Marine Mammal Observations during a Natural Resources Canada Acoustic Survey of Cape Lazo, Burrard Inlet, Howe Sound, Saanich Inlet, Stuart Channel, Samsun Narrows and Haro Strait.

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Prepared By

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For

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INTRODUCTION

A geophysical survey was carried out along the south coast of British Columbia (B.C.), Canada, in the Salish Sea using active source acoustic experiments for seabed mapping (Figure 1).

Cruise objectives from the data collected included:

- Seabed acoustic surveys to determine location, length and activity of potential fault systems near Cape Lazo, SE of Hornby Island, Stuart Channel, Nanaimo and Central Haro Strait;
- Seabed acoustic surveys to map landslide features in Saanich Inlet and Howe Sound;
- Seabed acoustic surveys to investigate some structures in Burrard Inlet that would assist in completing a geomorphology map and quantifying the venting source seen near pockmarks in English Bay; and,
- Hydrographic surveys to map priority areas in the Salish Sea.

The cruise was conducted aboard the 130-foot (39.74m) oceanographic research ship *CCGS Vector*, from August 11 to 18, 2021. A variety of sampling methods were applied including a: Geoforce Deep Tow System (DTS), a CHIRP 3.5 KHz echosounder, and a multi-beam bottom profiler. Note, the 3.5 KHz echosounder was only operated for a few minutes in Saanich Inlet to help with calibration of the hydrophone experiment with the local First Nations. Secondary contingency equipment was on board for grab samples and camera drops to ground truth seabed observations, however, this equipment was not utilized.

Geoforce Deep Tow System (DTS)

In addition to multi-beam sampling overnight, a Geoforce DTS deep-tow boomer/sparker system was towed behind the vessel in order to obtain a high resolution sub-bottom profile of specific areas of the ocean floor. The estimated sound pressure level (SPL) for the Geoforce DTS at its source (189.2 dB and its loudest) was equivalent to approximately 168.6 dB re 1µPa at 10 m from the source for the boomer and a corresponding SPL value of 160.8 for the sparker. Using an acoustic spreading loss equation, a 1,000 meter exclusion zone was determined then to well exceed the corresponding radius at which SPLs will have diminished below approximately 160 dB re 1µPa, which was calculated to for the Geoforce DTS to be at 29m. The system was deployed at a depth of 20 – 50 m with a typical clearance of 30 m from the seafloor.

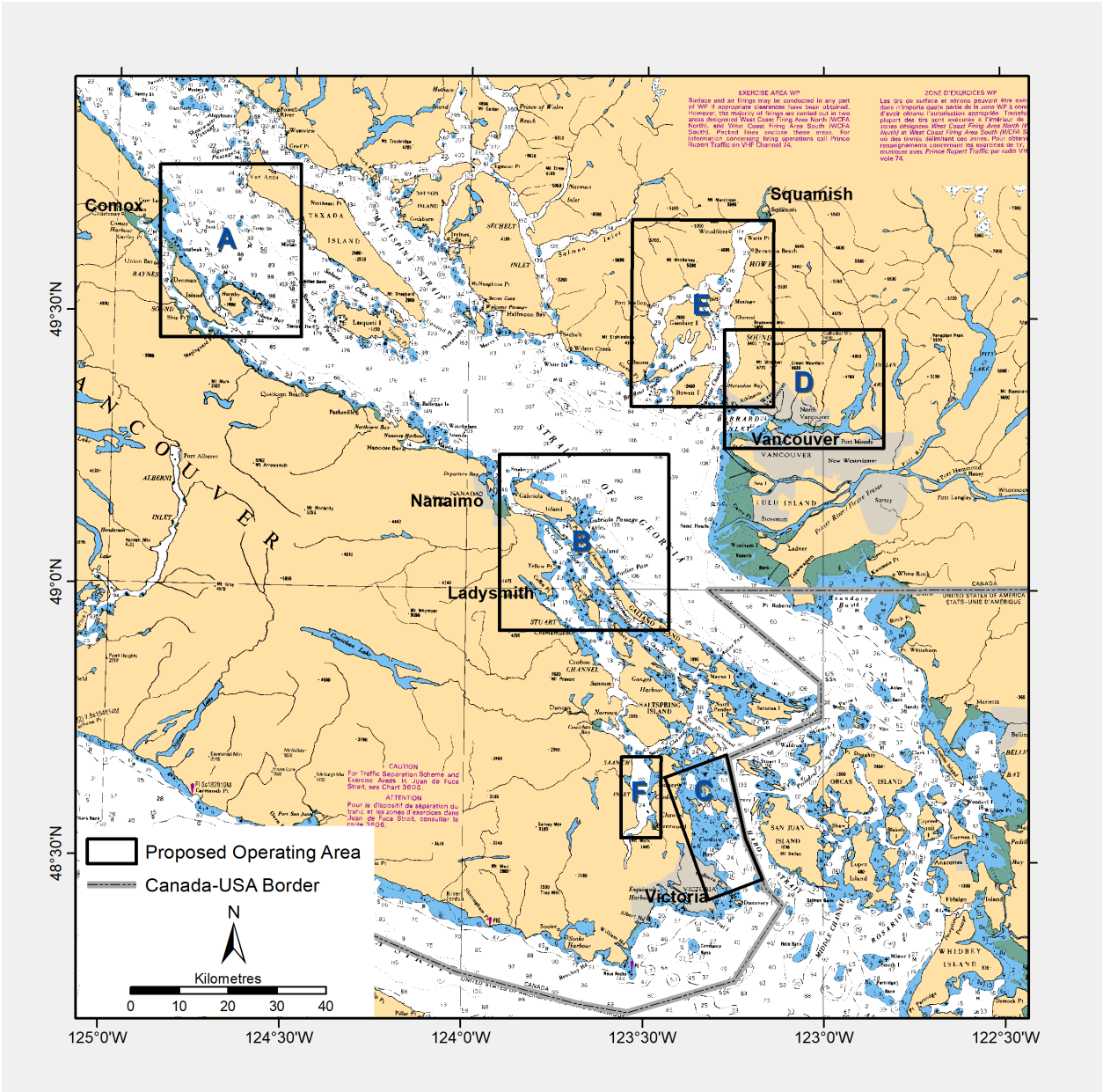


Figure 1. Proposed maximum operating areas for acoustics in the Salish Sea: A) Northern Salish Sea (Including Cape Lazo and South Hornby Island), B) Central Salish Sea (Including Nanaimo, and Stuart Channel), C) Southern Salish Sea (Including San Juan Fault and Central Haro Strait Fault. Work to be done on the Canadian side of the Canada-USA Border only), D) Burrard Inlet, E) Howe Sound, and F) Saanich Inlet.

Mitigation measures

The mitigation measures presently used by Fisheries and Oceans Canada (DFO) include the provision of a marine mammal observer onboard vessels undertaking seismic work, with the conditions pertaining to this survey outlined in a letter of response to a request for review by DFO from Mr. Steve Colwell of DFO (Pacific Region – Ecosystem Services Branch) to Karen Douglas (Marine Geoscientist) of Natural Resources Canada (Geological Survey of Canada – Pacific).

As outlined in the agreement, to avoid and mitigate the potential for prohibited effects to fish, fish habitat and aquatic species at risk (as listed in the document), the following measures were adhered to during the research cruise:

- Implemented measures outlined in the "Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment" (https://www.dfo-mpo.gc.ca/oceans/publications/seismic-sismique/index-eng.html);
- Engaged with 16 local first nations in order to adjust the timing of surveys based on their advice to mitigate any fish life cycle concerns;
- An experienced marine mammal observer made constant observation of the vicinity of the survey vessel prior to and during the operation of the Geoforce DTS survey equipment;
- An experienced marine mammal observer monitored the established exclusion zone for 30 minutes prior to initial start-up of the Geoforce DTS survey equipment or resumption of operations following a complete shutdown to allow for the detection of deep diving animals;
- Seismic survey operations were conducted only during daylight hours when the efforts of marine mammal observers were not compromised by light levels;
- An immediate and complete shutdown of the seismic survey equipment was initiated if a Killer Whale (resident or transient), whale with calf (any species) or aggregation of whales (any species) was observed;
- An immediate and complete shutdown of the seismic survey equipment was initiated for other observations of marine mammals (cetacean and/or pinniped) within an established exclusion zone of 1000m; and,
- An immediate and complete shutdown of the seismic survey equipment was initiated if any marine mammals was disturbed. A disturbance was defined as any change in behavior such as sudden spy-hopping or breaching in cetaceans, erratic swimming, or abruptly moving away from the vessel.

Due to the specifics of sound propagation in shallow (<100 m) versus deep water (> 100 m), and the expected elevated risk of harm to all cetaceans from seismic survey sources, the extent of seismic surveying in waters less than 100 meters in depth was restricted. A requisite exclusion zone of 1,000 meters for all marine mammals around the vessel was established to conform to a 160 dB re 1µPa sound pressure contour. This was greater than the minimum safety zone radius of 500 meters in the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment*. Further to this, additional protection for the *Endangered* Southern Resident Killer Whale was established through the immediate shut down of the Geoforce DTS survey equipment when a killer whale was detected through binoculars by the marine mammal observer on board the vessel.

Description of onboard mitigation procedures

All surveys conducted which required the use of the Geoforce DTS survey equipment were constrained to daylight hours. The marine mammal observer visually scanned for marine mammals 30 minutes prior to system startup and continuously during its operation. For the majority of all survey areas the equipment was operated on the lower/quieter mode, and sound was ramped up gradually at the start of each transect line in order to provide a greater buffer after the 30 minute pre-scan was complete.

Continuous observations were made from the bridge which provided a 360 degree viewing platform. Binoculars were used for long distance scans for marine mammals roughly every 10 minutes in additions to continuous scans without binoculars. Distance of animals from the ship was determined using reticulated binoculars, when an ocean horizon was visible. When an animal was sighted, the observer counted the number of reticles down from the horizon line and used the following formula to calculate distance from the ship:

Distance (m) = (eye height (m) + above sea level height (m)) X 1000 / No of MIL (1)

with each reticle of the binocular having a value of 5 MIL. The above sea level height (ASLH) of the bridge aboard the *CCGS Vector* is 26.5 ft or 8.1 meters. A table of distance from the ship for each reticle counted down from the horizon was calculated using equation (1) for quick reference by the marine mammal observers.

In addition to reticulated binoculars, distance estimates to sightings were also made with the help of chart plotting software and radar. Surveying was limited to periods of time with moderate to calm wind conditions and visibility of greater than 1,000 meters. In periods of strong winds and/or seas exceeding 2 meter wave heights, it is not possible for marine mammal observers to effectively clear a 1,000 meter exclusion zone due to poor visibility generated by white foam from breaking waves blow in streaks. During this survey, visibility was typically acceptable during system operation and did not preclude the systems use.

Marine mammal data collection

Marine mammal data collection included the date and time of species sighted, location relative to the vessel, estimated distance from the vessel, vessel position (latitude, longitude), visibility, species and number of animals and activity (Appendix 1). Vessel position was obtained from the ships GPS system that ran continuously during operations. The location of the sightings relative to the vessel was estimated in degrees, with 0° at the bow and 180° at the stern.

RESULTS

Research cruise summary

The research trip completed 58 hours and 01 minutes of Multichannel Boomer or Geoforce DTS Operations (Table 1). Most of the trip was spent acquiring seismic data during daylight hours, while any transiting between survey areas and hydrographic surveys were completed at night.

Geoforce DTS Operations were never interrupted due to poor sea conditions, however, some minor delays were experienced due to mechanical issues with the winch.

On August 14th while surveying off Cape Lazo a humpback whale and calf, as well as, a group of transient killer whales were observed at > 8km and > 4km respectively during the 30 minute scan prior to startup of the system (see Appendix 1 for detailed sightings notes). Additional observations of Dall's porpoise were also recorded within the exclusion zone. All groups of animals were continuously monitored as they travelled outside of the survey area and the seismic survey equipment did not startup until the exclusion zone was free of marine mammals for 30 minutes. Upon startup, the Geoforce DTS survey equipment was able to run uninterrupted until the completion of the transect line, with only a few observations of individual humpback whales observed outside the exclusion zone during this time. No visible evidence of disturbance to these animals was documented.

On August 17th while surveying in Haro Strait, a group of transient killer whales were observed at > 4km from the ship by the marine mammal observer during operation of the Geoforce DTS survey equipment (see Appendix 1 for detailed sightings notes). Upon observation of the transients an immediate and complete shutdown of the survey equipment occurred. While continuously monitoring this group of animals a second group of transient killer whales were detected to the Northwest of the ship. Both sets of animals were easy to track due to the presence of whale watching vessels in their vicinity. After approximately 1.5 hours of continuous observation of both groups of transient killer whales it was determined that survey efforts for Haro Strait should be discontinued and the research vessel transited out of the area to a secondary survey area. No visible evidence of disturbance to these animals was documented.

Table 1. Summary of the Total Monitoring hours and Total Geoforce DTS Survey Operation hours occurring between August 11 and August 18, 2021 aboard the *CCGS Vector.*

Approximate Total Survey Hours	
MMO Observation	65 hr 18 min
Geoforce DTS Survey Time	58 hr 01 min
Geoforce DTS Survey Time delayed due to marine mammal sighting(s)	35 min
Geoforce DTS Survey Time stopped due to marine mammal sighting(s)	01 hr 23 min

Data collection summary & Marine Mammal species sighted

The bridge of the ship provided a useful platform for collecting sightings data during the Geoforce DTS system operation. Out of approximately 65 hrs and 18 mins of monitoring time, only 18 sightings of marine mammals were recorded (Appendix 1 & Table 2). Three of these sightings were of harbor seals (*phoca vitulina*) which were all detected outside of the exclusion zone. Ten of these sightings were of humpback whales (*megaptera novaeangliae*) off Cape Lazo, one of which comprised a humpback and calf observed during the 30 minute monitoring period prior to a system startup. All other humpback sightings were of individual animals, however, many of the sightings were of the same individuals being re-observed within the survey area and outside the exclusion zone. Two groups of Dall's porpoises (*phocoenoides* dalli) were also sighted off Cape Lazo during the 30 minute monitoring period prior to a system startup. Only one of these sightings was within the exclusion zone.

Three sightings of transient killer whales (*orcinus orca*) were observed during the entire research cruise. One of these sightings was of 5 individuals off Cape Lazo, which required a delay in system startup until the survey area was clear of killer whales for 30 minutes (see Appendix 1 for ship location at time of delay). The second and third sightings of two groups of transient killer whales occurred in Haro Strait and caused a system shutdown and ultimately the termination of the survey in that area (see Appendix 1 for ship location at time of system shutdown).

All sightings were recorded and submitted to the B.C. Cetacean Sightings Network and to the Coastal Ocean Research Institute Whale Report Alert System, which uses sightings from the public to alert large commercial vessels to the presence of whales in real time in order to reduce the potential for ship strike.

Table 2. Summary of marine mammal observations during Geoforce DTS survey operations occurring between August 11 and August 18, 2021 aboard the *CCGS Vector.*

Species	# Sightings	# Individuals	System Delays	System Shutdowns	Sightings in Exclusion Zone (<1km)
Seal	2	2	0	0	0
Humpback Whale	10	11	1	0	0
Dall's porpoise	2	4	1	0	1
Killer Whale (transient)	3	12	1	1	0

Summary

Every effort was made to record the presence of marine mammals during daylight hours while the vessel was transiting or engaged in active surveying. Although animal detection decreased with increased wind, nearly all of the survey work was conducted during acceptable sightings conditions. All mitigation measures, as outlined by DFO, were adhered to and at no time did seismic activity appear to visibly disturb a marine mammal. Further to the current mitigation strategies, work with local first nations and DFO scientists should be undertaken to determine actual detected underwater noise levels generated from this specific seismic survey equipment within a specific frequency critical to marine mammals and what the potential impacts to marine mammals may be.

APPENDIX 1 - Sightings

Sampling Saanich Inlet - August 12, 2021

Time	Operation	species	# animals	Behaviour	Direction	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
7:05 AM	**PRESURVEY (1/2 hr pre obs)**						48	36.997	123	30.529	unl	2	high overcast
7:45 AM	**SCAN COMPLETE - NO MM**						48	35.007	123	31.171	unl	2	clear, haze/smoke
7:57 AM	Lost power to winch						48	36.529	123	30.089	unl	2	clear, haze/smoke
8:30 AM	Power restored - returning to start of survey line												
9:00 AM	Gradual increase of sound - Geoforce DTS						48	40.013	123	30.811	unl	1	clear, haze/smoke
9:40 AM	**START SURVEY**						48	40.557	123	30.724	unl	1	clear, haze/smoke
12:13 PM	Completed turn back N in Saanich Inlet						48	36.860	123	32.475	unl	1	clear, haze/smoke
12:48 PM	**Seal Sighting**	*Phoca vitulina*	1			>1000	48	33.341	123	30.861	unl	1	clear, haze/smoke
2:22 PM	Completed perimeter survey line						48	39.317	123	29.783	unl	1	clear, haze/smoke
2:47 PM	Start turn for diagonal survey lines						48	38.171	123	31.156	unl	1	clear, haze/smoke
3:00 PM	Turn onto survey line						48	37.348	123	29.698	unl	1	clear, haze/smoke
4:25 PM	Turn onto survey line						48	35.027	123	31.023	unl	1	clear, haze/smoke
4:47 PM	Turn onto survey line						48	34.805	123	29.905	unl	1	clear, haze/smoke
4:56 PM	Turn onto survey line						48	34.565	123	30.686	unl	1	clear, haze/smoke
5:05 PM	Turn onto survey line						48	34.446	123	29.96	unl	1	clear, haze/smoke
6:25 PM	**COMPLETED SURVEY**						48	33.95	123	30.342	unl	1	clear, haze/smoke

Total Survey Time: 9 hrs 25 min

Total Monitoring Time: 11 hrs 20 min

APPENDIX 1 - Sightings

Sampling Stuart Channel - August 13, 2021

Time	Operation	species	# animals	Behaviour	Direction	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
6:57 AM	**PRESURVEY (1/2 hr pre obs)**						49	5.228	123	44.494	unl	1	clear, haze/smoke
7:27 AM	**SCAN COMPLETE - NO MM**						49	5.697	123	44.881	unl	1	clear, haze/smoke
7:40 AM	**START SURVEY**						49	5.658	123	44.769	unl	1	clear, haze/smoke
8:14 AM	**Seal Sighting**	*Phoca vitulina*	1			>1000	49	4.145	123	42.360	unl	1	clear, haze/smoke
10:00 AM	Transiting across Stuart Channel towards Ladysmith						49	0.543	123	43.199	unl	1	clear, haze/smoke
11:28 AM	**Seal Sighting**	*Phoca vitulina*	1			>1000	48	56.812	123	44.059	unl	1	clear, haze/smoke
12:37 PM	Turn south on survey line						49	2.098	123	43.505	unl	1	clear, haze/smoke
1:05 PM	Turn south on survey line						48	59.721	123	43.323	unl	1	clear, haze/smoke
1:38 PM	Turn onto survey line						48	57.293	123	44.365	unl	1	clear, haze/smoke
2:20 PM	Turn onto survey line						49	0.129	123	42.697	unl	1	clear, haze/smoke
3:16 PM	Turn onto survey line (NW)						48	57.261	123	43.537	unl	1	clear, haze/smoke
3:45 PM	Turn onto survey line (SE)						48	59.536	123	42.505	unl	1	clear, haze/smoke
4:25 PM	Turn onto survey line (NW)						48	56.432	123	43.662	unl	1	clear, haze/smoke
4:56 PM	Turn onto survey line (SE)						48	58.442	123	42.268	unl	1	clear, haze/smoke
5:23 PM	Turn onto survey line (NW)						48	56.228	123	43.187	unl	1	clear, haze/smoke
5:52 PM	Turn onto survey line (SE)						48	58.268	123	41.974	unl	1	clear, haze/smoke
6:20 PM	Turn onto survey line (NW)						48	55.997	123	42.762	unl	1	clear, haze/smoke
6:55 PM	**COMPLETED SURVEY**						48	57.864	123	41.393	unl	1	clear, haze/smoke

Total Survey Time: 11 hrs 15 min

Total Monitoring Time: 12 hrs 0 min

APPENDIX 1 - Sightings

Sampling Cape Lazo - August 14, 2021

Time	Operation	species	# animals	Behaviour	Direction	angle (port)	angle (stbd)	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
6:50 AM	**PRESURVEY (1/2 hr pre obs)**								49	41.878	124	42.933	unl	1	clear, haze/smoke
6:57 AM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	2	travelling	N		25	>8000	49	41.996	124	44.225	unl	1	clear, haze/smoke
7:00 AM	**Dall's porpoise Sighting**	*Phocoenoides dalli*	2	travelling	N		30	400	49	41.204	124	44.767	unl	1	clear, haze/smoke
7:02 AM	**Dall's porpoise Sighting**	*Phocoenoides dalli*	2	travelling	S		0	>1000	49	41.047	124	45.219	unl	1	clear, haze/smoke
7:15 AM	**Transient Killer Whale Sighting**	*Orcinus orca*	5	travelling	NE		45	>4000	49	40.256	124	47.474	unl	1	clear, haze/smoke
7:55 AM	**START SURVEY - 1/2 hr scan clear**								49	39.281	124	50.082	unl	1	clear, haze/smoke
8:30 AM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	fluking			20	>6000	49	41.471	124	47.163	unl	1	clear, haze/smoke
8:55 AM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	travelling	NW		5	>1000	49	42.880	124	45.275	unl	1	clear, haze/smoke
9:06 AM	Turn onto survey line (SW)								49	43.354	124	44.290	unl	1	clear, haze/smoke
10:05 AM	Turn onto survey line (NE)								49	39.334	124	49.084	unl	1	clear, haze/smoke
11:05 AM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	Rolling at surface, Pec Wave			90	1750	49	43.003	124	43.937	unl	1	clear, haze/smoke
11:07 AM	Turn onto survey line (SW)								49	42.882	124	43.737	unl	1	few, haze/smoke
12:08 PM	Turn onto survey line (NE)								49	38.945	124	48.175	unl	2	few, haze/smoke
12:58 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	travelling	W	30		>1000	49	42.207	124	44.030	unl	2	few, haze/smoke
1:23 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	breaching				>8000	49	41.809	124	43.990	unl	3	few, haze/smoke
1:24 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	tail slap		20		1500	49	41.790	124	44.010	unl	3	few, haze/smoke
2:15 PM	Turn onto survey line (NE)								49	38.736	124	47.899	unl	3	clear, haze/smoke
2:26 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	travelling, fluking	E			1300	49	39.044	124	46.994	unl	3	few, haze/smoke
3:22 PM	Turn onto survey line (SW)								49	42.296	124	42.379	unl	2	few, haze/smoke
3:53 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	travelling, fluking	E	5		1500	49	40.375	124	44.736	unl	3	few, haze/smoke
4:30 PM	Turn onto survey line (NE)								49	38.391	124	47.210	unl	3	few, haze/smoke
5:06 PM	Turn onto survey line (SW)								48	25.835	124	3.568	unl	3	few, haze/smoke
5:37 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	fluking	NE			>2000					unl	3	few, haze/smoke
5:47 PM	Turn onto survey line (NE)								49	37.994	124	46.613	unl	2	few, haze/smoke
5:58 PM	**Humpback Whale Sighting**	*Megaptera novaeangliae*	1	travelling	NE		20	1200	49	38.265	124	45.842	unl	2	few, haze/smoke
6:30 PM	Turn onto survey line (SW)								49	39.885	124	43.754	unl	2	few, haze/smoke
7:20 PM	**COMPLETED SURVEY**								49	37.612	124	46.088	unl	2	few, haze/smoke

Total Survey Time: 11 hrs 25 min

Total Monitoring Time: 12 hrs 30 min

APPENDIX 1 - Sightings

Sampling Howe Sound - August 15, 2021

Time	Operation	species	# animals	Behaviour	Direction	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
7:00 AM	**PRESURVEY (1/2 hr pre obs)**						49	20.630	123	19.379	unl	3	few/smoke
7:30 AM	**START SURVEY - NO MM**						49	20.704	123	19.396	unl	3	few/smoke
8:30 AM	**SURVEY COMPLETED - pull Geoforce DTS and transit up sound**						49	24.938	123	16.712	unl	2	few/smoke
9:26 AM	**START SURVEY - NO MM**						49	31.769	123	16.391	unl	2	few/smoke
10:50 AM	Turn onto survey line (W)						49	37.610	123	13.061	unl	2	few/smoke
12:25 PM	Turn onto survey line (N)						49	31.795	123	16.706	unl	2	few
1:07 PM	Turn onto survey line (W)						49	34.961	123	15.097	unl	3	few
1:30 PM	Turn onto survey line (E)						49	35.531	123	14.108	unl	3	few
1:36 PM	Turn onto survey line (W)						49	35.571	123	14.154	unl	3	few
1:56 PM	Turn onto survey line (E)						49	36.448	123	13.792	unl	3	few
2:09 PM	Turn onto survey line (W)						49	37.130	123	13.797	unl	3	few
2:33 PM	Turn onto survey line (SE)						49	37.719	123	14.922	unl	3	few
3:16 PM	Turn onto survey line (SE)						49	36.142	123	15.097	unl	3	Broken
3:30 PM	Turn onto survey line (W)						49	35.977	123	13.677	unl	3	Scattered
3:45 PM	Turn onto survey line (SE)						49	35.705	123	15.264	unl	3	Scattered
3:59 PM	Turn onto survey line (W)						49	34.852	123	14.515	unl	3	Scattered
4:37 PM	**COMPLETED SURVEY**						49	33.655	123	18.461	unl	3	Scattered

Total Survey Time: 9 hrs 07 min

Total Monitoring Time: 9 hrs 37 min

APPENDIX 1 - Sightings

Sampling Burrard Inlet - August 16, 2021

Time	Operation	species	# animals	Behaviour	Direction	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
7:00 AM	**PRESURVEY (1/2 hr pre obs)**						49	19.239	123	29.116	unl	2	overcast/light rain
7:30 AM	**PRESURVEY COMPLETE - NO MM**						49	19.318	123	29.229	unl	2	overcast/light rain
7:37 AM	**START SURVEY - NO MM**						49	19.273	123	28.909	unl	2	overcast/light rain
9:00 AM	**Stellar Sea Lion Sighting**	*Eumotopias jubatus*	1	travelling		1500	49	19.404	123	19.454	unl	2	overcast/light rain
9:21 AM	Turn onto survey line (SE) - transit into harbour						49	19.340	123	17.008	unl	2	overcast/light rain
10:34 AM	Passing first narrows						49	19.033	123	9.342	unl	2	overcast/light rain
12:33 PM	Turning up Indian Arm						49	18.837	122	54.567	unl	1	overcast/light rain
2:55 PM	Turn onto survey line (NE)						49	25.172	122	52.309	unl	2	overcast
3:30 PM	Head of Indian Arm - turn S						49	27.592	122	52.694	unl	2	overcast/light rain
6:04 PM	Turn at Roche Pt into Burrard Inlet						49	17.828	122	57.273	unl	1	overcast
6:20 PM	**COMPLETED SURVEY**						49	18.091	122	58.813	unl	1	overcast

Total Survey Time: 10 hrs 50 min

Total Monitoring Time: 11 hrs 20 min

APPENDIX 1 - Sightings

Sampling Haro Strait - August 17, 2021

Time	Operation	species	group	# animals	Behaviour	Direction	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
6:50 AM	**PRESURVEY (1/2 hr pre obs)**							48	30.242	123	13.503	unl	2	high overcast
7:20 AM	**PRESURVEY COMPLETE - NO MM**							48	28.797	123	14.384	> 5	2	light rain
7:30 AM	**START SURVEY**							48	29.138	123	14.249	> 5	2	few/smoke
8:14 AM	Turn onto survey line (SW)							48	31.855	123	13.258	> 5	1	few/smoke
8:58 AM	Turn onto survey line (NE)							48	29.388	123	14.998	> 10	1	few/smoke
10:20 AM	Turn onto survey line (NE)							48	29.633	123	15.756	> 10	1	few
11:00 AM	Turn onto survey line (SW)							48	32.185	123	14.835	> 10	1	few
11:08 AM	**Transient Killer Whale Sighting**	*Orcinus orca*	T18s	2	travelling		>4000	48	31.581	123	15.169	> 10	1	few
11:08 AM	**STOP SURVEY**							48	31.581	123	15.169	> 10	1	few
12:07 PM	**Transient Killer Whale Sighting**	*Orcinus orca*		5	travelling	W	>5000	48	31.621	123	15.748	unl	1	few
12:31 PM	Discontinue Survey - Depart area for Samsun Narrows							48	31.724	123	15.699	unl	1	few

Total Survey Time: 3 hrs 38 min

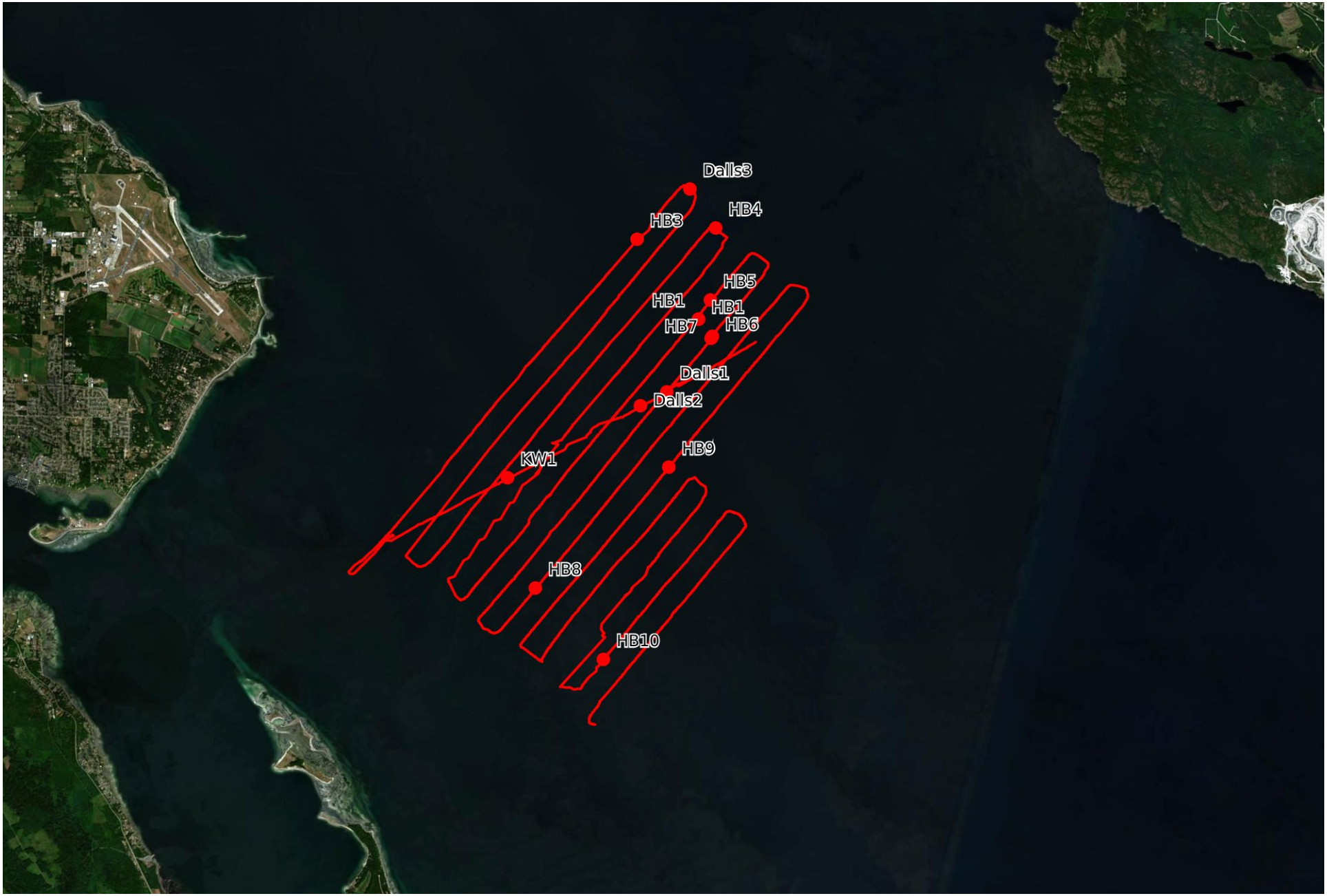
Total Monitoring Time: 5 hrs 40 min

APPENDIX 1 - Sightings

Sampling Samsun Narrows - August 17, 2021

Time	Operation	species	# animals	Behaviour	Direction	distance (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	vis. (nm)	sea state	weather
2:50 PM	**PRESURVEY (1/2 hr pre obs)**						48	42.928	123	31.139	unl	2	few
3:20 PM	**START SURVEY - NO MM**						48	44.043	123	32.673	unl	2	clear
5:35 PM	**Turn at end of survey line**						48	52.806	123	34.716	unl	2	clear
5:41 PM	**COMPLETE SURVEY**						48	52.501	123	35.166	unl	1	clear

Total Survey Time: 2 hrs 21 min
Total Monitoring Time: 2 hrs 51 min



Mercator Projection
WGS84
USNG 10UCV-10UCA
CALTOPO

5 10 15 km
1 2 3 4 5 6 7 8 9 mi

Scale **1:106022** 1 inch = 1.7 miles

N
MN
16°

Mercator Projection
WGS84
USNG Zone 10UDU

CALTOPO

1 2 3 4 5 6 7 8 9 km
1 2 3 4 5 mi

Scale **1:85187** 1 inch = 1.3 miles

N
MN
15°