

PROGRESS REPORT

**Assessing the Potential Effects of Near Shore
Hydrocarbon Exploration on Ringed and
Bearded Seals in the Beaufort Sea Region, 2006
(Year 4)**

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For

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ABSTRACT

A camp on the sea ice was established and occupied from 13 March – 1 April 2006. This was located 1.28 km SSW from the SDC drilling platform at Devon's Paktoa site N69 39.220 W 136 29.589. Drilling operations began 5 December 2005, and the well was tested and abandoned between 19 February and 20 March 2006. Systematic surveys with dogs detected seventy-four (74) seal structures in the study plot which measured 6 by 8 km. A total of eleven (11) ringed seals were captured, ten (10) of which were tagged with satellite transmitters. Thirty-three (33) ringed seals were collected by Tuktoyaktuk hunters 11-20 May 2006 for this study, from which biological specimens were obtained for age and body condition, disease, contaminants, PAH's, genetics and fatty acid profiles. An aerial survey was conducted from 28-30 May 2006 to count basking ringed seals in the same area as in the three previous survey years.



INTRODUCTION

This is the fourth and final year of a study designed to determine the distribution, densities, movements, behaviour, body condition and reproductive status of ringed and bearded seals living in the land-fast ice of the Beaufort Sea, in an area subject to drilling activity which began 5 December 2005 (Smith and Harwood 2003, 2004, 2005) with the SDC (photo right).

The results from this study will increase the knowledge base on the impact of the winter exploration activities on local seal population, and serve to:

- Provide advice on appropriate mitigating measures, which could be employed to avoid or reduce the impact of hydrocarbon exploration and development activities conducted during the ice covered period on local seal populations;
- Provide advice on suitable monitoring programs, which could be implemented to assess the longer term implications of hydrocarbon exploration and development activities on the local seal populations;
- Evaluate the methods and techniques used during the course of the study; and
- Incorporate the traditional knowledge of the Inuvialuit in the planning and implementation of the research.



The present progress report provides a summary of the 2006 field activities. This will be followed by the project report in late fall 2006, which will be published in the ESRF report series and provide an analysis and presentation of results from all four years of the study.

STUDY TIMING AND LOCATION, 2006

The field camp was established on the sea ice on 13 March 2006 at N 69 38.524 W136 29.479, a distance of 1.28 km SSW of the Paktoa site, where the SDC was drilling at N69 39.220 W136 29.589. Dog searches for seals (Smith and Stirling 1975, 1978) and the setting of traps in the breathing holes (Kelly and Quakenbush 1990) began on 17 March 2006. The last seals were captured, tagged with satellite transmitters and released 29 March, and the systematic dog surveys of the 6 by 8 km study area, identical to those of 2003, 2004, were completed the same day. The camp was pulled out on 1 April 2006.

The collection of biological specimens began on 11 May, and was completed on 20 May, with 33 ringed seals collected in total. All 33 seal carcasses were taken back to Tuktoyaktuk after the hunt and distributed to dog team owners in town. An additional 7 ringed seals were struck and lost by the hunters working on this project.

The systematic aerial survey of basking seals was flown on three consecutive days under excellent survey conditions, from 28 - 30 May 2006.

Consultation

Each year of the study, the Mackenzie Delta communities were consulted regarding results from the previous year and plans for the current year. For 2005/2006, the project was discussed with the Inuvialuit Game Council in June 2005, FJMC in August 2005, and with the Inuvik and Tuk HTC's on March 20 and 21, 2006 respectively.

METHODS

Sea Ice, Industry and Dog Searches

To gain information on the density, distribution and breeding status of seals, and to assess the effects of industry activity on seals in the near shore Beaufort Sea, this study was conducted from 2003-2006 in the western lease area held by Devon Canada. Three years of "pre-industry" study were completed in spring of 2003, 2004, and 2005. The drilling program began 5 December 2005, and the well was tested and abandoned between 19 February and 20 March 2006. During this period, an airstrip and an ice road were constructed. Demobilization of the drilling operation involving 30 semi loads were transported on the ice road between 20-31 March, and 42 twin otter flights used the airstrip between 16 February and 8 April 2006.

During the 2006 study, sea ice surface topography in the 6 by 8 km study area (red box on image below, 7 March 2006) was comparable to that seen in the 2003 and 2004 studies. Approximately 75% of the total area was passable allowing us to conduct dog searches and travel to most areas by snow machine. The ice was stable, but never more than 1.5 meters thick. The snow cover in the area appeared sparse this year. Those drifts, which did exist around ice hummocks and pressure ridges, were made up of loose snow and had not yet hardened sufficiently to form good sites for the making of seal lairs. One large crack was seen in the southern section of the study plot, which, in late March, began to open slightly. Seals had begun to use places along this crack as breathing sites. The ice in the northwest section of the study area was the roughest, containing rubble piles and several large pressure ridges.

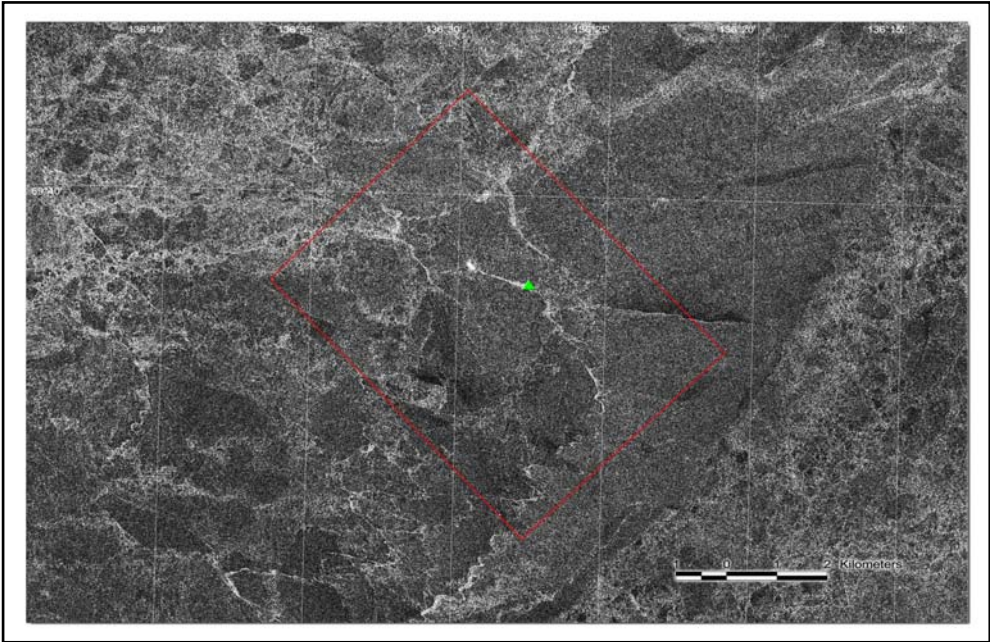


Photo credit: Sean McDermott, Horizon



Using three trained Labrador retrievers (photo below), who can detect the hidden seal structures by their keen olfactory sense, we conducted systematic surveys, in an area of ice measuring 6 by 8 km, and exactly where we had done identical work in 2003 and 2004. The 2005 study was adjacent to this study block, as a rubble field precluded working in the regular 6 x 8 km area.



Live-capture and Satellite Tagging

Seals were captured in trap nets that pursed below them when they entered their breathing holes (photo right). With funding from the Beaufort Sea Strategic Regional Plan of Action (BSSrPA), six traps, trigger boxes and antennas, all associated electronics and a receiver were purchased for this study. This equipment is modelled after that designed by Dr. Brendan Kelly of Alaska, and has proven successful in the live capture of seals in the Beaufort Sea at this time of year. The equipment was available for this year's project, and for future projects.



With this equipment, traps were monitored at distances of up to 5 km. The survey dogs were used to locate the seal breathing holes, and then the traps were deployed at multiple holes simultaneously (Kelly and Quakenbush 1990). The traps were monitored 24 hours per day. The greatest number of holes that were instrumented at any one time was ten, using a combination of the project equipment and equipment loaned to the project by the Alaskan colleagues. The instrumented breathing holes had to be visited regularly, daily where possible, to ensure the hole did not freeze over and that the trap remained functional.

When a seal enters an instrumented hole, the sound of the seal's breathing is transmitted to the camp, where it is picked up by the cycling FM receiver. Once a seal is known to be in a hole, the trap is triggered, the weight released to purse the net, and the seal is usually captured. There was no mortality as a result of this trapping method in any year of this study.

Five of the tags deployed in 2006 were SPOT (location only) and five were SPLASH (diving & location) tags manufactured by Wildlife Computers out of Redmond Washington USA. The satellite tag instrumentation in the SPLASH measures diving depth to a maximum of 1000 m, with a resolution of 2 m. The tags consist of transmitter, sensors, a strengthened antenna, 2 AA lithium batteries, circuitry, and a



microprocessor, all housed in an epoxy cast package.

The processor is programmed prior to deployment to collect and compress the data, and trigger the transmitter at each surfacing. The units were programmed for a maximum of 500 transmissions per day. The tags transmitted every time the seal hauled out and exposed the tag's antennae. In addition, information on the haul-out record (dry or wet readings from the salt water switch), the time spent at the surface, and the status of the sensors and battery performance were collected and transmitted in separate messages along with the location. Tags with diving capability also record time-at- depth categories, maximum dive-depths and number of dives, per six hour block of time. Tags were not duty cycled (i.e., they were not set to come on or go off at certain times to conserve battery life, as batter capacity was not limiting given study timing and parameters).



The tags were applied to the middle of the back of the seals, using five-minute epoxy glue warmed with a hair dryer to set the glue and secure the tag in position. The pelage was first cleaned with acetone. The seals were weighed, measured, claw bands counted and a small sample of skin taken for DNA analyses from the hind flipper area prior to release in 2006. Photos of each seal were taken for possible future identification purposes (photo left).

In 2006, seven additional SPOT tags, mounted on modified cattle ear tags, were attached to the hind flippers of the first seven seals, to which "regular" tags were also glued to their backs (photo right). These (location only) tags were deployed by the Alaskan scientists collaborating on this study, and may continue to transmit well beyond the 2006 spring moult and possibly for up to one year.



Seal Collection

In May 2006, a random sample of ringed seals was collected from within Devon's eastern lease area offshore of Tuktoyaktuk by a crew of four from the community. The target number of seals for this collection was 40 animals in each of 2004, 2005 and 2006. The 2006 season was the most successful to date in terms of obtaining the desired sample size.



The following information was taken from each seal: sex, date, location of kill, and the monitor's assessment of relative age. Seals were laid on their backs on a smooth flat surface, and using a steel tape measure, standard length (nose to tail) (± 1.25 cm) was measured (American Society of Mammalogists 1967). Body weight was measured to the nearest 0.5 kg using a spring dial scale suspended from a tripod. No corrections were made for blood loss. Other measurements taken by the monitor included blubber thickness at the sternum and at the hip, axillary girth and hip girth. The lower mandible and reproductive tracts were removed from all seals sampled (Smith 1973), as were samples of liver, kidney, muscle and blubber (for contaminants testing), blood and nasal mucous (for disease testing), skin (for genetics work), and liver and blubber (for PAH's, Fatty Acid profiling). These specimens were labeled, frozen in the field and at this time are in the freezers in Inuvik for shipping to the various laboratories.

One whole seal was determined sickly (thin) and was measured and weighed, then shipped whole to the collaborating veterinarian, Dr. Stephen Raverty, Center for Animal Disease, Abbotsford, BC for necropsy.

Aerial Survey

A systematic aerial survey of seals hauled out on the sea ice offshore of the Mackenzie Delta, which includes the Devon Lease areas, was conducted from 28 to 30 May along 15 pre-established north-south transect lines. The total transect distances flown in 2006 was 1302 linear km, with the range of coverage in past years being from 770 to 873 km. The effective survey area in 2006 was 1042 km², while surveyed area ranged from 551 – 616



km² in 2003-2005. The reason the coverage was greater in 2006 was that there was more ice available to survey and the weather was particularly favourable for surveying.

For the aerial survey transects, the planned survey speed was 200 km/h. The survey altitude was 152 m with the strip width of 400 m per side. Windows were marked using an inclinometer to delineate the inner and outer edges of the transect, which was offset from the flight path by 50 m to account for the area of reduced visibility directly under the aircraft. The north-south transect lines were spaced at 15' longitude, and covered Devon's western and eastern blocks.

Two experienced observers conducted the survey, and made tape recorded observations of ice, weather, and all marine mammals sighted. The same primary observers conducted the survey on all flights in all years of the study, from the same left and right rear seats, which were equipped with bubble windows.

Audiotapes were later transcribed to standardized data forms. Surveys were conducted in the afternoon and evening on each survey day to the extent possible. Sighting locations are determined using elapsed time, aircraft speed and the start and end coordinates for each transect from the aircraft's GPS. Radar satellite imagery for the corresponding date of each survey, or as close as possible to the survey date, were obtained from the Canada Space Agency for dates corresponding to the sea ice surveys and live capture work (7 March 2006) and the aerial survey (28 May 2006).



RESULTS

SEA ICE SURVEYS USING DOGS

Surveys were completed during the period 17-30 March 2006 using three dogs, Taps and Ulu (photo below), as in previous years, plus a young dog in training, Drummer. The study area was the same 6 by 8 km plot used in 2003-2004, which was searched along transects spaced at 500m intervals and run on bearings of 225°/45° true. The prevailing wind was from the NNE favouring these transect directions, which were at roughly 90 degrees to the scent of the seal structures being searched upwind.

Seventy four ringed seal structures were found during the systematic dog survey of the study plot (Appendix 1). No bearded seal breathing holes were found. Of the ringed seal structures, only four birth lairs and five resting lairs were found. A large proportion of the structures this year were breathing holes (36), plus 14 probable holes not seen because they were located under heavy ice. The only abandoned structures were six (6) non-tiggak breathing holes. All appeared to have been naturally abandoned since they were devoid of any predator sign or disturbance.



Fox tracks were first observed on 26 March and became abundant after that date. Only one resting lair was found in the surveys to be marked by fox urine. One dead pup, with remains of the umbilicus still showing, was found in a birth lair on 21 March. It had apparently been bitten in the head, possibly by a seal, since there was no sign of surface disturbance or entry into the lair.

Ten hobos were deployed on 30 March 2006, in active seal lairs. These were set to record air temperatures inside and outside the seal lairs, so that lair activity could be monitored. All ten hobos were retrieved on 4 May 2006 (photo right). One site had been opened by a bear, but the instrumentation was still intact (no. 67). A second site had been visited by a fox, but the instrumentation remained intact (no. 24). The wires on the hobo on a third site had been severed (72) but the hobo unit was recovered.



LIVE CAPTURE AND TAGGING 2006

In 2006, a total of 11 ringed seals, 8 males (7 of which were in rut), and 3 females (all sexually mature) were captured and released during the period 20-29 March 2006 (Appendix 2).

All captured seals appeared to be in good body condition. They were photographed for future identification and also tagged in the left hind flipper with a yellow plastic rototag (# 11-21). Ten of the seals were tagged with satellite transmitters glued to their backs and seven of these also had a satellite tag put on their hind flippers. The 11th seal was tagged only with a yellow Rototag (photo right).



All tags continued to transmit from deployment up until the moult in late May-early June. The longest lasting tag last transmitted on 20 June 2006. Analysis of the movement and diving data is underway.

Operating conditions this year were similar to those of 2003 and 2004, different from the rubble field/treacherous ice conditions encountered in 2005. The surface of the sea ice was smooth enough to allow access to most of the study area and the total number of seal structures found was similar to previous years. The paucity of consolidated snow drifts probably explains the dearth of birth and resting lairs. Nonetheless, rutting male structures and the captured seals showed that ringed seals in breeding condition were well represented in the area. All but one of the 11 captured seals, were sexually mature. Seals were found throughout the 6 by 8 km study area, including the vicinity of the camp and the SDC. Detailed spatial analysis of the seal structures, within and between years of the study, is underway at this time and will be included in the final report.



SEAL COLLECTION

A total of 33 ringed seals were collected from the fast ice by Tuktoyaktuk hunters for biological specimens. This was an increase in sample size compared with 2004 (13) and 2005 (22). The target in each year was 40 seals, and included any struck but lost seals. Specimens are presently being analyzed for age, reproductive history, body condition, with results to be compared with concurrent studies in Sachs and Holman, and compared to the long-term studies of ringed seal populations for the region available from the DFO database (Harwood *et al* 2000). Samples for

contaminants, metals, Omega 3 fatty acids, genetics and incidence of disease were also collected from these animals and will be included in DFO's database for the area that will include seals from Holman and Sachs Harbour in 2006. Stomach contents were obtained for 12 ringed seals, and these will be sent to the laboratory for identification and eventually included in the fish study being coordinated by Pete Cott of DFO.

One of the seals taken in the collection was deemed by the hunters to be sickly. The animal was sampled and measured, then shipped whole frozen to a veterinary pathologist for further analysis. This animal had a blubber thickness of 2 cm, which is 3 cm less than the average for the rest of the sample.

The collection of the 33 biological specimens revealed that the seals were in excellent body condition, on average with 4.9 cm of fat. Adult males and adult females were represented equally in the sample.

AERIAL SURVEY

The 2006 aerial survey was flown on three consecutive days from 28-30 May 2006, covering lines 2-16 inclusive, with replication of lines 3 and 15. A total of 1302 linear km were flown, with survey coverage of 1042 km².

Aerial surveys were flown 3 days earlier than in previous years, due to break up being ahead of schedule. Ice and weather conditions were good during the three days of the surveys. A total of 271 ringed seals were counted on transect, plus 4 beluga, 3 bearded seals, 2 polar bears and numerous polar bear tracks.



ACKNOWLEDGEMENTS

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From the communities, we acknowledge the enthusiastic and expert contributions in the field of our Inuvialuit technicians Ray Ettagiak, Joseph Felix Jr., Clarence Mangelana, Roger Memorana, Douglas Panaktalok, Charlie Ruben, the late Eric Ettagiak, Joe Nasogaluak, Peter Anikina, David Nasogaluak, Sam Pingo, Eric Cockney and Forrest Day (some in photo above). Dr. Brendan Kelly and John Moran of the University of Alaska Southwest, Juneau, provided invaluable advice, equipment, field assistance and instruction in the capture of the seals. Aaron Schweitzer of DFO provided valuable field assistance in 2006. Cal Wenghofer (DFO) assisted with the collection of instruments from lairs, and Dr. Stephen Raverty (Center for Animal Health) conducted a necropsy on the dead seal pup that was found. Our seal survey Labrador retrievers



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Taps and Ulu and the pup Drummer were unfailingly enthusiastic even in the harshest conditions. Aerial surveyors Kelly Cott and Magaly Chambellant are also gratefully acknowledged for their perseverance in the conduct of the aerial surveys over the years. We thank all those who have made contributions of their photographs.

The existence of a well maintained ice road all the way to the camp situated close to the SDC made the logistics of this year's project much easier. From the SDC/Devon, we thank Don Connelly, Marshall Borden, Randi Cofield and Sean McDermott and other staff from the SDC for support and assistance. From Chevron Canada, we thank Jerry Bullman, Don McDowell, and Peter Nelligan, and from Verilque Resources we thank Brian Buhr and others at Camp Farewell. We also thank Angus Alunik for expediting the project in all years, pilots from Canadian Helicopters and Highland Helicopters for safe helicopter flights, the drivers from Northwind Industries for expert hauling of our loads, and Alan Udell of Victory Point FX for processing Radar Sat imagery and the drafting of the figures. Diane Codère of E.M.C. Eco Marine Corporation, and Fred Taptuna, Alex Demeule, James Boraski and numerous staff of DFO for assistance with the project in many ways. This work was conducted under DFO Scientific License number SLE-04/05-328 and SLE – 05/06-322 and Animal Care Use Protocol FWI-ACC-2004-2005-001.



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Appendices

- 1. Dog search results for ringed seals**
- 2. Trapping Log**
- 3. Seal Collection Summary**
- 4. Aerial Survey Transects Flown**



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Appendix 1. Dog search results for ringed seals

Structures	Coordinates		Notes	Lairs			Breathing Holes			Structure of unknow type & status	Snow depth cm	Bearded seal	Bear dig	Bear kill
	N Latitude	W Longitude		Birth	Resting	Tiggak	Status	Hole	Tiggak					
001	N69 38.682	W 136 30.296				1	active							43
002	N69 38.916	W 136 30.894								1	ice cover			
003	N69 38.914	W 136 31.294						1		active				58
004	N69 38.789	W 136 31.096						1		active				24
005	N69 37.610	W 136 31.969									1			89
006	N69 37.837	W 136 31.523									1			105
007	N69 37.849	W 136 31.452						1		frozen				no snow
008	N69 38.025	W 136 30.664									1			54
009	N69 38.020	W 136 30.648			1		active							60
010	N69 39.524	W 136 26.617						1		active				22
011	N69 38.840	W 136 29.117							1	active				ice cover
012	N69 38.692	W 136 29.091				1	active							34
013	N69 38.951	W 136 29.045	Dead pup	1			active							38
014	N69 38.522	W 136 29.629						1		active				no snow
015	N69 38.089	W 136 31.685									1			ice cover
016	N69 38.091	W 136 31.690						1		active				18
017	N69 39.475	W 136 29.405						1		active				no snow
018	N69 39.724	W 136 28.744			1		active							60
019	N69 39.245	W 136 29.094							1	active				no snow
020	N69 38.653	W 136 29.123				1	active							46
021	N69 38.249	W 136 27.679									1			ice cover
022	N69 38.020	W 136 30.645									1			ice cover
023	N69 38.779	W 136 27.704						1		active				34
024	N69 39.135	W 136 26.598			1		active							69
025	N69 38.135	W 136 27.016									1			ice cover
026	N69 38.029	W 136 27.202									1			ice cover
027	N69 37.924	W 136 27.871							1	active				36
028	N69 37.860	W 136 28.259						1		active				no snow
029	N69 37.535	W 136 28.749									1			ice cover
030	N69 37.040	W 136 30.304									1			ice cover
031	N69 37.469	W 136 27.784									1			21
032	N69 37.469	W 136 27.786						1		frozen				ice cover
033	N69 37.377	W 136 28.047						1		frozen				20
034	N69 37.223	W 136 28.115									1			ice cover
035	N69 36.526	W 136 27.733				1	active							45
036	N69 36.227	W 136 27.519							1	active				20
037	N69 36.799	W 136 26.081												46
038	N69 36.802	W 136 26.085												40
039	N69 38.185	W 136 25.973							1	active				haul-out
040	N69 38.227	W 136 27.039									1			ice cover



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Appendix I cont'd

Structures	Coordinates		Notes	Lairs			Breathing Holes			Structure of unknow type & status	Snow depth cm	Bearded seal	Bear dig	Bear kill	
	N Latitude	W Longitude		Birth	Resting	Tiggak	Status	Hole	Tiggak						Status
040	N69 38.227	W 136 27.039								1	ice cover				
041	N69 38.348	W 136 27.096				1	active				ice cover				
042	N69 38.524	W 136 25.318				1	active				57				
043	N69 38.624	W 136 22.950						1		frozen	no snow				
044	N69 38.746	W 136 22.197						1		active	no snow				
045	N69 38.592	W 136 22.296						1		active	45				
046	N69 38.064	W 136 23.549						1		active	47				
047	N69 39.500	W 136 31.192						1		active	no snow				
048	N69 39.675	W 136 31.809						1		frozen	ice cover				
049	N69 40.489	W 136 30.366				1	active				40				
050	N69 40.226	W 136 31.425				1	active				46				
051	N69 39.905	W 136 31.647						1		frozen	ice cover				
052	N69 40.647	W 136 31.002						1		active	26				
053	N69 39.866	W 136 31.978							1	active	43				
054	N69 38.855	W 136 34.915				1	active				58				
055	N69 39.075	W 136 33.990				1	active				38				
056	N69 39.043	W 136 32.674						1		active	39				
057	N69 38.771	W 136 31.344		1			active				60				
058	N69 36.587	W 136 25.303						1		active	ice cover				
059	N69 37.429	W 136 23.353						1		active	on crack				
060	N69 38.522	W 136 29.633						1		active	no snow				
061	N69 38.240	W 136 32.033							1	active	ice cover				
062	N69 38.213	W 136 32.569		1			active				46				
063	N69 38.066	W 136 32.404							1	active	39				
064	N69 38.050	W 136 32.596				1	active				68				
065	N69 38.159	W 136 33.647				1	active				53				
066	N69 38.330	W 136 33.923							1	active	35				
067	N69 38.762	W 136 33.283		1			active				90				
068	N69 39.236	W 136 32.944							1	active	ice cover				
069	N69 37.116	W 136 29.985						1		active	28				
070	N69 37.619	W 136 26.333						1		active	27				
071	N69 38.101	W 136 26.162				1	active				69				
072	N69 39.203	W 136 29.159				1	active				81				
073	N69 39.424	W 136 27.617						1		active	38				
074	N69 39.715	W 136 25.855				1	active				58				
				2	2	10		15	5		1	0	0	0	



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Appendix 2. Trapping Log

Trapping Log, 2006 seal project											
Seal	PTT Alaska	DFO PTT	Date	length cm	Girth cm	weight kg	Sex	Age	Samples	Roto Tag	Comments
Pak0601	57997	23527	20/03/2006	105.00	107.00	54	M	6++	skin	11	Tiggak
Pak0602	57982	23529	20/03/2006	114.30	119.38	57	M	7++	skin	12	Tiggak
Pak0603	57983	23526	20/03/2006	107.95	111.76	55	M	5++	skin	13	Tiggak
Pak0604	57984	5092	21/03/2006	124.46	120.65	66	M	5++	skin	14	Tiggak
Pak0605	57988	57085	22/03/2006	117.00	119.00	75	F	6++	skin	15	pregnant, no nipples
Pak0606	57993	23528	23/03/2006	117.00	116.00	58	F	6++	skin	16	pregnant, no nipples
Pak0607	57980	57084	24/03/2006	119.38	111.76	64	F	5++	skin	17	pregnant, no nipples
Pak0608	N/A	21212	26/03/2006	126.00	117.00	65	M	6++	skin	18	Tiggak
Pak0609	N/A	11747	29/03/2006	124.00	114.00	59	M	7++	skin	19	Tiggak
Pak0610	N/A	5056	29/03/2006	121.00	119.00	75	M	6++	skin	20	Tiggak
Pak0611	N/A	N/A	29/03/2006	95.50	112.00	46	M	4+	skin	21	not Tiggak, no PTT
Dead pup	N/A		19/03/2006					less than 1 week	skin		bites to head; at necropsy S. Raverty



Appendix 3. Summary of seal collections

Summary of seal collections off Tuk, 2004-2006			
Parameter	2004	2005	2006
n=	13	22	33
no. females (%)	8 (61%)	13 (59%)	17(51.5%)
mean blubber thickness (cm)	4.6	4.7	4.9
mean weight (kg)	45.45	50.2	55.6
mean length (cm)	116.5	120.5	119.2
mean age (yr)	14.5	16.8	



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Appendix 4. Aerial survey transects flown in 2006

2006 aerial survey hauled up seals												
transect number	South Endpoint				North Endpoint*				Transect Length (km)	ransect leng n mi	Time (hr)	date (May 2006)
	2	69	12	136	45.0	69	54	136	45	77.78	42.00	0.39
3	69	18	136	30.0	70	10	136	30	96.30	52.00	0.48	28
4	69	24	136	15.0	70	10	136	15	85.19	46.00	0.43	29
5	69	29	136	0.0	70	20	136	0	94.45	51.00	0.47	28
6	69	31	135	45.0	70	20	135	45	90.75	49.00	0.45	29
7	69	37	135	30.0	70	20	135	30	79.64	43.00	0.40	28
8	69	37	135	15.0	70	20	135	15	79.64	43.00	0.40	29
9	69	41	135	0.0	70	20	135	0	72.23	39.00	0.36	28
10	69	42	134	45.0	70	20	134	45	70.38	38.00	0.35	29
11	69	44	134	30	70	20	134	30	66.67	36.00	0.33	28
12	69	44	134	15.0	70	17	134	15	66.67	33.00	0.31	30
13	69	39	134	0.0	70	20	134	0	75.93	41.00	0.38	28
14	69	37	133	45.0	70	20	133	45	79.64	43.00	0.40	30
15	69	33	133	30.0	70	30	133	30	82.56	57.00	0.53	28
16	69	33	133	15.0	70	10	133	15	45.52	37.00	0.34	30
3b	69	18	136	30.0	69	56	136	30	70.38	38.00	0.35	29
15b	69	33	133	30.0	70	10	133	30	68.52	37.00	0.34	30
linear km flown									1302.25			
km2 surveyed									1041.80			