travelling in very shallow water close to shore, and in tight groups at the surface (Laidre et al. 2006). Once the attack commenced, narwhal dispersed widely (approximately doubling their normal spatial distribution), beached themselves in sandy areas, and shifted their distribution away from the attack site. Normal (pre-exposure) behaviour was said to resume shortly (<1h) after the killer whales departed the area (Laidre et al. 2006). Another study used satellite telemetry data to track both predator (killer whale) and prey (narwhal) movements in Admiralty Inlet (Breed et al. 2017); with results demonstrating narwhal strongly altered their behaviour in the presence of killer whales (within approximately 100 km), and behavioural responses extending well beyond the discrete predation events.

Killer whales were observed in the RSA in 2020 in higher numbers than in 2019. In 2020, the highest count of killer whales recorded at one time was 67 animals on 26 August from the Bruce Head observation platform, compared to 15 killer whales on 29 August in 2019 (Golder 2021b). The earliest record of killer whale presence in the RSA in 2019 was 10 whales reported on 22 July based on aerial surveys conducted in Baffin Bay (Golder 2020). In 2020, the earliest record of killer whale presence in the RSA was 10 whales reported on 18 August in Eclipse Sound by a Pond Inlet community member (C. Matthews, pers. comm., 10 March 2021).

In 2020, as part of DFO's community-based killer whale data collection program, sightings of killer whales were reported by the community on 18 August (10 whales in Eclipse Sound East), 26 August (10 whales in South Milne Inlet), 28 August (20–25 whales in Pond Inlet) and 4 September (11 whales in Pond Inlet) (C. Matthews, pers. comm., 10 March 2021). Golder's aerial survey confirmed sightings of killer whales on 26, 27, and 29 August 2020 (Golder 2021a). The sighting on 27 August included a narwhal herding event where over 200 narwhal were chased by a group of ~30 killer whales into Fairweather Bay (along the western shore of Milne Inlet North) with confirmation of at least four narwhal kills including two calves, one adult female and one adult male.

Lefort et al. (2020) estimated that killer whales in the Canadian Arctic (with an estimated population size of 163 ± 27 animals) could consume >1,000 narwhal during their seasonal residency period in Arctic waters. Increased presence of killer whales in areas associated with decreased seasonal sea ice cover may result in increased narwhal mortality, narwhal population declines, and a range contraction as narwhal's southern range boundary shifts poleward into areas with greater sea ice cover (Lefort et al. 2020). A systematic comparison between narwhal and killer whale abundances across years is not possible because reliable abundance estimates for killer whale are not available. However, 2020 aerial surveys demonstrated an increase in animal detection rate for killer whale in 2020 (0.0045 animals/km) compared to 2019 (0.0010 animals/km). It is unclear to what extent killer whale presence may have contributed to lower narwhal numbers observed in Eclipse Sound in 2020, either by direct removal (i.e., hunting and feeding) and/or via seasonal displacement, but an increase in killer whale numbers in the RSA was apparent in 2020 and available IQ indicates that killer whales are likely to influence narwhal distribution and abundance in the RSA.

"And one of the other reasons that we see now is that there is a whole lot more killer whales coming to Pond Inlet area, like lots of them; and again, I was talking about earlier that there's different factors involved in narwhals not migrating to Pond Inlet area as they used to, and I believe this is one of them as well. The killer whales two years ago stayed in Milne area all summer and kept the narwhals away from that area; and again, they're killers, they'll just kill." [p.13, 06-Feb-19, p. 141 of QIA 2019]

"Yeah. Also for the last five years we've had a problem with killer whales, they're here all the time now. Last summer they came … where the narrows are, three days later seven more and they keep adding. And HTO decided let's count how many killer whales are there now and how many narwhales has been killed by killer whales. So we went right there, right here somewhere here, yeah. We went right there. And the killer whales were hunting over there, over there somewhere, yeah...Yeah. And we come, there were over 100 killer whales and they were teaching their young ones how to kill, narwhals." [p.07, 05-Feb-19, p. 142 of QIA 2019]

"I've personally hasn't observed them, though killer whales seem to be increasing every year here." [p. 18 of NWMB 2016]

"Since I was a boy there were always narwhal down near Padlavik on the water, since then there seem to be fewer and there are always narwhal and there are always killer whales now every summer. The narwhal would try to get away from the killer whales, not just narwhal, other species like seals. The narwhal seem to be fewer in pods now every year according to my knowledge. There used to be lots before there were noise pollution and there does not seem to be too much change in narwhal to my knowledge." [p. 36 of NWMB 2016]

"Yes..that is being mentioned more often now as they come every year now. They just go through here very fast, I've seen them where they can be as fast as the boats." [p. 47 of NWMB 2016]

"They seem to be increasing. There are smaller ones now but there are some that are huge. The smaller ones also come here now along with others they are bothering the narwhal, perhaps all the marine mammals as big as bowhead. I observed them when they were going after bowheads down at the point, they would surface among them and here I was going near them as they don't go after boats. We know that now maybe they are dangerous I don't know." [p. 51 of NWMB 2016]

"Perhaps its been two years they are late by more than a week that's what I've noticed when they should have arrived they haven't arrived yet." [Why?] "Killer whales, when people start seeing killer whales some don't make it here". "There are more now, they are seen more often and they are close, the killer whales seem to be coming closer that are seen" [p.66 of NWMB 2016].

''We can't really say how much narwhals have been affected by shipping during the summer. I can't say for certain whether you can see any more narwhals when there are ships in the area. Recently this past summer, as I was on my way home after teaching the younger generation about the procedures, we travelled by helicopter to Milne Inlet to refuel. There were some killer whales near the vicinity of Milne Inlet and there was a dead narwhal carcass floating. One orca had a narwhal in its mouth. One killer whale slammed a narwhal. Killer whales are very fast. Narwhals are more afraid of killer whales than ships. Narwhals don't seem to mind ships. Once ships are in the area they sometimes disperse, but once the ships have passed they return to the area. The ship that had teeth that was painted on the hull, the narwhals were maybe scared of that ship. Maybe they assumed the narwhal would be bitten by that ship. Those were my observances." [p. 183 of JPCS 2019]

4.4 Other Potential Factors to 2020 Findings

Other potential factors that may have contributed to the lower observed number of narwhal in Eclipse Sound in 2020 include direct or indirect effects of climate change on narwhal including, but not limited to, associated changes in predator/prey dynamics and subsequent effects on narwhal fitness or energy reserves prior to their arrival on the summer grounds, as further supported by Inuit hunter feedback and available IQ.

"Harvesters pay close attention to the health of whales. In recent years, hunters have observed that narwhal and beluga have become more scattered and thinner. Hunters think the change in behaviour is linked to lack of access to fish at floe edges, and more energy being spent by whales on travelling and hunting for food." [p. 42 of QIA 2018]

A detailed investigation into this potential factor is beyond the scope of the present report but should be considered in conjunction with the potential contributing factors discussed above.

5.0 ADAPTIVE MANAGEMENT RESPONSE

5.1 Approach

As part of the development of a tiered approach towards adaptive management in the draft Marine Monitoring Plan (Baffinland 2021), Baffinland has suggested a series of criteria that must be met to pass the 'High Risk' threshold. These criteria include:

- *Confirmed[4] Moderate severity behavioural responses (Severity Score 5 and 6) that persists for a set time beyond the acoustic detection period) as described in moderate risk column*

  AND/OR

- *Confirmed High severity responses (Severity Score 7 to 10). This would include:*
  - *Severe and or sustained (long-term) avoidance of disturbance zone area*
  - *Outright panic, obvious flight or freeze response, stampede, or stranding events that can be directly linked to shipping*

  AND

- *(iii) >25.0% decrease in calving rate (proportion of immatures) relative to pre-Phase 2 shipping dataset*
- ***AND/OR***
- *(iv) >25.0% decrease in stock size (abundance)[5] relative to 2019 aerial survey abundance*

[4] Confirmed that the Risk Status / Threshold trigger has been observed in at least two consecutive annual monitoring programs, whether during the regular monitoring schedule or confirmed through a specialized target study.

[5] Eclipse Sound summer stock

The results of the 2020 Marine Mammal Aerial Survey Program and Bruce Head Shore-based Monitoring Program indicate the following criteria component has been met:

- “>25.0% decrease in stock size (abundance) relative to 2019 aerial survey abundance.”

Without corresponding confirmation of a moderate or high severity behavioural response in narwhal to shipping activities, it is appropriate to further investigate the potential sources of the observed stock decline in 2020 and confirm whether prolonged moderate or high severity behavioural responses are observed in 2021.

Despite the existence of uncertainty with respect to the cause of the observed effect in 2020, and only part of the suggested High Risk threshold criteria being met, it is advisable for Baffinland to implement mitigation actions in 2021 to lower the potential of its activities contributing to the same effect in 2021 while continuing to investigate other potential contributors to changes in the narwhal population.

To address the uncertainty that exists as to the cause of the 2020 decline in abundance of the Eclipse Sound narwhal summer stock abundance, as established in Section 4 of this memo, Golder recommends that a ‘High Action Development Plan’ be developed by Baffinland in consultation with relevant parties and that it include the following elements:

1) Baffinland implementation of an interim mitigation response for 2021 icebreaking operations in light of unknown and/or unmitigated cumulative activities continuing to occur in 2021.
2) Baffinland monitor and evaluate the efficacy of the high action response for 2021 icebreaking in consultation with relevant parties.
3) That investigations continue as to the potential cause of the lower narwhal abundance observed in 2020 alongside the above actions.
4) Baffinland, in consultation with relevant parties, determine the need for the implementation of interim mitigation beyond 2021, based on the results of 2021 monitoring programs and the results of any additional investigations (by Baffinland or other responsible parties) into other sources of cumulative impacts. To this effect, consideration should be given to the potential role of 2020 construction activities in Pond Inlet on changes in narwhal distribution and abundance in the RSA, particularly with respect to the potential impacts of pile driving noise on narwhal migratory movements in Eclipse Sound.

To assist the responsible parties with their understanding of the potential causes of the 2020 abundance change, preliminary information has been compiled (see Section 4.0) and the desktop investigations identified in Section 5.3 are recommended to better characterize and understand all contributing factors. Given the regional nature of some of the causal factors, Golder recommends that additional desktop investigation be developed with oversight and input from the responsible parties and include IQ and community involvement (as per below).

To assist Baffinland and the responsible parties in identifying an appropriate operational response for avoiding or mitigating effects to narwhal, Golder has identified several mitigation options for consideration (Section 5.4).

5.2 IQ and Community Involvement

As per Section 1.5 of the draft Adaptive Management Plan (draft AMP) (June 2020), IQ and community involvement in environmental management are critical to the identification and understanding of potential environmental effects. Adaptive management is also anticipated to benefit from formal Inuit oversight, whether direct or indirect through various levels of involvement in the Environmental Management System (EMS) (e.g. participation in monitoring programs, environmental working groups, public engagements, etc.).

The draft AMP anticipates that IQ will be integrated along with western science into project planning, operation and monitoring and that accountable feedback mechanisms will exist for IQ to inform, change and improve the Project.

Therefore, Golder recommends that Inuit Organizations identify how IQ is best integrated into the adaptive measures identified here, how communities would prefer to be involved and potential community-based monitoring programs that Inuit feel are relevant to the 2020 narwhal monitoring results and which could inform adaptive management of the Project. At a minimum, Baffinland will ensure there is a process outside of the MHTO's participation in the MEWG to contribute to the development of the High Action Development Plan.

5.3 Desktop Investigation

5.3.1 Regional Sea Ice Conditions

Procurement of detailed remote sensing imagery will provide a more accurate representation of sea ice conditions on an annual scale that can be compared to annual shipping and icebreaking activities. The following information would provide a greater understanding of how narwhal distribution is affected by differences in sea ice conditions:

- Total ice cover of ice field ($km^{2)}$ in Eclipse Sound from time landfast ice is gone to <3/10 ice concentration
- Temporal persistence of ice leads
- Range in size of ice floes (max diameter and area (km^2))

This information is likely to provide a more accurate representation in terms of how long sea ice persists in Eclipse Sound during ice break-up and may be used to refine the proposed mitigation measures related to seasonal ice concentrations.

5.3.2 Construction Noise from Small Craft Harbour in Pond Inlet

Assuming relevant Parties are willing to share a detailed schedule of 2020 construction activities for the SCH site in Pond Inlet, Baffinland will commission JASCO to isolate all potential 'impulsive noise source' data from the 2020 PAM dataset and characterize the resultant sound levels from impact pile driving as part of this activity. If Baffinland is provided with raw data from the SCH Project, the resultant sound fields (noise contours) can be modelled and depicted in spatial plots/figures, along with distance estimates to the corresponding behavioural thresholds.

Golder understands that impact pile driving at the SCH in Pond Inlet is planned for the 2021 summer season, although details on the magnitude, timing and duration of this program is presently unknown. As this information becomes available, Golder recommends Baffinland re-evaluate in discussions with the MEWG what project monitoring may or may not be appropriate for the 2021 shipping season.

5.3.3 Increased Killer Whale Presence

It is Baffinland's understanding that DFO currently implements a community-based killer whale sightings program in both Arctic Bay and Pond Inlet that Baffinland hopes to build upon for addressing this critical data gap in the RSA. Underwater acoustic data collected from the Bruce Head, Bylot Island and Ragged Island recorders in 2020 will be used to identify seasonal occurrence and location of killer whales in the RSA to supplement the available 2020 sightings record (combined DFO/community and Baffinland sightings). This will help identify the earliest arrival of killer whales in the RSA for comparative purposes to previous years, to inform how killer whales may have influenced narwhal space use patterns at the time of the 2020 aerial surveys.

5.4 Enhanced Mitigation

5.4.1 Project Level

This section provides options for enhanced mitigation at the Project level for implementation during the 2021 shipping season. The additional mitigation being put forward is specifically designed for managing impacts on narwhal from Project icebreaking, even if the underlying causal factor(s) for the observed decrease in narwhal abundance in Eclipse Sound is presently unknown. This precautionary approach will allow for a concurrent investigation of potential causal factors of the observed change while adjusting shipping operations to further manage impacts from icebreaking on narwhal in the RSA.

Additional mitigation measures proposed for 2021 include the following:

OPTION 1:

- No icebreaker transits will occur in the RSA when ice concentrations of > 6/10 cannot be avoided along the shipping route.
- A maximum of two icebreaker transits (with escorted vessels) will occur per day (24-h period) where ice concentrations ≤ 6/10 but ≥ 4/10 cannot be avoided along the shipping route.
- When a continuous sailing route of uninterrupted ice concentrations of 3/10 or less is available between the entrance of Pond Inlet and Milne Port, then icebreaker transits in the RSA will proceed according to the normal shipping schedule.

Biological Rationale for Option 1: This is the most conservative mitigation biologically because it effectively eliminates icebreaking assuming vessels will still adhere to the primary mitigation of avoiding ice floes in low to moderate ice conditions as safe navigation allows. Based on the last three years of ice conditions, the time between initial ice break-up and when ice concentrations along the shipping route offer ≤6/10 is approximately 10-14 days.

OPTION 2:

- No icebreaker transits will occur in the RSA when ice concentrations of 9/10 or greater cannot be avoided along the shipping route.
- A maximum of one icebreaker transit (with escorted vessels) will occur per day (24-h period) where ice concentrations of > 6/10 (but < 9/10) cannot be avoided along the shipping route.
- A maximum of two icebreaker transits (with escorted vessels) will occur per day (24-h period) where ice concentrations ≤ 6/10 but ≥ 4/10 cannot be avoided along the shipping route.
- When a continuous sailing route of uninterrupted ice concentrations of 3/10 or less is available between the entrance of Pond Inlet and Milne Port, then icebreaker transits in the RSA will proceed according to the normal shipping schedule.

Biological rationale for Option 2: This would completely avoid impacting narwhal in leads, as the leads are unlikely to exist in 9/10 or greater ice concentrations. This would also minimize icebreaking noise, as it would eliminate breaking of thickest ice over a continuous period. Based on last three years of ice conditions, the time between initial ice break-up and when ice concentrations along the shipping route offer ≤9/10 is no longer than 9 days.

OPTION 3:

- No icebreaker transits will occur in the RSA when ice concentrations of 9/10 or greater cannot be avoided along the shipping route, unless the following conditions can be met:
  - Confirmation of 'sufficient narwhal absence' in ice leads in the annually recurring consolidated (≥9-10/10) ice field in Eclipse Sound. This would include all ice leads occurring within 20 km on either side of the shipping lane as this distance corresponds with the worst-case 120 dB disturbance zone range for icebreaker noise based on 2020 field measurements.
  - Confirmation of 'sufficient narwhal absence' in the adjacent floe edge area fronting the annually recurring consolidated ice field in Eclipse Sound. This would include a 20 km zone on the east side of the ice field as this corresponds with the worst-case 120 dB disturbance zone range for icebreaker noise based on 2020 field measurements.
  - That "confirmation of" be determined in direct consultation with DFO, Inuit and Baffinland (via daily meetings to discuss observed ice conditions, sighting/detection rates and narwhal distribution relative to ice conditions)
  - That "sufficient narwhal absence" be defined in collaboration with DFO and Inuit organizations through development of a threshold or trigger. Golder can present options for consideration for a threshold/ratio that can be rapidly obtained through a Leg 1 survey. For example, a threshold of 0.25 narwhal/km represents a reasonable threshold for this purpose as this value would not constitute an 'aggregation' of narwhal, and would be 10x lower than the narwhal detection rate observed in ice leads in 2020 and lower than the narwhal detection rate observed in open-water or low/moderate ice conditions (i.e., systematic transect grid surveys) in 2019 and 2020.

- A maximum of one icebreaker transit (with escorted vessels) will occur per day (24-h period) where ice concentrations of > 6/10 cannot be avoided along the shipping route (also assuming adherence to above bullet).
- A maximum of two icebreaker transits (with escorted vessels) will occur per day (24-h period) where ice concentrations ≤ 6/10 but ≥ 4/10 cannot be avoided along the shipping route.
- When a continuous sailing route of uninterrupted ice concentrations of 3/10 or less is available between the entrance of Pond Inlet and Milne Port, then icebreaker transits in the RSA will proceed according to the normal shipping schedule.

Biological rationale for Option 3: This would minimize impacting narwhal in ice leads, given it would be confirmed they are not there in large numbers. The extent of the survey effort is based on existing behavioural thresholds derived from field measurements (acoustic monitoring data). Note, based on what we have observed in 2019 and 2020, there is a moderate to high probability that narwhal be present in the leads or along the outer edge of the ice field in numbers exceeding the yet-to-be developed threshold.

OPTION 4:

- No icebreaker transits will occur in the RSA when ice concentrations of 9/10 or greater cannot be avoided along the shipping route, unless the following conditions can be met:
  - Confirmation of 'sufficient narwhal presence' in Milne Inlet (south of the consolidated ice field) either via aerial surveys or Bruce Head shore-based monitoring.
  - That "confirmation of" be determined in direct consultation with DFO, Inuit and Baffinland (via daily meetings to discuss observed ice conditions, sighting/detection rates and narwhal distribution)
  - That "sufficient narwhal presence" be defined in collaboration with DFO and Inuit organizations through development of a threshold or trigger. Golder can present options for consideration but this is somewhat challenging as it would require a biologically relevant sighting rate would be, which is presently unknown.
- A maximum of one icebreaker transit (with escorted vessels) will occur per day (24-h period) where ice concentrations of > 6/10 cannot be avoided along the shipping route (also assuming adherence to above bullet).
- A maximum of two icebreaker transits (with escorted vessels) will occur per day (24-h period) where ice concentrations ≤ 6/10 but ≥ 4/10 cannot be avoided along the shipping route.
- When a continuous sailing route of uninterrupted ice concentrations of 3/10 or less is available between the entrance of Pond Inlet and Milne Port, then icebreaker transits in the RSA will proceed according to the normal shipping schedule.

Biological rationale for Option 4: This would indicate that a ‘sufficient’ number of narwhal were able to clear the ice field in Western Eclipse and enter the deeper fjord areas of Milne Inlet. Operational limitation as there is some indication that narwhal prefer to remain in areas of ice cover (i.e., Eclipse Sound) as long as it remains present (i.e., narwhal may not elect to travel to Milne Inlet South until early August irrespective of icebreaking/shipping operations because this area is generally ice-free for most of July).

OPTION 5:

- Project vessels do not enter the RSA until 2 weeks after land-fast ice has initially fractured (as per Hamlet of Pond Inlet recommendation).

Biological rationale for Option 5: Based on historical ice conditions, it is unlikely that ice concentrations > 6/10 will persist much longer than two weeks following initial break-up (e.g., since icebreaking began in 2018, the maximum number of days that elapsed between initial break-up and the time when ice concentrations > 6/10 no longer existed along the shipping route was 10 to 14 days, and no longer than 9 days for ≥ 9/10 ice concentrations). This option therefore is very similar in function to Option 1.

5.4.2 Regional Level

To be determined by the responsible authority based on results from the 2020 SCH construction program in Pond Inlet (Advisian 2021).

5.5 Follow-up Monitoring

5.5.1 Project Level

Baffinland icebreaking cannot be ruled out as a contributing cause of the observed decrease in Eclipse Sound narwhal numbers in 2020 (i.e., potential displacement event). To better understand potential short-term, long-term and cumulative effects of icebreaker noise on narwhal during the early shoulder season, Golder recommends that Baffinland implement the following follow-up monitoring programs in 2021:

- 2021 Marine Mammal Aerial Survey Program (Leg 1 and Leg 2) (pending community consultation)
- 2021 Bruce Head Shore-based Monitoring Program (pending community consultation)
- 2021 Passive Acoustic Monitoring Program (pending community consultation)

In 2021, Baffinland also intends to prioritize planning for a 2022 early shoulder season narwhal tagging study to be designed in consultation with the MHTO, DFO and MEWG.

5.5.2 Regional Level

Potential longer-term regional-based narwhal monitoring studies, which could inform how regional factors may influence narwhal use of Eclipse Sound, are recommended to investigate potential non-Project influences on Eclipse Sound narwhal (e.g., abundance surveys of the Baffin Bay regional narwhal population, killer whale tracking studies; drone-based aerial photogrammetry to estimate narwhal body condition). These would be founded on local Inuit knowledge and implemented collaboratively between Baffinland, the community of Pond Inlet and the respective regulatory agencies.

Although it is the proponent's responsibility to monitor for the potential effects of its project activities on the Eclipse Sound narwhal stock, Baffinland is not best situated to investigate and/or collect data on external sources of potential impacts on Eclipse Sound narwhal that may act in a cumulative or additive manner with Project-related impacts (e.g., SCH pile driving program in Pond Inlet). To that end, Baffinland remains committed to contributing to regional monitoring initiatives that take place within the RSA by either carrying out a portion of the monitoring / investigation directly, or supporting others through financial support (i.e. community based monitoring) and/or in kind support (i.e. government research). Additional discussion is required with relevant parties on this subject before more detailed planning can occur.

6.0 SUMMARY

- Results from the 2020 aerial survey indicate: i) narwhal abundance in Eclipse Sound was statistically lower in 2020 than in previous aerial survey years undertaken in the RSA (2013, 2016 and 2019), and ii) the combined narwhal abundance in Eclipse Sound and Admiralty Inlet was similar in 2020 to that observed in previous years (2013 and 2019). These results suggest either potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020, a potential displacement of these animals to another area (e.g., Eastern Baffin Bay or Somerset summering ground), or a potential decrease in the Eclipse Sound summer stock.

- Results from the 2020 shore-based monitoring at Bruce Head indicate fewer narwhal than previous years and this aligns with aerial survey results indicating a lower abundance of the Eclipse Sound summer stock in 2020. However, narwhal calf ratio (i.e., a proxy for reproductive success) was shown to remain consistent with pre-shipping conditions, despite year-over-year increases in shipping in the RSA from 2014-2019. Multiple observations of nursing in the Bruce Head area in 2020 offers some evidence that females with dependent young continue to carry out critical life functions in the presence of vessel traffic during the open-water season.

- Results from the 2020 passive acoustic monitoring program indicate sound levels from active icebreaking are 10 to 20 dB lower than what was predicted (using analogous sound sources from other regions), and per-transit exposure durations at a level of 120 dB re 1 µPa are thus 60-90% lower than predicted, demonstrating that the acoustic modelling undertaken in the effects assessment is conservative. The 2020 PAM program also detected sequences of impulsive sound in July and August 2020 that is consistent with the type of impulsive noise generated by impact pile driving.

In consideration of the above findings, it is evident that there was a statistically significant decrease in the abundance of the Eclipse Sound narwhal stock in 2020 that requires further investigation. Potential contributing factors considered in this report included acoustic disturbance effects from icebreaking, acoustic disturbance effects from impact pile driving in Pond Inlet, and increased killer whale presence in the RSA. A preliminary analysis of these factors is as follows:

- Project icebreaking is considered a possible contributing factor to the observed decrease in Eclipse Sound narwhal summer stock in 2020. Longer periods of icebreaking occurred in 2018 and 2020, compared to 2019 when the ice was in a later stage of break-up. Lower numbers of narwhal in the RSA were also recorded through aerial surveys or reported by the community in 2018 and 2020, compared to 2019. In 2020, narwhal were concentrated in the ice leads in the western portion of Eclipse Sound, forming a more clumped distribution compared to 2019. During its first transit in the RSA in 2020, the MSV Botnica (escorting two carriers and two tugs) transited in close proximity to the leads where narwhal were confirmed to be holding. Narwhal distribution in the RSA during the 2018 early shoulder season is unknown as no aerial surveys were flown that year.
- Construction noise in Pond Inlet during the 2020 summer is considered a possible contributing factor to the observed decrease in the Eclipse summer stock in 2020. A preliminary analysis of underwater noise recordings in Eclipse Sound in 2020 has identified anomalous sounds, similar in nature to sounds generated by impact pile driving (and different than sounds generated by vessels). These impulsive sounds are not thought to be natural in origin and they correspond in time with impact pile driving which occurred in Pond Inlet as part of the 2020 SCH construction project. Additional effort is required to fully characterize the pile driving noise at Pond Inlet including the extent of the noise fields projecting in Eclipse Sound. A preliminary analysis by Golder indicates that the pile driving in Pond Inlet emitted high energy impulsive noise to the marine environment during a 52-day period that corresponded with the narwhal migration into Eclipse Sound. Acoustic compliance monitoring indicated that the permitted acoustic injury threshold of 30kPa was exceeded at 10m from the source, and that no mitigation was put into place to mitigate these impact pile driving sounds and exceedances.
- Increased killer whale presence in the RSA is considered a possible contributing factor to the observed decrease in Eclipse Sound narwhal summer stock in 2020 given the potential of increased narwhal mortality, narwhal population decline, or a range contraction as suggested by Lefort et al. (2020). Additional effort is required to determine the extent and timing of killer whale presence in the RSA in 2020 and how this may be linked to the observed lower number of narwhal that year.
- Commensurate with Baffinland’s recommended tiered adaptive management thresholds, preliminary 2020 monitoring suggests a ‘High Risk’ threshold has potentially been triggered, and one of the identified response actions is implementation of precautionary Project-based operational mitigation measures. The proposed additional mitigation being put forward aim to avoid and/or further minimize impacts on narwhal from Project icebreaking, even if the underlying causal factor(s) for the observed decrease in narwhal abundance in Eclipse Sound is unconfirmed. This precautionary approach will allow for a simultaneous investigation of potential causal factors of the observed change while adjusting current shipping operations to reliably manage impacts from icebreaking on narwhal in the RSA.

To better understand potential short-term, long-term and cumulative effects of icebreaker noise on narwhal during the early shoulder season, Baffinland will implement the following follow-up monitoring programs starting in 2021:

- 2021 Aerial Survey Program
- 2021 Bruce Head Shore-based Monitoring Program
- 2021 Passive Acoustic Monitoring Program

Baffinland also intends to prioritize in 2021 planning for a 2022 early shoulder season narwhal tagging study to be designed in consultation with the MHTO, DFO and MEWG.

To better understand potential cumulative effects on narwhal, potential longer-term regional-based narwhal monitoring studies, which could inform how regional factors influence narwhal use of Eclipse Sound, are recommended to investigate potential non-Project influences on Eclipse Sound narwhal (e.g., abundance surveys of the Baffin Bay regional narwhal population, killer whale tracking studies; drone-based aerial photogrammetry to estimate narwhal body condition). These would be founded on local Inuit knowledge and implemented collaboratively between Baffinland, the community of Pond lnlet and respective regulatory agencies.

7.0 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional information, please contact the undersigned.

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Attachments: Attachment 1: Daily Ice Charts for Period of 12-22 July (2018, 2019 and 2020)
Attachment 2: Pond Inlet Project – 2020 Construction Season Annual Report

https://golderassociates.sharepoint.com/sites/11206g/deliverables (do not use)/issued to client_for wp/1663724-285-tm-rev1-48000/1663724-285-tm-rev1-48000-narwhal abundance memo-07apr_21.docx

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ATTACHMENT 1

Daily Ice Charts for Period of 12-22 July (2018, 2019 and 2020)

ATTACHMENT 2

Pond Inlet Project – 2020 Construction Season Annual Report

APPENDIX F

Response to MEWG Comments

Baffinland

Name: Chantal Vis, Allison Stoddart, Jordan Hoffman

Agency / Organization: Parks Canada Agency

Date of Comment Submission: July 8th, 2021

#	Document Name	Section Reference	Comment	Baffinland Response
11	2020 Marine Mammal Aerial Survey	Results 3.2.1	Given that Navy Board Inlet generally has low densities of narwhal and survey 2 missed the top half of Navy Board Inlet due to poor sighting conditions, is it feasible to include survey 2 in the calculation of the abundance estimate given that survey 1 and 3 produced abundance estimates that were significantly different? Following comment 12 (below) what would the resulting averaged abundance estimate be if these three surveys (surveys 1-3) of leg 2 of Eclipse Sound are combined?	Survey 2 was not included in the abundance estimate because: • it was surveyed over two days unlike Surveys 1 and 3 which were surveyed in a single day. • it was missing transects at the top of Navy Board Inlet, and sea states were considerably higher during Survey 2 (thus affecting animal detection). Based on these factors, there was less confidence in the Survey 2 results and this survey was therefore not considered suitable for calculating the abundance estimate for the Eclipse Sound summer stock. The report has been revised to clearly outline what surveys were carried forward in distance sampling, and what surveys were used for the basis of the abundance estimate, along with a rationale on why certain surveys were excluded.

Baffinland

#	Document Name	Section Reference	Comment	Baffinland Response
12	2020 Marine Mammal Aerial Survey	Results 3.2.6.3.1 Eclipse Sound Stock	Given that surveys are providing an estimate of abundance, and it is assumed there will be variability, it has been common practice by Fisheries and Oceans Canada to average the abundance estimates and calculate a CV for the combined surveys. Why was the highest abundance estimate (Survey 3) taken rather than producing an average abundance estimate over the surveys given the comparable CVs?	It is appropriate to average results from multiple survey replicates if there is reasonable confidence that conditions (i.e., factors influencing abundance and distribution) remain consistent between the respective replicate surveys and if the confidence intervals between the respective replicate surveys overlap (i.e., no significant difference between replicates). This was not the case in this example. The abundance estimate for Survey 3 (5,018 narwhal, CV = 0.03, 95% CI of 4,736–5,317) was significantly higher than the abundance estimate for Survey 1 (3,519 narwhal, CV = 0.03, 95% CI of 3,308–3,743) (Z-test = -8.10, p < 0.0001) with the majority of the sightings based on photographic data for both surveys. Given the higher confidence of animal detection associated with the photographic survey data, the Survey 3 results were considered to reflect a more accurate representation of actual narwhal abundance in the RSA and were therefore retained as the best 2020 abundance estimate for the Eclipse Sound stock. The difference in abundance estimates between Survey 1 and 3 was likely attributed to less narwhal being present in the dedicated photographic survey areas during Survey 1 compared to Survey 3. This may have been due to natural movement patterns of narwhal in and out of the photographic survey areas, or may reflect non-random narwhal distribution / movement patterns in the RSA due to influences of

#	Document Name	Section Reference	Comment	Baffinland Response
				killer whales (Survey 3 was the only survey replicate in 2020 when killer whale were present during active surveying). Other potential contributing factors may have included weather, as sighting conditions were poorer during Survey 1 due to higher sea state conditions at this time Although Fisheries and Oceans Canada (DFO) has in the past averaged abundance estimates from multiple replicate surveys, there is also precedence by DFO for using a single survey replicate for this purpose (rather than systematically averaging two or more survey replicates conducted the same the survey period). This occurred when there was reason to believe that one survey replicate was thought to represent a more accurate estimate of the actual population. The text in the 2020 MMASP report has been revised to more clearly explain the rationale for selecting Survey 3 as the most accurate estimate for narwhal abundance in Eclipse Sound and Admiralty Inlet.

Baffinland

Name: Jeff Higdon, Bruce Stewart (with additional technical review by Pierre Richard)

Agency / Organization: Qikiqtani Inuit Association

Date of Comment Submission: 08 July 2021

#	Document Name	Section Reference	Comment	Baffinland Response
1	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	General	The use of a Z test to compare annual estimates may be inappropriate because the error distribution of these survey estimates is unlikely to be normal. A non-parametric test such as Mann-Whitney or Kruskal-Wallis would be more appropriate to use to test the significance of the difference between annual estimates. Furthermore, there are enough survey estimates for both Eclipse Sound and Admiralty Inlet for time series analyses.	The T test and Z test are the recommended statistical analyses in Buckland et al. (2001) for comparisons between two distance sampling estimates. It is generally suggested that a log transformation should be considered before the test if the CV is much beyond 20 % (Laake 2006). In the current situation, we do not compare two values that have a CV beyond 20 % and therefore did not use a log transformation before the test. Had the Z test formula recommended by Laake (2006) been used, this would not have changed the statistical significance of the comparisons made between the combined narwhal abundance estimates for 2013/2019 or 2013/2020. The Mann-Whitney or Kruskal-Wallis tests mentioned above are not appropriate for comparisons between survey years since we only have one abundance estimate per year. Only the two most recent yearly datasets (2019 and 2020) have sufficiently low CVs to enable trend analysis. Additional years of data are required to enable this analysis

#	Document Name	Section Reference	Comment	Baffinland Response
				(see Golder 2020, Appendix C – Power Analysis). Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L., and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, xv + 432 p. Golder. 2020. 2019 Marine Mammal Aerial Survey. Final Report submitted to Baffinland Iron Mines Corporation. Report No. 1663724-191-R-Rev0-22000. 5 August 2020. Laake, J.L. 2006. 'Distance Sampling' Google Group conversation. Subject heading: "Re: significance testing & calculating unweighted global or". 10 March 2006.
2	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	Executive Summary, page ii	Were the harp seal numbers based on visual counts or photos? Or both? They are hard to count in large herds.	For the visual-based surveys, the harp seal numbers were based on visual counts only.

Baffinland

#	Document Name	Section Reference	Comment	Baffinland Response
3	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	Executive Summary, page ii	During photo surveys there were 4,582 sightings of 6,737 individual unidentified seals. Is photo quality not sufficient for identification?	Photographic surveys are flown at 2,000 ft. The resolution at that altitude is not sufficient for seal species identification.
4	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	Executive Summary	The Executive Summary should report the Admiralty Inlet narwhal population estimates (i.e., along with the Eclipse Sound and combined estimates).	The combined Eclipse Sound and Admiralty Inlet narwhal stock estimate is provided in the Executive Summary. The Executive Summary has been revised to also include the 2020 stock estimate for the Admiralty Inlet summer stock. The stock estimate for Admiralty Inlet is also provided in the Results and Discussion sections.
5	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 1.2, page 3	This section notes that one of the objectives of the Marine Monitoring Program (MMP) is "[t]o assess the accuracy of the predictions contained in the Final Environmental Impact Statement (FEIS) for the Project". Are all impact predictions for marine mammals being assessed, or just a subset?	No, not all impact predictions are assessed through the one program (i.e. the MMASP).

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6	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 1.2, pages 3-4; s. 5.0, page 70	PCC 107-109 refer to the shipboard observer program and vessel noise, not other monitoring programs such as aerial surveys. The aerial survey program is an important component of Project monitoring, but these PCC requirements aren't being met by aerial surveys.	Comment acknowledged. The rationale for referencing PCC 107-109 is because the aerial survey results can, to a certain extent, inform on whether narwhal are demonstrating strong responses to shipping at distances far ahead of the ship (too far to be detected by on-board observers), and whether narwhal distribution and occurrence in the RSA is affected by ship noise (PCC 107 and 109). By monitoring the Eclipse Sound and Admiralty Inlet grids, the aerial survey program can track potential displacements of narwhal from the Eclipse Sound to Admiralty Inlet.
7	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 1.2, page 4	"Since 2013, regular community engagement meetings regarding the Project have been carried out in Arctic Bay, Clyde River, Sanirajak, Igloolik, and Pond Inlet." What about other potentially impacted communities like Resolute Bay and Kugaaruk? What consultation and engagement has been done in late 2020/early 2021 re: narwhal investigations?	In follow-up to the release of the 2020 Preliminary Summary of Marine Monitoring Programs, Baffinland provided to representatives from the Hamlet and HTOs of each of the five impacted communities an update on its plans for the 2021 Shipping Season. Baffinland is also working under the assumption that comments provided by the QIA on all monitoring reports reflect relevant information from harvesters that the QIA would have consulted with in preparing this submission. If QIA as the Designated Inuit Organization representing these communities, including Resolute Bay, has any additional information from harvesters that would be relevant to Baffinland's analysis of Project effects monitoring, Baffinland

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				invites QIA to share this information as soon as practicable. Baffinland will continue to engage directly with Inuit from Pond Inlet in the investigation into the 2020 marine mammal monitoring program results. Baffinland notes that input from the Hamlet of Pond Inlet and the MHTO drove the enhancement of proposed mitigation measures to initiate the 2021 shipping season. Prior to planning for the 2022 shipping season commences, Baffinland will engage Inuit from Pond Inlet in the interpretation of the 2020 and 2021 marine mammal monitoring programs to outline where our observations align and diverge with the experiences of Inuit. Should Baffinland propose any formal IQ workshops as part of the investigation, Baffinland will work with QIA consistent with the provisions of the Mary River IIBA.
8	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 1.3, pages 4-8	There are some inaccuracies and missing information in this section, which are not described in detail in these comments. But some highlights: - it mentions 4 Baffin Bay summer stocks first before going on to note the other recognized summer stocks (Smith Sound, Jones Sound). - there is very little information on IQ in this section.	Information on the Baffin Bay stocks are based on information provided in several DFO publications and available IQ: DFO (Fisheries and Oceans Canada). 2015a. Abundance estimates of narwhal stocks in the Canadian High Arctic in 2013. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/046. DFO. 2020. Information related to the delineation of the Eclipse

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			- population vs sub-population used interchangeability for polar bear (more accurate term is Management Unit, Baffin Bay and Lancaster Sound management units) - "No investigations of [ringed seal] population structure specific to Baffin Bay have been done." - see the recent (2019) COSEWIC updated status report for information on population structure (although scientific evidence is largely limited to several theses)	Sound and Admiralty Inlet narwhal stocks. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/048. Richard, P., J.L. Laake, R.C. Hobbs, M.P. Heide-Jørgensen, N.C. Asselin and H. Cleator. 2010. Baffin Bay narwhal population distribution and numbers: Aerial surveys in the Canadian High Arctic, 2002-04. Arctic. 63: 85-99. Doniol-Valcroze, T., Gosselin, J.F., Pike, D.G., Lawson, J.W., Asselin, N.C., Hedges, K., and S.H. Ferguson. 2020. Narwhal Abundance in the Eastern Canadian High Arctic in 2013. NAMMCO Scientific Publications 11. https://doi.org/10.7557/3.5100. Doniol-Valcroze, T, Gosselin, J.F., Pike, D., Lawson, J., Asselin, N., Hedges, K., and S. Ferguson. 2015a. Abundance estimates of narwhal stocks in the Canadian High Arctic in 2013. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/060. v + 36 p. Jason Prno Consulting Services Ltd (JPCS). 2017. Technical Supporting Document (TSD) No. 03: Results of Community Workshops Conducted for Baffinland Iron Mines Corporation's – Phase 2 Proposal. Report submitted to Baffinland Iron Mines Corporation. January 2017. IQ is referenced throughout the document, including in the discussion. The following IQ references have been added to the section in question: "IQ also indicated that narwhal are concentrated in Tremblay Sound,

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				western Eclipse Sound, Milne Inlet, and Koluktoo Bay in August (JPCS 2017)." "This is consistent with IQ (JPCS 2017) which included observations of bowhead migrating through the RSA in Aujaq (end of July to September)." "IQ indicates that killer whales are generally not observed at floe edge or leads because their dorsal fins interfere with ice travel (QIA 2019). Killer whales normally do not arrive until Aujaq (i.e., July to September). Further, killer whales have been observed leaving before freeze up so that they will not be trapped in ice (QIA 2019)." "IQ indicates that seal pupping season runs from February to March and there are no certain areas for seal pups; they are born everywhere (JPCS 2017). IQ also notes there are seal pups in the area until the middle of April (JPCS 2017)." The terms population vs sub-population were used in the context cited in the corresponding references. COSEWIC 2019 states "There are no data available for a wide-ranging population assessment, and there is insufficient information on trends at the level of the designatable unit (i.e., the entire range in Canada and adjacent areas) and limited data at the regional (or smaller) level. This adds substantial uncertainty to any

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				status assessment." The Baffin Bay population estimate of 1.2 million seals will be added to the report, based on Kingsley (1998).
9	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 2.2, pages 10-14	The text should provide more information on how survey lines were established. QIA asked during the last MEWG call whether the same lines were flown in 2020 as in 2019, and Golder responded that the lines are randomly assigned and were not exactly the same lines. The transects lines in the maps appear very similar to those used in 2019 and additional detail should be provided on how the transects lines were assigned in 2020. Was the starting line randomly assigned, or were the transects randomly placed new each year? Were the same lines flown in each replicate in 2020? To follow statistical estimation orthodoxy, each survey in each year should have a random start to its systematic design. If it does cause a bias it is not likely to be significant if most of the narwhals are in the photographic survey component, but it is nonetheless important to ensure that methodological details are reported clearly.	Five sets of offset survey lines have been produced for the Eclipse Sound and Admiralty Inlet survey grids. The starting line was randomly assigned for each of the five sets of survey lines. The same set of offset lines are used each year, but only one or two of the surveys get analyzed for abundance estimates. The transect lines in Milne Inlet and Tremblay Sound are not offset due to the limited geographic area they are flown in.

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10	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 2.2, pages 10-14	Re: Figures 2, 3, 4, there was no survey coverage of the southern fjords and inlets in the Eclipse Fjords stratum (Oliver Sound, Tay Sound, Paquet Bay, White Bay, or Eskimo Inlet). This is potentially an important gap in survey coverage. What IQ and Inuit harvester observations are available for these areas during the 2020 open water season? What efforts have been made to consult with Mittimatalingmiut on their observations in these fjords and inlets?	The southern fjords and inlets in the Eclipse Fjords stratum (Oliver Sound, Tay Sound, Paquet Bay, White Bay, or Eskimo Inlet) were all flown on each survey undertaken during the 2020 open water season - see Appendix B10-B15. This increased survey effort in the southern fjords in 2020 was based on recommendations provided by the QIA on the 2019 MMASP Report. See also response to Comment No. 10.
11	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 2.3, pages 14-15	Stratum areas were calculated in ArcGIS - what projection was used?	The projection used for calculating stratum areas was NAD 83 UTM 17.

12	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 2.5, pages 17-22	It is unclear where some of the availability correction factors came from. Golder quotes Watt et al 2015a (e.g., Table 2, page 18) for their availability correction but that paper does not calculate such a correction factor. There is a Watt et al. 2015 report (CSAS Research Document 2015/044) which does calculate one. It is 3.18 (SE 0.107, i.e., equivalent to a CV 0.0337), not Golder's quoted 3.16. Golder also erroneously quotes a bowhead whale availability correction paper by Watt et al., also dated 2015.	We acknowledge that the reference originally cited is the incorrect Watt et al. (2015b) publication and should be the other Watt et al. (2015b) publication referenced below. However, the availability correction factor stated in the report (3.16) is correct for narwhal observed in late August. On p.4 of Watt et al. (2015b), it is stated: "In late August, narwhals (n = 24) spent an average of 31.6 ± 0.86 % of their time in the 0-2 m bin". The correction factor is derived from this value by using the following equation: 1/31.6*100 = 3.16. The correction factor of 3.18 (1/31.4*100) is used for surveys conducted in mid-August, or earlier. This is outlined in Table 2 of the 2019 and 2020 Marine Mammal Aerial Survey Reports (Golder 2020,2021) Golder. 2020. 2019 Marine Mammal Aerial Survey. Final Report submitted to Baffinland Iron Mines Corporation. Report No. 1663724-191-R-Rev0-22000. 5 August 2020. Golder. 2021. Draft 2020 Marine Mammal Aerial Survey. Draft Report submitted to Baffinland Iron Mines Corporation. Report No. 1663724-270-R-RevB-39000. 22 April 2021. Watt, C.A., Marcoux, M., Asselin, N.C., Orr, J.R., and Ferguson, S.H. 2015b. Instantaneous availability bias correction for calculating aerial survey abundance estimates for narwhal (Monodon monoceros) in the Canadian High Arctic. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/044. v + 13 p.

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13	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 2.5.1, page 17	Some more detail would be helpful here, for example how did observers on both sides collect data along the floe edge, was the aircraft far enough out for observers on both sides, or did only one side collect observation data?	The floe edge transect was flown approximately 1 km offshore of the floe edge, so observers positioned on both sides of the aircraft collected observational data.
14	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 2.5.2.2, page 20	How many photos were checked by a second analyst? What is meant by "[a] randomly selected photo survey"? One day? One stratum? Water clarity was subjectively classified as clear or murky - all done by same analyst? Any assessment of repeatability? How was ice measured? I.e., 10% threshold determined from Canadian Ice Service data, or measured on each photograph?	As stated in the report on p. 54, 504 photos were assessed for reliability and repeatability. What is meant by the 'randomly selected photo survey' is that one of the seven photo surveys analyzed was randomly selected to evaluate reliability and repeatability. Water clarity was classified by one analyst only. No assessment of repeatability was done due to the limited number of photos with murky water. No ice was observed in the 2020 photographic surveys. In 2019, the ice was measured based on what was in the photographs.

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15	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 3.1.2, page 26	For Figure 9, is this all pack ice or does it include landfast in the 9-10/10? The report text says fast ice was present until 17 July, so surveys 1-4 presumably include both landfast and pack ice?	The 9-10/10 ice concentration in Figure 9 includes both pack ice and landfast ice.
16	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 3.1.4.1, pages 34-35	What statistical comparisons between 2019 and 2020 can be made?	None because of the variability in survey effort and environmental conditions during Leg 1. Comparing general trends is all that can be done for the animal detection rates calculated during Leg 1.
17	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 3.2.1, page 35	Table 9 shows effort in linear km for both visual and photographic surveys, but the two types of survey don't have the same width of areal coverage (visual effective transect width (not given) probably around 500 m vs photo transect width ca. 760 m (0.8986*846 m) so a linear unit of effort is improperly used. Effort should be measured in area to be additive (as in Asselin and Richard 2011 (DFO CSAS Research Document 2011/065) p.19), not total length of transects. Otherwise the photographic survey effort is undervalued relative to the visual effort.	Table 9 is a summary table showing linear effort and is not used in the abundance calculations. Photo surveys use the area of the photographs to calculate abundance (see Methods Section 2.5.2.2). Visual surveys used distance analysis to calculate abundance estimates (see Methods Section 2.5.2.1.1). Distance analysis does use linear effort in its calculation of abundance along with several other variables. Animals beyond the effective strip width are included in the distance analysis so

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				using the effective strip width is not an accurate measure of effort. Narwhal abundance estimates were calculated using the same method used by Asselin and Richard (2011), Marcoux et al. (2016) and Matthews et al. (2017). Asselin, N.C. and P.R. Richard, 2011. Results of narwhal (Monodon monoceros) aerial surveys in Admiralty Inlet, August 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/065. iv + 26 p. Marcoux, M., B. Young, N. C. Asselin, C. A. Watt, J. B. Dunn, and S. H. Ferguson. 2016. Estimate of Cumberland Sound beluga (Delphinapterus leucas) population size from the 2014 visual and photographic aerial survey. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/037. Iv + 19 p. Matthews, C.J.D., Watt, C.A., Asselin, N.C., Dunn, J.B., Young, B.G., Montison, L.M., Westdal, K.H., Hall, P.A., Orr, J.R., Ferguson, S.H., and M. Marcoux. 2017. Estimated abundance of the Western Hudson Bay beluga stock from the 2015 visual and photographic aerial survey. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/061. v + 20 p.

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18	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 3.2.6.1, page 52	"The number of narwhal sightings during fjord transects was too small (n = 5) to appropriately perform abundance estimates using the Density Surface Modelling technique (Doniol-Valcroze et al. 2015)". What fjords? None of those south of Mittimatalik were surveyed, correct?	Incorrect. The southern fjords and inlets in the Eclipse Fjords stratum (Oliver Sound, Tay Sound, Paquet Bay, White Bay, or Eskimo Inlet) were all flown on every survey during the 2020 open water season (see Appendix B10-B15).
19	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 3.2.6.3, pages 51-60	Golder selected the highest abundance estimate of the two replicates (for Eclipse Sound, Admiralty Inlet, and the combined survey estimate). The text states that the abundance estimate that was significantly higher "was therefore retained as the abundance estimate." That in itself is not justification for selecting the highest one. CVs were generally lower for the higher estimates, which does support their selection, but the simple fact that it was significantly higher does not. A weighted average of both surveys could be calculated (see Asselin and Richard 2011 (DFO CSAS Research Document 2011/065) for Admiralty Inlet). This would also facilitate comparisons with past DFO surveys for this region. How large would the apparent decline in Eclipse Sound narwhal abundance be if both replicates were used to calculate a weighted average?	The abundance estimates for two replicates were significantly different from one another. The higher abundance estimate was selected because logically the abundance estimate with the lower CV and the statistically higher number of animals represented a more accurate estimate of narwhal numbers in Eclipse Sound during the peak abundance period. It is appropriate to average results from multiple survey replicates if there is reasonable confidence that conditions (i.e., factors influencing abundance and distribution) remain consistent between the respective replicate surveys and if the confidence intervals between the respective replicate surveys overlap (i.e., no significant difference between replicates). This was not the case in this example. The abundance estimate for Survey 3 (5,018 narwhal, CV = 0.03, 95% CI of 4,736?5,317) was significantly higher than the abundance estimate for Survey 1 (3,519 narwhal, CV = 0.03, 95% CI

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				of 3,308–3,743) (Z-test = -8.10, p < 0.0001) with the majority of the sightings based on photographic data for both surveys. Given the higher confidence of animal detection associated with the photographic survey data, the Survey 3 results were considered to reflect a more accurate representation of actual narwhal abundance in the RSA and were therefore retained as the best 2020 abundance estimate for the Eclipse Sound stock. The difference in abundance estimates between Survey 1 and 3 was likely attributed to less narwhal being present in the dedicated photographic survey areas during Survey 1 compared to Survey 3. This may have been due to natural movement patterns of narwhal in and out of the photographic survey areas, or may reflect non-random narwhal distribution / movement patterns in the RSA due to influences of killer whales (Survey 3 was the only survey replicate in 2020 when killer whale were present during active surveying). Other potential contributing factors may have included weather, as sighting conditions were poorer during Survey 1 due to higher sea state conditions at this time. Although Fisheries and Oceans Canada (DFO) has in the past averaged abundance estimates from multiple replicate surveys, there is also precedence by DFO for using a single survey replicate for this purpose (rather than systematically averaging two or more survey replicates conducted

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				the same the survey period). This occurred when there was reason to believe that one survey replicate was thought to represent a more accurate estimate of the actual population. The text in the 2020 MMASP report has been revised to more clearly explain the rationale for selecting Survey 3 as the most accurate estimate for narwhal abundance in Eclipse Sound and Admiralty Inlet.
20	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.0, page 61	The text states that the leg 1 surveys were designed to "collect data on the presence/absence and distribution of marine mammals in the RSA specific to available ice conditions at that time of year." The report doesn't provide any quantitative information on the distribution of marine mammals specific to ice conditions, however. For example there is no assessment of selection or avoidance of ice types, or whether habitat selection patterns vary in the absence vs presence of vessels.	Leg 1 was not designed to obtain a quantitative evaluation on the distribution of marine mammals in the RSA relative to ice conditions. A quantitative evaluation of sea ice use (selection and/or avoidance) by narwhal is not possible using the existing dataset because of the variable ice conditions present during Leg 1, the non-systematic manner in which data was collected (Leg 1 was limited to a qualitative evaluation of narwhal presence in the RSA relative to ice conditions), the lack of replication in survey effort, and the limited number of vessel passages occurring during the Leg 1 period.
21	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.1, page 61	"Narwhal distribution differed between 2019 and 2020 due to the different ice conditions in the study area." Again, some quantitative assessments are needed, for example habitat selection analyses, statistical assessments of changes in distribution, etc.	Leg 1 was not designed to obtain a quantitative evaluation on the distribution of marine mammals in the RSA relative to ice conditions. A quantitative evaluation of sea ice use (selection and/or avoidance) by narwhal is not possible using the existing dataset because of the variable ice conditions present during Leg 1, the non-systematic manner in which data was collected (Leg 1 was limited to a

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				qualitative evaluation of narwhal presence in the RSA relative to ice conditions), the lack of replication in survey effort, and the limited number of vessel passages occurring during the Leg 1 period.
22	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s.4.1.2, page 63	We tried to reproduce the combined survey estimates given in the draft survey report and noticed an error in Table 23 where the Eclipse Sound and Admiralty Inlet 2019 surveys incorrectly sum to 38,771, rather than the correct sum of 38,677. All calculations should be carefully double-checked.	There was an error in the reported combined stock abundance in the 2019 aerial survey report. The reported value of 38,771 for the combined Eclipse and Admiralty stock will be corrected to 38,677 in the final report. The source of the error stems from a corrected value for 'survey effort' for the 2019 Admiralty Inlet survey which resulted in a revised abundance estimate for the Admiralty Inlet stock. This revised abundance estimate was not carried over to the combined stock value in the 2019 aerial survey report. All statistical tests using the corrected value of 38,677 have been re-run and this did not change the statistical significance of any of the comparisons.
23	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.2, pages 65-66	We expected this to be a significant expansion on the information provided in the previous memo from April 2021. There is little new information here however, which suggests the Proponent's investigation is not progressing rapidly.	The Preliminary Summary of 2020 Narwhal Monitoring Programs is dated 7 April 2021. The 2020 Marine Mammal Aerial Survey Report was released to the MEWG on May 13 2021. It is unclear what additional information the QIA was expecting to be provided, particularly in the timeframe between delivery of the two documents which also overlapped with the Phase 2 Public Hearing. Baffinland also notes that attempts made on June 18 2021 to further discuss the 2020 monitoring results with the QIA as part of our investigation were left unanswered

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				and QIA did not participate in opportunities for consultation beyond the meetings they attended as MEWG members in May and June of 2021. Baffinland would also advise the QIA to review Baffinland's 2021 Shipping and Marine Vessel Management Report that has been in their possession since July 14 2021
24	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.2.1, page 65	The report should provide additional information (e.g. maps, charts) on the *Botnica's* routes, the ice conditions experienced including the distribution of leads, and narwhal observations.	Appendix B of the report does provide maps on the *Botnica*'s routes, the ice conditions, and the narwhal observations for each survey that was flown in the Eclipse Sound grid during the Leg 1 surveys.
25	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.2.3, page 66	There is a wealth of literature on killer whale predation and narwhal response to predation risk available that has not been used here. Killer whales do not seem to have been any more abundant than usual based on Inuit observations and knowledge collected and published by DFO.	As stated on p. 67 of the report, we discussed a limited comparison of killer whale densities collected during Baffinland's marine mammal aerial survey program between 2019 and 2020. We are not aware of a DFO publication that compares killer whale abundance in 2020 (based on Inuit observations and knowledge) to previous years. In addition, Inuit knowledge shared by Pond Inlet community members indicates that killer whales are more abundant in the area than historically (Gonzales 2001; NWMB 2016; QIA 2019). Gonzalez, N. 2001. Inuit traditional ecological knowledge of the Hudson Bay narwhal (Tuugaalik)

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				population. Department of Fisheries and Oceans, Iqaluit, Nunavut, Canada Nunavut Wildlife Management Board (NWMB). 2016. Qikiqtarjuaq Narwhal IQ Interview Report. Prepared by Sheila Oolayou, Inuit Qaujimajatuqngit Coordinator for the NWMB. 10 November 2016. Qikiqtani Inuit Association (QIA). 2019. QIA's Tusaqtavut for Phase 2 Application of the Mary River Project. Final report. 14 June 14 2019.
26	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.2.4, page 66	This short section highlights the importance of having better IQ integration and effective EWIs related to narwhal health, fitness, and condition.	We encourage the QIA to reference specific IQ sources that they would like to see integrated in the current investigation. Section 5.0 indicates that "These results suggest a potential displacement of a portion of the Eclipse Sound stock to the Admiralty Inlet summering ground during the summer of 2020". Contrary to the QIA comment, the fact that this potential displacement was recorded in Baffinland's monitoring programs and statistically compared to 2019 results is an indicator of the effectiveness of the monitoring programs. It also highlights that project indicators do not have to be labelled "early warning" indicators (EWIs) to be effective indicators. Additional EWIs related to narwhal health, fitness and condition would not have provided an early warning of narwhal displacement from Eclipse Sound to Admiralty Inlet. The reported 2020 narwhal abundance and distribution monitoring results are consistent with Baffinland's 2020 EWI

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				monitoring results in that the results do not suggest an overall decrease in the combined abundance estimate between Eclipse Sound and Admiralty Inlet.
27	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 4.2.4, page 66	The number of ore and support vessels transiting to and from Milne Port varies from day to day. An analysis of the density of ship transits (ships/day) in the days prior to and during the aerial surveys would be instructive.	Considering the geographic scale being surveyed by the aircraft in a single day and the variance in ship transit density within the RSA during the same survey period, it would be very challenging to statistically compare changes in regional abundance estimates of narwhal to ship transit density.
28	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 5.0, page 70	What efforts have been made to solicit Inuit observations from nearby communities to better understand 2020 narwhal distribution, e.g., were more narwhal than typical seen near Clyde River, Resolute Bay, or Grise Fiord?	See response to Comment No. 7.
29	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020	s. 5.0, page 70	"However, the addition of new stressors in 2020, including the Small Craft harbour construction in Pond Inlet…" How is this a "new stressor"? Didn't construction including pile driving occur in 2018 and 2019 as well, when narwhal abundance was largely unchanged (based on 2019 results)?	Based on our current understanding of the SCH Project in Pond Inlet, impact pile driving using a drop hammer was first initiated in 2020. In the preceding construction seasons, in-water works were limited to installation of fill and dredging activities and not impact pile driving to the best of our knowledge. We are hopeful

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	MMASP Report 22APR_21.pdf)			this can be confirmed by the project proponent or the respective authorities in order to assist with the current investigation process. In particular, it is our understanding, based on information available in the Advisian Construction Monitoring report, that the impact pile driving conducted in 2020 was undertaken without effective application of the required mitigation measures, as outlined in the Fisheries Act Authorization issued by DFO for these in-water works.
30	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	s. 5.0, page 70	"… further investigation regarding the cause(s) of the observed decrease in Eclipse Sound narwhal stock is warranted (Golder 2021a; see Appendix E)." Why is there no further investigation reported here? Shouldn't this be ongoing? No update since 2020 memo was provided in the spring?	See response to Comment No. 23.
31	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020	s. 6.0, page 71	"However, if pile driving for the Small Craft Harbour Construction at Pond Inlet continues under similar conditions in 2021, results of the 2021 MMASP may, again, not be a reliable indicator of Project-related effects." The MMASP is one component of Project monitoring, and	Baffinland relies on the MEWG and its members to inform the marine monitoring program development, including cumulative impact assessment. MEWG members that are involved in or have information on project activities occurring within the RSA are encouraged to share the details of these activities to Baffinand so that monitoring

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	MMASP Report 22APR_21.pdf)		comprehensive monitoring programs including PAM should provide reliable indicators of Project-related effects. This also highlights deficiencies in the Cumulative Effects Assessment - how did it consider and address the SCH construction, which was a reasonably foreseeable future development? And how did that assessment of cumulative impacts inform monitoring and mitigation? Re: recommendation to include IQ and community involvement - what progress has been made on this since the original memo was provided (Golder 2021a, Appendix E)?	programs can effectively target project-related activities. It should be noted that pile driving activities planned for 2020 were not shared with Baffinland by MEWG members, including DFO, GN, MHTO or the QIA, during program development meetings. The fact that this activity was independently recorded by Baffinland is an indicator of the robustness of its marine monitoring programs.
32	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	Appendix B (map book)	Quantitative summary information is needed, e.g., habitat selection/avoidance, distribution as a function of habitat type (sea ice characteristics), etc. Information on narwhal observations as a function of distance to shore, across the open-water surveys, could be compared with killer whale sightings to better understand narwhal responses to predation risk in 2020. For example, Figure 22B (s. 3.2.4) shows expected narwhal behaviour in the presence of killer whales (i.e., coastal distribution vs complete departure of area).	There is currently insufficient data available on killer whale occurrence in the RSA during 2020 to accurately assess this component. This may be possible in 2021, depending on the outcome and results of the Pond Inlet-DFO collaborative killer whale tagging program (assuming this was undertaken).

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33	Golder Associates Ltd. 2021. Mary River Project 2020 Marine Mammal Aerial Survey. Draft report 1663724-270-R-RevB-39000 (File: 1663724-270-R-RevB-39000_2020 MMASP Report 22APR_21.pdf)	Appendix D (Distance Sampling and Mark-Recapture Models)	Reporting of Akaike Information Criterion (AIC) weights would be useful here.	Akaike Information Criterion (AIC) weights are reported in Appendix D.

Baffinland

Name: Kristin Westdal

Organization: Oceans North

Date of Comment Submission: July 8, 2021

#	Document Name	Section Reference	Comment	Baffinland Response
9	2020 Marine Mammal Aerial Survey Program	Potential Contribution Factors to 2020 Findings	Did the small craft harbour construction in Pond Inlet in 2018 and 2019 include pile driving when the narwhal survey showed no decline in population? Killer whales have been visiting Eclipse Sound and Milne Inlet for generations, and seasonally each year for long before the mine began shipping. How are both of these factors considered to contribute to the low narwhal population estimate as opposed to the cumulative effects of regular shipping transits? Why has the cumulative effects of project shipping not been considered?	Based on our current understanding of the SCH Project in Pond Inlet, impact pile driving using a drop hammer was first initiated in 2020. In the preceding construction seasons, in-water works were limited to installation of fill and dredging activities and not impact pile driving to the best of our knowledge. We are hopeful this can be confirmed by the project proponent or the respective authorities in order to assist with the current investigation process. All available literature and IQ indicates that killer whales were uncommon in the Canadian Arctic prior to the 1950s and that their presence in this region only recently increased as the eastern and western Canadian Arctic have become increasingly more accessible due to reduced sea ice cover and a longer open-water season associated with climate change (Gonzales 2001; Moore and Huntington 2008; Higdon and Ferguson 2009; Ferguson et al. 2010; NWMB 2018, QIA 2019). Recent increases in the abundance of killer whale, or shifts in its distribution in the Arctic, could disrupt the Canadian Arctic

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				marine ecosystem through effects on prey not historically exposed to high levels of killer whale predation (Breed et al. 2017). As suggested by the Hamlet of Pond Inlet in their response to Golder (2020), “there is little reason, knowing the relationship between ice cover and the presence of narwhal and their season migrations in relation to ice cover, to not assume that there are, and are likely to be further changes in the relationship between narwhals and killer whales in Eclipse Sound and Milne Inlet.” By considering killer whale influences on narwhal abundance, we are not concluding predation as the sole driver of the observed narwhal decline, nor are we ignoring its potential influence on seasonal narwhal abundance. Its inclusion as a potential contributor is to ensure we examine all possibilities, including the cumulative effects imposed by natural predation in addition to anthropogenic stressors. Although the long-term effects of killer whale predation on narwhal abundance remain largely unknown, it would be naïve to eliminate this potential factor in our follow-up assessment. The cumulative effects of project shipping has been considered. See response to Comment # 11 for details.

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				Gonzalez, N. 2001. Inuit traditional ecological knowledge of the Hudson Bay narwhal (Tuugaalik) population. Department of Fisheries and Oceans, Iqaluit, Nunavut, Canada Higdon, J.W., and S.H. Ferguson. 2009. Loss of Arctic sea ice causing punctuated change in sightings of killer whales (Orcinus orca) over the past century. Ecol. Appl. 19: 1365–1375. Higdon, J.W., D.D.W. Hauser, and S.H. Ferguson. Submitted. Killer whales in the Canadian Arctic: distribution, prey items, group sizes, and seasonality. Arctic (in review Moore, S.E., and H.P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. Ecol. Appl. 18(Suppl.) Arctic Mar. Mamm.: S157–S165 Nunavut Wildlife Management Board (NWMB). 2016. Qikiqtarjuaq Narwhal IQ Interview Report. Prepared by Sheila Oolayou, Inuit Qaujimajatuqngit Coordinator for the NWMB. 10 November 2016. Qikiqtani Inuit Association (QIA). 2019. QIA's Tusaqtavut for Phase 2 Application of the Mary River Project. Final report. 14 June 14 2019.

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10	2020 Marine Mammal Aerial Survey Program	Page 66	BIMC notes the abundance of killer whales in 2020 compared to 2019 Bruce Head survey results. What was the abundance in other years? What does IQ indicate about killer whale presence before and after the start of mine operations? See Higdon, Westdal & Ferguson, (2013) for historical perspective	Killer whales were only sighted one other year in Eclipse Sound during aerial surveys conducted for the Project and that was in 2007. There were three killer whale sightings in Eclipse Sound on 17 September 2007 during aerial surveys conducted for the Project (Mary River Project FEIS, Appendix 8A-2, Feb 2012). The number of killer whales present in the Study Area during aerial surveys does not enable the calculation of an abundance estimate for this species. See also response to Comment No. 9 above. A historical review on the presence of killer whales in the RSA is beyond the scope of the current 2019 Marine Mammal Aerial Survey Report.
11	2020 Marine Mammal Aerial Survey Program	Page 66	'Other potential factors to 2020 findings' Why are the cumulative effects of year after year of increased vessel traffic and noise disturbance not included here?	Open-water shipping was not identified as a likely contributing factor to the observed decline in 2020 for several reasons. Firstly, open-water shipping levels were slightly lower in 2020 compared to 2019. In 2019, narwhal numbers in the RSA were shown to be stable relative to baseline (2013) and previous survey years when shipping was occurring (2016). During these surveys, no evidence of displacement was observed. Therefore, it is considered unlikely that open-water shipping in 2020 would suddenly trigger a high severity response in narwhal (such as a large-scale displacement from the RSA) when shipping levels were in fact slightly reduced that year.

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				Secondly, the type of behavioural responses observed in narwhal to date from open-water shipping suggests that this is not the cause of the observed decrease in 2020. Behavioural responses to shipping have been limited to temporary and localized disturbance effects at close range to vessels (up to 5 km distance). These effects, when present, last for a short duration with animals quickly returning to their pre-response behaviour following exposure. These are considered to be low to moderate severity responses that are not thought to result in any significant biological consequences on reproduction or survival, and hence on the stock or population. In comparison, narwhal responses to killer whales in the RSA consist of rapid dispersal to shallow water nearshore areas, freeze behaviour and suspension of vocal activity, with effects persisting for periods well beyond the exposure event. This would be considered a high severity response with potential significant biological consequence. To date, no similar anti-predator response has been demonstrated by narwhal to shipping as part of Baffinland's monitoring programs.

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#	Document Name	Section Reference	Comment	Baffinland Response
12	2020 Marine Mammal Aerial Survey Program	Appendix E	'Close proximity' is noted in a few places. How far was the consolidated ice field and prominent lead "occupied by large numbers of narwhal, including many mother/calf pairs" from the ice breaker's track line?	Appendix B provides maps of the aerial survey narwhal sightings along with Project vessel tracks for days of survey activities. It is not possible to know how far the distances were as the sightings shown on the map do not overlap in time with the vessel tracks shown. Both marine mammal distribution and ice fields geographically shift over the course of a day, as well as between days.
13	2020 Marine Mammal Aerial Survey Program	Appendix E Mitigation	In addition to the proposed change in start of ice breaking (which we do not recommend and believe should not occur in support of the MHTO and Hamlet of Pond Inlet) – has BIMC considered no ice breaking within a specified range of large numbers of narwhal?	This comment does not pertain to the 2019 Marine Mammal Aerial Survey Program Report.

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14	2020 Marine Mammal Aerial Survey Program	Appendix E Page 7	There were a few (n=3) RAD surveys with more than 1 vessel transiting compared to 2019 (n=11). Was this chance? Or were there less occurrences in 2020 when vessels were in the zone at the same time? The Bruce Head report notes that there was only 1 sighting recorded in the presence of more than one vessel within 7 meters from the BSA. As a result there is no analysis on the potential effect of the presence of more than one vessel. In 2021 how many times are two or more vessels expected to be in within the same area? And under Phase 2? The LGL aerial survey report noted change in abundance in the presence of 2 or more vessels. What data does BIMC have on narwhal behaviour in response to multiple vessels?	This comment does not pertain to the 2019 Marine Mammal Aerial Survey Program Report.

Baffinland

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Date of Comment Submission: July 9, 2021

#	Document Name	Section Reference	Comment	Baffinland Response
11	Mary River Project *2020 Marine Mammal Aerial Survey*	p.10 2.2 Study Area and Design	Golder describes an adaptive sampling method where survey method switches from visual to photographic. This method requires previously-defined criteria to decide when to switch from the systematic transect lines to the adaptive extra effort. Please provide the exact rule for when to switch from visual survey to photographic. This will influence how the variance for the encounter rate is calculated. The absence of a formal adaptive sampling strategy precludes from robust statistical analysis of the results. Please refer to Chapter 8 of Advanced Distance Sampling book (Buckland et al 2004) for more information. Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, D.L., and Thomas, L. 2004. Advanced distance sampling. Oxford University Press, New York.	On page 14 of the aerial survey report, it states: "During visual line-transect surveys, if large aggregations (e.g., >50 narwhal or when observers indicated that they could not accurately keep up with narwhal counts) were identified, a photographic survey was flown with complete coverage over the group to allow for accurate counts of animals." Chapter 8 of Buckland et al. (2004) refers to conducting additional visual survey lines when large aggregations are encountered and does not specifically address criteria for changing from visual to photographic surveys. Baffinland and DFO are having ongoing discussions on this topic to ensure that the best analysis methodology is used.

#	Document Name	Section Reference	Comment	Baffinland Response
12	Mary River Project *2020 Marine Mammal Aerial Survey*	Table 2 Table 2: Availability bias correction factors p. 18	DFO Science, as part of the Joint Commission of Narwhals and Belugas Joint Working Group (JWG), is currently working at revising the availability bias correction factors. The group has noted that the coefficients of variation of these correction factors are too low. This will result in a higher coefficient of variation of the aerial survey. This work is in progress and DFO will communicate with BIM when the work is completed.	Baffinland and DFO are engaged in ongoing discussions on this topic to ensure that the best analysis methodology is used.
13	Mary River Project *2020 Marine Mammal Aerial Survey*	P 22. 2.5.2.3 Abundance Estimate	How did you calculate the variation in encounter rate related to the large groups that were photographed on transect lines during adaptive sampling? I believe that it is not currently taken into account. This will increase the variance of the encounter rate. Please refer to Chapter 8 of Advanced Distance Sampling book (Buckland et al 2004) for more information. Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, D.L., and Thomas, L. 2004. Advanced distance sampling. Oxford University Press, New York.	The current analysis method separates the variance associated with the photographic and visual surveys in regions were both survey types occur. Although we are not currently aware of a method to incorporate the photographic survey data within the distance sampling framework, Baffinland will continue to work with DFO and investigate this further. As per recent discussions with DFO, Baffinland will modify the survey protocols this year such that all visual transects with large aggregations of narwhal will be fully surveyed (i.e., visual observations) before switching to a photographic survey of the aggregation area. In previous surveys, the survey aircraft would break off the survey line immediately when encountering large aggregation to switch to a photographic survey of the area.

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14	Mary River Project *2020 Marine Mammal Aerial Survey*	Figure 9	From this figure, it looks like the ice concentration is increasing with the survey number. Can you explain why?	Ice concentrations are dependent on where the surveys are flown. During the first couple of surveys, more effort was put into the open water areas because narwhal had not penetrated far into the higher ice concentrations. As the survey program progressed, more ice leads developed in the ice field resulting in larger numbers of narwhal pushing deeper into the ice field and thus more effort was required to survey regions with higher ice concentrations.
15	Mary River Project *2020 Marine Mammal Aerial Survey*	Figure 14 and 15	What is the date of the ice conditions shown on the maps?	The date is indicated in the figure legends. It is July 21, 2020.
16	Mary River Project *2020 Marine Mammal Aerial Survey*	p. 35 3.2 Leg 2: Open-Water Surveys in Eclipse Sound and Admiralty Inlet 3.2.1 Survey Coverage	In the text, it says that: *"Surveys 1 and 3 were completed in a single day under good sighting conditions."* for both Eclipse Soundand Admiralty Inlet. However, the survey date is August 21-22. Does that mean that Eclipse Sound was complete in one day and Admiraltywas completed on another day?	That is correct. Each survey grid was completed in a single day using both aircrafts in the same grid on the same day. Eclipse Sound was surveyed on 20 August (see Appendix B, Figure B-10) and Admiralty Inlet was surveyed on 21 August (see Appendix B, Figure B-11).
17	Mary River Project *2020 Marine Mammal Aerial Survey*	p. 45 Table 12: Photographic survey sightings in the Eclipse Sound and Admiralty Inlet grids during Leg 2.	Did you count the number of marine mammals in the photos of Survey 2 and 4? This information might help to understand the low abundance of narwhals in 2020.	No, surveys 2 and 4 were not analyzed because the survey grid was not flown within a day. Survey 2 was missing several transects in Navy Board Inlet and the environmental sighting conditions were less favorable on Surveys 2 and 4 compared to Surveys 1 and 3.
18	Mary River Project *2020 Marine Mammal Aerial Survey*	p. 51 Table 15: Relative Abundance of Marine Mammals in Eclipse Sound and Admiralty Inlet survey grids during Leg 2 in 2019 and 2020.	What are the units of this table?	animals/km The table has been updated to include this information.

19	Mary River Project *2020 Marine Mammal Aerial Survey*	3.2.6.3.1 Eclipse Sound Stock and 3.2.6.3.2 Admiralty Inlet Stock and 3.2.6.3.3 Combined Eclipse Sound and Admiralty Inlet Stocks p.60	In the case of the Eclipse Sound stock survey, the Admiralty Inlet stock survey and the combined survey estimates, BIM found a significant different in the estimates obtained from Survey 1 and survey 3. This might be an indication that the coefficient of variation of the estimates do not capture the actual variance around the abundance estimate of the survey. This might be due to the two comments above about the coefficient of variation of the correction factor for the availability bias as well as the calculation of the variation of the encounter rate. In general, the best practice is to use an average of the surveys instead of picking one (e.g. Gosselin et al 2007, Marcoux et al 2016). The changes between the two estimate might simply be due by different behaviour of the narwhals the two days of the study that might have caused them to spend more or less time at the surface. It might also be due to the high degree of aggregation in narwhal. - Gosselin, J.-F., Hammill, M.O., and Lesage, Véronique. 2007. Comparison of photographic and visual abundance indices of belugas in the St. Lawrence Estuary in 2003 and 2005. DFO Canadian Science Advisory Secretariat Res. Doc. 2007/025: ii + 27 p. - Marcoux, M., Young, B.G., Asselin, N.C., Watt, C.A., Dunn, J.B., and Ferguson, S.H. 2016. Estimate of Cumberland Sound beluga (Delphinapterus leucas) population size from the 2014 visual and photographic aerial survey. DFO Canadian Science Advisory Secretariat Research Document 2016/037: iv + 19 p.	Historically, surveys that have been averaged overlap in the range of the confidence intervals. It is also not uncommon for DFO to select one survey as its population abundance for a given year, rather than systematically averaging all of the surveys conducted that year, if there is reason to believe that one survey may be a more accurate estimate of the actual population. The 2020 survey results did not overlap in confidence intervals. As indicated, Baffinland will continue to engage with DFO on refining calculation of coefficients of variation as more details become available. As DFO indicated, this will likely result in updates being required for both DFO and Baffinland narwhal abundance estimates. The possibility of averaging both surveys will be re-evaluated at that point. It is important to note however that the reason why statistical analyses are conducted is to determine the probability that the difference between survey results are actually different or simply differ due to factors such as changes in surface patterns or the degree of aggregation by narwhal groups.

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