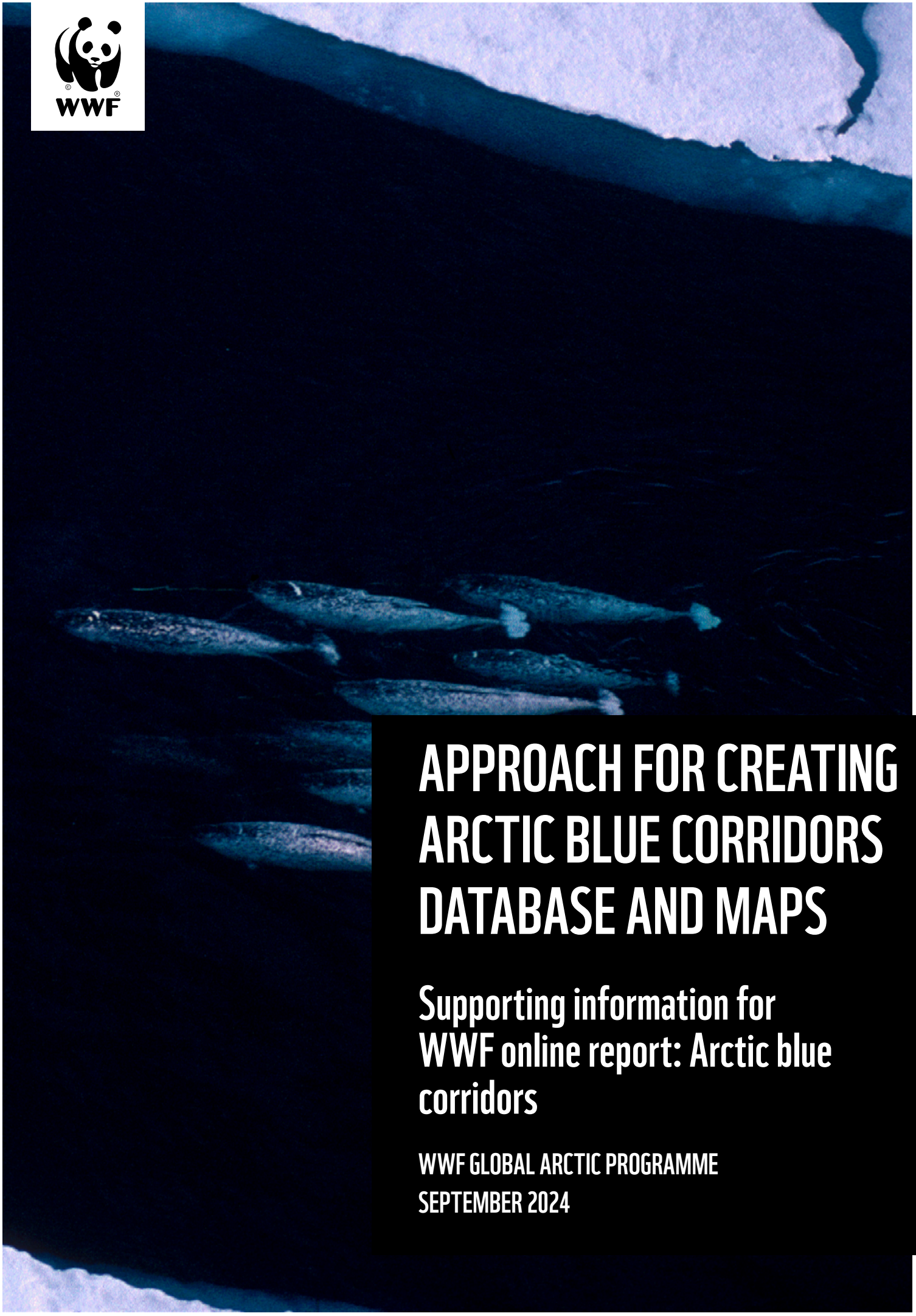

APPROACH FOR CREATING ARCTIC BLUE CORRIDORS DATABASE AND MAPS

Supporting information for WWF online report: Arctic blue corridors

WWF GLOBAL ARCTIC PROGRAMME

SEPTEMBER 2024

Approach for creating Arctic blue corridors database and maps

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The Arctic blue corridors database was created by the WWF Global Arctic Programme. We collated and mapped publicly available spatial and temporal information on the migration routes of the three whale species endemic to the Arctic region: narwhal (*Monodon monoceros*), bowhead whale (*Balaena mysticetus*), and beluga whale (*Delphinapterus leucas*). We call on Arctic States, the Arctic Council, International Maritime Organization and the shipping industry to consider blue corridors in the creation of protected and conserved area networks and sustainable use of the Arctic Ocean, to safeguard Arctic whales from risks and impacts caused by shipping.

Tracking whale migrations under harsh Arctic conditions is logistically and technologically challenging, labour-intensive and costly. While many Arctic coastal Indigenous communities have observed whale migrations for millennia and scientific research is ongoing, there is much we still do not know about Arctic whales' migratory behaviour. The maps in this database are a first look at Arctic whales' migratory behaviour, both where their blue corridors are situated and when the corridors are being used by the whales. Together with other information sources, this database can help identify priority areas for research, management and conservation.

Database creation

Whale species and populations

We collated spatio-temporal data on seasonal migrations (autumn and spring) for the three Arctic whale species, to the level of recognised populations or stocks (herein referred to as populations) based on CAFF delineations (ref)). This included all 12 narwhal populations, all three bowhead whale populations and six of 15 beluga whale populations. Of the remaining beluga whale populations, seven exhibit no migrations or very local migratory behaviour (Bristol Bay, Cumberland Sound, Eastern Bering Sea, Gulf of Anadyr, James Bay, Svalbard, White Sea), one population is near-extinct and has unknown migratory behaviour (Ungava Bay), and one population is extinct (southwest Greenland). Finer-scale migratory behaviour of largely resident populations could be included in a future iteration of the database.

Data sources

We identified data through a literature review of peer-reviewed scientific papers, white papers, agency reports, and other grey literature. Information on whale migrations in the Russian Federation is frequently only available in the Russian language, therefore data were also collected through an additional literature review conducted by a cetacean expert with Russian language skills. Data collected were independently reviewed for currency, accuracy and completeness for Canada, the US and Russian Arctic. WWF Global Arctic Programme experts also performed further targeted data searches to fill knowledge gaps.

Most publicly available sources of information were from the scientific literature. A small number of publications and reports included multiple types of knowledge. These were referred to by the authors as Indigenous Knowledge, Traditional Ecological Knowledge, Aboriginal Traditional Knowledge, expert knowledge, local knowledge and observations from hunters. Initiatives to gather Indigenous Knowledge would further enrich current collective understanding of Arctic whale migrations.

Data types

Methods reported for collecting information on migratory behaviour of Artic whales included observations, satellite telemetry, aerial surveys, vessel (ship/boat)-based observations, photo identification, acoustic arrays and genetic sampling. We created a geodatabase aggregating the spatial data, with temporal data also included. Data types include point data (from visual observations via aerial or boat-based survey or satellite telemetry), line data (from satellite telemetry and migration routes based on Indigenous Knowledge and knowledge syntheses), and polygon data (based on knowledge syntheses from multiple sources and kernel densities from satellite telemetry or other methods).

Data accuracy

Spatial accuracy

All data were assigned a level of accuracy to indicate geopositional quality. 'Low' accuracy indicates manually digitised coordinates from paper or digital maps, or general descriptions (e.g. 40 km from the north of Belyi Island). Data from low-spatial-accuracy technologies, like acoustic sensors (sound recorders) were also classified as 'low' accuracy. These data are assumed to have an accuracy level within 50-100 km. 'Medium' accuracy refers to low-precision coordinates or manually digitised points from fine-scale maps. These data are assumed to have an accuracy level within 10 km. 'High' accuracy indicates GPS data or original spatial data directly from authors, online data repositories, supplementary materials or listed coordinates.

Temporal accuracy

Available data varied in temporal accuracy from day to month to season (e.g., autumn, spring, migration). Where available, dates and times from datasets were maintained in the database. Where exact dates were not available, month and/or season were extracted from the data.

We identified data as relevant to migration if it was identified as such by author(s), if it was labelled as autumn or spring by the author(s), and/or if it was collected from March to July (spring, numeric months 3-7) or September to November (autumn, numeric months 9-11). However, we avoided including information that was identified by the author(s) as representing summer or winter (e.g., "late summer foraging habitat"), even if it fell into the above spring or autumn months. Migration timing within a season can vary among species and populations, within populations of a species, and among years. We are aware that our migration windows may be too long for some populations, and where that is the case, this may have resulted in conflation of some migration areas if they included data from the adjacent season. This can be remedied as needed in the future.

Data inclusions and exclusions

Whenever possible, we included multiple lines of primary (raw) data for each population to maximise accuracy, currency and completeness. However, we avoided duplicating the same datasets in the database, i.e., those that were re-drawn from primary data already present in the database. We made exceptions when additional analyses of the data or additional sources of information were included in consolidated datasets. Decisions and justifications were recorded for each population and source.

In summary, we excluded data that were:

- Spatially too general (e.g. extent of range, area of distribution, hypothetical distribution)
- Temporally too general (e.g., year-round, unspecified)
- Temporally outside migration months as we defined them, specified by the author(s) as belonging to summer or winter, or where most of data fell outside the migration season and therefore were likely not representative of migration, unless specified otherwise.

- A duplication of primary spatial data already in the database (e.g. generalised polygons from the same source as points or lines, in which case the points or lines were included and polygons filtered out).

Processing of data into the database

1. All spatio-temporal data (polygons, points and lines) were imported into R (version 4.4.1).

2. Data were harmonised across data sources to ensure consistency and facilitate the combination of datasets. This included assigning numeric months and tidying the data to be one row per month, assigning seasons (described in detail under the 'Data accuracy' section), and harmonising data collection types (called 'Value' in the datasets).

* Descriptions such as "July – Oct" were assigned all relevant months: '7, 8, 9, 10'.
* Where month descriptions after initial data filtering included 'various', 'varies' or 'unknown', a month value of NA was assigned.

3. Each species was filtered into its own data frame and converted into an sf object (simple features object, which has a geometry column).

4. All datasets were merged by species and data type:
    a. We ensured all column names and Value levels per data type were consistent across datasets, irrespective of species.
    b. All datasets were transformed to North Pole Lambert Azimuthal Equal Area (ESRI:102017) to ensure consistency in the projected coordinate system across objects.
    c. For each species, all points were merged into one data frame, lines were merged and polygons were merged.

Visualising Arctic blue corridors on maps

Map visualisations of Arctic blue corridors were created using R and ArcGIS Pro.

Creation of Arctic blue corridors rasters

1. Data frames for each migration season were created by selecting autumn or spring data respectively.

* Where seasons were not specified for data specific to migration, data were included in both spring and autumn data frames.

2. Two rasters (spring blue corridors, autumn blue corridors) were created for each of the three whale species by doing the following:
    a. All data types (polygons, points and lines) were rasterised into Raster* (stars) objects using an empty raster template based off a grid consisting of the Large

Marine Ecosystems (LMEs) of the Arctic Ocean[1] (a 28.4 x 28.4 km resolution, transformed to North Pole Lambert Azimuthal Equal Area). 'Value' (data collection type) was used as the raster attribute.

b. For points and lines, the option 'all-touched = TRUE' was also used to ensure that all raster cells touched by points or lines were included.
c. To be able to represent presence of data vs. absence, an ID column was added and raster cells with a value were given an ID value of 1.

* To account for point and line data occasionally being from the same source or tracking dataset, point and line rasters were merged and ID values averaged.
* This combines the two rasters but maintains a presence value of 1 (due to taking the average of 1+1 for cells where both points and lines are present).

d. The merged point and line raster was merged with the polygon raster, additively. This summed the cells across the various rasters, producing the following cell values:
    0 = no evidence for whale migration
    1 = polygons OR points OR lines
    2 = polygons AND points or lines.
e. Areas with no evidence for migration were masked by reclassifying 0 into 'NA'.

3. Two combined rasters (spring, autumn) for all three whale species were created by merging all three completed combined rasters for each species, additively. This produced cell values ranging between 0 (no evidence) and 6 (polygons AND points or lines for all 3 whale species).

4. All rasters (spring and autumn for each species and all species) were exported as .tiff files.

Final visualisation of maps in ArcGIS

1. Rasters were imported into ArcGIS Pro (v. 3.2.0) to assign symbology and create the final maps.

2. A blue colour gradient was applied to visualise the blue corridors and represent the amount of information available (lightest blue indicated less information and darkest blue represented most information). Whole number intervals were used to classify the rasters and assign the colours (1 – 6 for all species, and 1 – 2 for individual species).

3. Land masses were overlaid on the blue corridors, an Arctic region[2] boundary was applied and relevant map features were labelled.

[1] PAME (2013) Large Marine Ecosystems (LMEs) of the Arctic area: revision of the Arctic LME map. Second Edition. Arctic Council, Akuyeri, Iceland.
[2] Arctic area under the definition of the Conservation of Arctic Flora and Fauna (CAFF) working group of the Arctic Council.

Data sources used to create database and maps

Below is the list of sources used to develop the Arctic blue corridors database and associated maps. Further details on the data included and excluded from individual sources can be provided on request.

	SPECIES	POPULATION/STOCK	DATA SOURCE
1	Narwhal	Eclipse Sound	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049.(Errata: January 2018).
	Narwhal	Eclipse Sound	Laidre, K.L., Heide-Jørgensen, M.P., Dietz, R., Hobbs, R.C. and Jørgensen, O.A., 2003. Deep-diving by narwhals Monodon monoceros: differences in foraging behavior between wintering areas?. *Marine Ecology Progress Series*, *261*, pp.269-281.
	Narwhal	Eclipse Sound	Shuert, C.R., Hussey, N.E., Marcoux, M., Heide-Jørgensen, M.P., Dietz, R. and Auger-Méthé, M., 2023. Divergent migration routes reveal contrasting energy-minimization strategies to deal with differing resource predictability. *Movement Ecology*, *11*(1), p.31.
2	Narwhal	Admiralty Inlet	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049.(Errata: January 2018).
	Narwhal	Admiralty Inlet	Dietz, R., Heide-Jørgensen, M.P., Richard, P., Orr, J., Laidre, K. and Schmidt, H.C., 2008. Movements of narwhals (Monodon monoceros) from Admiralty Inlet monitored by satellite telemetry. *Polar Biology*, *31*, pp.1295-1306.
	Narwhal	Admiralty Inlet	Shuert, C.R., Hussey, N.E., Marcoux, M., Heide-Jørgensen, M.P., Dietz, R. and Auger-Méthé, M., 2023. Divergent migration routes reveal contrasting energy-minimization strategies to deal with differing resource predictability. *Movement Ecology*, *11*(1), p.31.
3	Narwhal	Somerset Island	DFO. 2011. Identification of Ecologically and Biologically Significant Areas (EBSA) in the Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/055.
	Narwhal	Somerset Island	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049.(Errata: January 2018).

	Narwhal	Somerset Island	Heide-Jørgensen, M.P., Dietz, R., Laidre, K.L., Richard, P., Orr, J. and Schmidt, H.C., 2003. The migratory behaviour of narwhals (Monodon monoceros). *Canadian Journal of Zoology*, *81*(8), pp.1298-1305.
	Narwhal	Somerset Island	Laidre, K.L., Heide-Jørgensen, M.P., Dietz, R., Hobbs, R.C. and Jørgensen, O.A., 2003. Deep-diving by narwhals Monodon monoceros: differences in foraging behavior between wintering areas?. *Marine Ecology Progress Series*, *261*, pp.269-281.
4	Narwhal	Jones Sound	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
5	Narwhal	Smith Sound	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
6	Narwhal	Baffin Island fjords	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
7	Narwhal	Northern Hudson Bay	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
	Narwhal	Northern Hudson Bay	Westdal, K.H., Richard, P.R. and Orr, J.R., 2010. Migration route and seasonal home range of the northern Hudson Bay narwhal (Monodon monoceros). *A little less Arctic: top predators in the world's largest northern inland sea, Hudson Bay*, pp.71-92.
8	Narwhal	Inglefield Bredning	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
9	Narwhal	Melville Bay	Dietz, R. and Heide-Jørgensen, M.P., 1995. Movements and swimming speed of narwhals, Monodon monoceros, equipped with satellite transmitters in Melville Bay, northwest Greenland. *Canadian Journal of Zoology*, *73*(11), pp.2106-2119.
	Narwhal	Melville Bay	Heide-Jørgensen, M.P., Richard, P.R., Dietz, R. and Laidre, K.L., 2013. A metapopulation model for Canadian and West Greenland narwhals. *Animal Conservation*, *16*(3), pp.331-343.

	Narwhal	Melville Bay	Laidre, K.L., Heide-Jørgensen, M.P., Dietz, R., Hobbs, R.C. and Jørgensen, O.A., 2003. Deep-diving by narwhals Monodon monoceros: differences in foraging behavior between wintering areas?. *Marine Ecology Progress Series*, *261*, pp.269-281.
10	Narwhal	East Greenland	Heide-Jørgensen, M.P., Nielsen, N.H., Hansen, R.G., Schmidt, H.C., Blackwell, S.B. and Jørgensen, O.A., 2015. The predictable narwhal: satellite tracking shows behavioural similarities between isolated subpopulations. *Journal of Zoology*, *297*(1), pp.54-65.
	Narwhal	East Greenland	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
11	Narwhal	Northeast Greenland	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
12	Narwhal	Svalbard/Northwest Russian Arctic	Belikov, S.E. and Boltunov, A.N., 2002. Distribution and migrations of cetaceans in the Russian Arctic according to observations from aerial ice reconnaissance. *NAMMCO Scientific Publications*, *4*, pp.69-86.
	Narwhal	Svalbard/Northwest Russian Arctic	Chaadaeva, E.V., Voyta, L.L., Afanasyeva, G.A., Baleeva, N.V., Starkov, A.I., Danilov, M.B. 2018. Marine mammals of the Kara Sea: summer season. Marine Mammals of the Holarctic, abstracts of the conference presentations.
	Narwhal	Svalbard/Northwest Russian Arctic	Gavrilo, M. V., Ershov, R. V. 2010. Notes on Cetaceans of the Franz-Josef Land–Victoria region. Marine Mammals of the Holarctic, abstracts of the conference presentations.
	Narwhal	Svalbard/Northwest Russian Arctic	Gorchakovskyi A. A. 2015. Polar bear and marine mammals of the southern Kara Sea. In: Fauna of the Urals and Siberia (in Russian language).
	Narwhal	Svalbard/Northwest Russian Arctic	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.

	SPECIES	POPULATION/STOCK	DATA SOURCE
1	Bowhead whale	Bering-Chukchi-Beaufort Seas	Citta, J.J., Quakenbush, L.T., George, J.C., Small, R.J., Heide-Jørgensen, M.P., Brower, H., Adams, B. and Brower, L., 2012. Winter movements of bowhead whales (Balaena mysticetus) in the Bering Sea. *Arctic*, pp.13-34.
			Citta, J.J., Okkonen, S.R., Quakenbush, L.T., Maslowski, W., Osinski, R., George, J.C., Small, R.J., Brower Jr, H., Heide-Jørgensen, M.P. and Harwood, L.A., 2018. Oceanographic characteristics associated with autumn movements of bowhead whales in the Chukchi Sea. *Deep Sea Research Part II: Topical Studies in Oceanography*, *152*, pp.121-131.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Clarke, J.T., Ferguson, M.C., Brower, A.A., Fujioka, E. and Deland, S., 2023. Biologically important areas II for cetaceans in US and adjacent waters-Arctic region. *Frontiers in Marine Science*, *10*, p.1040123.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Cobb, D.G. and Department of Fisheries and Oceans, Ottawa, ON(Canada); Canadian Science Advisory Secretariat, Ottawa, ON(Canada), 2011. *Identification of ecologically and biologically significant areas (EBSAs) in the Canadian Arctic* (No. 2011/70). DFO, Ottawa, ON(Canada).
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Cole, D.G., 2018. Ecological Atlas of the Bering, Chukchi, and Beaufort Seas, by Daniel P. Huffman et al. *Cartographic Perspectives*.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Heide-Jørgensen, M.P., Laidre, K.L., Quakenbush, L.T. and Citta, J.J., 2012. The Northwest Passage opens for bowhead whales. *Biology letters*, *8*(2), pp.270-273.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Insley, S.J., Halliday, W.D., Mouy, X. and Diogou, N., 2021. Bowhead whales overwinter in the Amundsen Gulf and eastern Beaufort Sea. *Royal Society Open Science*, *8*(4), p.202268.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Olnes, J., Citta, J.J., Quakenbush, L.T., George, J.C., Harwood, L.A., Lea, E.V. and Heide-Jørgensen, M.P., 2020. Use of the Alaskan Beaufort Sea by bowhead whales (Balaena mysticetus) tagged with satellite transmitters, 2006–18. *Arctic*, *73*(3), pp.278-291.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Moore, S.E., Stafford, K.M., Melling, H., Berchok, C., Wiig, Ø., Kovacs, K.M., Lydersen, C. and Richter-Menge, J., 2012. Comparing marine mammal acoustic habitats in Atlantic and Pacific sectors of the High Arctic: year-long records from Fram Strait and the Chukchi Plateau. *Polar Biology*, *35*, pp.475-480.
	Bowhead whale	Bering-Chukchi-Beaufort Seas	Szesciorka, A.R. and Stafford, K.M., 2023. Sea ice directs changes in bowhead whale phenology through the Bering Strait. *Movement Ecology*, *11*(1), p.8.

2	Bowhead whale	East Canada-West Greenland	Cobb, D.G. and Department of Fisheries and Oceans, Ottawa, ON(Canada); Canadian Science Advisory Secretariat, Ottawa, ON(Canada), 2011. *Identification of ecologically and biologically significant areas (EBSAs) in the Canadian Arctic* (No. 2011/70). DFO, Ottawa, ON (Canada).
	Bowhead whale	East Canada-West Greenland	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049.(Errata: January 2018).
	Bowhead whale	East Canada-West Greenland	Heide-Jørgensen, M.P., Laidre, K.L., Quakenbush, L.T. and Citta, J.J., 2012. The Northwest Passage opens for bowhead whales. *Biology letters*, *8*(2), pp.270-273.
	Bowhead whale	East Canada-West Greenland	Matthews, C.J., Breed, G.A., LeBlanc, B. and Ferguson, S.H., 2020. Killer whale presence drives bowhead whale selection for sea ice in Arctic seascapes of fear. *Proceedings of the National Academy of Sciences*, *117*(12), pp.6590-6598.
	Bowhead whale	East Canada-West Greenland	Nielsen, N.H., Laidre, K., Larsen, R.S. and Heide-Jørgensen, M.P., 2015. Identification of potential foraging areas for bowhead whales in Baffin Bay and adjacent waters. *Arctic*, pp.169-179.
3	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	Belikov, S.E., Gorbunov, Y.A. and Shilnikov, V.I., 1984. Observations of cetaceans in the seas of the Soviet Arctic. *Report of the International Whaling Commission*, *34*, pp.629-632.
	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	Chaadaeva E.V., Starkov A.I., Bordukov K.Yu., Danilov M.B. 2016. Sightings of bowhead whales (Balaena mysticetus) in the Kara Sea. Marine Mammals of Holarctic. Abstracts of the conference presentations.
	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	De Korte, J. and Belikov, S.E., 1994. Observations of Greenland whales (Balaena mysticetus), Zemlya Frantsa-Iosifa. *Polar Record*, *30*(173), pp.135-136.
	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	Goryaev Yu.I. 2017. Distribution of Marine Mammals in the Barents Sea in April and May 2016. Transactions of the Kola Science **Centre** of RAS (in Russian).
	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	Goryaev Yu.I. 2019. Distribution of Marine Mammals in the Barents Sea in April and May 2018. Transactions of the Kola Science **Centre** of RAS (in Russian).

	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	Kovacs, K.M., Lydersen, C., Vacquiè-Garcia, J., Shpak, O., Glazov, D. and Heide-Jørgensen, M.P., 2020. The endangered Spitsbergen bowhead whales' secrets revealed after hundreds of years in hiding. *Biology Letters*, *16*(6), p.20200148.
	Bowhead whale	NE Greenland-Svalbard-Frans Josef Land	Wiig, Ø., 1991. Seven bowhead whales (Balaena mysticetus L.) observed at Franz Josef Land in 1990. *Marine Mammal Science*, *7*(3), pp.316-319.

	SPECIES	POPULATION/STOCK	DATA SOURCE
1	Beluga whale	Eastern Chukchi Sea	Clarke, J.T., Ferguson, M.C., Brower, A.A., Fujioka, E. and Deland, S., 2023. Biologically important areas II for cetaceans in US and adjacent waters-Arctic region. *Frontiers in Marine Science*, *10*, p.1040123.
	Beluga whale	Eastern Chukchi Sea	Cobb, D.G. and Department of Fisheries and Oceans, Ottawa, ON(Canada); Canadian Science Advisory Secretariat, Ottawa, ON(Canada), 2011. *Identification of ecologically and biologically significant areas (EBSAs) in the Canadian Arctic* (No. 2011/70). DFO, Ottawa, ON (Canada).
	Beluga whale	Eastern Chukchi Sea	DFO. 2014. Re-evaluation of Ecologically and Biologically Significant Areas (EBSAs) in the Beaufort Sea. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/052.
	Beluga whale	Eastern Chukchi Sea	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
	Beluga whale	Eastern Chukchi Sea	Moore, S.E., Stafford, K.M., Melling, H., Berchok, C., Wiig, Ø., Kovacs, K.M., Lydersen, C. and Richter-Menge, J., 2012. Comparing marine mammal acoustic habitats in Atlantic and Pacific sectors of the High Arctic: year-long records from Fram Strait and the Chukchi Plateau. *Polar Biology*, *35*, pp.475-480.
	Beluga whale	Eastern Chukchi Sea	Richard, P.R., Martin, A.R. and Orr, J.R., 2001. Summer and autumn movements of belugas of the Eastern Beaufort Sea stock. *Arctic*, pp.223-236.
	Beluga whale	Eastern Chukchi Sea	Solovyev, B.A., Platonov, N.G., Glazov, D.M., Shpak, O.V. and Rozhnov, V.V., 2012. Distribution of beluga whales (Delphinapterus leucas) in the Russian Arctic seas according to the results of

			expedition aboard RV Mikhail Somov, September–November 2010. *Biology Bulletin*, *39*, pp.654-658.
	Beluga whale	Eastern Chukchi Sea	Sullender, B.K. and Smith, M.A., 2016. Ecological Atlas of Alaska's Western Arctic. Audubon Alaska, Anchorage, AK.
	Beluga whale	Eastern Chukchi Sea	Suydam, R.S., Lowry, L.F. and Frost, K.J., 2005. *Distribution and movements of beluga whales from the eastern Chukchi Sea stock during summer and early autumn*. Fairbanks, AK: Coastal Marine Institute, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks.
2	Beluga whale	Eastern Beaufort Sea	Clarke, J.T., Ferguson, M.C., Brower, A.A., Fujioka, E. and Deland, S., 2023. Biologically important areas II for cetaceans in US and adjacent waters-Arctic region. *Frontiers in Marine Science*, *10*, p.1040123.
	Beluga whale	Eastern Beaufort Sea	Cobb, D.G. and Department of Fisheries and Oceans, Ottawa, ON(Canada); Canadian Science Advisory Secretariat, Ottawa, ON(Canada), 2011. *Identification of ecologically and biologically significant areas (EBSAs) in the Canadian Arctic* (No. 2011/70). DFO, Ottawa, ON(Canada).
	Beluga whale	Eastern Beaufort Sea	Cole, D.G., 2018. Ecological Atlas of the Bering, Chukchi, and Beaufort Seas, by Daniel P. Huffman et al. *Cartographic Perspectives*.
	Beluga whale	Eastern Beaufort Sea	DFO. 2014. Re-evaluation of Ecologically and Biologically Significant Areas (EBSAs) in the Beaufort Sea. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/052.
	Beluga whale	Eastern Beaufort Sea	Moore, S.E., Stafford, K.M., Melling, H., Berchok, C., Wiig, Ø., Kovacs, K.M., Lydersen, C. and Richter-Menge, J., 2012. Comparing marine mammal acoustic habitats in Atlantic and Pacific sectors of the High Arctic: year-long records from Fram Strait and the Chukchi Plateau. *Polar Biology*, *35*, pp.475-480.
	Beluga whale	Eastern Beaufort Sea	Richard, P.R., Martin, A.R. and Orr, J.R., 2001. Summer and autumn movements of belugas of the Bastern Beaufort Sea stock. *Arctic*, pp.223-236.
	Beluga whale	Eastern Beaufort Sea	Sullender, B.K. and Smith, M.A., 2016. Ecological Atlas of Alaska's Western Arctic. Audubon Alaska, Anchorage, AK.
3	Beluga whale	Western Hudson Bay	DFO. 2011. Identification of Ecologically and Biologically Significant Areas (EBSA) in the Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/055.

	Beluga whale	Western Hudson Bay	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049.(Errata: January 2018).
	Beluga whale	Western Hudson Bay	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
	Beluga whale	Western Hudson Bay	Smith, A.J., Higdon, J.W., Richard, P., Orr, J., Bernhardt, W. and Ferguson, S.H., 2017. Beluga whale summer habitat associations in the Nelson River estuary, western Hudson Bay, Canada. *PLoS One*, *12*(8), p.e0181045.
4	Beluga whale	Eastern Hudson Bay	Bailleul, F., Lesage, V., Power, M., Doidge, D.W. and Hammill, M.O., 2012. Migration phenology of beluga whales in a changing Arctic. *Climate Research*, *53*(3), pp.169-178.
	Beluga whale	Eastern Hudson Bay	Bailleul, F., Lesage, V., Power, M., Doidge, D.W. and Hammill, M.O., 2012. Differences in diving and movement patterns of two groups of beluga whales in a changing Arctic environment reveal discrete populations. *Endangered Species Research*, *17*(1), pp.27-41.
	Beluga whale	Eastern Hudson Bay	DFO. 2011. Identification of Ecologically and Biologically Significant Areas (EBSA) in the Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/055.
	Beluga whale	Eastern Hudson Bay	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049. (Errata: January 2018).
	Beluga whale	Eastern Hudson Bay	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
5	Beluga whale	Eastern High Arctic-Baffin Bay	DFO. 2011. Identification of Ecologically and Biologically Significant Areas (EBSA) in the Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/055.
	Beluga whale	Eastern High Arctic-Baffin Bay	DFO. 2015. Ecologically and Biologically Significant Areas in Canada's Eastern Arctic Biogeographic Region, 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/049. (Errata: January 2018).
	Beluga whale	Eastern High Arctic-Baffin Bay	Heide-Jørgensen, M.P., Richard, P., Dietz, R., Laidre, K.L., Orr, J. and Schmidt, H.C., 2003. An estimate of the fraction of belugas (Delphinapterus leucas) in the Canadian High Arctic that winter in West Greenland. *Polar Biology*, *26*, pp.318-326.

	Beluga whale	Eastern High Arctic-Baffin Bay	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
	Beluga whale	Eastern High Arctic-Baffin Bay	Koski, W.R., Davis, R.A. and Finley, K.J., 2002. Distribution and abundance of Canadian High Arctic belugas, 1974-1979. *NAMMCO Scientific Publications*, *4*, pp.87-126.
	Beluga whale	Eastern High Arctic-Baffin Bay	Richard, P.R., Heide-Jørgensen, M.P. and St. Aubin, D., 1998. Fall Movements of Belugas (Delphinapterus leucas) with Satellite-Linked Transmitters in Lancaster Sound, Jones Sound, and Northern Baffin Bay. *Arctic*, pp.5-16.
	Beluga whale	Eastern High Arctic-Baffin Bay	Richard, P.R., Heide-Jørgensen, M.P., Orr, J.R., Dietz, R. and Smith, T.G., 2001. Summer and autumn movements and habitat use by belugas in the Canadian High Arctic and adjacent areas. *Arctic*, pp.207-222.
6	Beluga whale	Barents-Kara-Laptev	Belikov, S.E. and Boltunov, A.N., 2002. Distribution and migrations of cetaceans in the Russian Arctic according to observations from aerial ice reconnaissance. *NAMMCO Scientific Publications*, *4*, pp.69-86.
	Beluga whale	Barents-Kara-Laptev	Belikov, S.E., Gorbunov, Y.A. and Shilnikov, V.I., 1984. Observations of cetaceans in the seas of the Soviet Arctic. *Report of the International Whaling Commission*, *34*, pp.629-632.
	Beluga whale	Barents-Kara-Laptev	Boltunov, A.N., Belikov, S.E., Nikiforov, V., Semenova, V.S., Stishov, M.S. and Pukhova, M.A., 2014. Aerial survey of the Pechora Sea and the area of Vaigach Island in spring 2014. *Marine Mammals of the Holarctic. Collection of Scientific Papers*.
	Beluga whale	Barents-Kara-Laptev	Boltunov A.N., Alekseeva Ya.I., Belikov S.E., Krasnova V.V., Semenova V.S., Svetochev V.N., Svetocheva O.N., Chernetskyi A.D. 2015. Marine Mammals and Polar Bear of the Kara Sea: the review of the current status. Ed. Belkovich V.M. Moscow. 104 p. (in Russian).
	Beluga whale	Barents-Kara-Laptev	Gavrilo, M.V. and Ershov, R.V., 2010. Notes on Cetaceans of the Franz-Josef Land–Victoria region. *Marine Mammals of the Holarctic*, pp.120-125.
	Beluga whale	Barents-Kara-Laptev	Hobbs, R.C., Reeves, R.R., Prewitt, J.S., Desportes, G., Breton-Honeyman, K., Christensen, T., Citta, J.J., Ferguson, S.H., Frost, K.J., Garde, E. and Gavrilo, M., 2019. Global Review of the Conservation Status of Monodontid Stocks. *Marine Fisheries Review*, *81*.
	Beluga whale	Barents-Kara-Laptev	Kuznetsova, D.M., Glazov, D.M., Shpak, O.V. and Rozhnov, V.V., 2016. Winter distribution and migrations of beluga whales (Delphinapterus leucas) in the White Sea based on satellite tracking data. *Biology Bulletin*, *43*, pp.914-917.

Beluga whale	Barents-Kara-Laptev	Lukin L.R., Vasiliev L.Yu. 2004. Distribution of beluga whale Delphinapterus leucas in the White and south-eastern Barents Seas during the ice season. *Ecology* (in Russian).
Beluga whale	Barents-Kara-Laptev	Solovyev, B.A., Platonov, N.G., Glazov, D.M., Shpak, O.V. and Rozhnov, V.V., 2012. Distribution of beluga whales (Delphinapterus leucas) in the Russian Arctic seas according to the results of expedition aboard RV Mikhail Somov, September–November 2010. *Biology Bulletin*, *39*, pp.654-658.
Beluga whale	Barents-Kara-Laptev	Udovik D.A., Solovyev B.A., Kuznetsova D.M., Shpak O.V., Platonov N.G., Glazov D.M. & Rozhnov V.V. 2012. Marine mammal observations in the Russian Arctic seas: results of Mikhail Somov research vessel expeditions 2010 and 2011 // Marine mammals of the Holarctic: Collection of studies presented at the 7th International Conference. Suzdal: MMC. P.306–311.
Beluga whale	Barents-Kara-Laptev	Lukin L.R., Vasiliev L.Yu. 2004. Distribution of beluga whale Delphinapterus leucas in the White and south-eastern Barents Seas during the ice season. *Ecology* (in Russian).