



Marine Environment

Phase 2 Proposal

Final Hearing Iqaluit and Pond Inlet November 2019



Outline

- Summary
- Assessment Approach
- Mitigation
- Valued Ecosystem Components
- Construction & Operation
- Shipping
- Cumulative Effects
- Addressing Uncertainty
- Assessment Conclusion
 - Final Written Submissions
 - Project Certificate



Summary of Assessment Conclusions

- With mitigation, no significant residual effects to Marine Environment
- Comprehensive Phase 2 assessment with notable input from Inuit/communities
- Construction & Operations
 - Dust effectively managed
 - Ballast water management will continue to exceed Regulations
- Marine Shipping
 - Precedent setting mitigation measures will protect marine mammals
 - Underwater noise will not affect narwhal population/stock integrity
- Extensive follow-up monitoring to verify assessment predictions
- Future community involvement

Assessment Approach – Baffinland Knowledge

Building on past approvals

- Multiple environmental impact review processes
- Deep understanding of key risks

Willingness to reflect on past years' experiences and integrate key learnings as operations grow

- Implementation of mitigation and management measures over 5 years



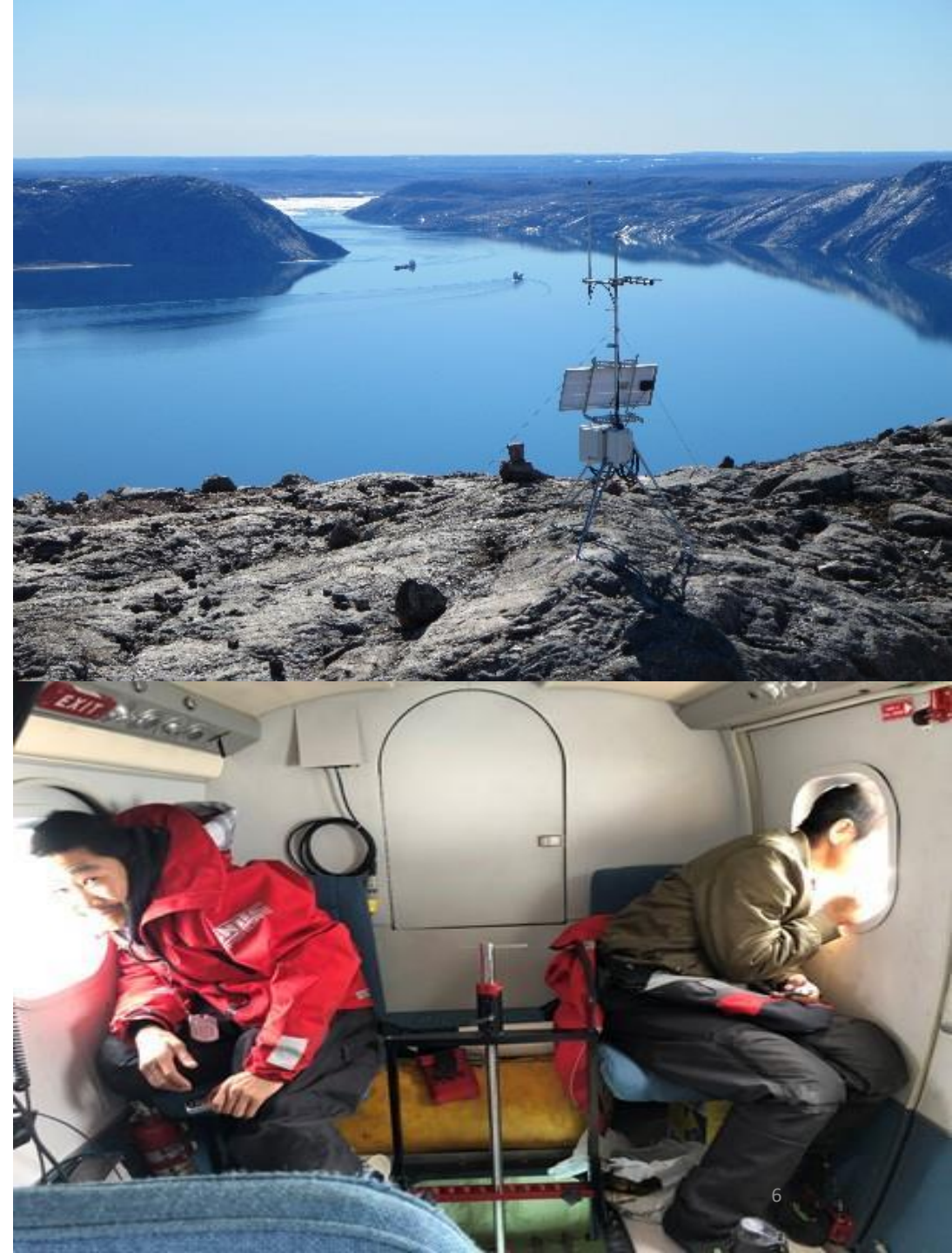
Assessment Approach – Inuit Knowledge

- Extensive sharing of Inuit knowledge through interviews, workshops, community meetings
- Close alignment between Inuit knowledge & assessment findings
- Used to provide baseline information, identify valued ecosystem components, potential effects, inform mitigation measures
- Inuit involvement and input into monitoring
- Continuous process leading to operational changes and adaptive management practices
 - “No go” zones – Koluktoo Bay, western shore of Milne Inlet



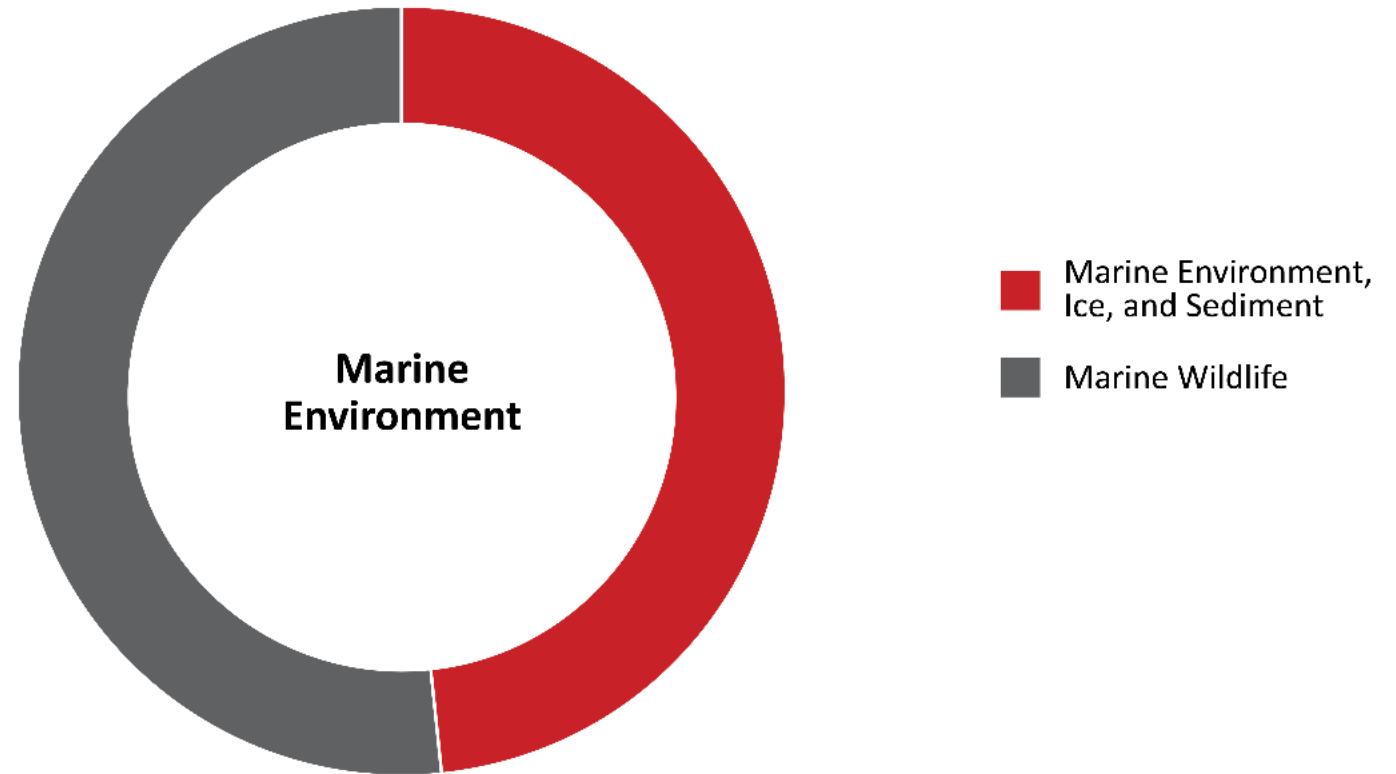
Assessment Approach – Technical Rigour

- Integration of Inuit knowledge
- Builds on previous studies
- Continuous biophysical monitoring at Milne Port
 - 10+ years of data collected
 - Over 30 regional studies
- Peer reviews
- Notable focus on:
 - Marine Mammals
 - Marine Environment



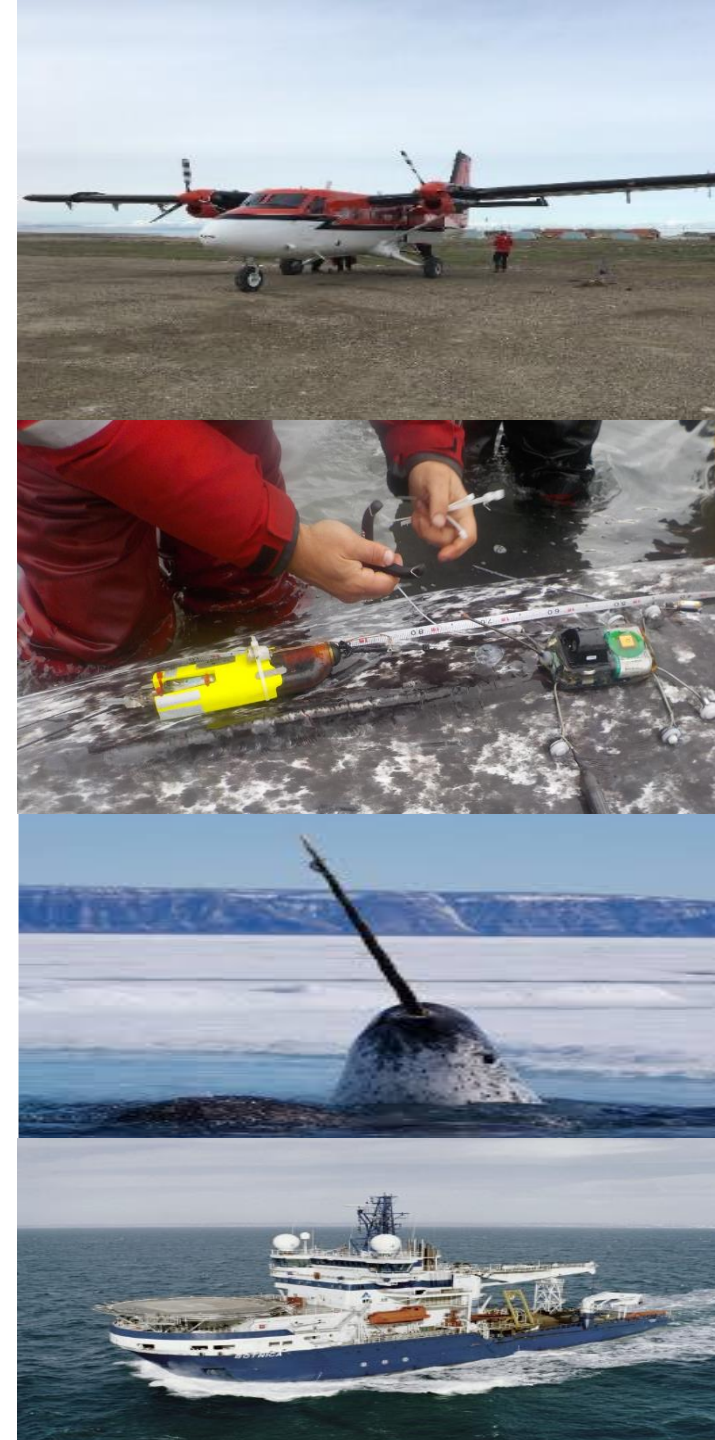
Community Feedback

- A total of 159 comments or questions related to the Marine Environment.
 - 82 related to Marine Wildlife
 - 77 related to Marine Environment, Ice and Sediment



Assessment Approach – Marine Mammals

- Narwhal Tagging with DFO
- Shore-based Monitoring
- Aerial Surveys
- Ship-based Wildlife Observers
- Acoustic Modelling & Monitoring
- Ice & Vessel Movement Data



Assessment Approach – Marine Environment

Marine Effects Monitoring Program (MEEMP)

- Water and Sediment Quality
- Fish and Fish Habitat
- Benthic Invertebrates
- Marine Vegetation
- Aquatic Invasive Species
- Habitat Offset Monitoring
- Ballast Water Monitoring
- Ship Hull Biofouling
- Physical oceanography (tides, currents, salinity, temperature)



Assessment Approach – Precautionary Principle

- Assessed worst case scenarios
- Conservative model assumptions
- Multiple, effective mitigation measures
- Extensive and frequent monitoring
- Peer reviews
- Adaptive management approach



Select Examples – Additional Assessment Information

- Icebreaking Assessment
- Shipping Activity Animation
- Vessel Traffic and Anchorage Study
- Ballast Water Dispersion Sensitivity Simulations
- North Water Polynya Mapping
- Daily Ship Exposure Periods for Narwhal
- Baffinland Early Shipping Season – Operational Guide
- Vessel Speeds in RSA during 2019 Shipping Season



Mitigation

Baffinland Approach to Mitigation

- Focused on potential effects from Project including:
 - Underwater noise
 - Ballast water management
- Also includes additional measures asked for by community & regulators
- Highly adaptive approach: building on current operational experience
- Precedent setting for Canadian ports



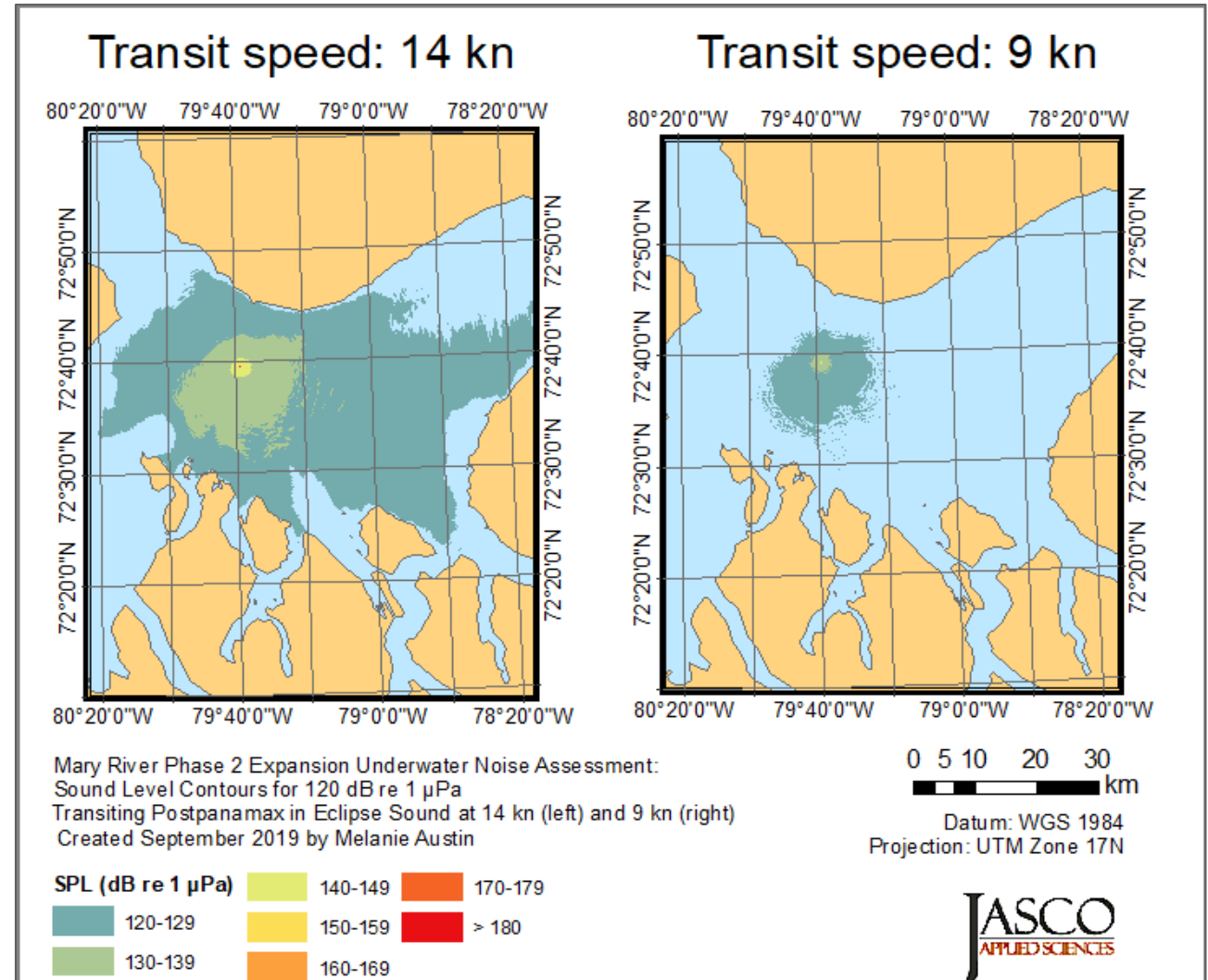


Mitigation – Marine Environment

- Best management practices during in-water construction including:
 - Silt curtains
 - Underwater noise management plan
- Precedent-setting during future & existing operations:
 - Ballast water monitoring (for salinity & temperature) on all vessels at Port
 - Biological sampling in marine receiving environment for non-native species
 - Pilot program for biological sampling of ballast water (2020)

Mitigation – Shipping

- Speed restriction of 9 knots in regional study area
- No icebreaking during sensitive ringed seal periods
- Vessel exclusion within 40 km of Nunavut Settlement Area
- Pond Inlet confirmation floe-edge is closed before icebreaking
- No breaking land-fast ice
- Vessels take path of least resistance = less icebreaking
- End of season aerial surveys (clearance)
- Inuit wildlife monitors on icebreakers



Vessel Management in Heavier Ice Conditions

Mitigation – Icebreaking

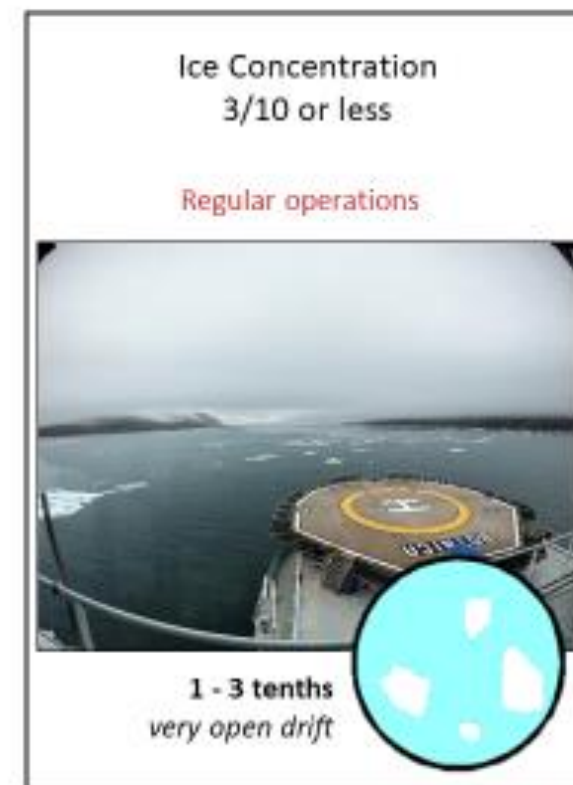


Daily noise exposure:

9.5 hours



9 hours

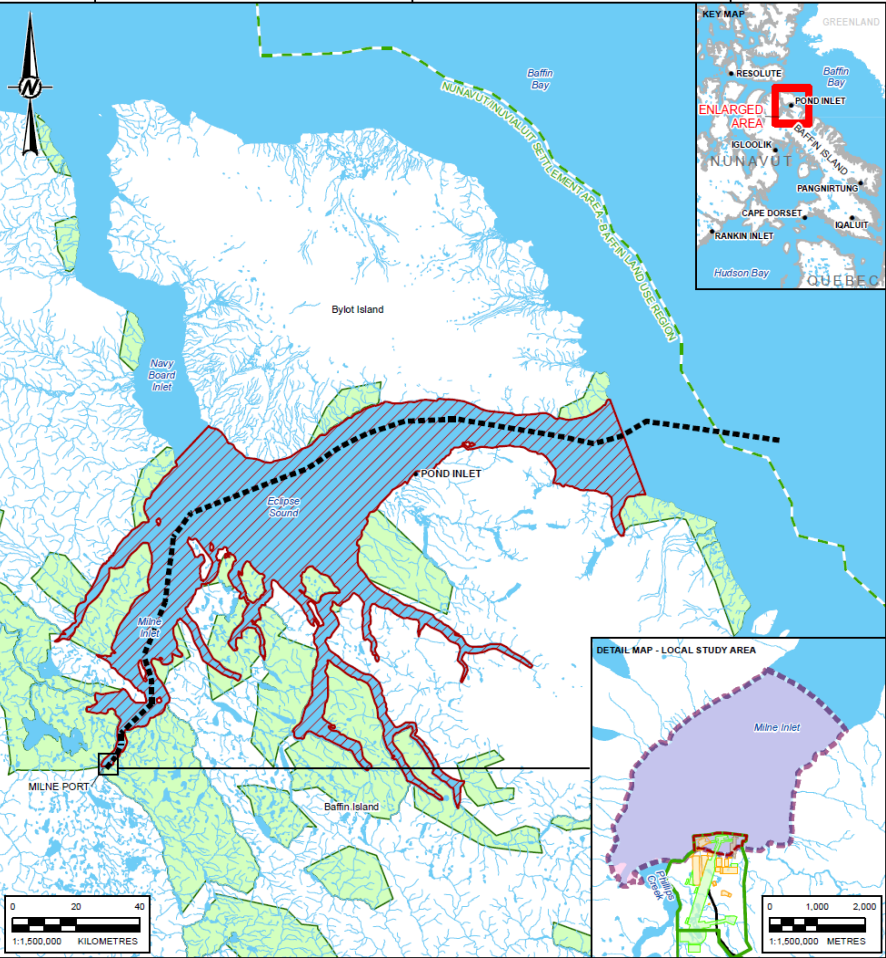


12.4 hours

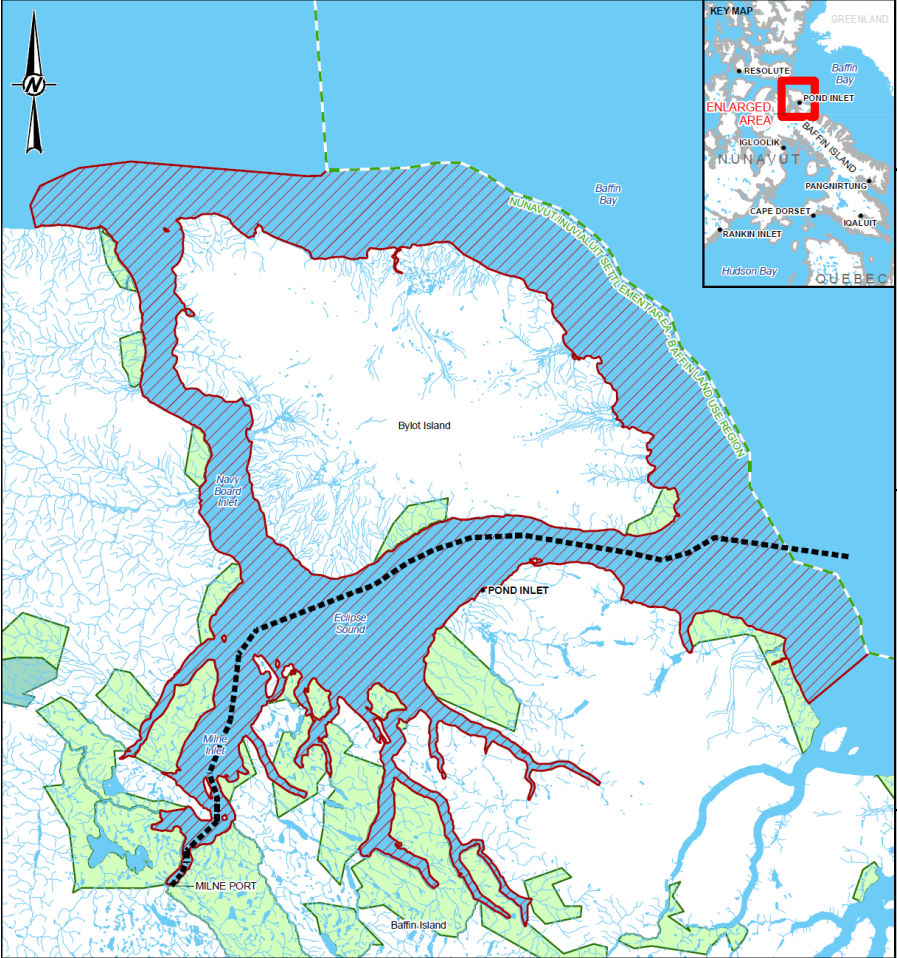


Assessment

Spatial Boundaries



Marine Environment



Marine Mammals

Valued Ecosystem Components

Phase 2 Assessment Marine Valued Ecosystem Components

Marine Water &
Sediment
Quality



Marine Fish
Habitat



Arctic Char
Health



Marine Birds



Marine
Mammals



Sea Ice



Valued Ecosystem Components

Phase 2 Assessment Marine Valued Ecosystem Components

Marine Water &
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Quality



Marine Fish
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Arctic Char
Health



Marine Birds



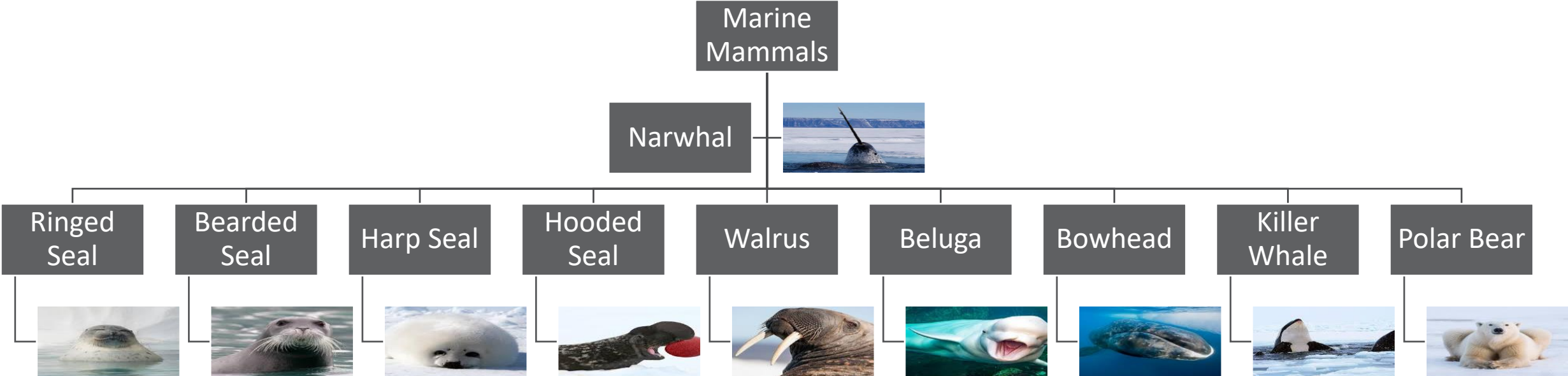
Marine
Mammals



Sea Ice



Valued Ecosystem Components – Marine Mammals



Valued Ecosystem Components- Narwhal

- Baffin Bay population ~142,000 individuals
- Eclipse Sound stock ~10,500 individuals
- Use Regional Study Area as a summering and calving area
- Migrate in June/July after staging at floe edge and begin outmigration to Baffin Bay in late September/early October
- Predators: Killer whales, polar bears



Valued Ecosystem Components – Arctic Narwhal Distribution



Valued Ecosystem Components - Ringed Seal

- Population in Canadian High Arctic at least a few million.
- Abundant in regional study area
- Non-migratory but move seasonally with sea ice.
 - Summer: move into offshore pack ice
 - Fall: return to coastal areas as new ice forms
- Pups born in snow dens created by rough sea ice in March-April
- Not harvested commercially but can be taken year-round for subsistence



Phase 2 Considerations



Milne Port

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Structure Modifications

- **Construction**
- **Wastewater and site water discharge**
- **Dust deposition, dispersion**

- **Habitat Loss and Alteration**
- **Changes in Sediment and Water Quality**



Milne Port

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Increased Port Activity

- **Wastewater and site water discharge**
- **Dust deposition, dispersion**
- **Ballast water discharge**

- **Habitat Loss and Alteration**
- **Changes in Sediment and Water Quality**
- **Introduce Invasive Species**
- **Change to Temperature and Salinity**



Shipping

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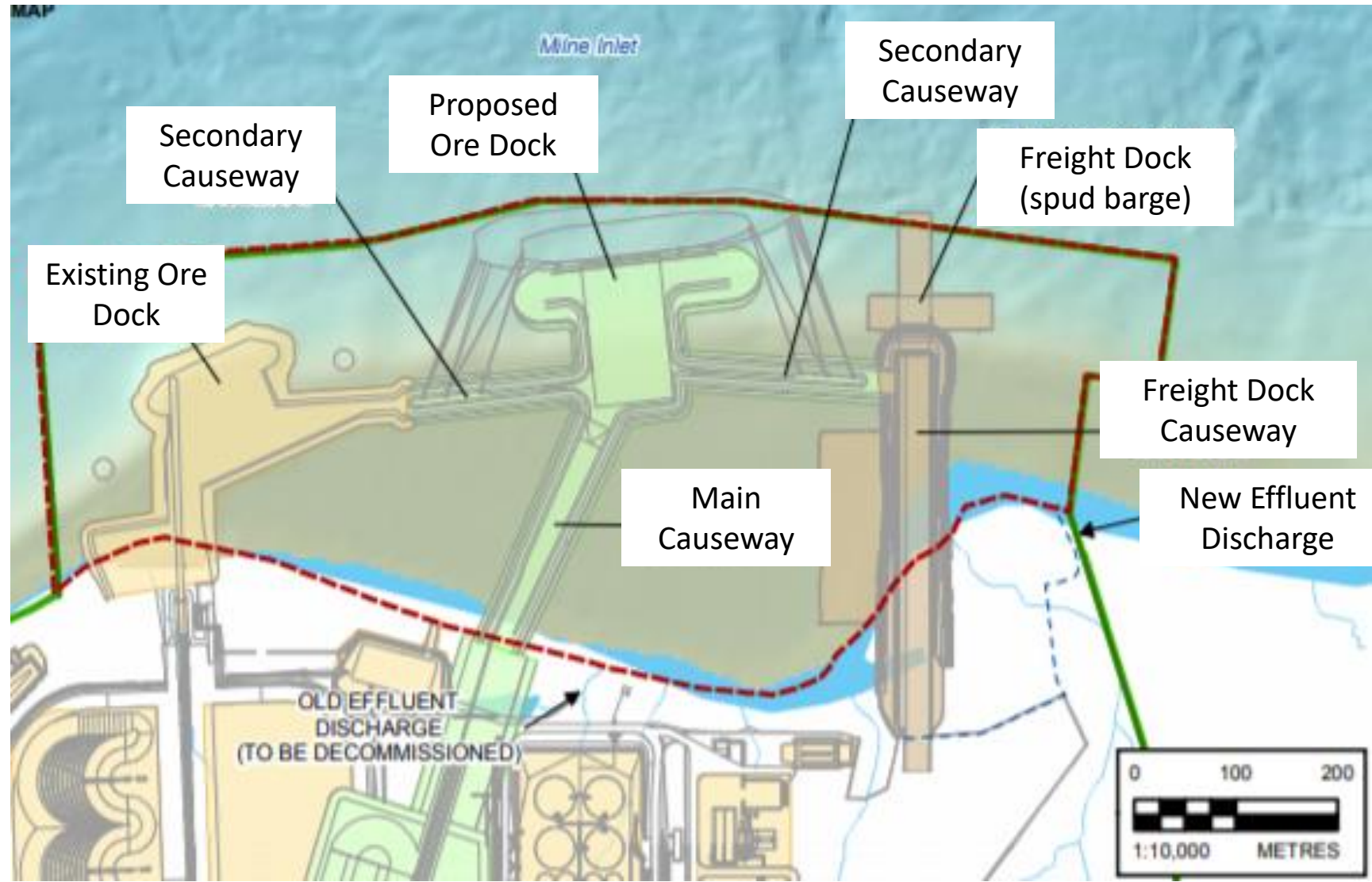
- Ship Wake, Propeller Wash
- Increased Vessel Traffic
- Icebreaking

- **Sediment Resuspension**
- **Habitat Erosion**
- **Vessel Strikes**
- **Acoustic Effects**
- **Entrapment**



Milne Port

Construction & Operation





Construction
Wastewater and site water
discharge
Dust deposition, dispersion

- **Habitat Loss and Alteration**
- **Changes in Sediment and Water Quality**



- **Wastewater and site water discharge**
- **Dust deposition, dispersion**
- **Ballast water discharge**

- **Habitat Loss and Alteration**
- **Changes in Sediment and Water Quality**
- **Introduce Invasive Species**
- **Change to Temperature and Salinity**

Pathways of Effect



- 28

Port Operation – Ballast Water Modelling

- **2017/2018 (TSD18)**
 - Co-developed advanced model with Danish Hydrographic Institute (DHI) Water & Environment
 - Calibrated to 2014 data
 - 3-month simulation
 - Modelled Existing and Proposed condition
- **2019 Updated Modelling**
 - Included 2018 Milne Inlet oceanographic and ballast water data
 - Validated with new oceanographic data
 - Evaluated sensitivity to temperature and salinity of ballast water
 - Assessed potential temperature and salinity changes in ambient water



Port Operation – Ballast Water Modelling Results

Effects of ballast water discharge on water quality predicted to be not significant

Rain Drop;
1 milliliter or $1 \times 10^{-6} \text{ m}^3$



Bathtub;
340 litres or 0.34 m^3



Coffee Mug;
0.2 litres or 0.0002 m^3



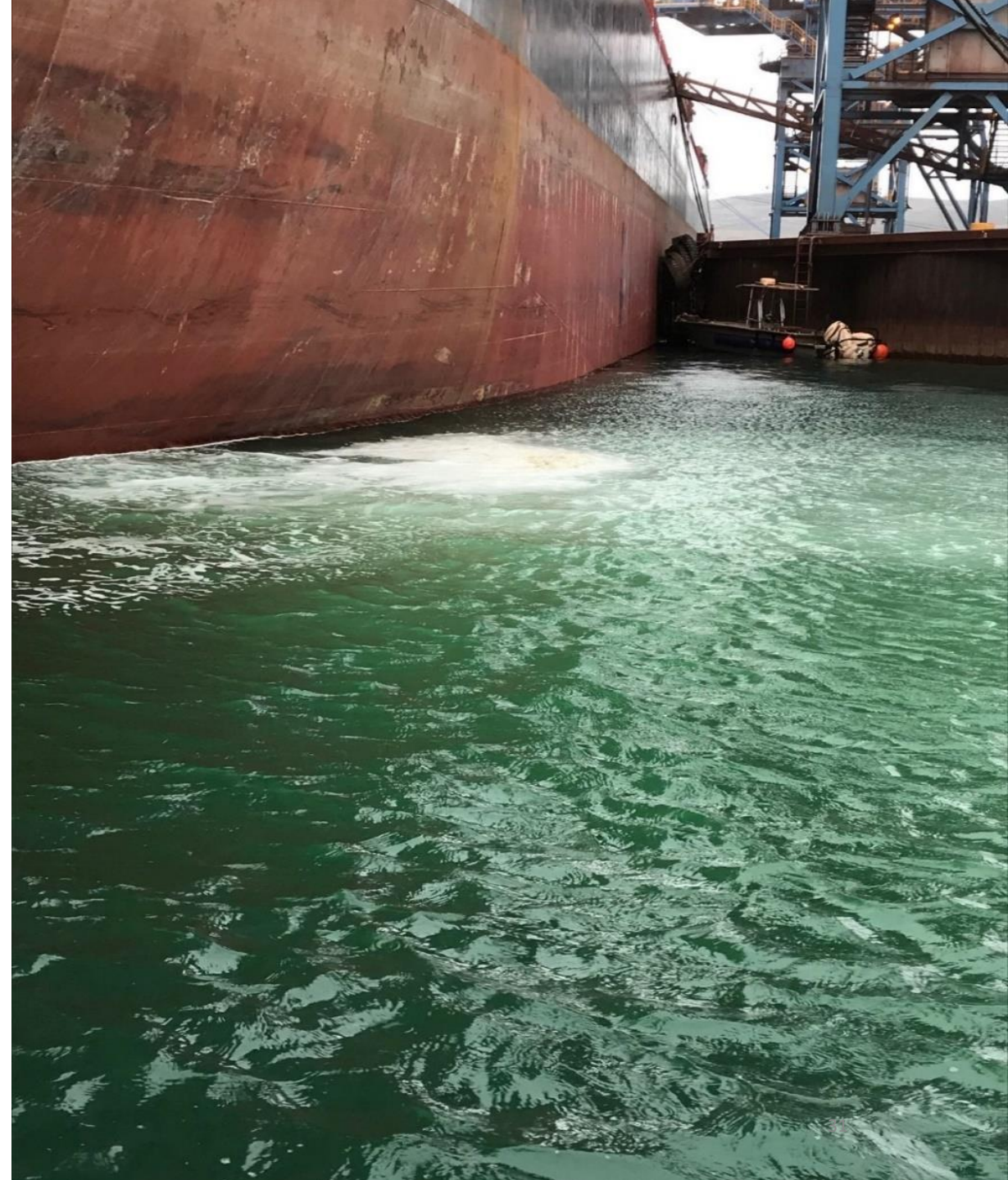
Modelled Ballast Water
Over a Shipping Season:
 $0.00002 \times 10^{11} \text{ m}^3$

Modelled Water Volume Milne Inlet
(Ragged Island south to Milne Port):
 $5 \times 10^{11} \text{ m}^3$

Modelled Freshwater Inputs
Over a Shipping Season:
 $0.003 \times 10^{11} \text{ m}^3$

Port Operation – Ballast Water Management

- Precedent-setting in Canada & Arctic
- Protocol exceeds regulatory requirements (International Maritime Organization & Transport Canada)
- Ballast water compliance testing (salinity and temperature) by Baffinland to verify exchange
- Commitment to pilot biological monitoring of ballast water program (2020) based on DFO protocol



Port Operation – Biophysical Monitoring for Ballast Water & Invasive Species

- Monitoring inside, outside, and on vessels hulls

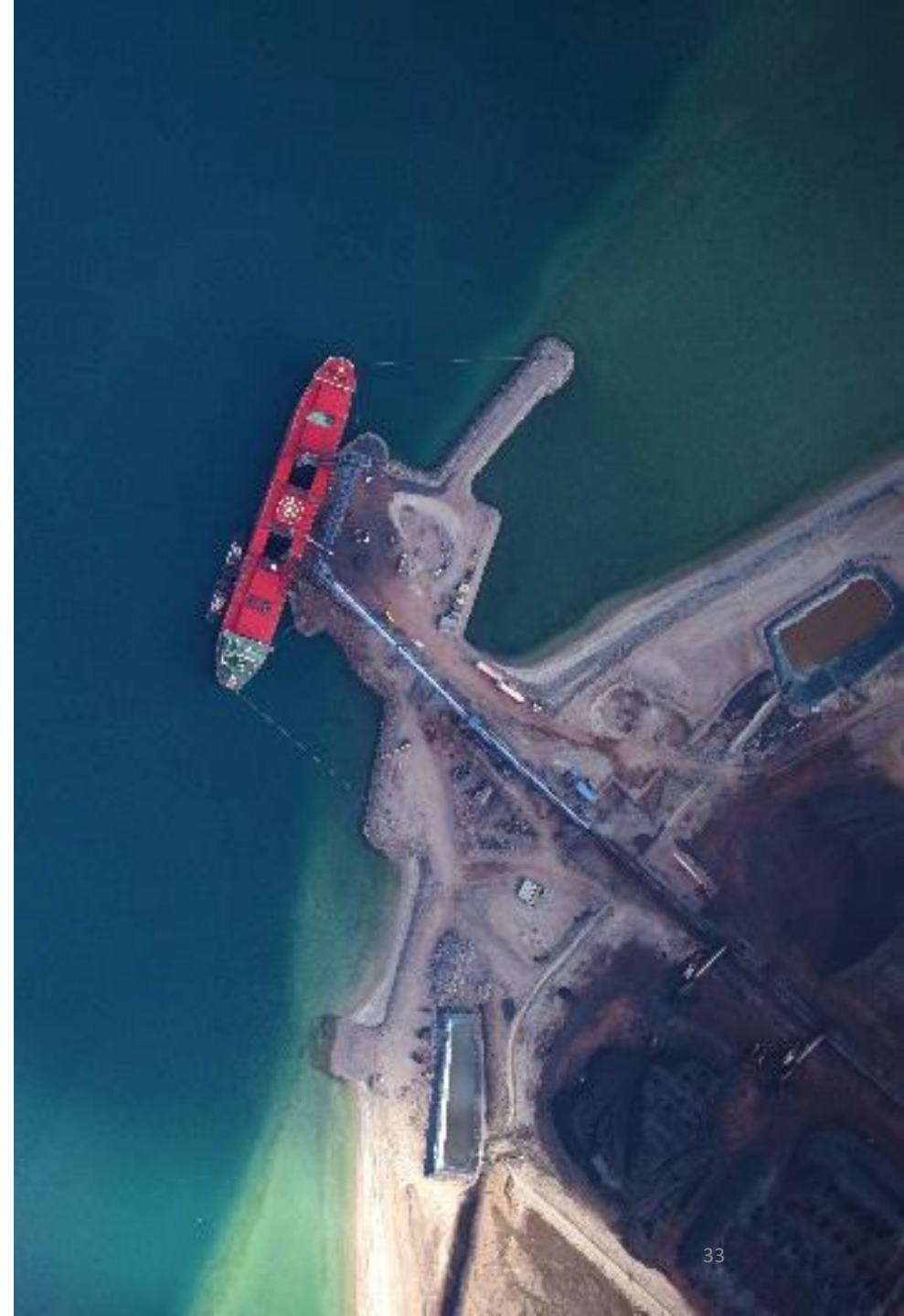
Monitoring in Receiving Environment:

- Vertical profiling of currents, temperature, and salinity
- Multi-trophic Aquatic Invasive Species Monitoring in Milne Inlet
 - No invasive species identified in local study area to date



Port Operation – Ore Dust Modelling

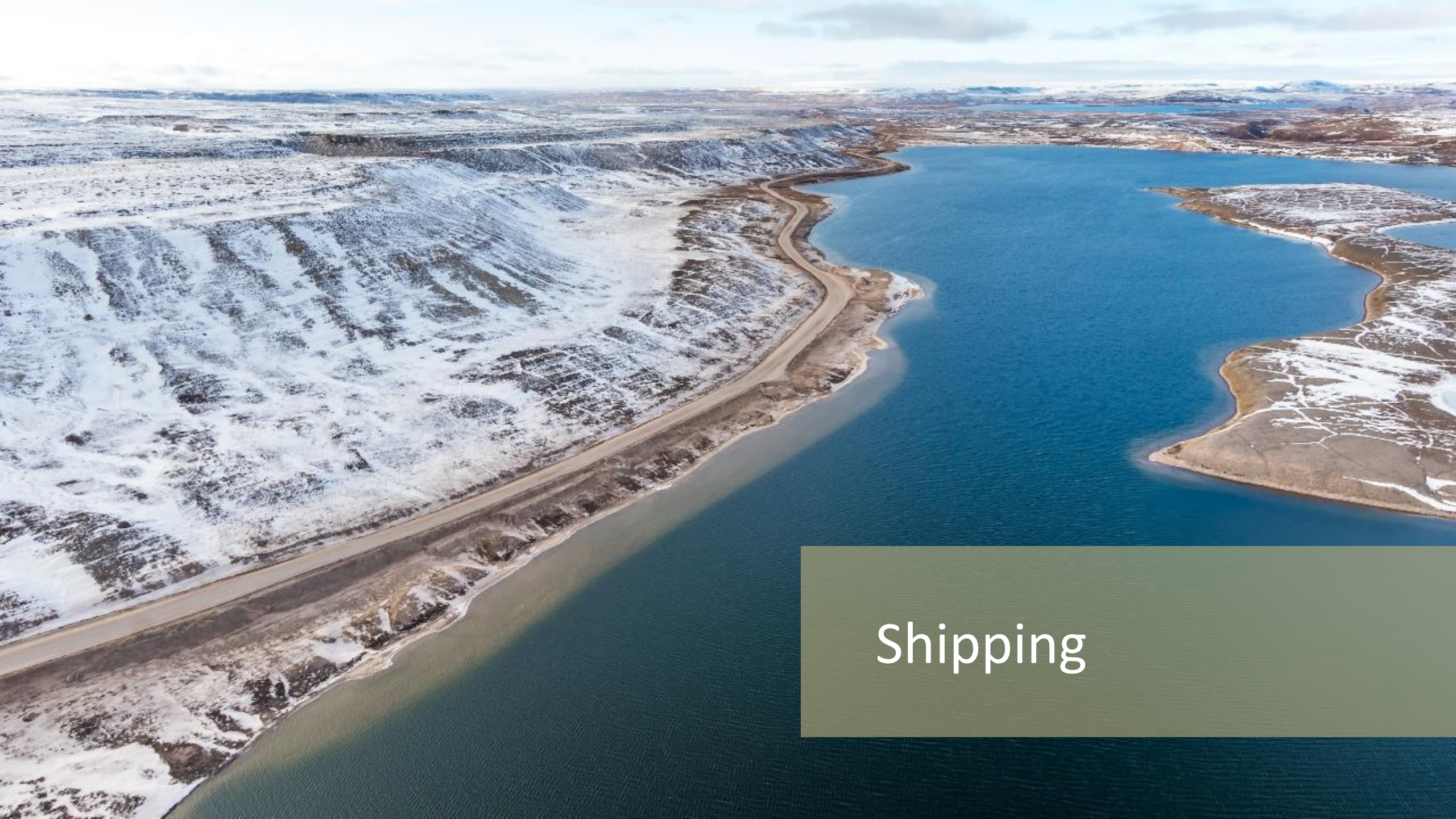
- Air quality and effluent loading models assessed direct (via air transport from stockpiles) and indirect (via site run-off) deposition into marine environment
- Minor increases in Total Suspended Sediment, deposition, and metals predicted in localized areas – assessed as not significant
 - Naturally high concentrations of iron
 - Natural dispersal via tidal flux
- No predicted changes Arctic char health via ore dust deposition



Port Operation – Ore Dust Monitoring & Management

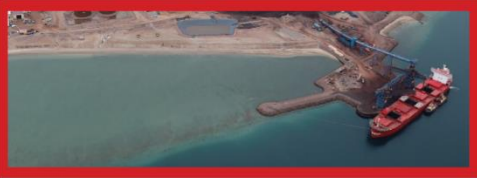
- Sediment sampling (radial gradient design):
 - No significant changes observed in iron levels in marine sediment (2015-2018)
 - Starting in 2019, additional stations and new transect added based on input from regulators
- Fish tissue analysis (3 species)
 - Metal concentrations consistent 2010-2018, generally below detection limits



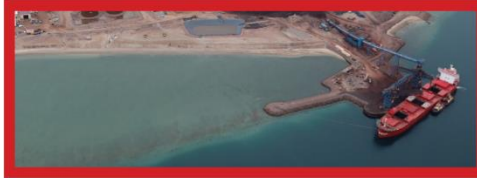


Shipping

Pathways of Effects



Milne Port
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Milne Port

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Shipping

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- Ship Wake, Propeller Wash
- Increased Vessel Traffic
- Icebreaking

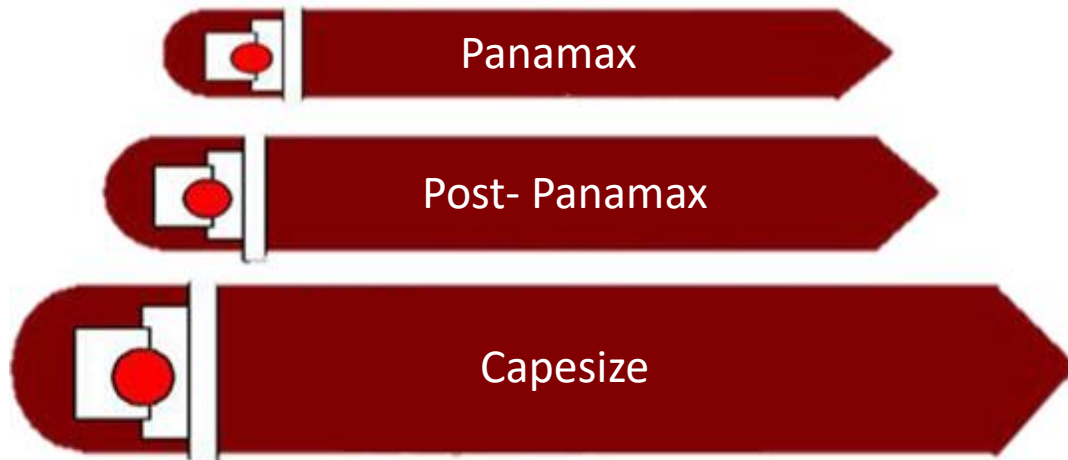
- **Sediment Resuspension**
- **Habitat Erosion**
- **Vessel Strikes**
- **Acoustic Effects**
- **Entrapment**

Outline

- Context
- Activity Overview
- Key Inuit Knowledge & Assessment Findings
- Effects
- Mitigation
- Conclusion



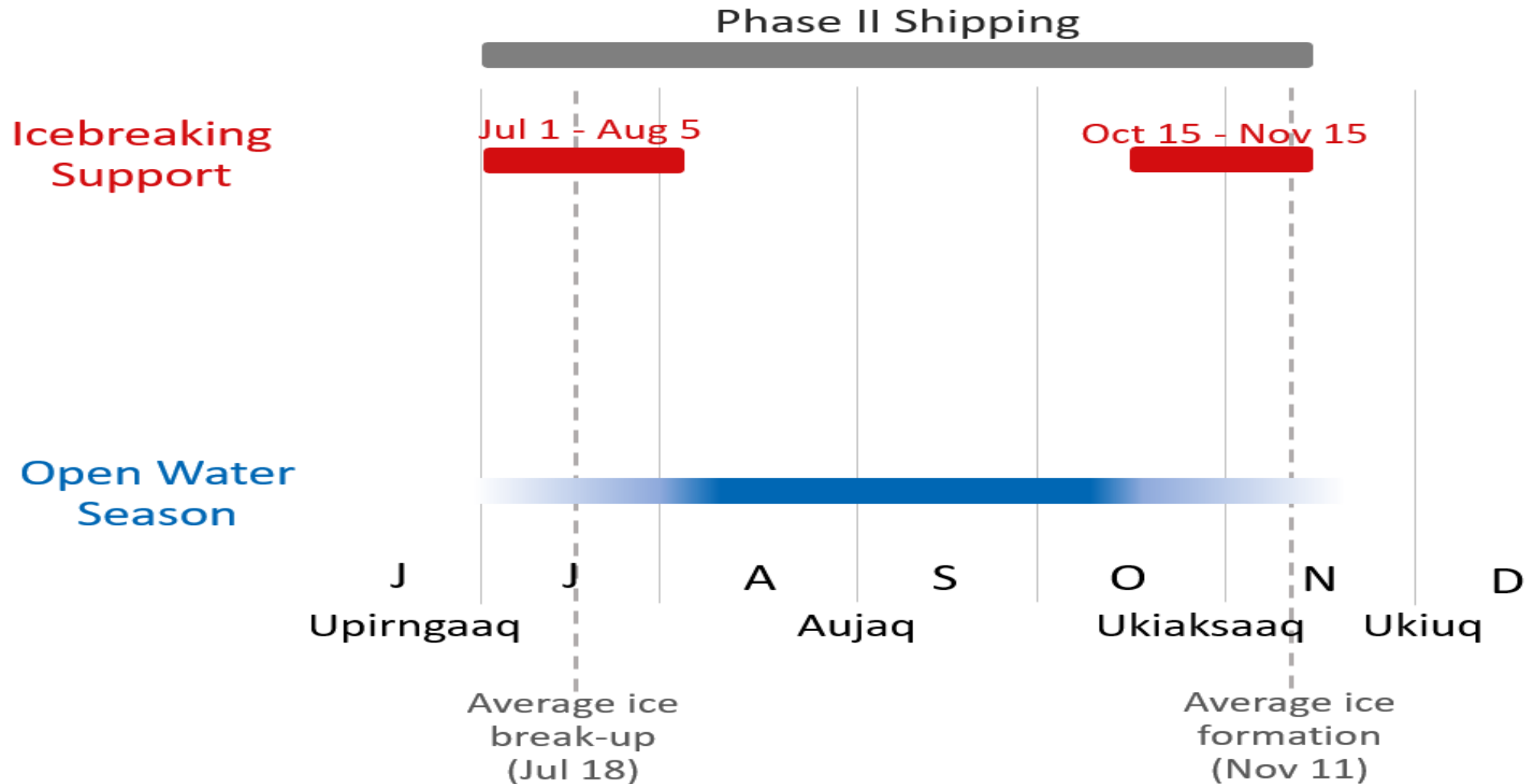
Vessel Size



Similar size to Crystal Serenity cruise ship

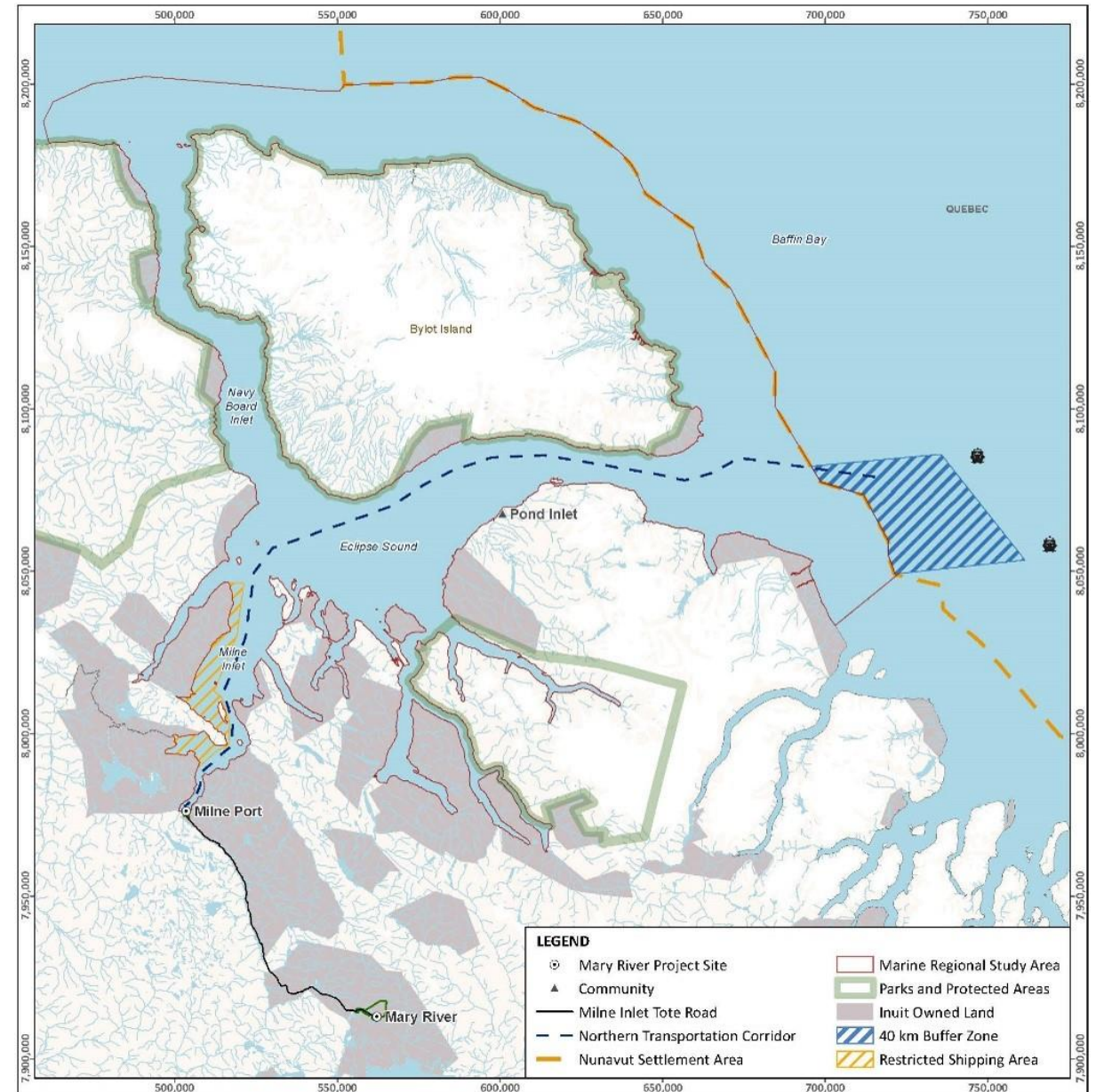


Shipping Activity Overview – Shipping Season



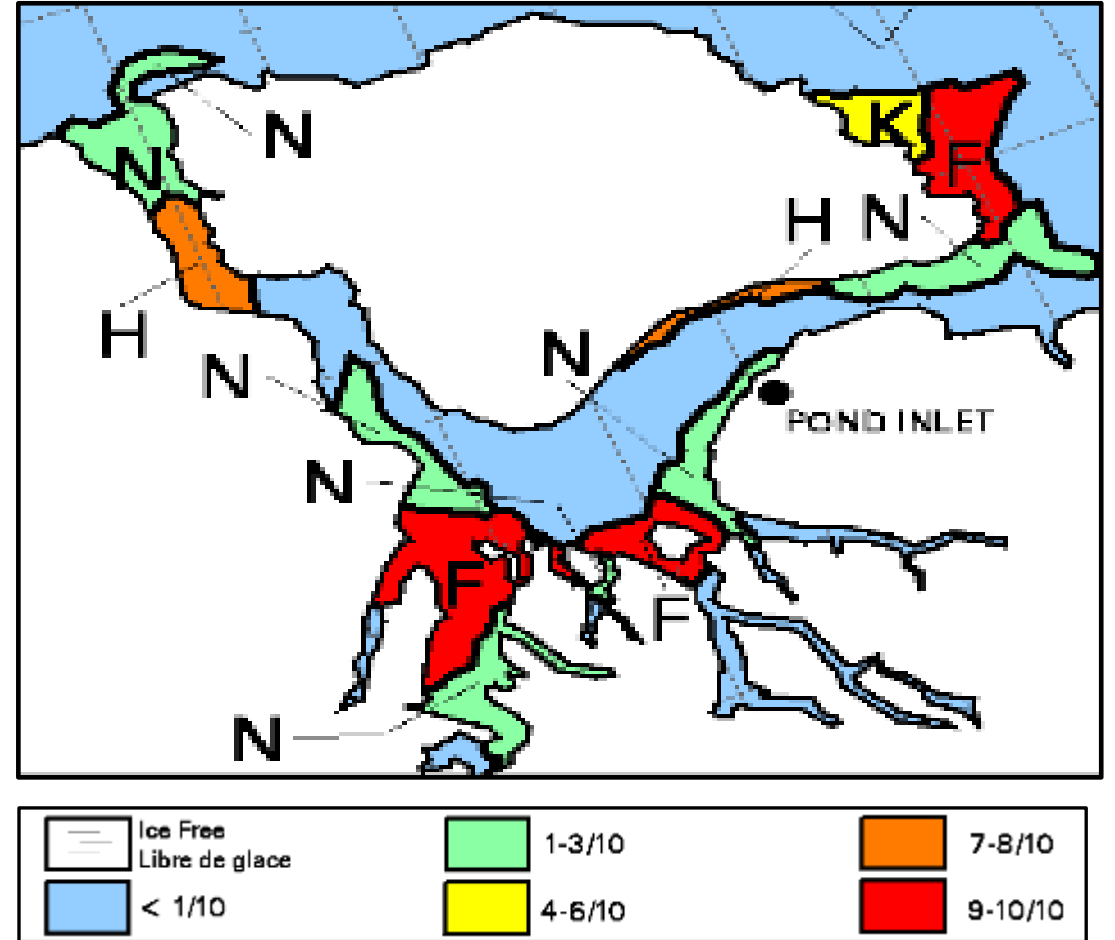
Shipping Activity Overview – Route

- Modified based on input from Pond Inlet
- Route & speed restrictions monitored by Baffinland using satellite technology
- Notifications triggered when vessels:
 - Deviate off route
 - Enter no-go zones
 - Speeds exceed voluntary 9 knots
 - Drifting in Eclipse Sound



Shipping Activity Overview

- Timelapse of Botnica transit July 19, 2019



Shipping Activity Overview - # of Vessels

Vessel (Phase 2)	July	August	September	October	Total
Ore Carriers	22	62	60	32	176
Other Project	12	6	6	8	32
Total	34	68	66	40	208
Daily Avg/Mth	2.3	2.2	2.2	1.3	1.7

Shipping Activity Overview – Vessel Speeds

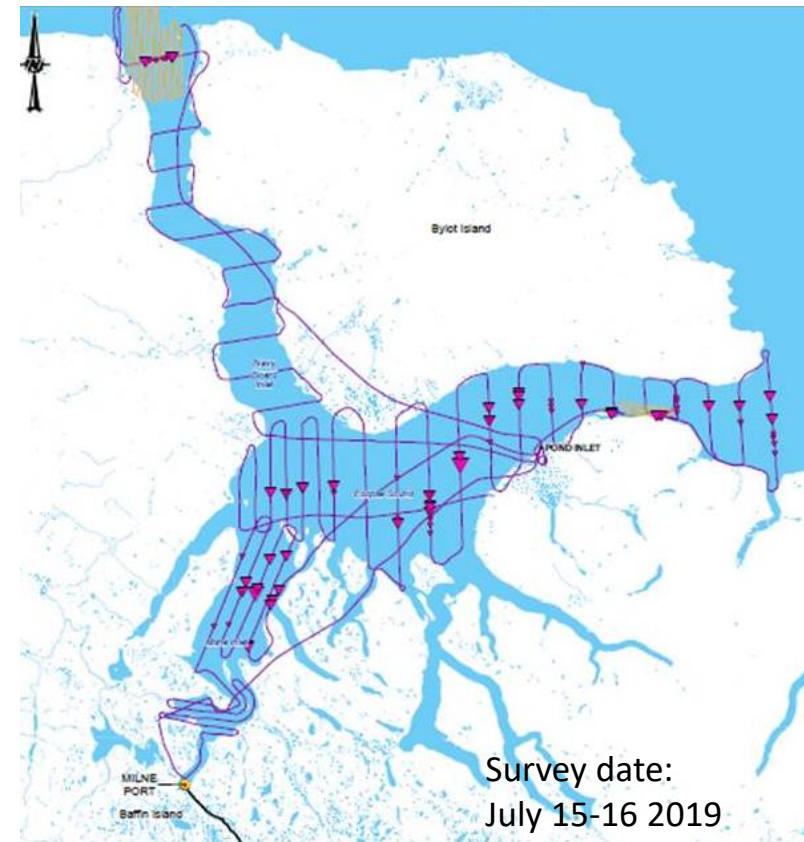
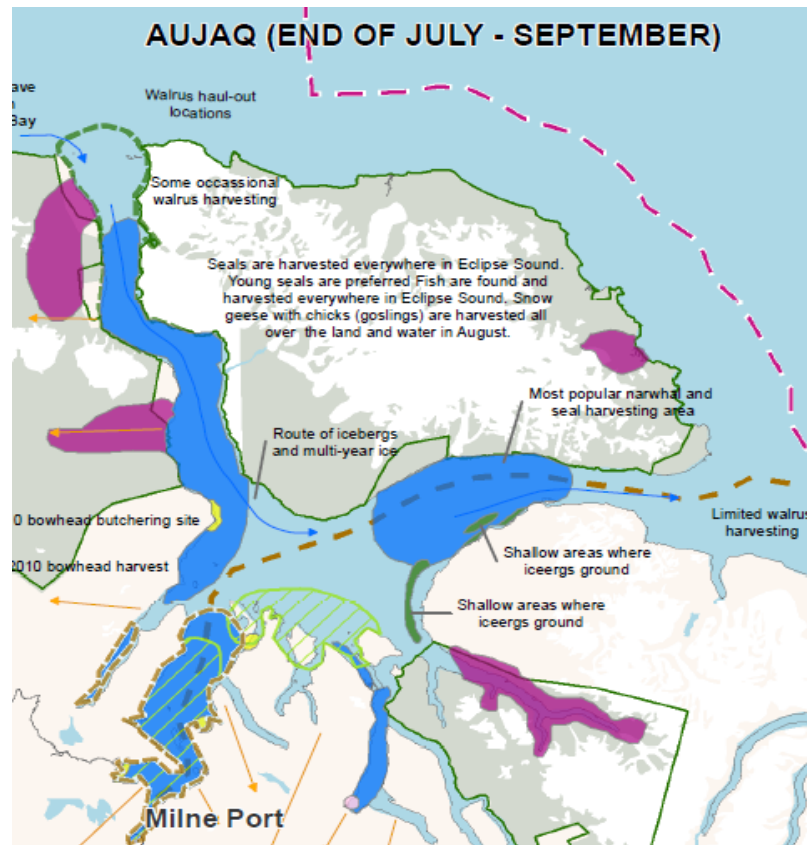
- 9 knot restriction for all Project vessels in regional study area

Vessel Type	% time under 9 knots (2019 data)
Project Ore Carriers	99
Project Icebreaker	99
Cruise Ships	32
Coast Guard Icebreakers	35



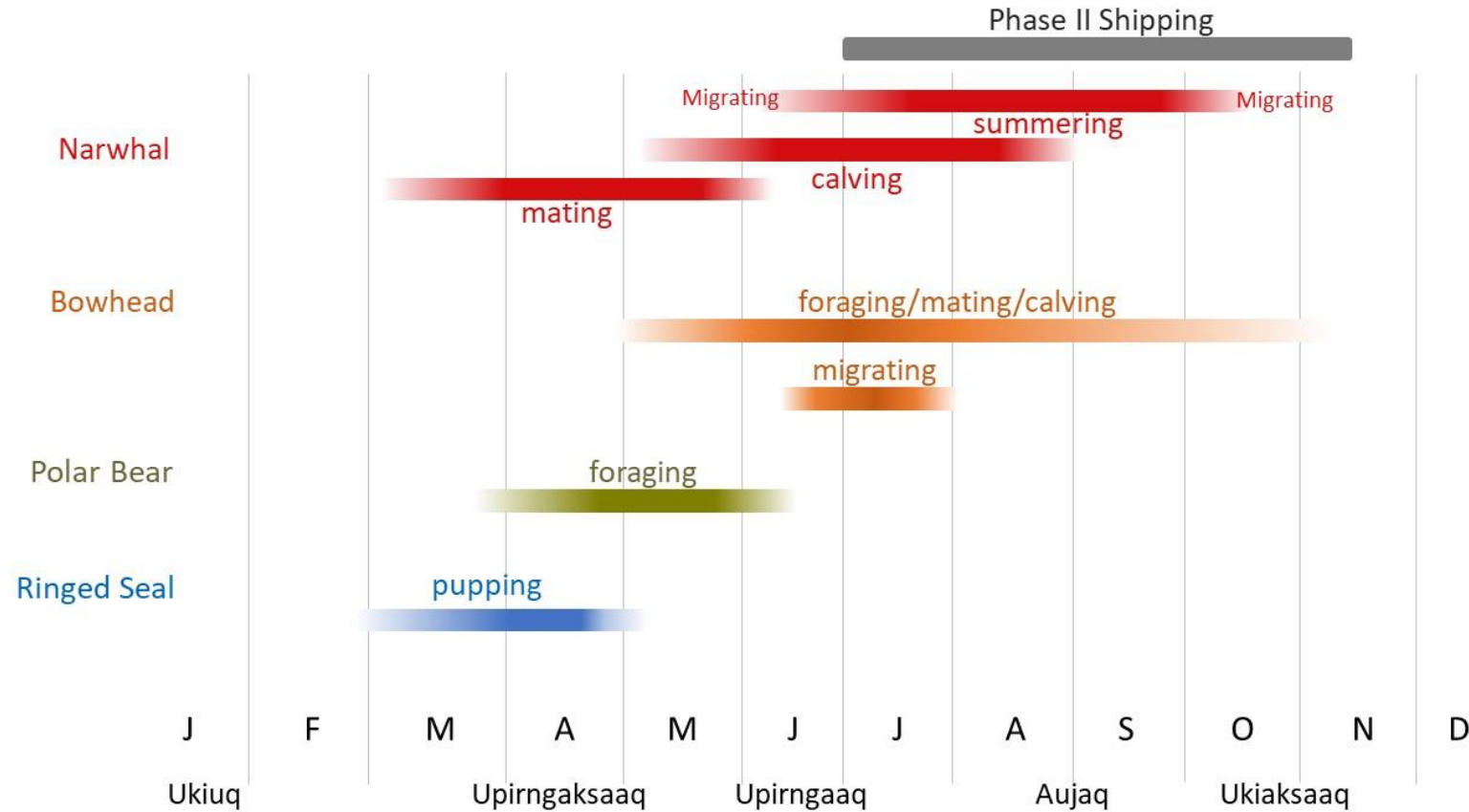
Shipping – Key Inuit Knowledge & Assessment Findings

- Inuit knowledge and science on narwhal distribution & abundance



Shipping – Key Inuit Knowledge & Assessment Findings

- Consistency between Inuit knowledge & science on seasonal mammal presence



Shipping – Key Inuit Knowledge & Assessment Findings

- Annual variability in narwhal abundance
- 2019 Bruce Head sightings comparable to previous years in light of increased shipping

Statistic	Bruce Head Shore Based Surveys (August)				
	2014	2015	2016	2017*	2019
Narwhal Sightings (total #)	10,463	14,599	28,309	11,862	14,690
Project Vessel Transits (#) for the season	0 (Baseline)	13	38	56	81

*shore-based surveys not run in 2018

Shipping – Key Inuit Knowledge & Assessment Findings

- 2019 Sightings - small white dots are narwhal

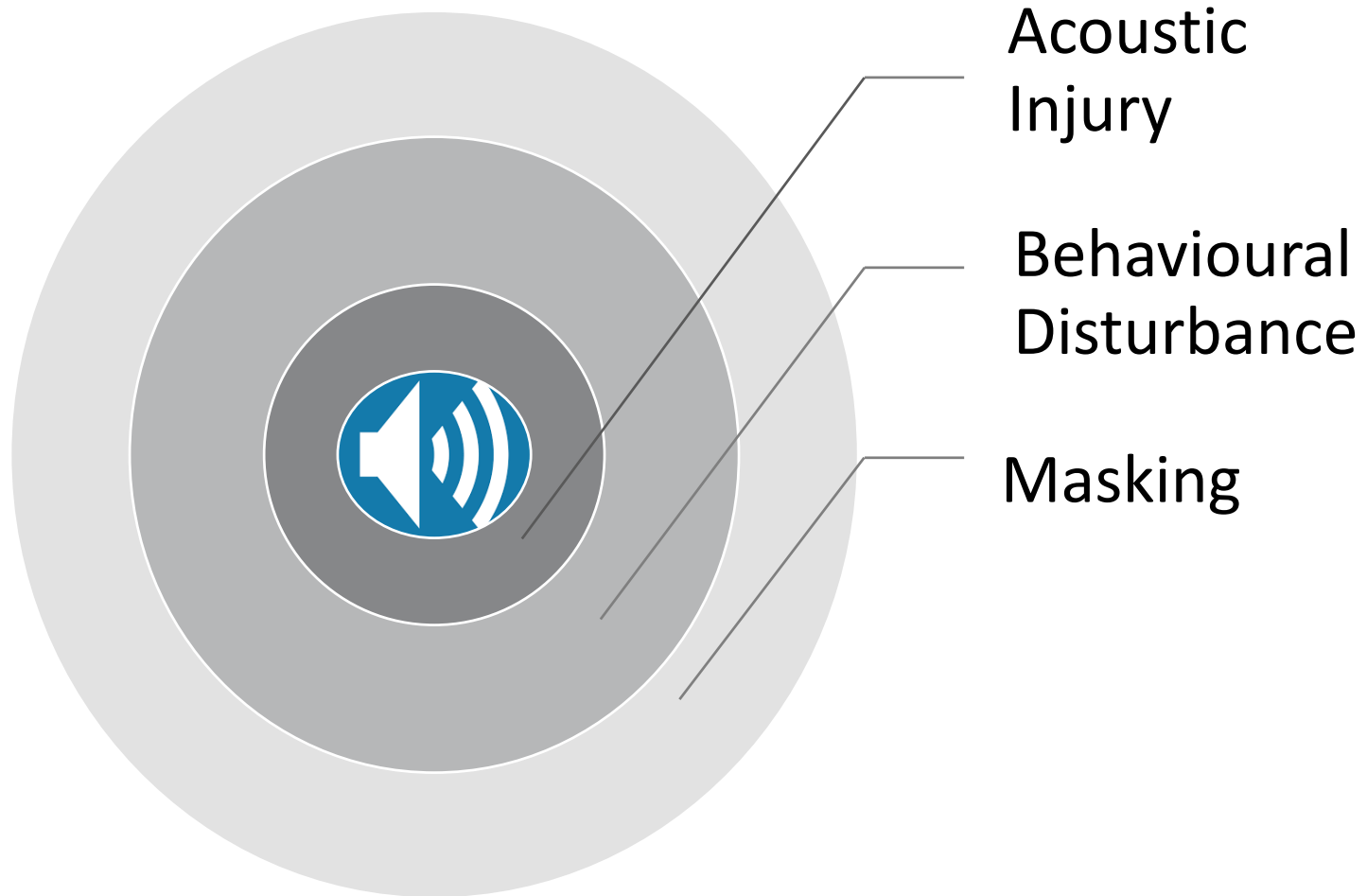


Shipping – 2019 Monitoring Summary

- 4 programs undertaken (aerial, shore, acoustics & vessel-based)
 - Collectively cover entire regional study area (including floe edge)
 - Notable Inuit participation in all 4 programs (including data analysis)
- Confirms large abundance of narwhal: similar to levels observed since 2014
- Underwater noise recordings in Eclipse show modeling to be very conservative (actual vessel-based sounds approximately 1/3 that of modelled sounds)
- Shows vessel-based mitigation working as predicted



Potential Acoustic Effects on Marine Mammals



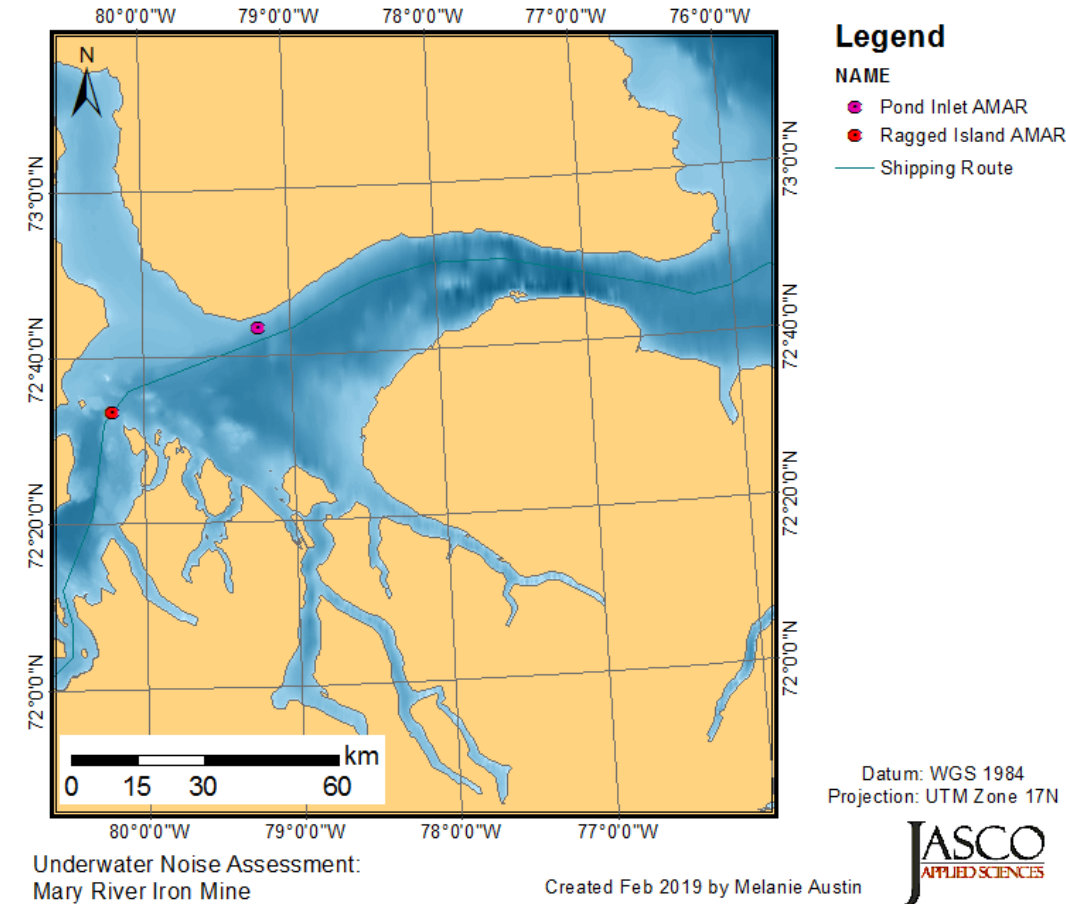
Shipping – No Acoustic Injury

- No potential for acoustic injury (temporary or permanent), based on both modelling and field data
- Tagging data shows narwhal stay 100s of metres away from vessels – outside of injury radius
- Mitigation measures effectively reduce spatial and temporal overlap with vessel noise
- Monitoring program to verify prediction that icebreaking noise will not exceed injury thresholds



Shipping – Behavioural Disturbance

- Multiple lines of evidence indicate narwhals will be disturbed by vessel-based sound
- Response is short-term, localised, and less dramatic than response to presence of killer whales
- In-field acoustic recordings (2019) show modelling results are conservative and over-representative of measured effects
- Average quiet time during icebreaking is 12-15 hours per day and during open water 12.5 hours per day based on model predictions

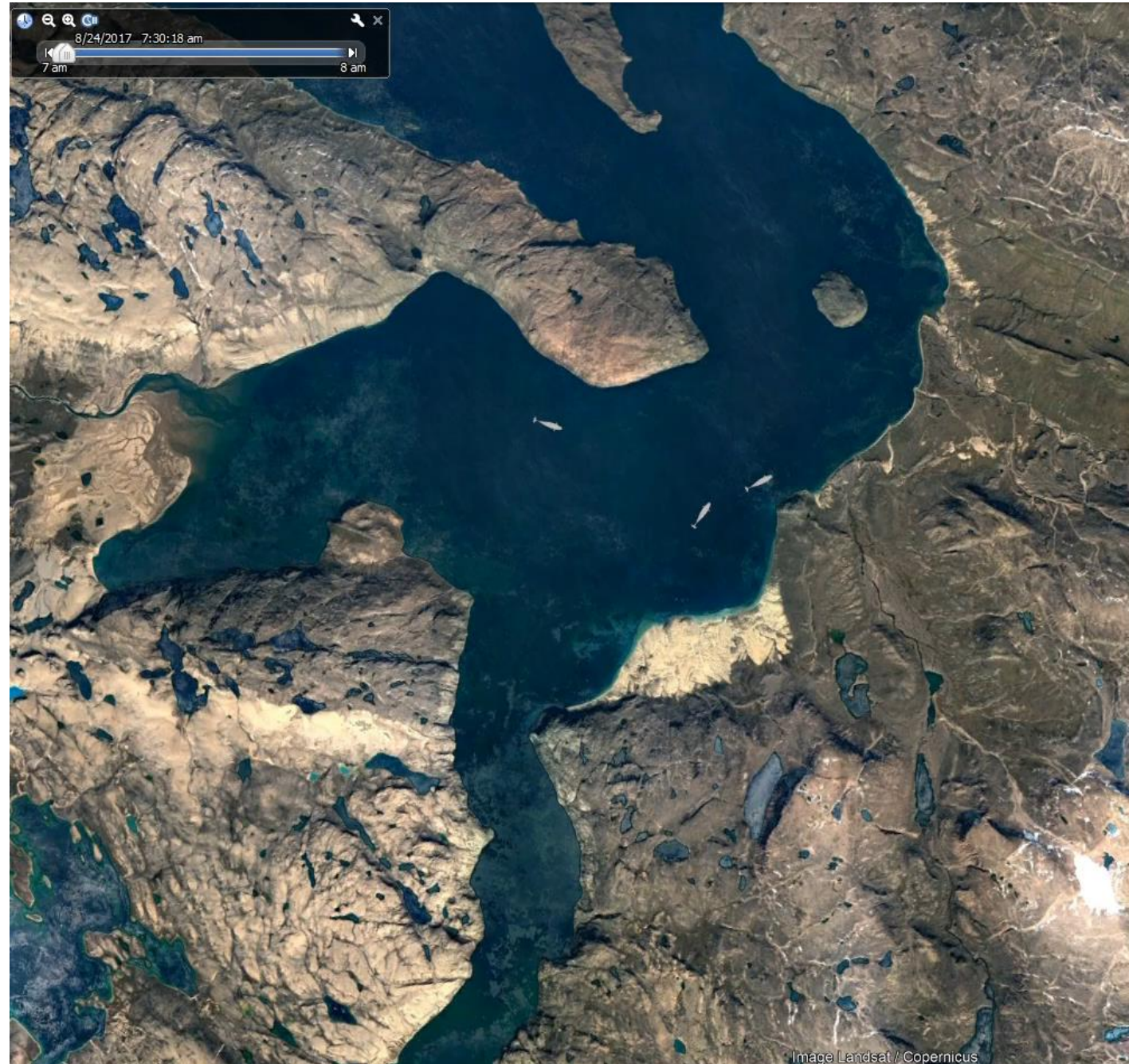


Shipping – Behavioural Disturbance (cont'd)

- Mitigation measures will reduce source levels (such as speed restrictions) and overlap (such as limiting # of transits in heavy ice)
- Residual effect characterised as not significant
- Follow-up monitoring to better understand or confirm effects of multi-year disturbance
- No evidence of large-scale or long-term abandonment of regional study area in response to shipping

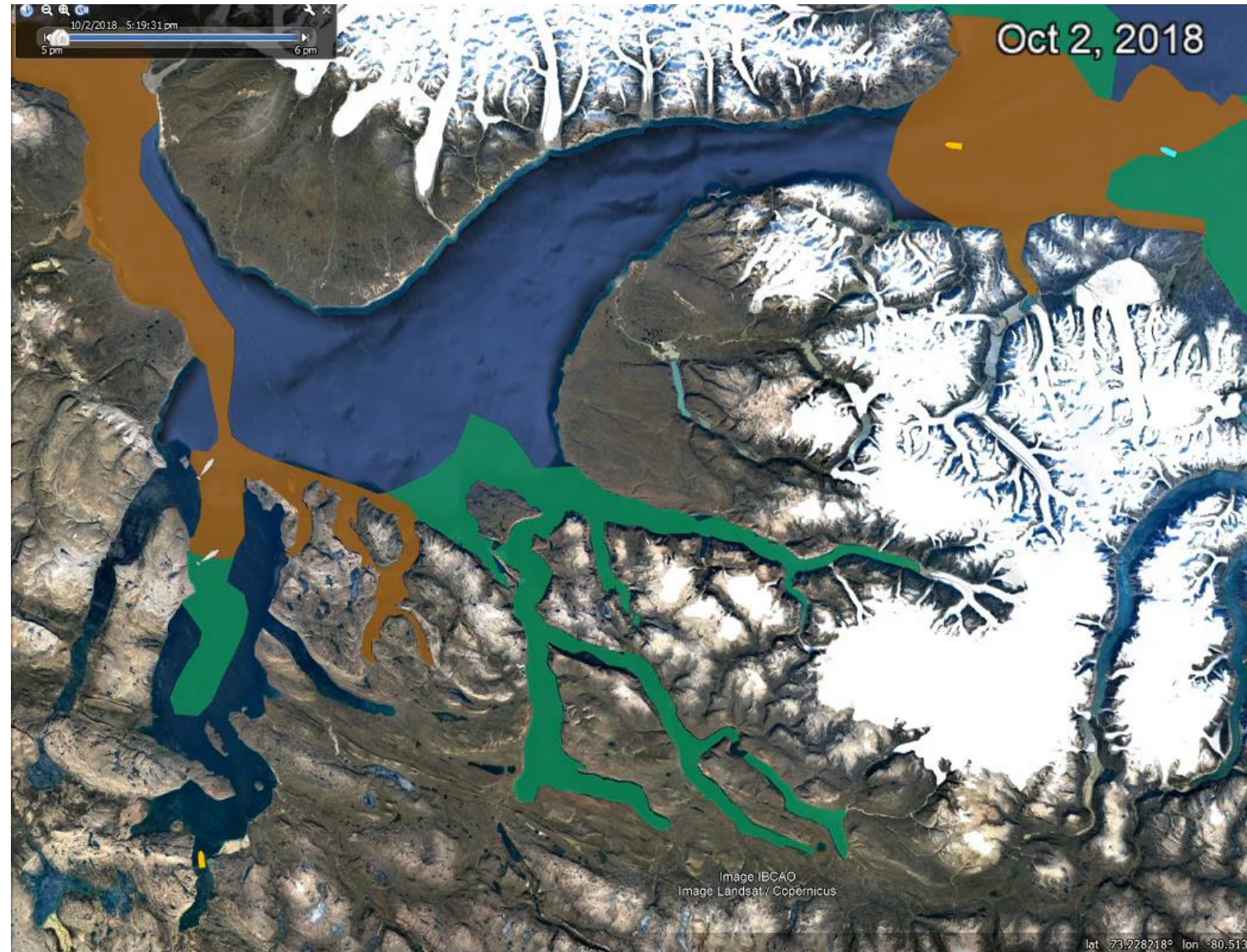
Shipping – Behavioural Disturbance

- Animation of tagged narwhal in relation to active shipping during open water season



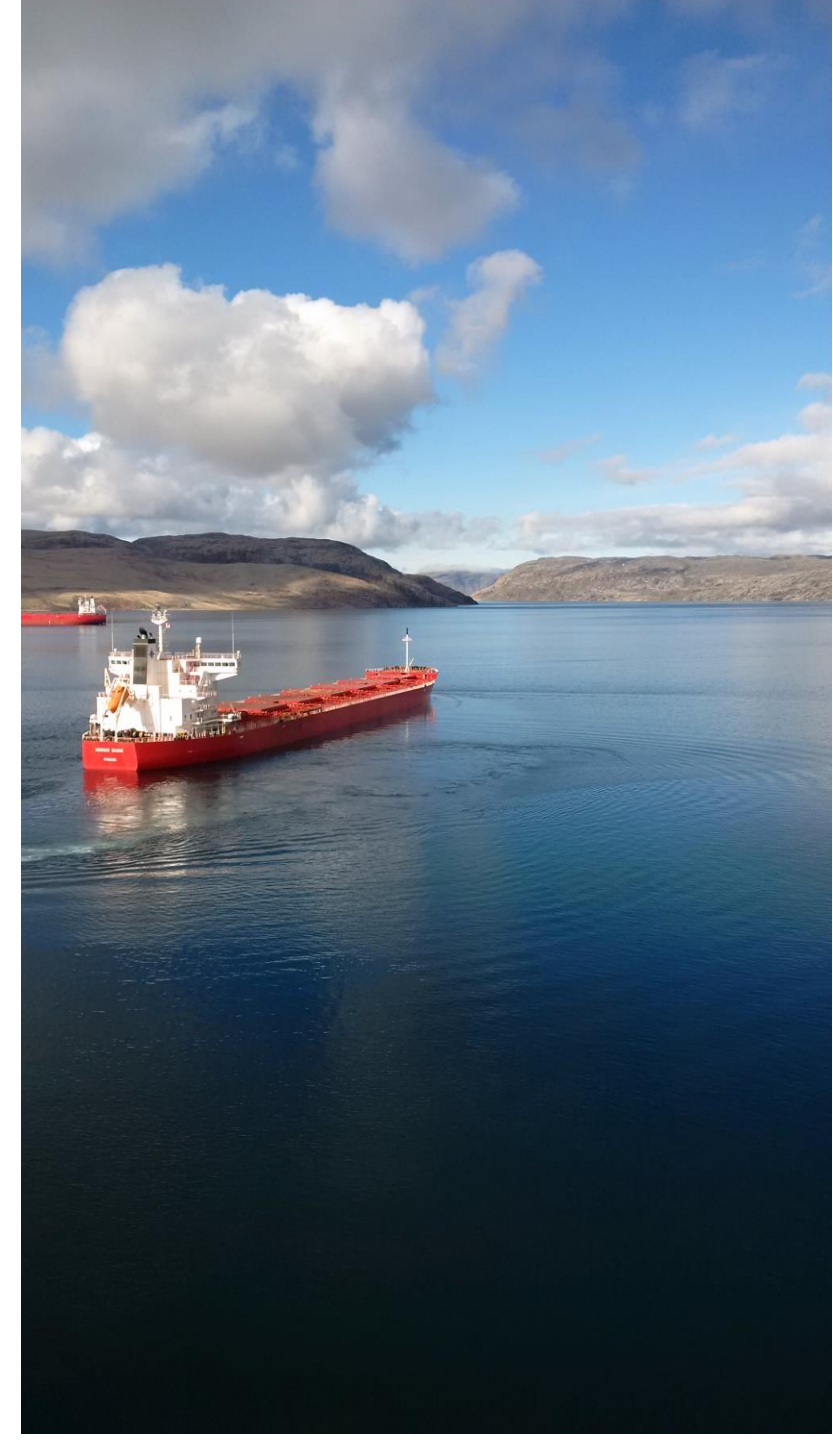
Shipping – Behavioural Disturbance

- Animation of tagged narwhal in relation to active shipping during icy conditions



Shipping – Temporary Acoustic Masking

- No established regulatory thresholds
- Masking predicted to be intermittent in frequency and temporary in nature
- Narwhal generally communicate at higher frequencies than vessel noise and may use natural anti-masking strategies
- Mitigation measures effectively reduce spatial and temporal overlap with vessel noise
- Baffinland partnered with University of New Brunswick to better understand effects of masking on narwhal



Shipping – No Ice Entrapment

- Ice entrapment naturally occurring phenomenon, documented in Arctic for hundreds of years
- No evidence to suggest Project shipping activities will cause ice entrapment
- Two entrapment events in regional study area in last decade, no shipping occurring at time of either
- Multiple lines of evidence show most narwhal have left (or are leaving) regional study area at time of ice freeze-up
- Baffinland has committed to a post-season narwhal clearance survey



Shipping – No Vessel Strikes

- With mitigation, no strikes anticipated
- 13 knots considered speed threshold above which mortality is likely (based on literature)
- 10 knot restrictions for endangered North Atlantic right whale (Gulf of St. Lawrence)
- 9 knot speed restriction in regional study area is more conservative, goes above and beyond existing precedent, and notably minimizes strike potential
- Compliance is diligently monitored – a notification system is in place that alerts Baffinland staff if a vessel exceeds the 9 knot speed limit.



Shipping - Monitoring

- Shore (Bruce Head)
- Ship (Icebreakers)
- Airplanes
- Satellite tagging (with DFO)
- Underwater noise recorders



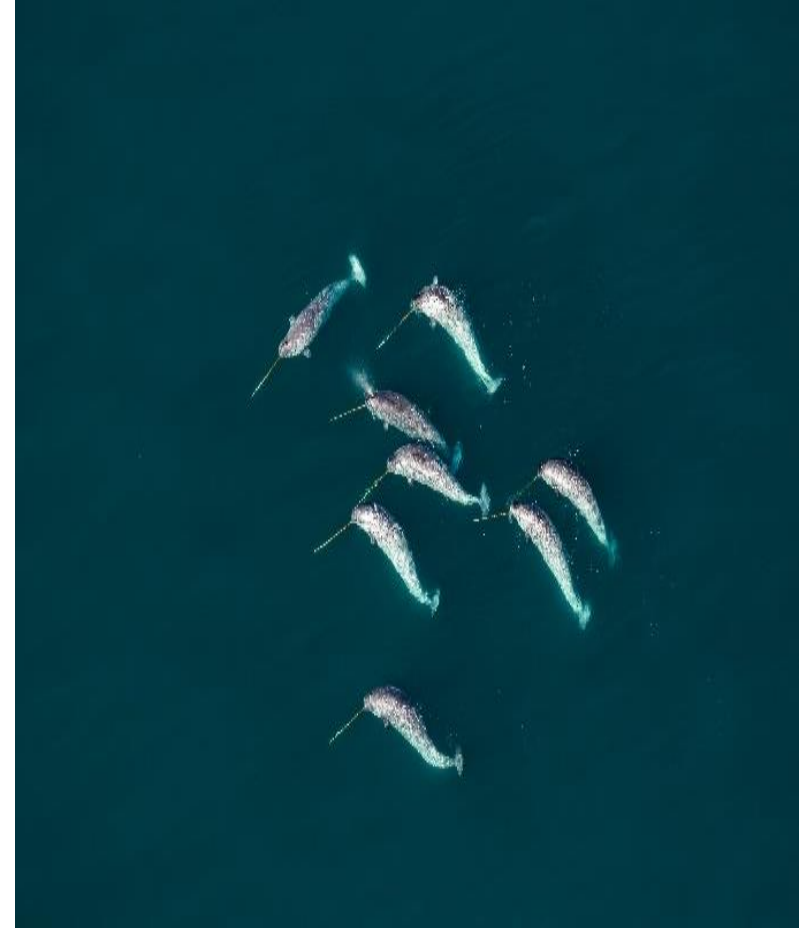
Monitoring: Inuit Involvement

- 71 days (710 hours) of training
- 590 days (~5900 hours) of employment
- A total of 18 Inuit (some worked on multiple programs) in 2019 vs 14 non-Inuit personnel
- Lead Inuit Researchers identified on monitoring programs
- Program-specific follow-up meetings in Pond Inlet with all Inuit researchers
- In-person meetings twice a year with MHTO
- Inuit monitors are involved in data analysis and reporting
- New shore-based shipping monitors stationed in Pond Inlet (Active Watch of Project Vessels)



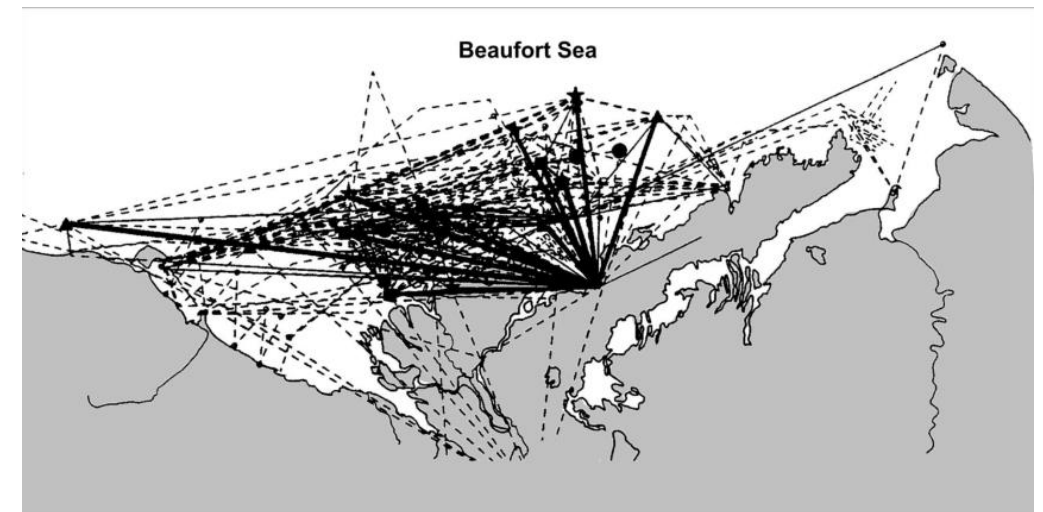
Shipping – Context of Residual Effects

- In the regional study area, narwhal population (Baffin Bay) & stock (Eclipse Sound) are large and stable (~140,000 & ~14,000 individuals, respectively)
- Narwhal distribution heavily influenced by ice conditions and presence of killer whales



Other Marine Mammal Populations & Shipping

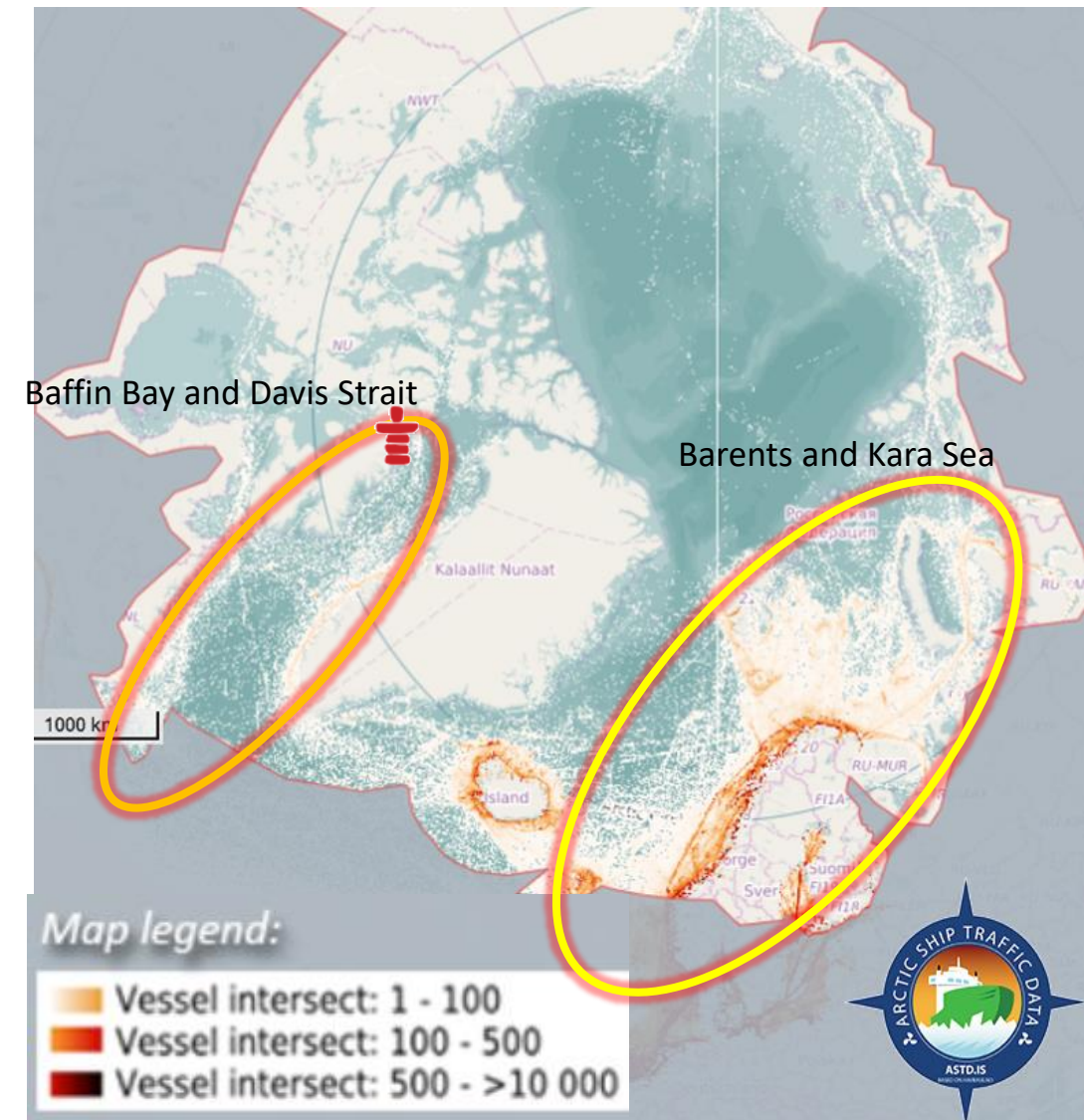
- Canadian Beaufort Sea
 - Beluga, bowheads and seals present
 - Extensive industrial activity which also create underwater noise
 - For example, from 1980-1985
 - 5 drilling vessels per year
 - 71 vessels including icebreakers
 - 8 dredges
 - 5 seismic vessels
 - 11 offshore helicopters
 - 200 vessel passages per week (Brouwer et al. 1988)
 - Mammal populations stable



Other Marine Mammal Populations & Shipping

- Barents and Kara Sea (Russia & Scandinavia)
 - Heavy shipping traffic - much more than in Baffin Bay/Davis Strait
 - No negative impacts on animals from shipping activities
 - No reports of significant impacts due to vessel strikes
 - Mitigation in place to reduce impacts

(Arctic Marine Shipping Assessment 2009 Report)



Cumulative Effects

- None identified for dock construction
- Cumulative effects identified between Project and non-project shipping
 - 206 Project calls and 19-76 non-project calls
- Analysis indicates:
 - Adds up to 2 hours per day of potential disturbance (from 9 to 11 hours)
 - Spatial extent of noise field will slightly increase when ships cross
- No significant cumulative effects predicted
- Proposed follow-up monitoring will verify effect predictions

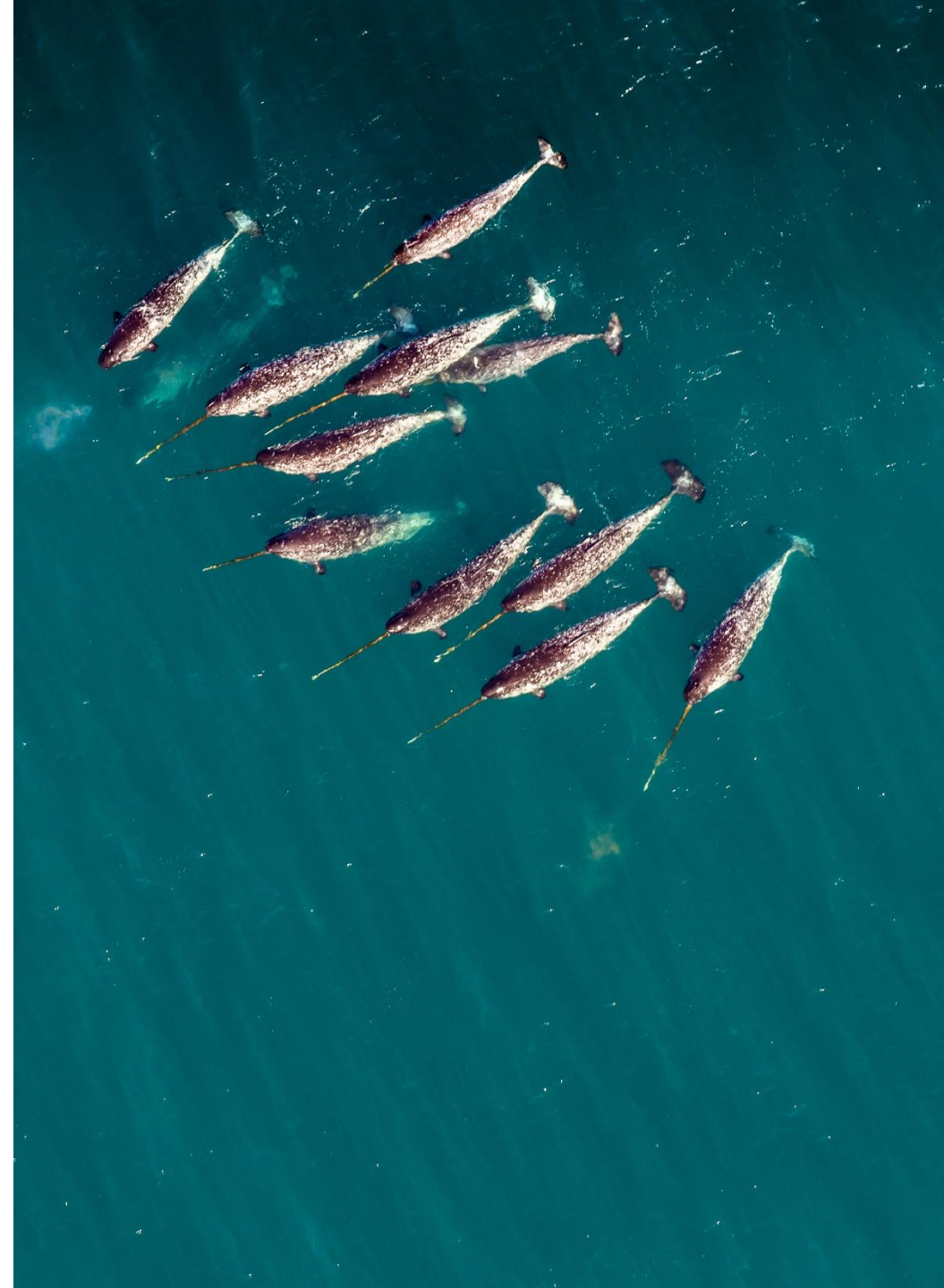
Addressing Uncertainty

- Incorporating Inuit knowledge
- Extensive multi-year baseline and monitoring data
- Robust modelling to inform predictions
- Use of conservative assumptions
- Use of precedent setting mitigation measures
- Peer reviews
- Integrating learnings as operations proceed
- Adaptive follow-up monitoring programs to verify effect predictions



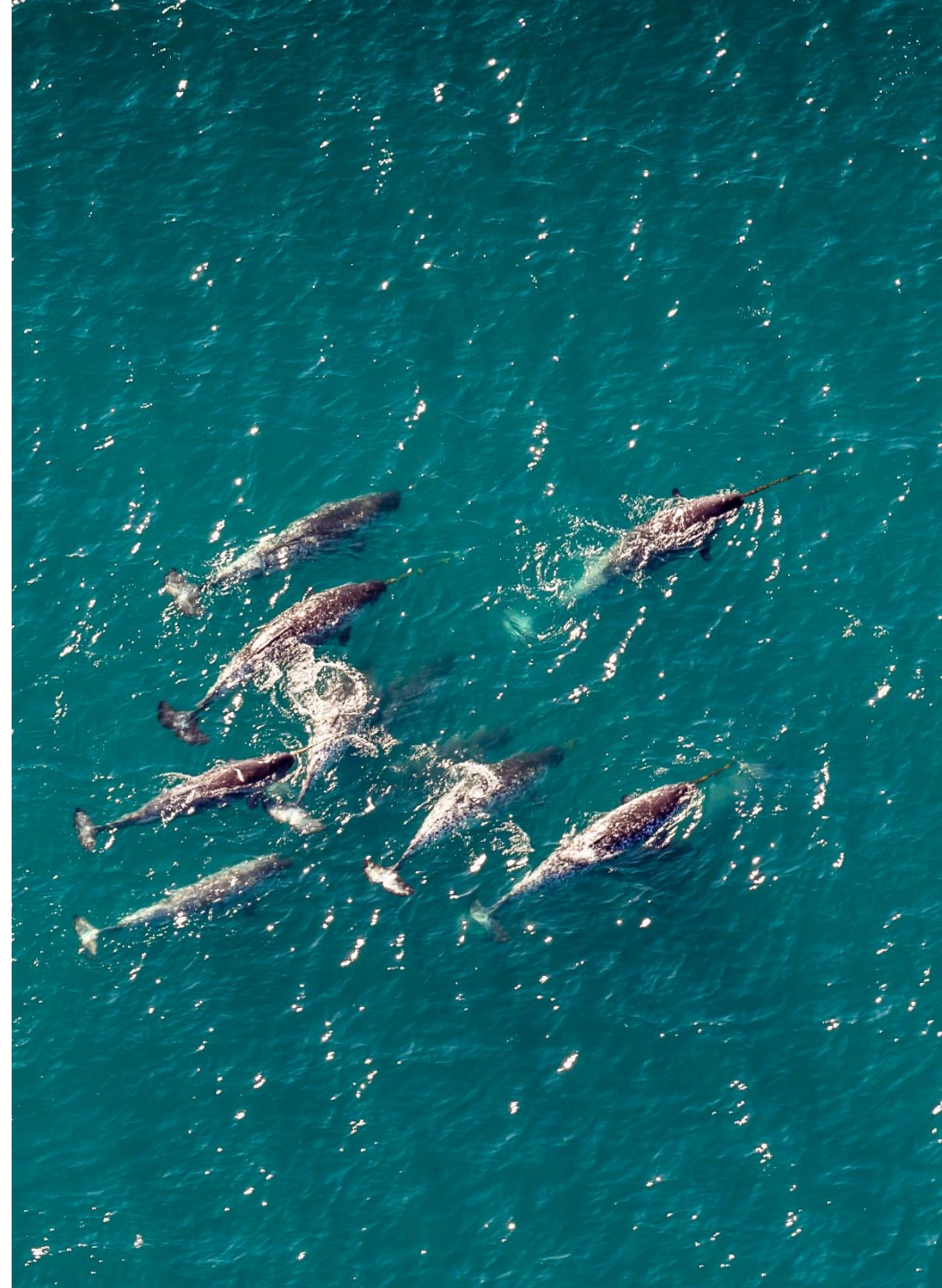
Shipping - Conclusions

- Assessment is conservative
 - Model predictions up to 3x louder than actual noise
- Narwhal continue to use regional study area in 2019 in numbers consistent with past years in light of increased shipping activities
- Narwhal response to vessel-based underwater noise:
 - Is localised and temporary, across regional study area & for duration of shipping season
 - Unlikely to compromise the integrity of the Baffin Bay Population or Eclipse Sound stock



Shipping – Conclusions

- Mitigation is effective including:
 - Managing transits in heavy ice;
 - Vessel speed restrictions;
 - 40 km buffer zone from Nunavut Settlement Area; and,
 - “No-go” zones in key calving areas
- Follow-up monitoring, with community, to confirm assessment predictions
- Marine Environmental Working Group and regulators engaged on monitoring findings & adaptive measures





Assessment Conclusions

Assessment Conclusions

- Phase 2 assessment on marine environment is robust, includes:
 - Inuit knowledge & Science
 - Conservatism
 - Knowledge gained from current operations
 - Effective, and precedent setting, mitigation measures; and
 - Long term monitoring
- Ballast water management & monitoring will continue to exceed current regulatory requirements
- Dust management and monitoring plan will protect sediment & water quality and Arctic char health

Assessment Conclusions

- 2019 showed numbers of narwhal consistent with previous years
- Evidence from elsewhere in Arctic show shipping & marine mammals successfully co-exist
- Phase 2 includes known effective & precedent setting shipping mitigation
- Inclusion of such mitigation & conservatism indicates there will be no significant environmental effects
- Extensive monitoring & adaptive management will be undertaken to verify the prediction of no significant residual effect

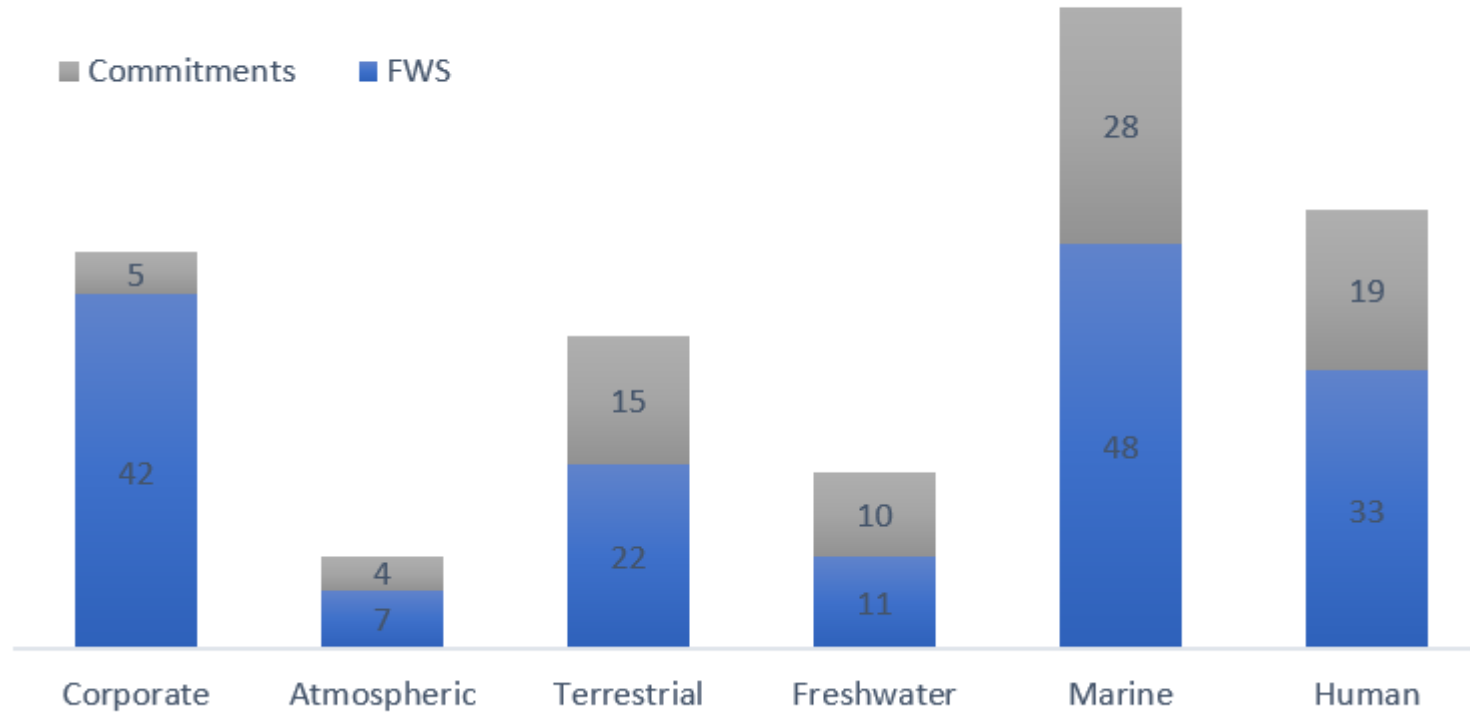


An aerial photograph of a large, deep blue reservoir. A wide, light-colored road or path runs along the left side of the water, separating it from a steep, snow-covered embankment. The embankment shows signs of erosion and is dotted with patches of dark vegetation. The surrounding landscape is flat and covered in a thin layer of snow, with distant mountains visible on the horizon under a cloudy sky.

Technical Review Summary

Final Written Submissions

Final Written Submissions and Commitments



Select Examples – Commitments

- Shoulder season traffic management
- commitment to ongoing aerial surveys
- End-of-season Narwhal Entrapment Aerial Surveys
- Update of Ballast Management Plan
- Use of Walrus Haul out Buffer Zone Guidelines
- Conduct additional Arctic diesel fuel spill modelling to account for shoulder season shipping
- Ringed Seal Monitoring Plan
- Avoid North Water Polynya

Current Project Certificate Conditions

- General Marine Environment (#76; Remove since completed)
- Marine Working Group (#77; no change)
- Icebreaking and Shipping (#78-80; Update 78)
- Shoreline Effects and Sediment Redistribution (#81-85; Remove 81, update 82, Remove 83(a) and 84)
- Ballast Water (#86-91; Update 87 & 89; Remove 90 & 91)
- Spill Prevention (#92-98; Remove #92 & 96)
- Supplemental Baseline Assessments (#99-100; Update #99)
- Monitoring (#101 ; Update to streamline and reduce repetition)

Current Project Certificate Conditions

- Traffic Log and Shipping Information (#102–105 ; remove 102&104; update 103)
- Shipboard Observers (#106-108; update 106 and remove 107-108)
- Ship Noise (110-112; update 110 and remove 111-112 to remove duplication)
- Arctic Char (#113-115; remove 115)
- Blasting (#116-118; update 116 and remove 117-118)
- Ringed Seals (#119; update)
- Marine Mammal Interactions (#120-124; update 121&124; Remove 122&123)
- Public Engagement (#125-128; Remove 126-128)



Questions?