ENCANA

YUKON/NWT GRAVITY SURVEY

FINAL REPORT

FORT LIARD, NORTHWEST TERRITORIES

August 15 to November 15, 2003

Submitted by:

EXCEL GEOPHYSICS INC.

Box 5056

302 Centre Street S

High River, Alberta, Canada T1V 1M3

Phone: (403) 652-1068

Fax: (403) 652-1085

Email: excelgeo@excelgeophysics.com

Prepared for:

ENCANA

2900 421 7th Avenue SW, PO Box 2850

Calgary, Alberta, Canada T2P 2S5

April 22, 2004

CONTENTS

FIGURES

TABLES

ENCLOSURES

AT THE END OF MAIN REPORT

Hardcopy Maps

1. Bouguer Gravity
2. Polynomial & 8km Regional Gravity
3. 4km Regional Gravity
4. 3km Regional Gravity
5. 2km Regional Gravity
6. 1500m Regional Gravity
7. 1500m Residual Gravity
8. Surface Geology
9. DEM

CD-ROM

A. Images (full size maps in jpg format)
   1. Bouguer Gravity
   2. Polynomial & 8km Regional Gravity
   3. 4km Regional Gravity
   4. 3km Regional Gravity
   5. 2km Regional Gravity
   6. 1500m Regional Gravity
   7. 1500m Residual Gravity
   8. Surface Geology
   9. DEM

B. Digital Data (Data Listings in Microsoft Excel spreadsheet)
   1. Observed Land Gravity Data
   2. Observed Longline Gravity Data
   3. Bouguer Gravity Data

C. Final Field Report
   1. Fort Liard Final Report.doc

UNDER SEPARATE 11” X 17” COVER

Hardcopy Data Listing

1. Observed Land Gravity Data
2. Observed Longline Gravity Data
3. Bouguer Gravity Data

INTRODUCTION

The following report describes the gravity survey conducted by *Excel Geophysics Inc.* (*Excel*) for *EnCana Corporation.* (*EnCana*) during the summer/fall of 2003. The Fort Liard area of exploration interest was defined as an approximately 5800 square kilometer block located in the Northwest Territories and Yukon, near Fort Liard. The survey was conducted from August 15 through November 15, 2003. This heavily forested and mountainous area was accessed and surveyed via helicopter. Figure 1 shows the location of the program.

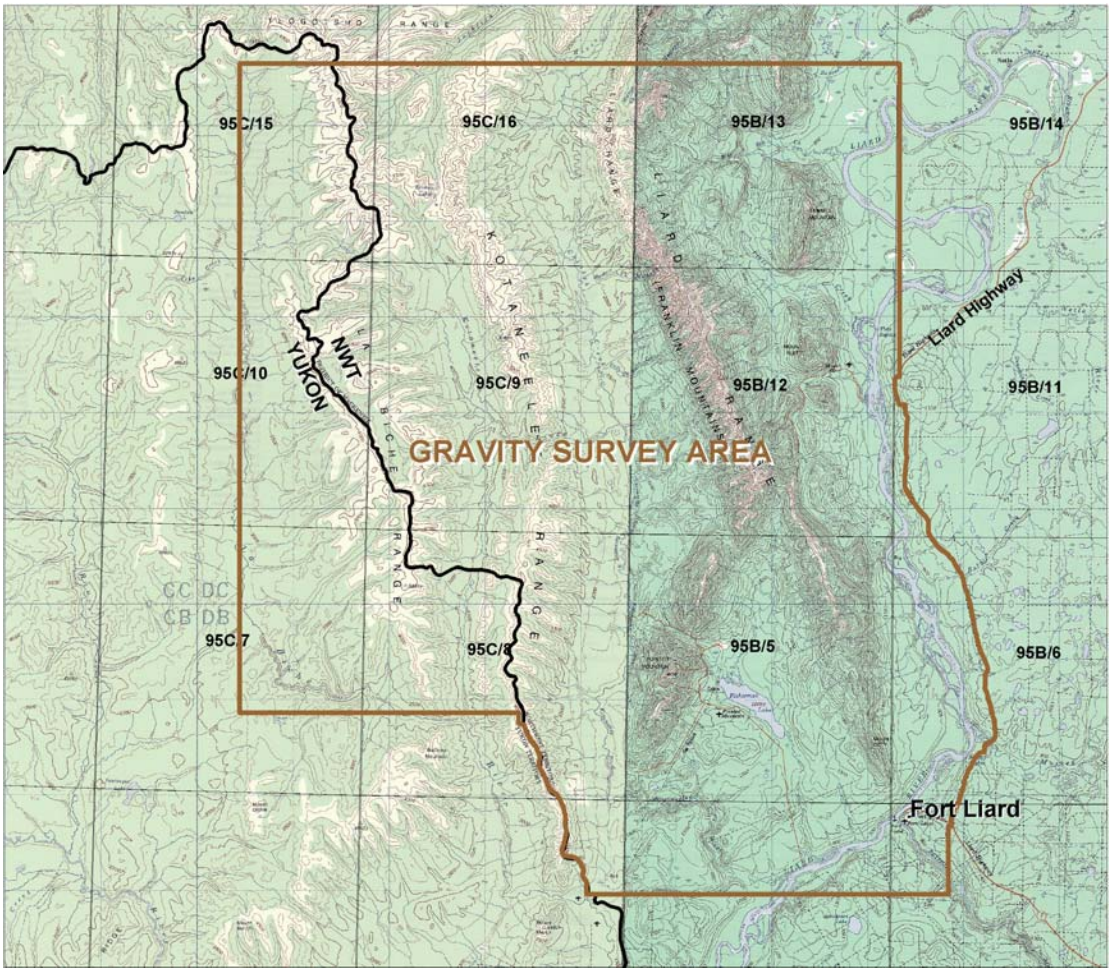

Figure 1. Fort Liard survey area

SAFETY

Each crewmember held current safety certifications in Emergency First Aid, H_2S Awareness, WHMIS and Bear Awareness. An emergency response plan, containing contact numbers and emergency procedures, was distributed and explained to all field staff. Safety meetings were held by the field staff to help identify any potential safety hazards. No injuries, accidents or incidents occurred during the survey. Safety meetings and hazards were discussed with the crew on a regular basis.

Excel ensured that each member of the crew was equipped with appropriate outdoor wear, a two-way radio, a cellular phone, a first-aid kit, and a fluorescent vest. Helicopters were maintained on a regular basis and were equipped with satellite phone, first-aid supplies, fire extinguishers, and emergency beacons.

A minimum of three helicopters were on site for the duration of the survey and had constant communication with each other in the field. In the case of an incident, there was always a second helicopter to be used for evacuation. Daily flight routes were planned in advance and a copy of this flight plan was posted in camp. This ensured that everyone on the crew knew the general location of the helicopters in the event of an emergency.

Dave West of Vertical Systems specializes in longline evacuation. Dave was on-site for the beginning on the project from August 16 through September 23, 2003. During the time Dave West was in camp, we surveyed the east edge of the project area which was determined to have higher risk of requiring longline evacuation if an accident were to occur. Steep terrain, thick undergrowth and tall trees caused there to be fewer landing sites and longline evacuation would be critical. On the western side of the survey, the topography changed to rolling hills and less tall trees therefore ample landing spots were available in the event of an accident requiring evacuation.

GRAVITY SURVEY PARAMETERS

The following two tables outline the main details of the gravity survey as well as the people involved with this project.

Table 1. Gravity Survey Parameters

Gravity Survey Parameters	
General Survey Location	Fort Liard, NWT. Latitude: 60° 10’ N – 60° 56’ N Longitude: 123° 45’ W – 123° 18’ W
Survey Duration	August 15 to November 15, 2003
Gravity Station Spacing	1000m
Gravity Stations Acquired	5768
Terrain Corrections	to 40 km
Methods of Transportation	Hughes 500 provided by Great Slave Helicopters and Bell 206 (Jet Ranger) provided by Trans North Helicopters
Longline Gravity Meters Used	LaCoste and Romberg U-27 LaCoste and Romberg U-18
Land Gravity Meters Used	LaCoste and Romberg G-181

Table 2. Project Personnel

Project Personnel		
***Excel* Operations Manager**	Jessica Pugh	
Gravity Field Crew	Vern Barcelona	Jay Cooke
	Rob Folkersen	Greg Johanson
	Sheldon Kasper	Camille LeRouge
	Jill Parsons	Dave Parsons
	Matt Stokes	Paul Teniere
Data Processors	Nicole Trenholm	Sheldon Kasper
***Great Slave* Pilots**	Gord Bean	Ian Hayne
	Guy Henry	Tom McMahon
	Clayton Shearcroft	Kevin Shott
	John Thorstiensson	Craig Ward
	Bert Wells	
Engineers	Rob Bacon	Kevin Clare
	Eric Draper	Linsay Gebarer
	Neil Laamanen	
***Trans North* Pilots**	Dave Reid	Doug Hladun
Engineers	Bryan Flucke	
Vertical Systems	Dave West	Eriks Suchous
***EnCana* Project Manager**	Doug Iverson	

GRAVITY SURVEY PROCEDURE

The survey crew consisted of three to five Excel geophysical operators/data processors, along with two to four pilots and one helicopter engineer from Great Slave Helicopters and one pilot and engineer from Trans North Helicopters. Great Slave Helicopters conducted the longlining portion of the survey while Trans North was used as the support helicopter to set-up base stations, sling fuel, and transport personnel. Excel had a supervisor on site for the duration of the project to coordinate all aspects of the operation including data quality control, client communications, aviation fuel placement, staffing, environmental compliance and adherence to safety guidelines.

Operations were based out of Fort Liard Open Camp located in Fort Liard, Northwest Territories. The camp is equipped with a dining area, sleeping accommodations, a recreation room, and laundry facilities.

The entire area of exploration interest was surveyed by helicopter. A longline gravity meter was slung under the helicopter on a 150-foot longline. Figure 2 shows an example of the Hughes 500 helicopter and Figure 3 shows the longline gravity apparatus as it appeared from the ground. Gravity readings were spaced at 1000m intervals. The Kodiak GPS navigation system was used for navigation to each gravity station using a preprogrammed set of coordinates. The precise location of the helicopter and gravity meter at each survey station was determined using geodetic grade Leica dual frequency GPS receivers. This aspect of the survey is described in detail under GPS survey procedure and processing.

Gravity data acquisition was conducted by the operator/processor keying computer controls linked via data cable to the suspended gravity meter. The pilot was required to first lower the suspended meter to the ground, lay out a few meters of slack in the cable to eliminate helicopter vibration to the meter, and then maintain a nearby hovering position. During this hovering phase a gravity reading was acquired. On average, a gravity reading was obtained every ten minutes.

Figure 2. Example of Hughes 500 Helicopter

Figure 3. Hughes 500 helicopter and longline gravity meter on the 150-foot longline

GRAVITY BASE STATIONS

The Fort Liard survey was tied to a local Geological Survey of Canada (GSC) gravity base 9153-1990 located at the Nursing station in Fort Liard. GSC base 9153-1990 is shown in Figure 4. *Excel* set-up three main bases for this project which were located at the Fort Liard airport, near the helicopter landing pads. The base out and base in gravity readings were recorded at the beginning and end of each day at these locations. Table 3 shows the coordinates and gravity values for all of the Fort Liard project bases.

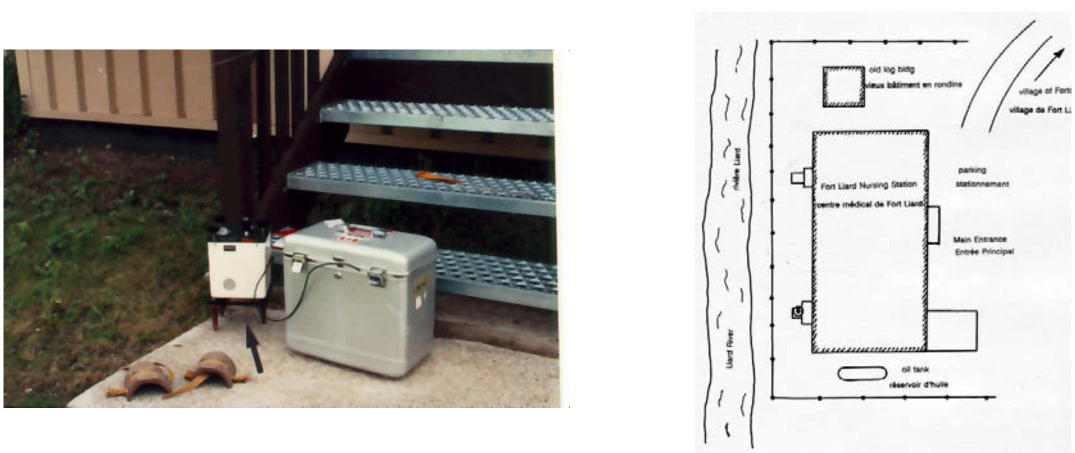

Figure 4. GSC Gravity Base 9153-1990, Fort Liard, NWT

Table 3. Sikanni Project Gravity Bases

Base Name	NAD 83 UTMx, m	NAD 83 UTMy, m	Observed Gravity mGal
Fort Liard; 9153-1990	473901	6678697	981811.64
Fort Liard Airport Longline Base 2831	473962	6677976	981810.64
Fort Liard Airport Longline Base 2832	473971	6677954	981810.50
Fort Liard Airport Longline Base 2833	N/A	N/A	981810.45

GPS SURVEY PROCEDURE AND PROCESSING

Excel established a GPS control base at the Fort Liard Open Camp. The coordinates for this base are shown in Table 4. This control base at the Fort Liard Camp was reoccupied each day in order to solve for our temporary field bases set up in the survey area, which in turn, were used as the base network to solve the data from our roving GPS units on the helicopter.

Table 4. Fort Liard Camp GPS Base

Base Name	NAD 83 Latitude	NAD 83 Longitude	Elevation (m)
Fort Liard Open Camp 283 08141	60° 14’ 37.398242”	123° 25’ 50.512097”	225.2504

Prior to gravity data acquisition each day, an *Excel* operator set up three or four Leica 299, 9500 or 500 series GPS receivers as temporary control bases. A helicopter was used to access suitable sites and a land gravity meter was used to obtain a reading at each of these sites. Figure 5 shows what these temporary control bases typically look like. This picture shows the equipment that was used; however, in actual practice the gravity reading is taken directly under the GPS base for accurate elevation control.

To ensure ample GPS coverage, the receivers were positioned so the distance to the roving unit on the helicopter was no more than five to eight kilometers.

Figure 5. Typical temporary GPS control base

Excel's operator/processor in the longline helicopter was responsible for recording multiple instantaneous readings with the Leica 500 GPS receiver on board. Multiple readings provide better accuracy for final results. The readings were recorded only when the gravity meter was placed on the ground and the helicopter was positioned directly above the meter with the longline cable fully extended. At that position, the distance from the gravity meter to the helicopter mounted GPS antenna can be treated as a constant. This constant is calculated from the length of the longline and the position of the antenna on the helicopter.

The Leica 500 series GPS technology was chosen for longline gravity application because of its reliability, fast satellite acquisition, ease of operation, and small size. It also has advanced kinematic operational modes that are well suited to a non-stationary recording platform, such as a hovering helicopter.

GPS data were processed each evening using Leica Geosystem's post-processing software. All field bases were used to calculate solutions for the GPS rovers on the helicopter. Factors such as satellite position, signal strength and topography affect the results; the highest quality solutions were selected for each station.

GRAVITY DATA REDUCTION

The Lacoste and Romberg land gravity meter (G-series) is operated manually and is capable of reliable and repeatable gravity readings to an accuracy of 0.02 mGal by experienced operators. The operator must ensure that the meter is operated at the recommended regulated temperature and level during the reading.

The date, time, dial reading and instrument height are recorded in a field notebook at the time each reading is made. A gravity base is measured at the beginning and end of each day to correctly account for meter drift. Each evening the field data are entered into a laptop computer and corrected for sun/moon tide and instrument drift to obtain the observed gravity. Refer to the *Observed Land Gravity Data Listing* (under separate cover) for the raw land data, observed gravity and intermediate reduction values for each day.

The Lacoste and Romberg longline gravity meter (U Series) works on the same principles and basic mechanics as the land gravity meter and is capable of reliable and repeatable gravity readings from the helicopter of 0.05 mGal by experienced operators. A laptop computer in the helicopter is linked to the longline meter through a data cable, enabling an operator to adjust the meter using servomotors. Temperature is monitored on the screen and leveling is done automatically. When a reading is taken the date, time, dial reading and a gravity value already corrected for sun/moon tide are written to a file. As with the land gravity meter, a gravity base station is recorded with the longline meter at the beginning and end of the day. In addition, a gravity reading is recorded at each helicopter refueling to correctly account for meter drift. Refer to the *Observed Longline Gravity Data Listing* (under separate cover) for the raw longline data, observed gravity and intermediate reduction values for each day.

After the GPS coordinates and elevations are processed and merged with the observed gravity for each station, intermediate corrections were applied to the observed gravity to yield final Bouguer anomaly values. See Table 4 for the formulae used to determine the intermediate corrections and Bouguer gravity values. Refer to the *Bouguer Gravity Data Listing* (under separate cover) for the Bouguer values and all intermediate corrections.

Table 5. Gravity Correction Formulae

Gravity Corrections	Description
Latitude Correction	Standard latitude correction adopted by the International Association of Geodesy, 1967. G=978031.85 * (1+0.005278895 $\sin^2$(latitude) + 0.000023462 $\sin^4$(latitude))
Free Air Correction	(elevation (m) – datum (m)) * 0.3068 mGal/m
Bouguer Correction	- (elevation (m) – datum (m))* density (g/cm^3) * (2.0 * pi * 0.006672) (note: density values vary depending on surface geology)
Terrain Corrections	Terrain corrections (2m to 40km) with variable densities computed with proprietary software.
Final Bouguer Values	Bouguer anomaly (mGal) = observed gravity – latitude correction + free air correction + Bouguer correction + terrain corrections

The elevation datum used in this survey was 900m.
Gravity correction units are in mGal.

DATA QUALITY

The gravity survey was of excellent quality. A critical examination of the residual gravity maps reveals that the survey is clearly within an error envelope of 0.05 mGal.

WILDLIFE

The Liard Range is habitat for an abundant variety of animals. On September 11, 2003, the wildlife biologist Nic Larter went to the field with the crew and monitored the activities of the helicopters. Mr. Larter also scouted the Liard Range for the presence of sheep in the area. It was determined that this area provides habitat for hundreds of sheep. Sheep are particularly sensitive to helicopter disturbance, therefore we ensured that we surveyed only one side of the range in the same day. This allows escape routes for the sheep and minimizes disturbance. Also, if sheep were visible in the area, then we would stay a minimum of one to three kilometers away from the sheep or stay clear of the area and return a different day. At the completion of the survey, no environmental damage had been done and no trace of our presence remained. Appendix C gives a detailed listing of the wildlife sightings during this survey.

SUMMARY

No incidents or accidents occurred on this project. The survey was conducted in a timely manner and completed on schedule. There was little to no negative impact to the wildlife in the area. This was a successful survey as we achieved very accurate results in an extremely rugged and inaccessible region.

APPENDIX A - UTM Zone 10 Coordinate System Parameters

The coordinate system used for mapping purposes is UTM Zone 10 (NAD83). All data was collected and processed in NAD83. Parameters for the WGS84 ellipsoidal coordinate system with NAD 83 grid projection are shown in Table 5.

Table 6. UTM Zone 10 Mapping Parameters

Project Mapping System	
Datum	NAD 83
Ellipsoid	WGS 84
Latitude of Origin	Equator, 0º
Central Meridian	123º W
Grid Projection	UTM Zone 10
Scale Factor	0.9996
False Easting	500,000.0 m
False Northing	0.0 m

Ellipsoids:	**WGS 84**
Semi-major axis	6378137.0 m
Semi-minor axis	6356752.3 m

APPENDIX B - Data Listing Format of Reports in 11 x 17 binder

Observed Longline Gravity Data

The Observed Longline Gravity table contains the listing of all longline data collected by the crew during the survey period. The data is presented in chronological order for each meter used on that survey day.

Each day of data for the meter is separated with a blank row. Station numbers were assigned in a row-column format during the initial layout phase of the project. The gravity base was always assigned a line number 0 and can be seen at the start and end of each day. Fuel caches were assigned a line number of 55. The date, time, Greenwich Mean offset and project location is used to compute the sun/moon gravity tide correction.

Observed Land Gravity Data

The LaCoste and Romberg land gravity meter uses a zero length spring supporting a mass on a beam as is standard in all modern gravity meters. A counter dial is turned to adjust the position of the beam to a recommended position. The meter is nulled when it is level and the beam is at this position. A calibration table is used to convert the reading dial value to a value in mgals. Gravity meter drift can be accurately identified and corrected by reoccupying a known gravity station.

The relative gravity is computed by summing all of the terms:

Relgrav = calibrated counter reading + HI correction + tide correction - drift

Gravity base values can be seen in Table 3.

Bouguer Gravity Data

The Bouguer Gravity table displays the raw gravity and coordinate data with the applied corrections and variable density Bouguer gravity values. The table summarizes all of the collected data including the survey coordinates, elevation, and gravity at each station location. Latitude and Longitude values are given as well as UTM zone 10 coordinates in NAD83. The elevations shown are above mean sea level calculated using the GSD95 geoid model. The intermediate corrections include the correction for latitude, elevation from a datum of 900m and the Bouguer correction. The Bouguer gravity is computed using density values determined from surface geology which range from 2.50 g/cm^3 to 2.72g/cm^3. Terrain corrections were calculated for all stations using DEM data.

APPENDIX C – Wildlife Sightings

Date	Approx.	Approximate Location		Type of Animal	Number
	Time	Latitude	Longitude		Of
		(N)	(W)		Animals
(mm/dd/yy)	(hh:mm)	(dd mm ss.s)			
08/17/03	19:40	60 20 41.8	123 30 30.2	Black Bear	1
08/25/03	13:17	60 34 05.2	123 45 51.8	Black Bear	1
08/29/03	08:00	60 29 01.6	124 00 56.8	Moose	1
08/30/03	19:30	60 25 55.7	123 52 59.9	Black Bear	1
09/06/03	16:00	60 31 45.3	124 05 40.7	Black Bear	1
09/15/03	14:30	60 54 51.2	123 38 28.3	Swans	2
09/15/03	19:30	60 50 16.3	123 30 29.4	Swans	2
09/15/03	19:30	60 50 16.3	123 30 29.4	Moose	2
09/16/03	14:00	60 46 33.8	124 12 25.5	Moose	3
09/16/03	14:40	60 40 39.5	124 09 02.4	Moose	2
09/16/03	14:45	60 47 58.9	124 15 38.4	Moose	1
09/16/03	20:00	60 50 17.2	124 12 12.0	Moose	2
09/17/03	17:50	60 38 21.5	124 14 24.7	Moose	3
09/21/03	16:45	60 36 02.1	124 13 27.5	Black Bear	1
09/28/03	10:00	60 50 54.5	124 36 03.2	Moose	5 – 10
09/30/03	15:12	60 48 24.8	124 17 18.2	Sheep	4
09/30/03	17:10	60 46 48.8	124 13 39.4	Moose	2
09/30/03	17:10	60 46 48.8	124 13 39.4	Beaver	1
10/01/03	09:20	60 49 28.4	124 20 10.4	Grizzly Bear	1
10/01/03	09:30	60 47 28.0	124 16 43.0	Sheep	6
10/02/03	09:30	60 38 26.1	123 51 30.6	Sheep	6
10/03/03	08:30	60 45 24.5	123 55 33.9	Sheep	6
10/04/03	08:30	60 53 17.8	124 01 29.3	Grizzly and cubs	3
10/05/03	09:30	60 53 17.8	124 01 29.3	Grizzly and cubs	3
10/05/03	09:30	60 53 29.9	124 01 07.0	Sheep	10
10/05/03	15:30	60 52 19.8	123 59 40.9	Sheep	10
10/05/03	13:10	60 53 26.0	123 59 39.8	Grizzly and cubs	3
10/05/03	13:10	60 53 26.0	123 59 39.8	Grizzly and cubs	3
10/05/03	11:15	60 53 57.7	124 02 59.6	Sheep	6
10/05/03	14:55	60 53 57.5	124 00 45.4	Sheep	8
10/05/03	13:40	60 51 16.2	124 01 40.4	Sheep	10
10/05/03	14:05	60 55 01.1	123 58 35.4	Sheep	6
10/06/03	13:00	60 42 30.0	123 51 15.0	Grizzly Bear	1
10/06/03	14:30	60 17 14.1	123 40 29.4	Swans	5
10/06/03	15:30	60 20 55.6	123 53 32.0	Black Bear	1
10/06/03	17:00	60 23 07.8	124 10 37.9	Grizzly Bear	1
10/08/03	12:15	60 36 53.8	124 41 01.6	Moose	3
10/08/03	16:15	60 24 32.3	124 15 57.5	Black Bear	1
10/08/03	17:20	60 27 54.3	124 11 26.5	Grizzly Bear	1
10/11/03	14:30	60 36 53.1	124 41 01.6	Moose	2
10/11/03	14:35	60 35 00.2	124 34 21.8	Moose	3
10/11/03	15:40	60 28 34.9	124 11 31.5	Bear	1

Date	Approx.	Approximate Location		Type of Animal	Number
	Time	Latitude	Longitude		Of
		(N)	(W)		Animals
(mm/dd/yy)	(hh:mm)	(dd mm ss.s)			
10/12/03	19:10	60 25 45.9	124 27 15.5	Moose	1
10/20/03	10:00	60 30 44.7	124 30 02.3	Grizzly Bear	1
10/29/03	14:07	60 33 13.6	124 34 27.6	Moose	3
10/29/03	14:15	60 30 12.3	124 25 34.3	Moose	4
10/30/03	14:05	60 45 50.9	124 33 31.5	Moose	4
10/30/03	14:07	60 34 37.5	124 33 23.4	Moose	3
11/01/03	13:30	60 35 56.5	124 32 38.6	Moose	14
11/01/03	13:35	60 32 42.1	124 30 07.0	Moose	4
11/01/03	13:40	60 32 54.6	124 27 32.9	Moose	1
11/02/03	08:50	60 14 44.5	124 05 15.7	Moose	2
11/03/03	09:20	60 15 44.3	124 04 22.4	Moose	2
11/03/03	16:00	60 15 23.9	124 04 49.0	Moose	2
11/03/03	16:00	60 17 18.4	124 02 12.1	Moose	2
11/04/03	09:30	60 31 49.4	124 26 38.0	Moose	4
11/04/03	09:30	60 33 04.1	124 28 38.3	Moose	3
11/04/03	09:30	60 33 44.0	124 29 36.0	Moose	2
11/04/03	09:30	60 36 56.0	124 33 04.0	Moose	7
11/04/03	16:55	60 33 00.0	124 28 24.0	Moose	2
11/05/03	09:00	60 34 53.0	124 30 43.0	Moose	2
11/05/03	09:40	60 35 41.0	124 32 06.0	Moose	2
11/05/03	09:45	60 34 06.0	124 29 20.0	Moose	20
11/05/03	09:50	60 32 55.0	124 20 21.0	Moose	8
11/05/03	16:30	60 28 21.0	124 26 04.0	Moose	9
11/05/03	16:35	60 28 59.0	124 28 52.0	Moose	1
11/05/03	16:40	60 30 37.0	124 34 51.0	Moose	3
11/05/03	16:45	60 41 57.0	124 38 42.0	Moose	2
11/05/03	13:28	60 39 34.8	124 37 38.2	Moose	4
11/05/03	10:13	60 31 00.3	124 31 51.1	Moose	3
11/05/03	10:44	60 32 42.8	124 30 42.4	Moose	3
11/05/03	10:15	60 31 00.3	124 31 51.0	Moose	9
11/05/03	12:58	60 33 08.5	124 36 11.9	Moose	3
11/05/03	13:03	60 33 39.6	124 36 15.5	Moose	2
11/05/03	11:00	60 35 55.3	124 31 59.0	Moose	7
11/05/03	10:35	60 36 55.2	124 33 14.7	Moose	2
11/09/03	09:15	60 31 20.0	124 26 12.0	Moose	4
11/09/03	09:18	60 32 03.0	124 26 59.0	Moose	2
11/10/03	12:15	60 30 36.0	124 34 10.0	Moose	2
11/10/03	12:18	60 31 27.6	124 35 33.4	Moose	1