CORONATION GULF MARINE MAMMAL AERIAL SURVEYS, 8–13 SEPTEMBER 2012

Prepared for



by



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CORONATION GULF MARINE MAMMAL AERIAL SURVEYS, 8–13 SEPTEMBER 2012

Prepared for

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1. INTRODUCTION

MMG Resources Inc. is proposing to construct a port in Grays Bay in Coronation Gulf to ship ore concentrate via ocean-going vessels from the Izok Corridor Project (the Project) mines to markets in Europe and Asia and to receive cargo to resupply mine and port operations. Shipping will be carried out during the open-water season. Underwater noise from project activities at the dock and along the shipping route during the construction and operations phases may disturb marine mammals. During the open-water shipping season (August–October), ringed seals, bearded seals, belugas, narwhals, bowhead whales and polar bears may occur along the shipping route. In order to document the distribution and numbers of marine mammals along parts of the shipping route, aerial surveys were conducted in September 2012 to improve the baseline information available for preparation of a draft Environmental Impact Statement (DEIS) of the Project.

This report presents the results of the marine mammal aerial survey that was conducted in Coronation Gulf, Nunavut, during 8–13 September 2012. The main objectives of the survey were to document the use of Coronation Gulf by ringed seals and other marine mammals during the open-water season. The surveys emphasized the area around the proposed port site in Grays Bay. Detailed information on the distribution and numbers of marine mammals during the open water season in Coronation Gulf was lacking before the surveys reported here. Historically, cetaceans have been uncommon in Coronation Gulf, but in 2011 and 2012, belugas were seen near Kugluktuk at the western end of Coronation Gulf (Gagnon 2011; N. Thorpe, pers. comm. 2012), and narwhals were seen in Cambridge Bay at the eastern end of Coronation Gulf (George 2011, 2012).

2. METHODS

2.1 Survey Design

During 8–13 September 2012, aerial survey transects were flown between the eastern end of Coronation Gulf to the western edge of Dease Strait. The transect locations, orientation, and spacing are the same as those used during the September 2004 aerial survey (Gartner Lee Ltd. 2006). Two replicate transects were flown: the first on 8–10 September, and the second on 10–13 September. Additional shoreline surveys were also conducted to record bird observations. Bird data not are presented in this report.

Each replicate included an 'extensive' grid consisting of 21 north-south transects and an 'intensive' grid consisting of 16 north-south transects. Transects in the extensive grid were 27.9 to 91.9 km in length and were 26 km apart, giving a spacing of 0.5° longitude between transects (Figure 1). Transects in the intensive grid were 31.1 to 42.9 km in length and were 4.2 km apart, giving a spacing of 0.1° between transects.

2.2 Survey and Data Recording Procedures

The survey used line-transect methodology, which has become standard practice for marine mammal aerial surveys. Two primary observers occupied seats in the second passenger row on opposite sides of the aircraft. Two secondary observers and a computer operator were

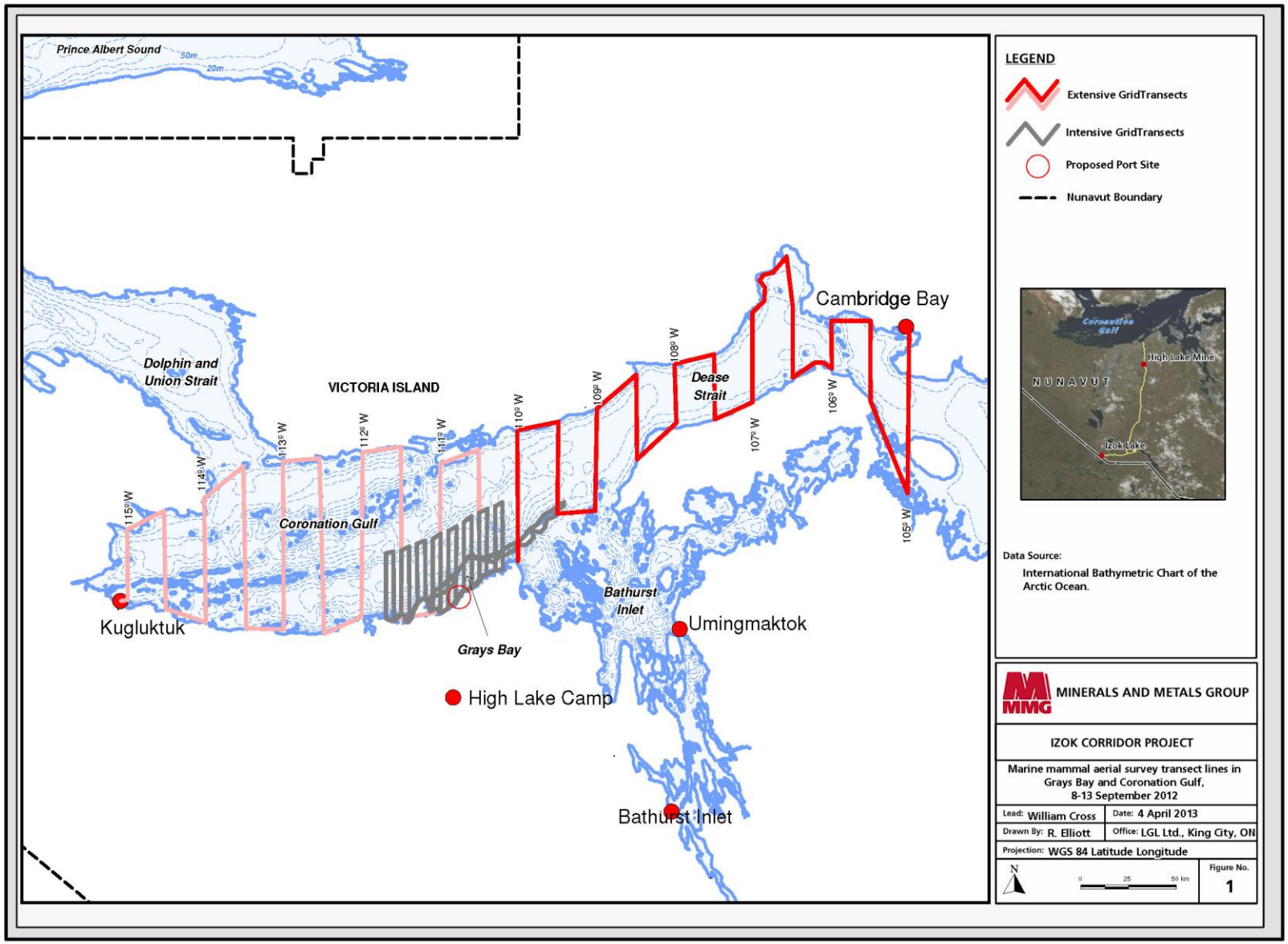


Figure 1. Aerial survey transects flown in Coronation Gulf, 8–13 September 2012.

located behind the primary observers. To address the concern that fatigued observers may not adequately detect marine mammals, primary observers rotated to the computer operator position every two transects (41 min) during the extensive survey and every four transects (42 min) during the intensive survey. Secondary observers did not rotate out of their observer position. Additional rest periods for observers occurred during transit and refuelling stops.

Observers focused their effort on a 1000-m strip width continuously while on transect to ensure good coverage of the area near the aircraft. These strips extended from 85 m to 1085 m from the centreline of the aircraft track. Observers also scanned for and recorded "off transect" sightings beyond the defined strip width. Tape was placed on the aircraft windows at appropriate inclinometer angles to help observers identify the boundaries of the on-transect search area. The angle of inclination to each sighting location was measured using an inclinometer.

Surveys were usually conducted at a nominal altitude of 152 m (500 ft) above sea level at a ground speed of 222 km/h (120 knots). A de Havilland Twin Otter Series DHC-6-300 (Figure 2) with extended range fuel tanks (maximum range of 4.9 h at a cruising speed of 222 km/h) was used for the survey. The aircraft was equipped with four bubble windows, two in the emergency exit windows of the second passenger row for use by the primary observers, and two in the rear cargo doors for use by bird observers. Secondary marine mammal observers looked through flat windows. In the event that large groups of marine mammals were encountered in relatively restricted areas, the survey team would photograph the group to determine more accurate counts of individuals. An aft ventral camera port was installed in aircraft to allow for photos of large groups.



Figure 2. Twin Otter used to conduct the aerial surveys in Coronation Gulf, 8–13 September 2012.

At the end of each 2-min (7.4 km) period along a transect, a timer emitted an audible signal and the two primary observers dictated onto a digital voice recorder the time, sea surface conditions using the Beaufort wind force scale, visibility (n.mi.), ice cover (intervals of 10%), ice type, sun glare (none, moderate, severe), and overall sightability conditions (subjectively classified as excellent, good, moderately impaired, severely impaired, or impossible). In addition, two digital single-lens reflex (DSLR) high-resolution (18 megapixel) cameras[1] set up on each side of the aircraft were automated to record habitat conditions along the transects at 3–4 sec intervals.

[1] Canon EOS 7D with EF-S 15-85 mm IS lens, 64 GB compact flash card, and remote interval shutter release

Additional environmental data were recorded by the pilots during flight. These variables included cloud cover (in tenths), height of cloud ceiling (ft), visibility (n.mi.), wind speed (knots), wind direction (ºT), and air temperature (°C). Wind data were acquired from the aircraft's global positioning system (GPS), and air temperatures were acquired from a thermometer mounted externally on the aircraft.

For each marine mammal sighting by a primary or secondary observer, the observer dictated onto a digital voice recorder and over their headset the species, number, age class, behaviour, direction of movement (relative to aircraft heading), angle of inclination to the sighting location using a clinometer, associated ice cover, ice type, and proportion of open water. Observers also recorded incidental sightings of seabirds. Marine mammal sightings were recorded to species only when there was a positive identification, otherwise sightings were recorded as accurately as possible (e.g., unidentified seal).

A notebook computer was used onboard the aircraft to store flight observational data. The computer system was connected to a Garmin GPS receiver[2] with an external antenna that was placed on the cockpit dashboard. Latitude, longitude, and flight altitude data from the GPS were transmitted to the computer through a standard USB cable approximately every second. A software program (NRoute by Garmin) allowed the computer operator (off-duty primary observer) to view the aircraft's track line in real time and to enter waypoints based on the current GPS position into a database. The waypoints were entered when the primary observers dictated their sightings over the intercom, and the computer operator included sighting information with the waypoints entered. A second handheld GPS receiver placed on the cockpit dashboard served as a backup.

2.3 Data Processing and Analysis

Marine mammal sighting locations were determined by matching the time when the sighting was perpendicular to the aircraft survey track with the position recorded for that time in the GPS log. Time periods with severely impaired sightability (severe glare, fog impairing observations, or Beaufort wind force >5) were excluded from all analyses. Each sighting was also linked to the environmental variables recorded for the corresponding 1–2 min time period. For consistency with previous marine mammal surveys, strip boundaries were not adjusted, nor were densities calculated to account for "earth curvature" as described by Lerczak and Hobbs (1998).

When data were of adequate quality (acceptable sample size and environmental conditions), distance-sampling estimates of marine mammal abundance and density were obtained using DISTANCE software (Buckland et al. 2001; Thomas et al. 2010), specifically the common distance sampling (CDS) estimation method.

Harwood and Stirling (1992) determined that seals are reliably sighted in sea conditions with Beaufort wind force ≤2. In our analysis, acceptable environmental conditions for pinnipeds were good sightability conditions and Beaufort wind force of ≤2. Density estimates were calculated for all pinnipeds, because numbers of bearded seals and unidentified seals were too

[2] Garmin GPSMap76CSX

small to warrant independent analysis. The estimates of abundance and density of all pinnipeds were then multiplied by the proportions of ringed seal, bearded seal, and unidentified seal sightings among all the sightings to produce individual estimates for the various seal categories.

Common distance sampling (CDS) produces classical distance-sampling estimates of detection functions that are used to correct the raw survey sightings/individuals to overall population and density estimates. The advantage of using the CDS method is that it can incorporate multipliers to account for reductions in sighting rates attributable to factors including availability bias, trackline detection probability bias, perception bias, and sightings without inclinometer measurements. These factors and their calculation are described in Section 3.3, below.

3. RESULTS

3.1 Survey Effort and Conditions

Overall, 100% of the planned survey effort was completed. All 37 transects of Replicate 1 and of Replicate 2 were surveyed during 8–13 September. High winds and corresponding high sea states prevented transects from being flown on 11 September. In total, 3,775 km of transects were surveyed over 33.3 on-transect hours (Table 1). Based on a strip width of 1 km on each side of the aircraft, a total area of 7,550 km^2 was surveyed.

Table 1. Summary of survey effort and conditions during the marine mammal aerial survey, 8–13 September 2012.

Rep-licate	Area surveyed	Date (2012)	Flight period			On-transect km	Wind speed (km/h)		Sky conditions
			Start	Finish	Length		Low	High	
1	Extensive-West	08-Sep	09:08	12:56	03:48	582	9	28	partly cloudy, clear
1	Extensive-Central	08-Sep	13:41	17:13	03:31	391	15	30	clear sky
1	Extensive-East	09-Sep	08:55	12:06	03:10	307	13	48	partly cloudy
1	Intensive-East	09-Sep	12:58	16:20	03:22	384	13	24	clear sky
1	Intensive-West	09-Sep	17:01	18:31	01:30	204	13	19	clear sky
1	Shoreline	10-Sep	08:54	10:51	01:57		6	6	partly cloudy
2	Extensive-Central	10-Sep	10:57	13:09	02:12	354	7	30	partly cloudy
2	Extensive-West	10-Sep	14:02	17:39	03:36	407	7	37	partly cloudy
2	Intensive	12-Sep	08:48	12:27	03:38	587	7	31	partly cloudy
2	Extensive-East	12-Sep	13:15	15:47	02:32	301	6	26	partly cloudy
2	Extensive-East	12-Sep	16:14	18:46	02:32	258	19	31	clear sky
2	Shoreline	13-Sep	11:08	12:32	01:24		28	30	overcast
Total					33.3	3,775			

Of this, 7550 km^2 were considered suitable for analysis of cetacean sighting data and 3442 km^2 were considered suitable for analysis of pinniped sightings data. On small parts of the transects (215 km or <6% of the total), the sighting conditions were rated "severely impaired" or "impossible" because of heavy fog. Also, glare was a problem periodically.

Sea conditions were variable during the surveys, with Beaufort wind forces from 0 to 5. Areas affected by high wind and large waves depended on the prevailing wind direction during and leading up to the survey flights. High winds producing Beaufort 2–5 occurred during most

of the Replicate 1 flights. Areas of calmer winds and lower Beaufort sea conditions occurred more often during Replicate 2 flights, with Beaufort wind forces ≤2 along many of the transects.

The survey area in Coronation Gulf and Grays Bay had 0% ice coverage.

3.2 Cetacean Sightings

Sightings of 20 beluga whales and 5 unidentified whales were made north of Kugulutuk during Replicate 1 (Table 2, Figure 2). Density estimates were not calculated for whales because the number of sightings was too low.

3.3 Pinniped Sightings and Density Estimates

There were 120 sightings (155 individuals) of pinnipeds in Coronation Gulf. Ringed seals (124) and bearded seals (7) were positively identified during the surveys. Twenty-four seals were not identified to species level. Most pinniped sightings occurred in the central part of Coronation Gulf (Figure 2), which reflects the distribution of favourable sightability conditions.

Three times as many pinniped sightings and about three times as many individuals were seen during Replicate 2 compared to Replicate 1, largely because of the calmer sea conditions. Pinniped group sizes ranged from 1 to 7 individuals, with most sightings of single animals. The mean group size was 1.06.

The flight altitude (152 m) was appropriate for cetacean surveys; lower altitudes (90 m) appropriate for pinniped surveys were not possible because of MMG flight safety restrictions and the data collection requirements for cetaceans. Neverthless, on two days (10 and 12 September) the sea conditions were such that pinnipeds were easily seen in the water from the 152-m survey altitude. Approximately 77% of all pinniped sightings were made during good sightability conditions and Beaufort ≤2.

Table 2. Summary of the numbers of sightings and individuals seen by only the primary (1º) observer, or by only the secondary (2º) observer, or by both observers during the marine mammal aerial surveys in Coronation Gulf, 8–13 September 2012.

	Total						On-transect only[1]					
	Replicate 1 Observer			Replicate 2 Observer			Replicate 1 Observer			Replicate 2 Observer		
Species	1°	2°	Both	1°	2°	Both	1°	2°	Both	1°	2°	Both
Sightings												
Beluga	0	1	0	0	0	0	0	1	0	0	0	0
Unidentified whale	0	1	0	0	0	0	0	1	0	0	0	0
Bearded seal	0	0	0	1	3	0	0	0	0	1	3	0
Ringed seal	14	3	1	24	35	16	1	0	0	24	30	16
Unidentified seal	11	1	0	7	1	3	5	1	0	6	1	4
All pinnipeds	25	4	1	32	39	19	6	1	0	31	34	20
Individuals												
Beluga	0	20	0	0	0	0	0	20	0	0	0	0
Unidentified whale	0	5	0	0	0	0	0	5	0	0	0	0
Bearded seal	0	0	0	1	6	0	0	0	0	1	6	0
Ringed seal	23	3	1	32	47	18	1	0	0	26	39	18
Unidentified seal	12	1	0	7	1	3	5	1	0	6	1	4
All pinnipeds	35	4	1	40	54	21	6	1	0	33	46	22

[1] Includes all on-transect cetacean sightings during acceptable sighting conditions, and on-transect pinniped sightings during acceptable sighting conditions and when the Beaufort wind force was ≤2.

Those seal sightings were primarily on transect lines 6–15 of the extensive grid and all transect lines of the intensive grid during Replicate 2 with good conditions. The survey effort and the 92 sightings during Beaufort ≤2 were used to produce an estimate of seal density, which was extrapolated to the entire study area to calculate abundance. Shoreline surveys were not used for density estimation because level flight was not maintained. The shoreline surveys were flown at a fixed distance from the shoreline (~150 m), which was more suitable for enumerating birds along the coastline.

The pinniped density estimate was generated using the common distance sampling (CDS) method. CDS produced a density estimate that accounted for declining detectability away from the trackline, as well as missed sightings attributable to perception bias and availability bias. The analysis included four factors: availability bias from the literature and three factors calculated using data on trackline detection probability bias, perception bias, and missing clinometer angle bias. These factors are used to correct the raw sightings and individuals to provide overall population and density estimates.

Availability bias is the inverse of the proportion of individuals of a population that are at the water surface and visible. This proportion is usually obtained by direct observation or determined from dive profiles. NFECN (2008) reported that the proportion of time that harbour seals were within 3 m of the surface was 0.5. In the absence of ringed or bearded seal dive profiles, it is assumed that they are similar to that of the harbour seal, and that seals within 3 m of the water surface are visible from a survey aircraft. Thus, the correction factor for this bias is 2.0.

Trackline detection probability bias [$f(0)$] is associated with diminishing sightability with increasing lateral distance from the trackline. It is the inverse of effective strip width (ESW), the distance from the line for which as many individuals are detected as are missed. The factor $f(0)$ was calculated based on individual sighting distances from the trackline recorded by the observers for all pinnipeds. Best estimates of the sighting distances based on clinometer angles were used to produce an estimated "relative detection function". The detection function (Figure 3) illustrates the declining probability that sightings can be made at increasing distances from the survey aircraft. From the detection curve, the calculated ESW in km is 0.25, and $f(0)$ is 4.0.

Perception bias is the inverse of the number of sightings seen by both independent observers (primary observers and secondary observers) divided by the number of sightings seen by primary observers. Based on the number of matched sightings between the primary and secondary observers divided by all sightings made during the Replicate 2 survey (20/85), the proportion of matched sightings is 0.2353, and this bias factor is 4.25.

Missing clinometer angle bias is the inverse of the number of the sightings with missing clinometer angles divided by the total number of sightings. Based on our survey data for Replicate 2, this ratio is 64/85 or 0.7529 and the bias factor is 1.328.

Density and abundance estimates are given in Table 3.

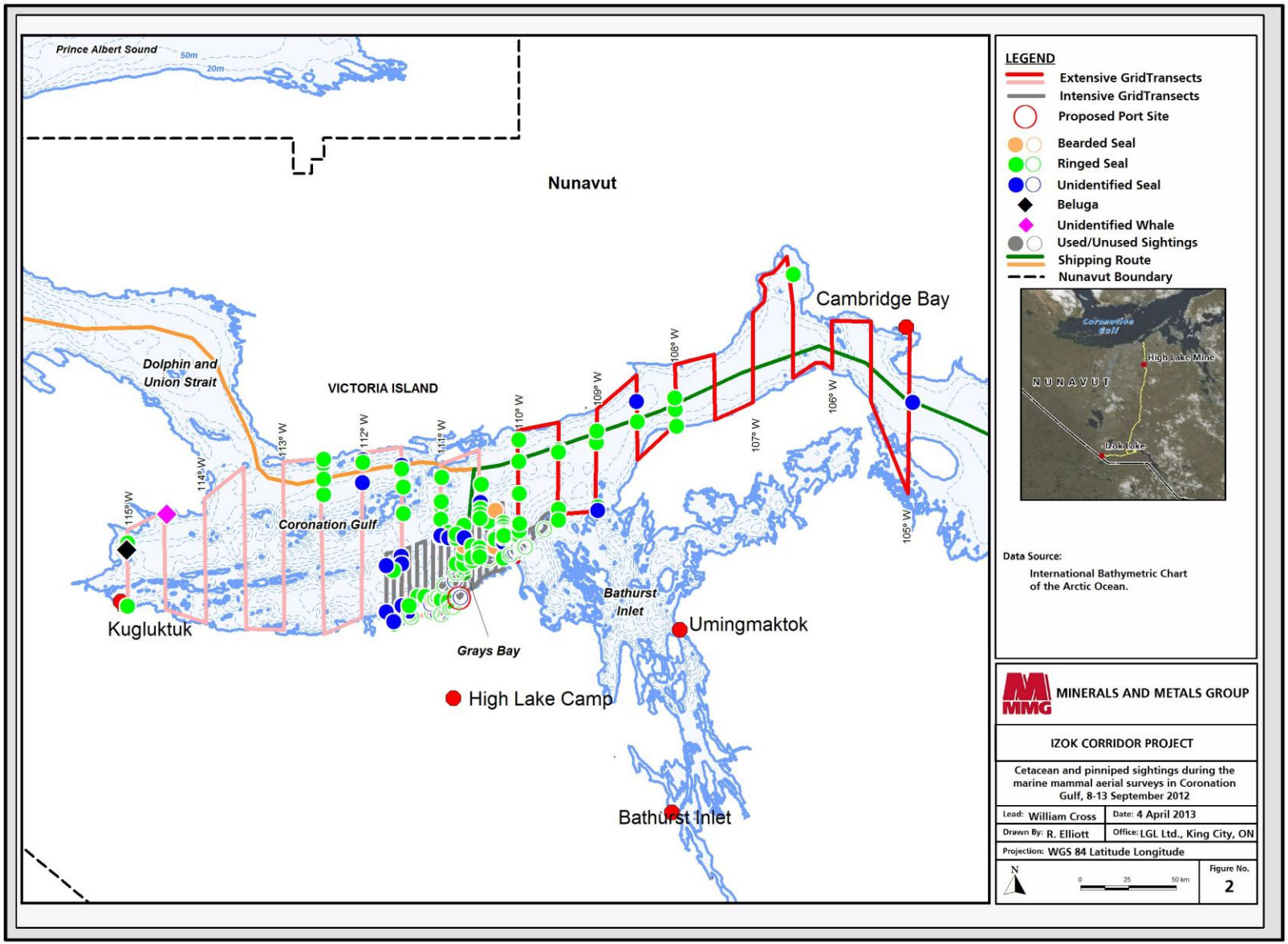


Figure 2. Cetacean and pinniped sightings during the marine mammal aerial surveys in Coronation Gulf, 8–13 September 2012.

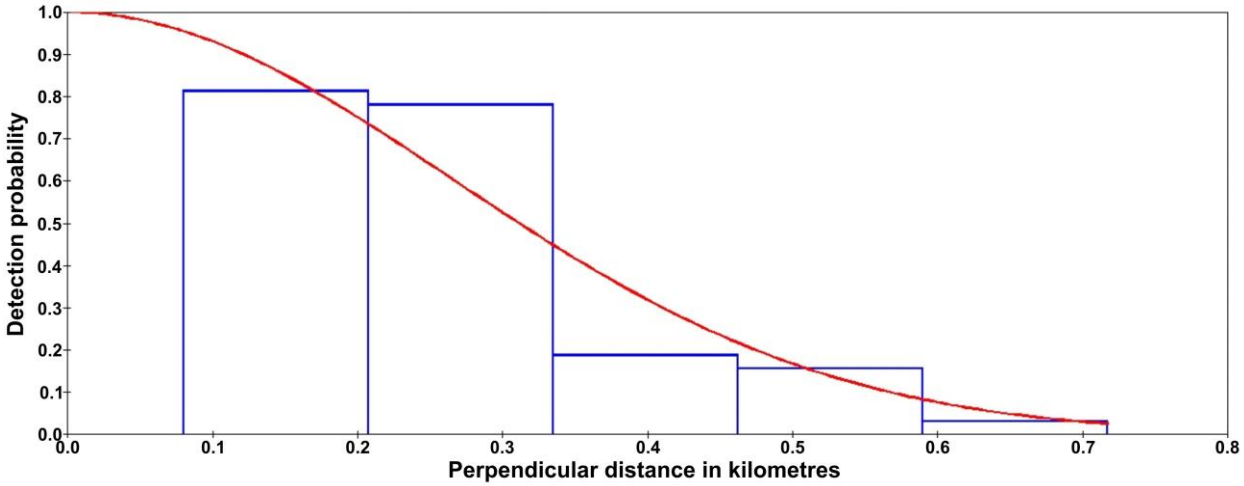


Figure 3. Detection function produced by the Common Distance Sampling analysis of pinniped sighitngs.

Table 3. Estimated abundance and density of pinniped species sighted during the marine mammal aerial surveys in Coronation Gulf, 8–13 September 2012.

Species	Abundance in Coronation Gulf	Density (#/km^2)
Bearded seal	927	0.03666
Ringed seal	10,996	0.43482
Unidentified seal	1,458	0.05764
All pinnipeds	13,381[1]	0.52912[2]

[1] 95% Confidence Interval 9,287–19,281
[2] 95% Confidence Interval 0.36722–0.76,239

4. SUMMARY

During the marine mammal survey conducted in Coronation Gulf during 8–13 September 2012, sightings were made of beluga whales, ringed seals, and bearded seals.

Only two sightings of cetaceans were made during this survey, which did not allow for reliable abundance and density estimates. This finding is consistent with the paucity of cetacean sightings in Coronation Gulf during the September 2004 surveys (Gartner Lee Ltd. 2006).

Although the altitude flown during the surveys was higher than preferred for pinniped surveys, two of the five survey days had ideal wind and wave conditions, which resulted in numerous sightings of pinnipeds during the extensive surveys of Coronation Gulf and the intensive surveys centred on Grays Bay. Based on the CDS method, pinniped abundance in Coronation Gulf was estimated at 13,381 and density was estimated at 0.53/km^2. Of the pinnipeds sighted, 82.2% were ringed seals, 6.9% were bearded seals, and 10.9% were unidentified seals.

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facilitated the surveys. Jeremy Giroux (Great Slave Helicopters) ferried us to the Sand Lake airstrip and Jon Norrish and Josh Stevens prepared excellent meals for us while staying at the High Lake camp. Glenn Wagner (MMG) also provided support for the project. Bill Koski and Val Moulton of LGL Limited assisted with the final survey design, and Bill Koski and Rolph Davis (LGL) reviewed the report.



Aerial survey crew. From left to right: Ryan Denbigh (MMG), Mike Setterington (EDI), Laurence Turney (Ardea BCL), Bruce Mactavish (LGL), Ted Elliott (LGL), and Heather Smith (LGL). George Taptuna (MMG) missing from photo.