ATTACHMENT A
ENVIRONMENTAL IMPACT ANALYSIS

FIGURES

Figure 1-1
Study Area Map

BP Exploration (Alaska) Inc.
Liberty uERD Development

Figure 1-2
Alternatives

Existing Pipeline
Potential Pipeline Route
Existing Road
Potential Road Route

Aerial Photos Taken Summer 1998
(Photo Mosaic © AERO-METRIC, Inc.)

MAP LOCATION
ALASKA

Scale in Miles
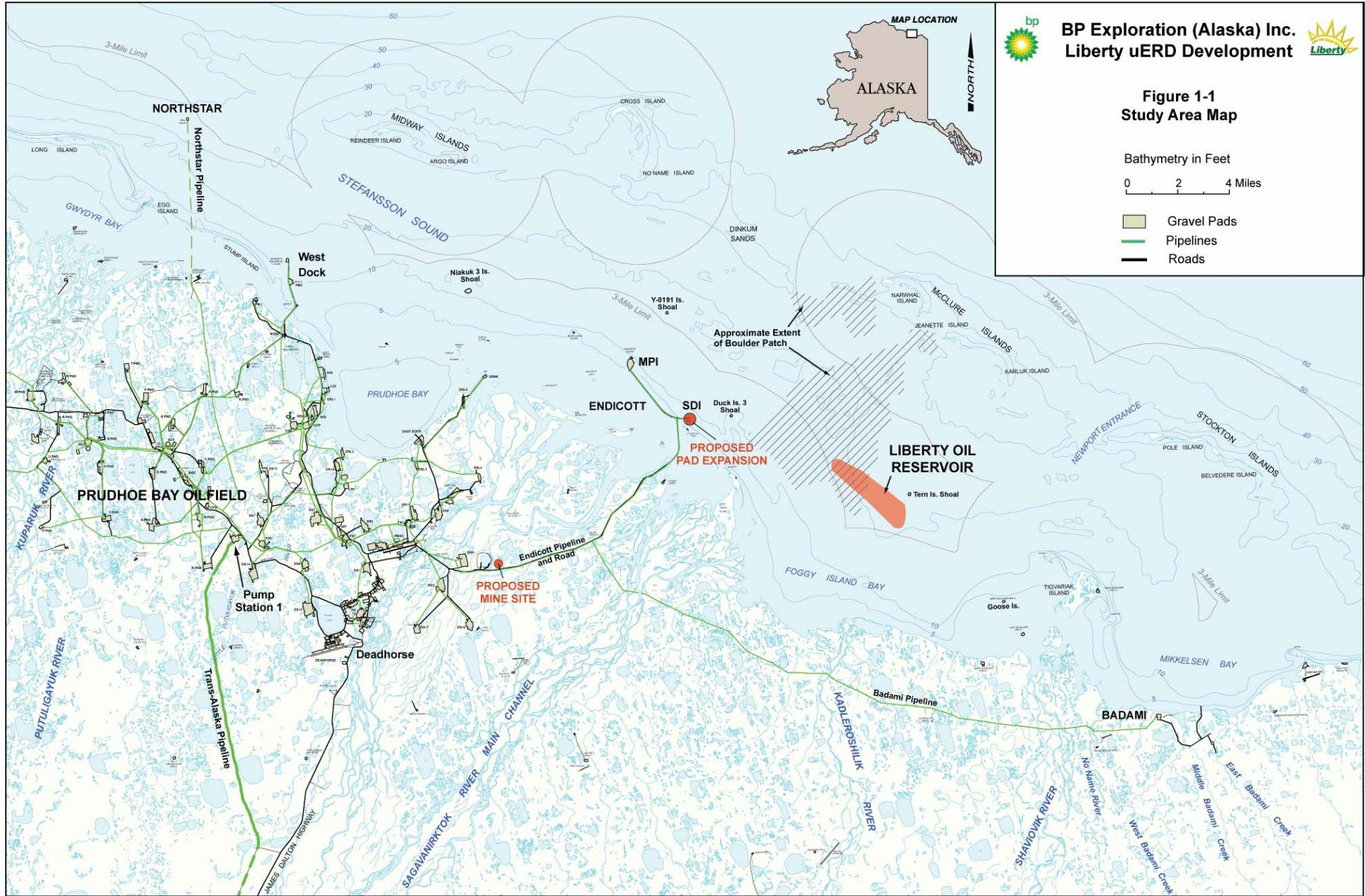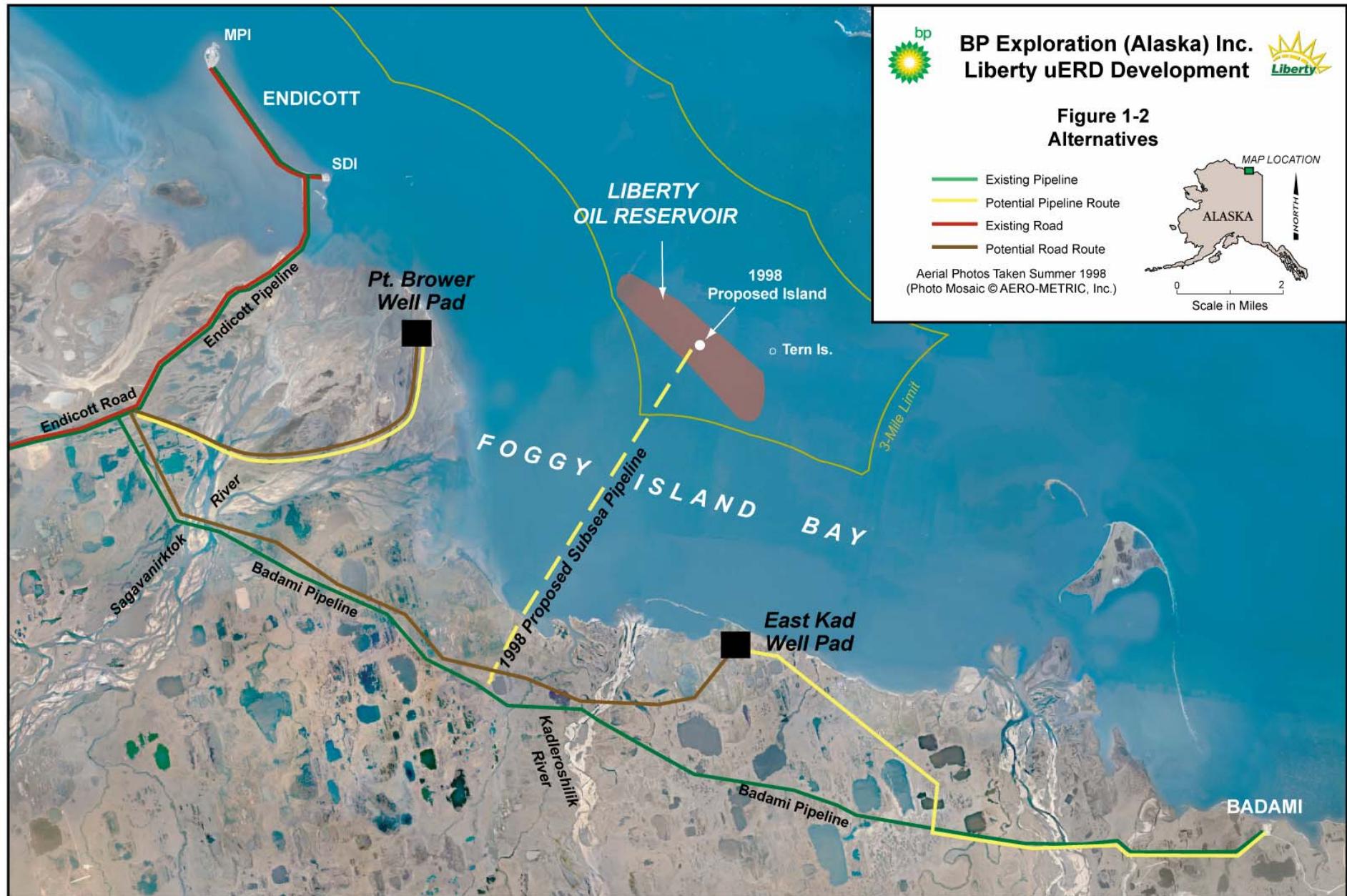
Figure 2.1-1
Location of the Meteorological Stations on the North Slope
Source: NCDC (2005)
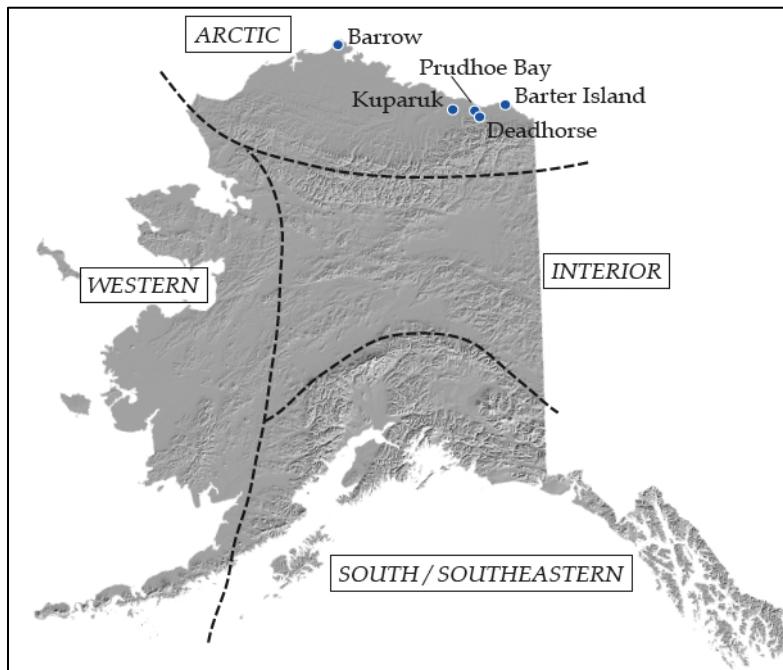
Figure 2.1-2
Annual Course of Temperature for Barrow (Mean High and Low, and Record Maximum and Record Minimum Based on the 30-Year Time Period 1975-2004)
Source: NCDC (2005)
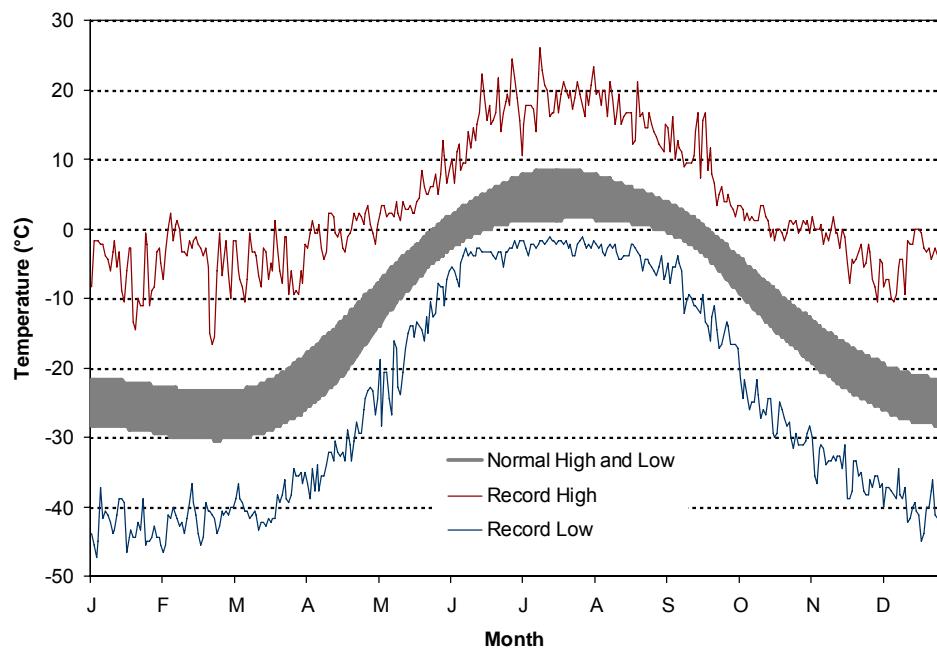
Figure 2.1-3
**Mean Daily Snow Depth at Barrow and Barter Island**
Source: NCDC (2005)
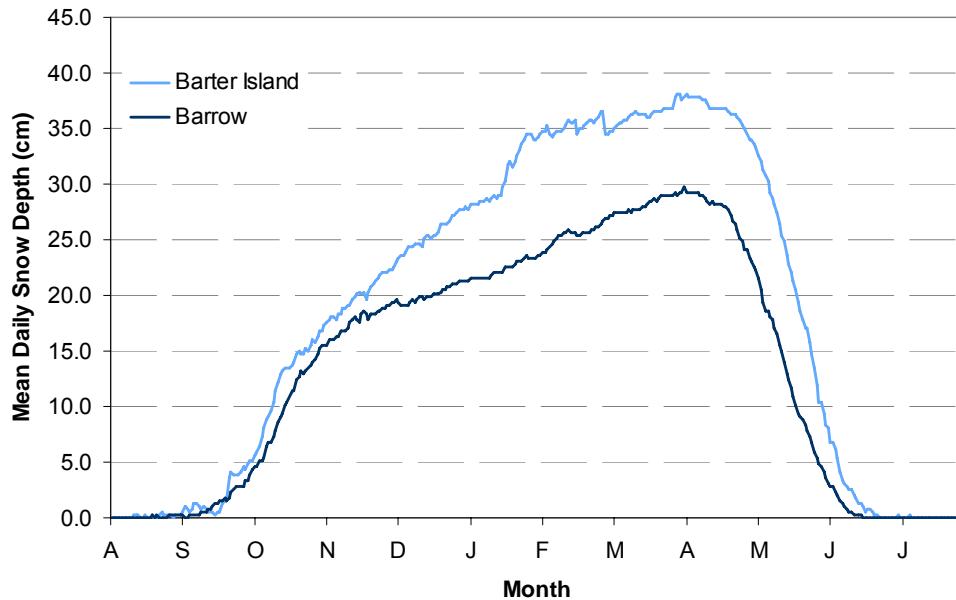
Figure 2.1-4
Wind Rose for Barrow
Source: NCDC (2005)
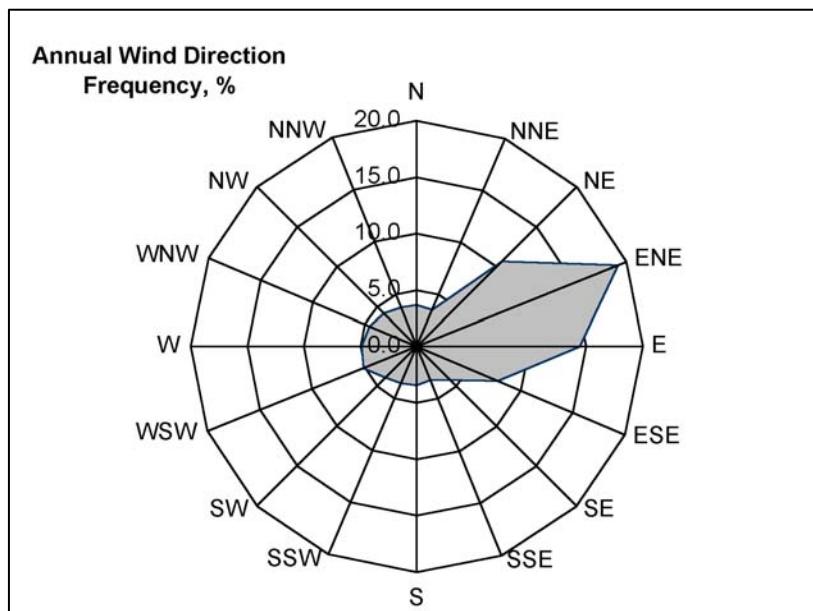
Figure 2.1-5
**Number of Days per Year with Wind Speed in Excess of 30 kt at Barrow (1987-2003)**
Source: NCDC (2005)
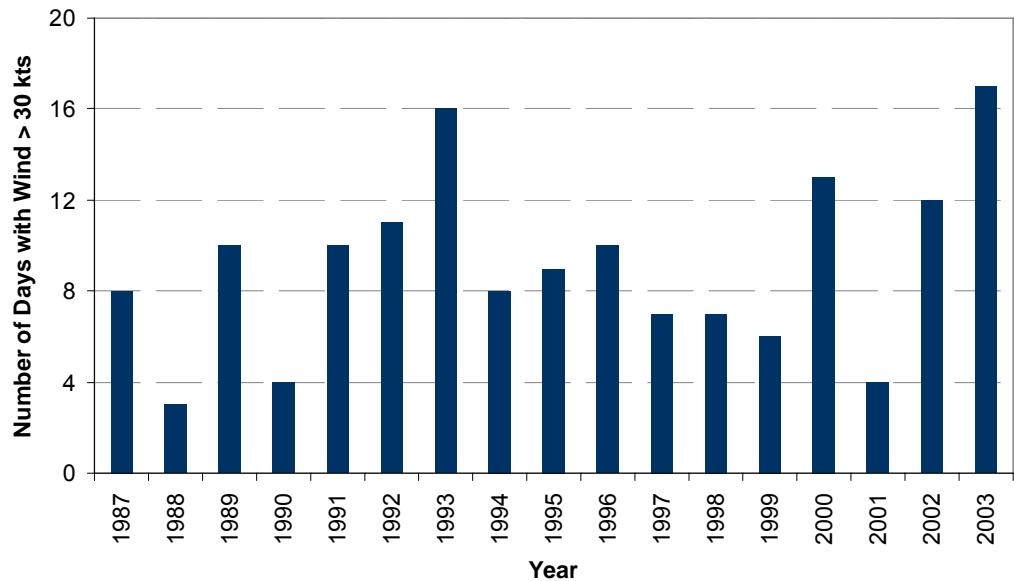
Figure 2.1-6
Mean Annual Temperatures for North Slope Climatological Stations
Source: NCDC (2005)
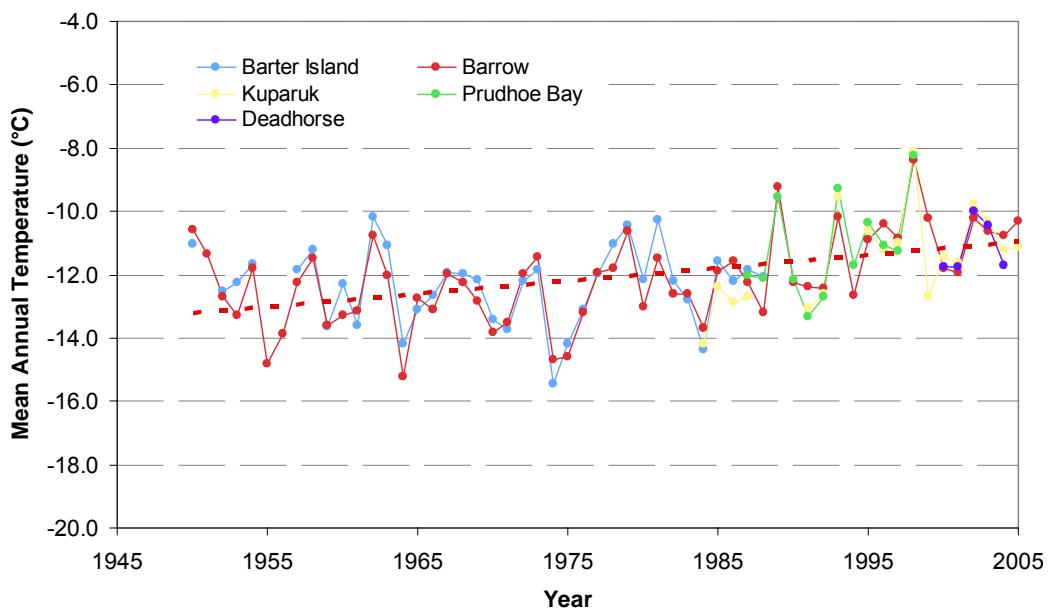
Figure 2.1-7
Mean Annual Ice Concentration in the Beaufort Sea for a 50-Km-Wide Strip
**off the Coast of Northern Alaska**
Source: Wendler et al. (2003)
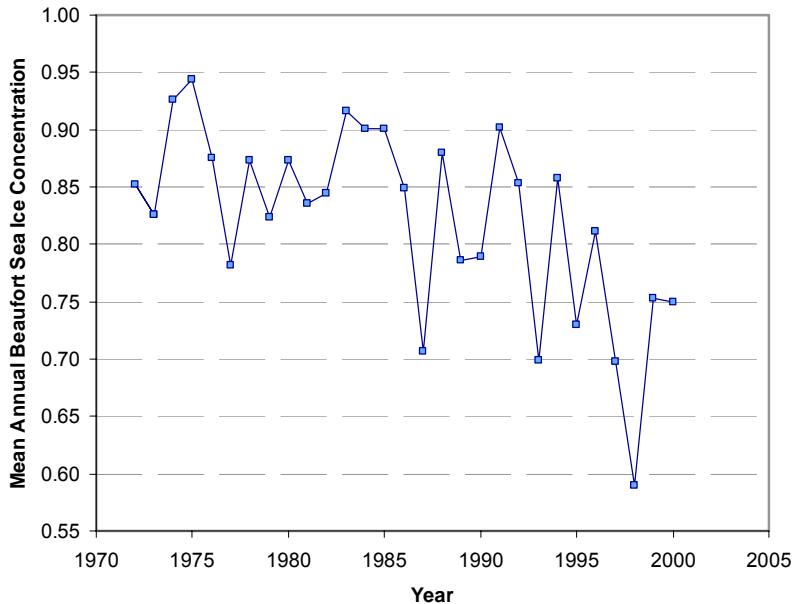
Figure 2.1-8
Number of Days per Year with a Daily Minimum Temperature
**Below -18°C and -34°C for Barrow (1949–2004)**
Source: NCDC (2005)
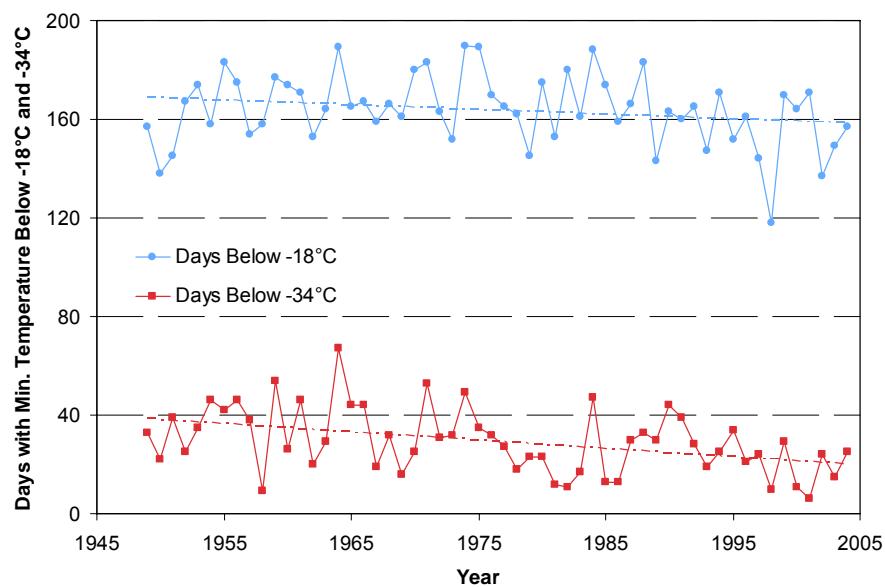
Figure 2.1-9
Number of Days per Year with a Daily Maximum Temperature
Above 0°C and 10°C for Barrow (1949-2004)
Source: NCDC (2005)
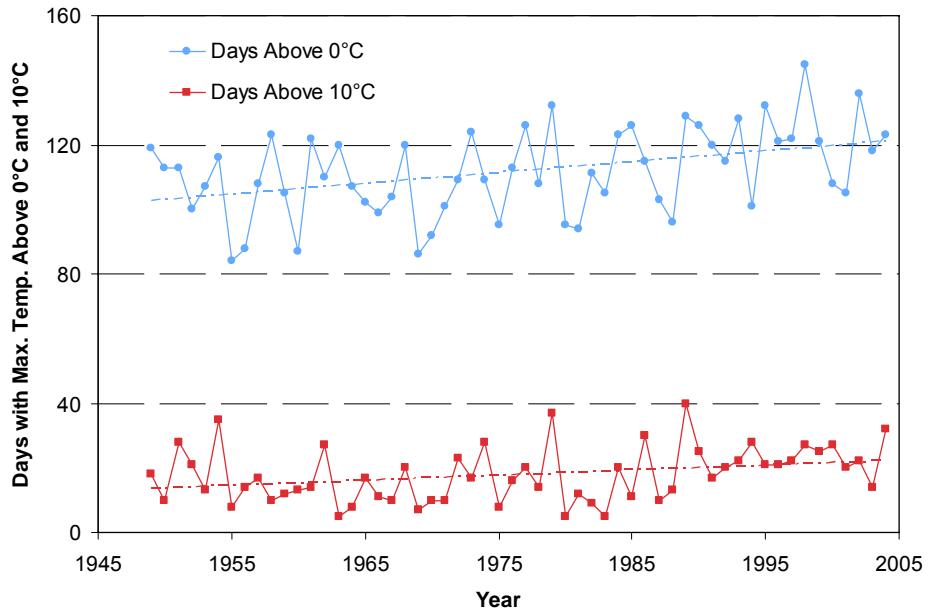
Figure 2.3-1
Foggy Island Bay and Sites of Bluff Erosion Studies
Source: NCDC (2005)
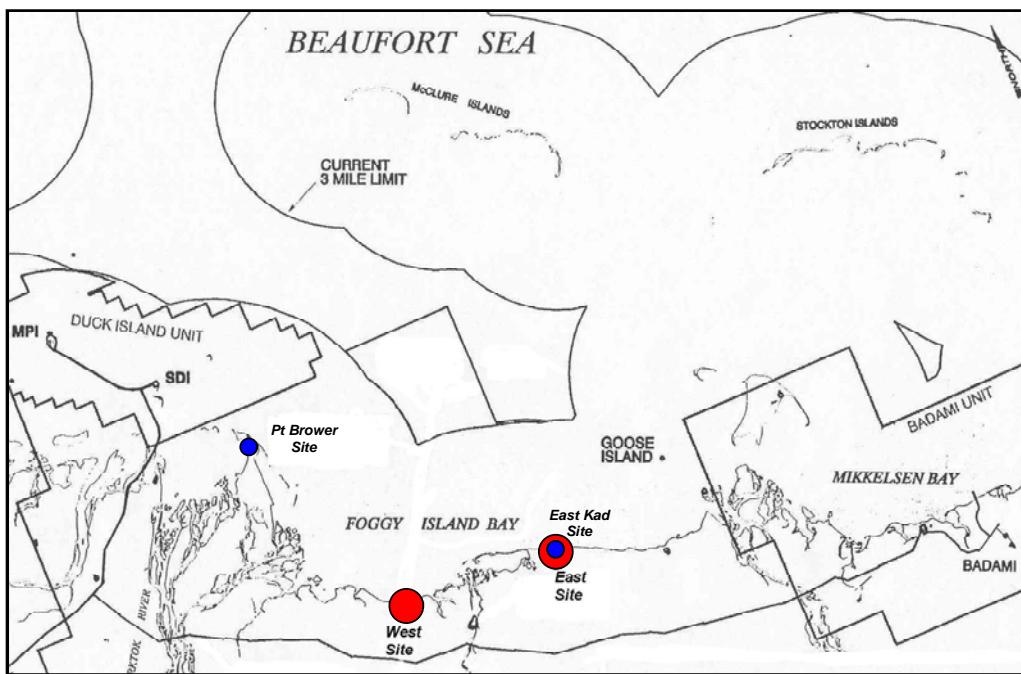
Figure 2.4-1
Wave Prediction Stations Near Endicott SDI
Source: Resio and Coastal Frontiers (2007)
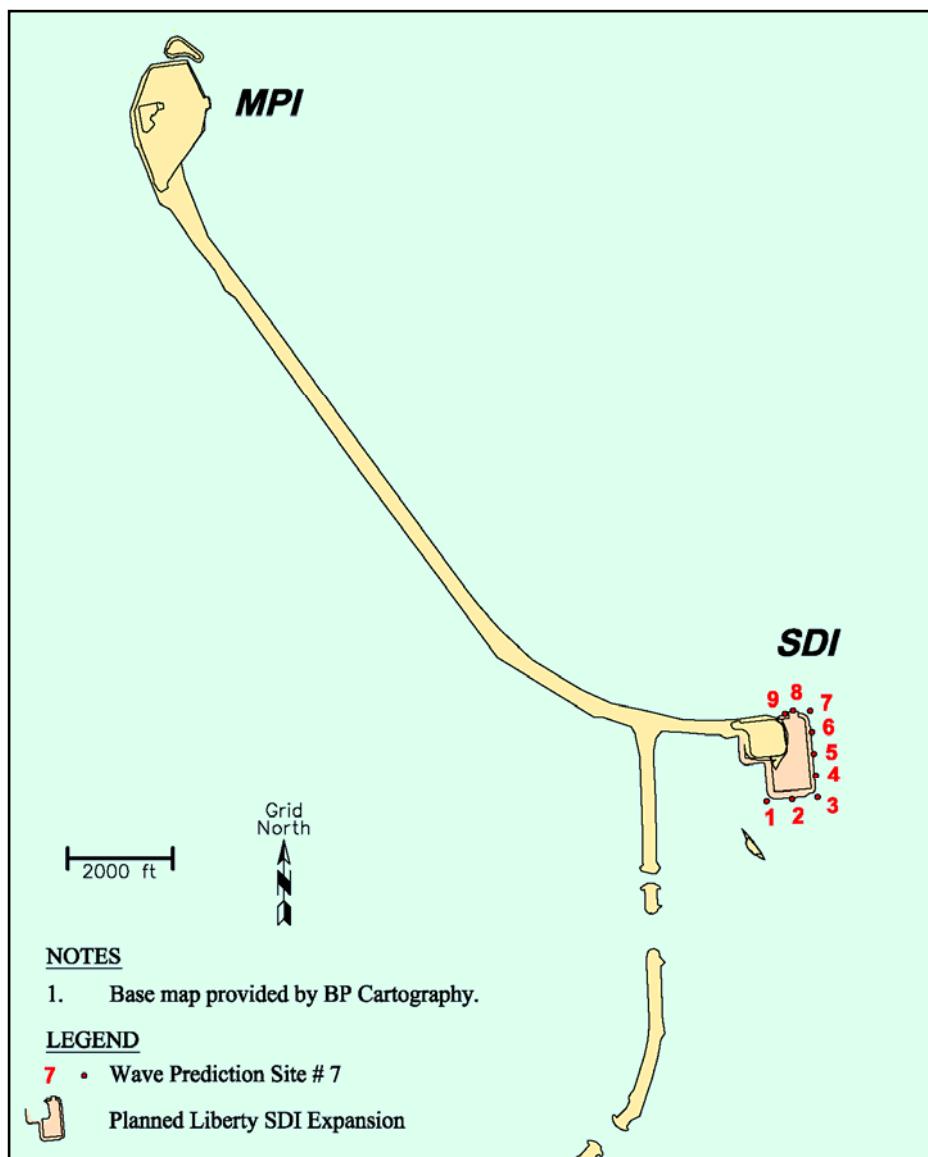
Figure 2.4-2
Mean Monthly Discharge in Sagavanirktok River, 1983-2005
(USGS Stream Gauge 15908000)
Source: USGS (2007)
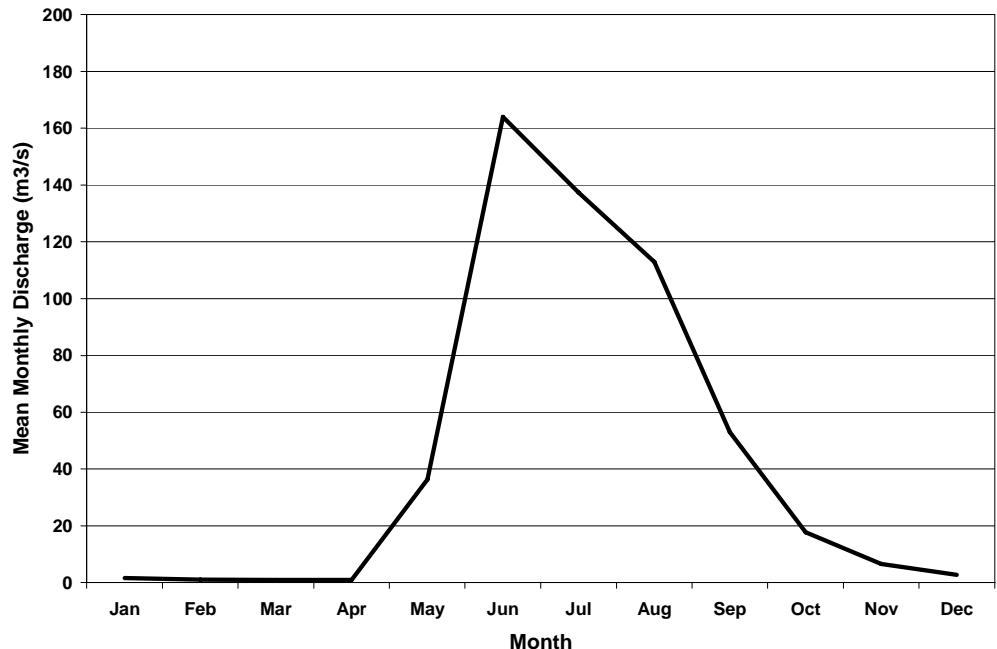
Figure 2.4-3
Average Daily Discharge in the Sagavanirktok River
(USGS Stream Gauge 15908000)
Source: USGS (2007)
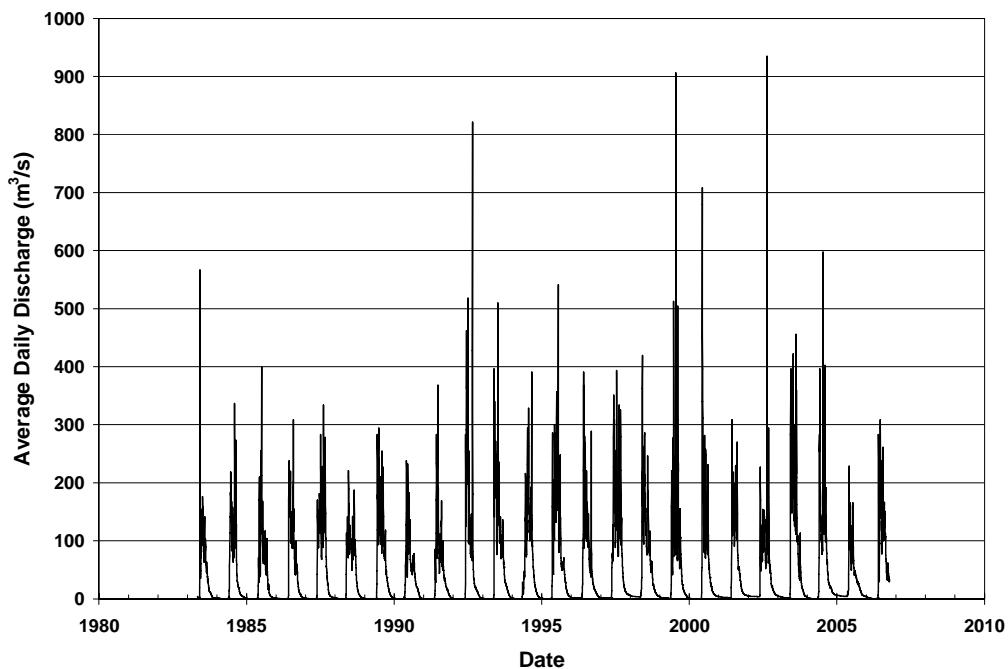
Figure 2.4-4
Historical River-Overflood Limits in Foggy Island Bay
Source: D.F. Dickins (1999) and Coastal Frontiers (2000, 2003a)
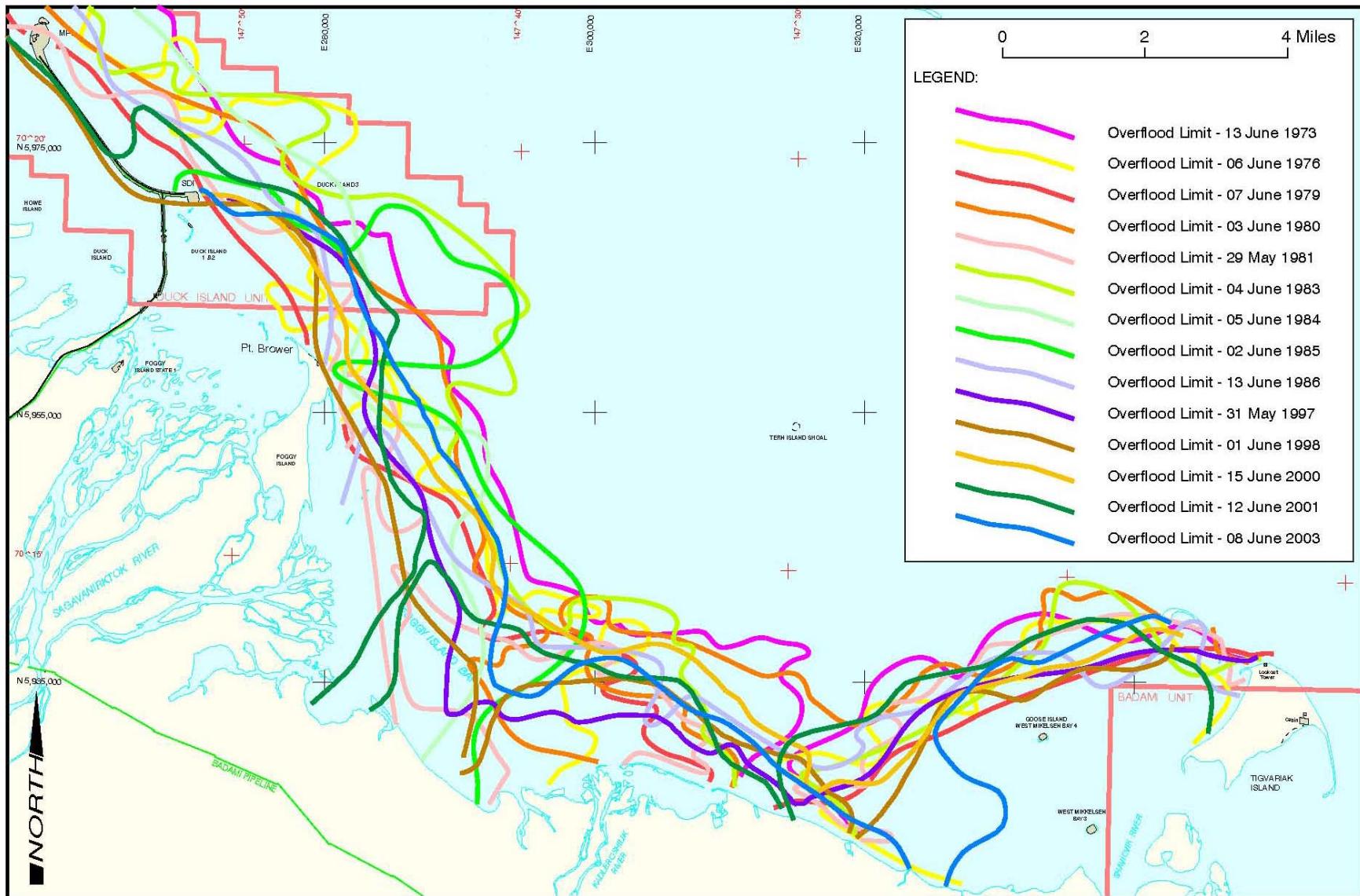
Figure 2.4-5
**Ice Pile-up (7.5 m High) Encroached 40 ft onto the Slope of Tern Island during a 25-kt Southwesterly Storm on July 7, 1984**
Source: K. Vaudry

Figure 2.4-6
Ice Rubble Pile 6 m High Formed on West Side of the Duck Island 3 Manmade Gravel Island during a 20-kt Westerly Storm on 15-17 October 1984
Source: K. Vaudry

Figure 2.5-1
Interpolated Concentrations of TSS in Foggy Island Bay
Source: Dunton et al. (2005)
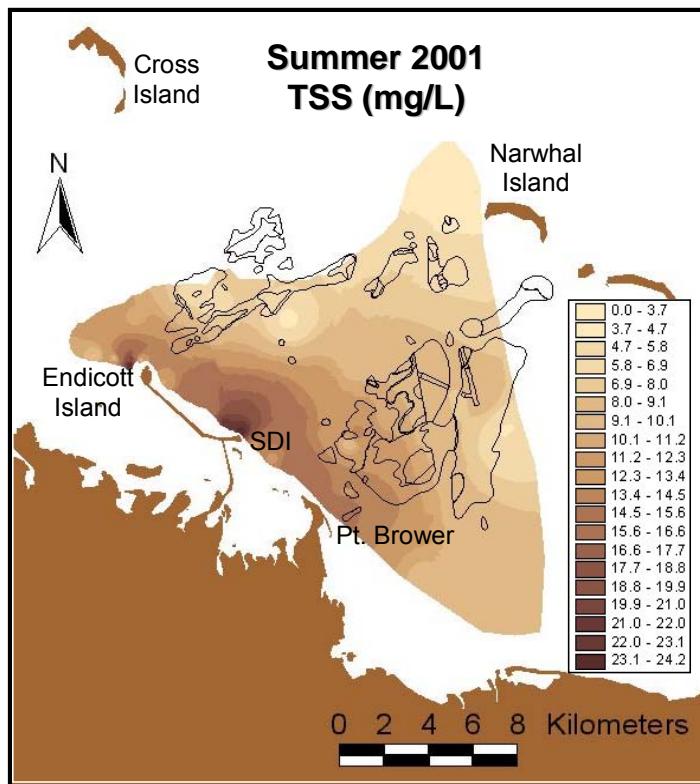
Figure 2.5-2
Concentrations of TSS and River Discharge for the
Sagavanirktok River During Spring 2001
Source: Trefry et al. (2004a)
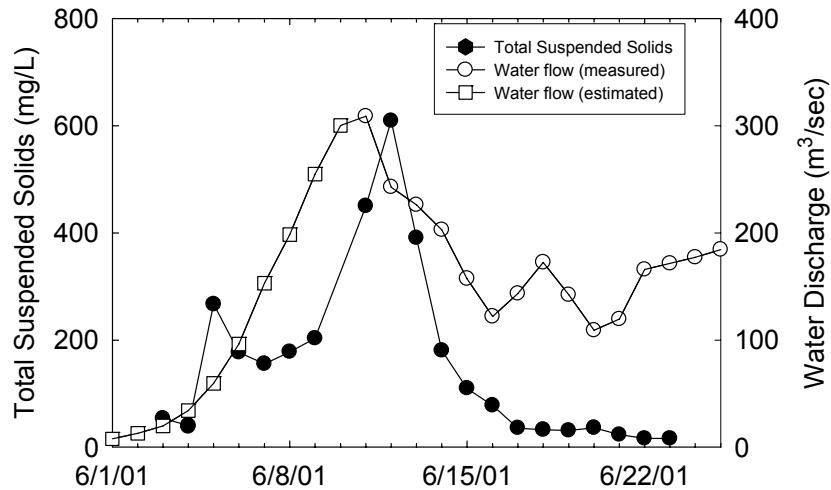
Figure 2.5-3
Concentrations in Sediment from the Coastal Beaufort Sea, including Foggy Island Bay, for Al Versus (a) Cu, (b) Pb, (c) Hg and (d) Ba
Source: Trefry et al. (2003)

Equations are from linear regression calculations, r is the correlation coefficient and n is the total number of data points. Dashed lines above and below the regression line show the 99% prediction intervals. Points marked with large letters on selected graphs are for suspended sediment from the Sagavanirktok (S), Kuparuk (K) and Colville (C) rivers. Data for sites identified on the graph were not included in the regression calculations.
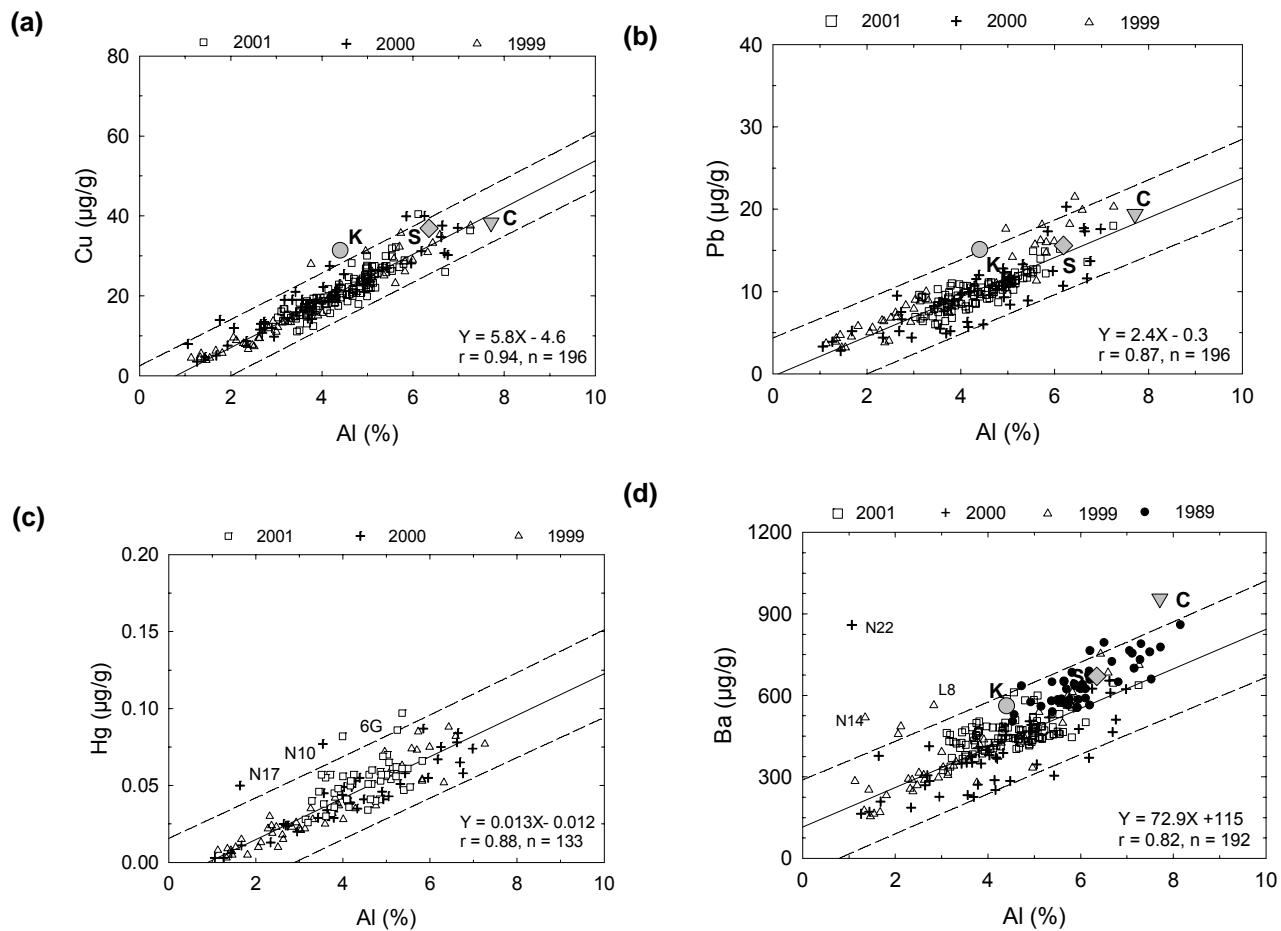
Figure 2.5-4
Trace Metal Concentrations in Clams (Astarte) from the Coastal Beaufort Sea,
Including Foggy Island Bay

Source: Brown et al. (2004)
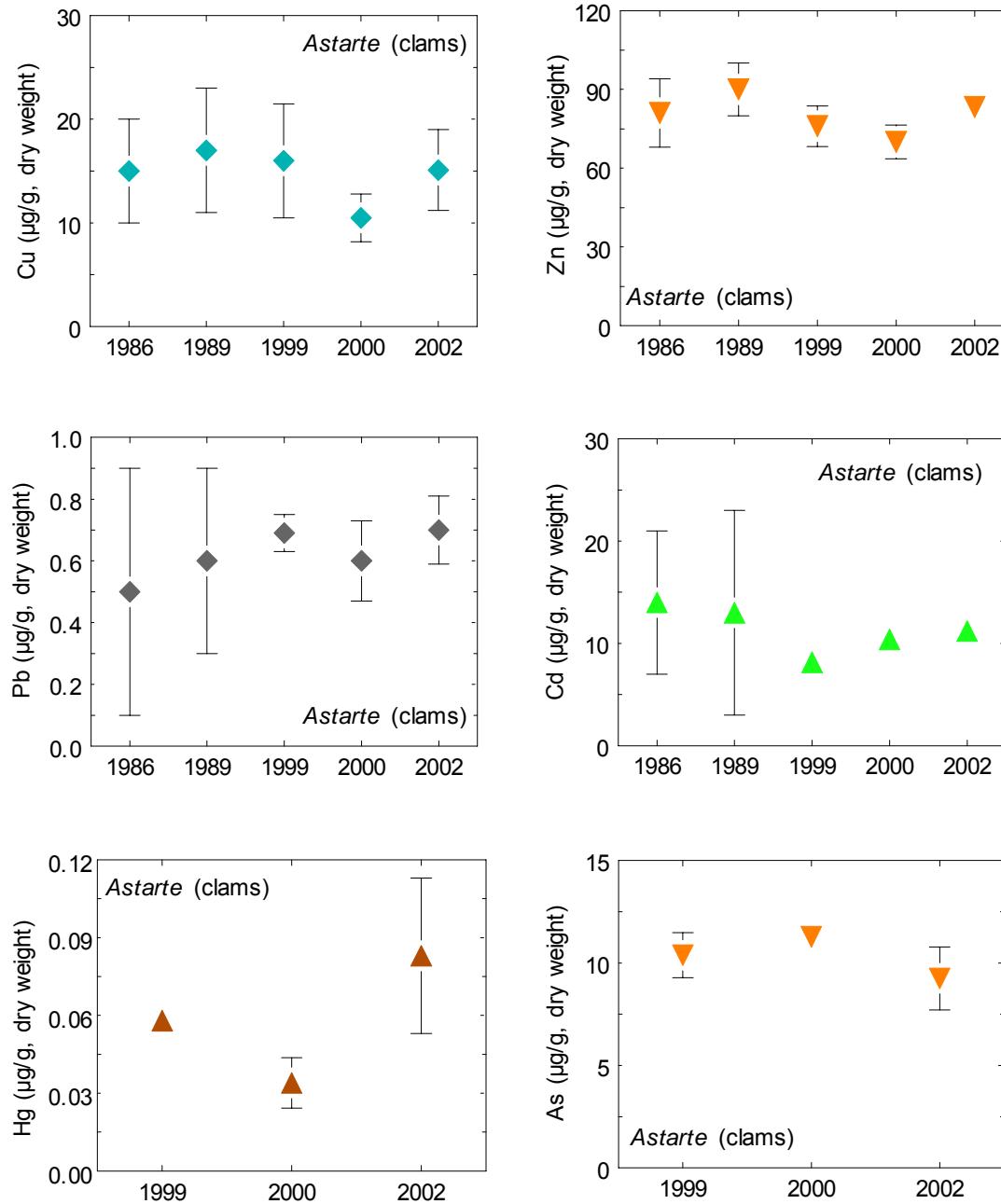
Figure 2.5-5
**Map Showing Foggy Island Bay Sampling Stations and Table of Concentrations for
Selected Organic Parameters and Grain Size in Sediment Samples**

PAH = polynuclear aromatic hydrocarbons; PHC = petroleum hydrocarbons; S = steranes; T = triterpanes;
TOC = total organic carbon

Source: Brown et al. (2004)
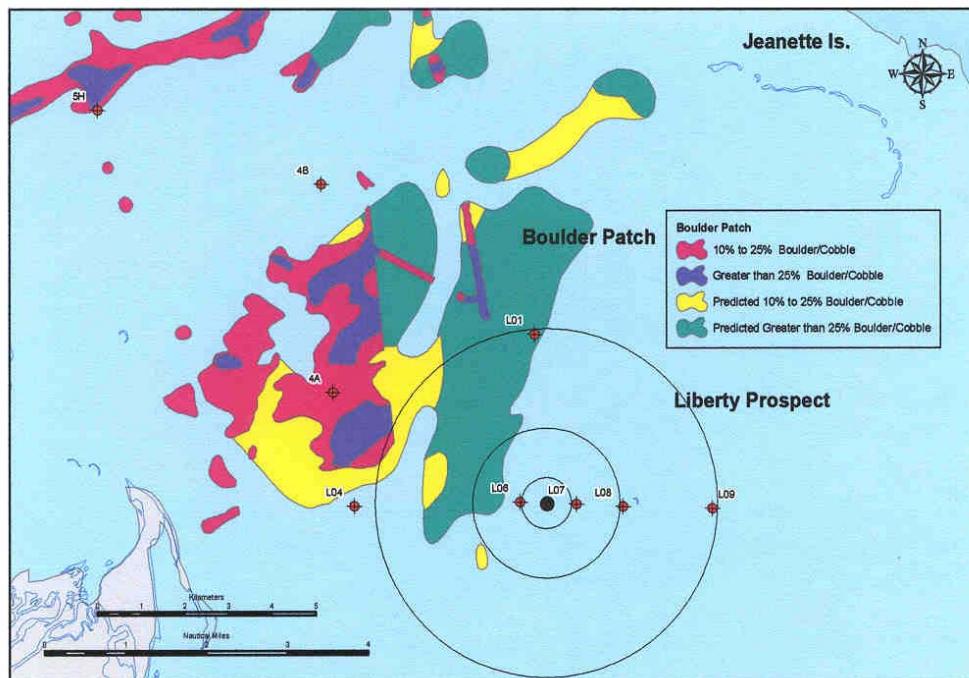
Station	Total PAH (µg/kg)	Total PHC (mg/kg)	Total S/T (µg/kg)	TOC (%)	Silt+Clay (%)
Foggy Island Bay- 2000					
L01	610	12	62	1.0	66
L04	400	7.7	51	0.47	60
L06	400	11	51	0.90	94
L07	220	6.9	20	1.5	36
L081	280 (70)	12 (1.7)	41 (10)	0.24 (0.06)	31 (7.4)
L09	99	1.9	11	0.49	5.3
Mean (SD)	340 (180)	8.6 (3.9)	39 (20)	0.76 (0.45)	49 (31)

Station	Total PAH (µg/kg)	Total PHC (mg/kg)	Total S/T (µg/kg)	TOC (%)	Silt+Clay (%)
Foggy Island Bay- 2002					
L01	150	2.9	15	0.59	11
L04	400	7.1	34	0.71	53
L06	420	6.5	32	1.2	58
L07	340	5.9	28	0.88	49
L08	340	10	52	0.67	6.4
L09	84	3.4	11	0.18	9.7
Mean (SD)	290 (140)	6.0 (2.6)	29 (15)	0.70 (0.33)	31 (24)

Note[1] – Field triplicates were collected at this station. The average value of the triplicates is reported with the standard deviation in parentheses

Figure 2.5-6
Concentrations of (silt + clay) versus Total Polynuclear Aromatic Hydrocarbons (PAH) in Sediments from Foggy Island Bay, Northstar and the Coastal Beaufort Sea for 1999, 2000, 2002 and 2004
Source: Brown et al. (2006)

The central line, the 95% prediction intervals, and the r-squared are from linear regression calculations.
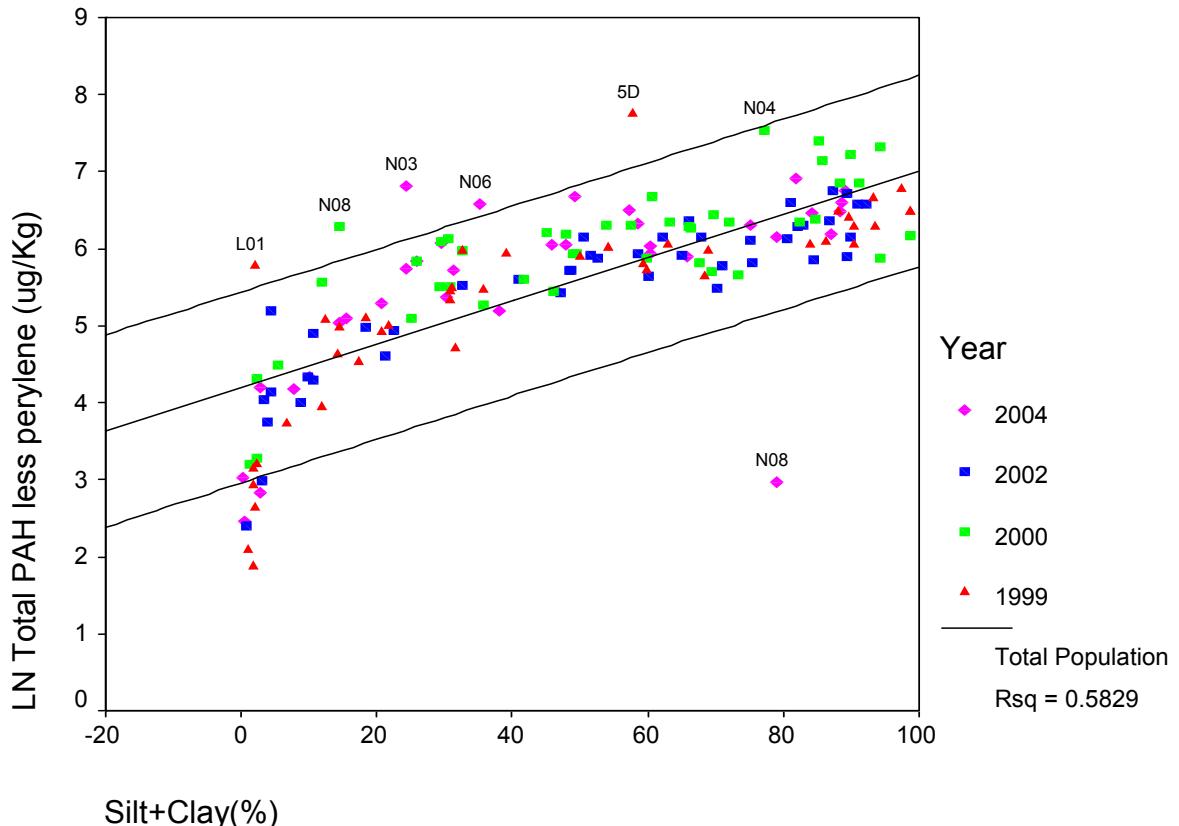
Figure 2.5-7
Concentrations of Total Polynuclear Aromatic Hydrocarbons (Total PAH) for Sediments from the Sites in the Beaufort Sea Monitoring Program — BSMP, Foggy Island Bay, and Northstar
Source: Long et al. (1995); Brown et al. (2006)

Horizontal lines show values for the Effects Range Low (ERL) and Effects Range Median (ERM)
Note: the y axis is a logarithmic scale
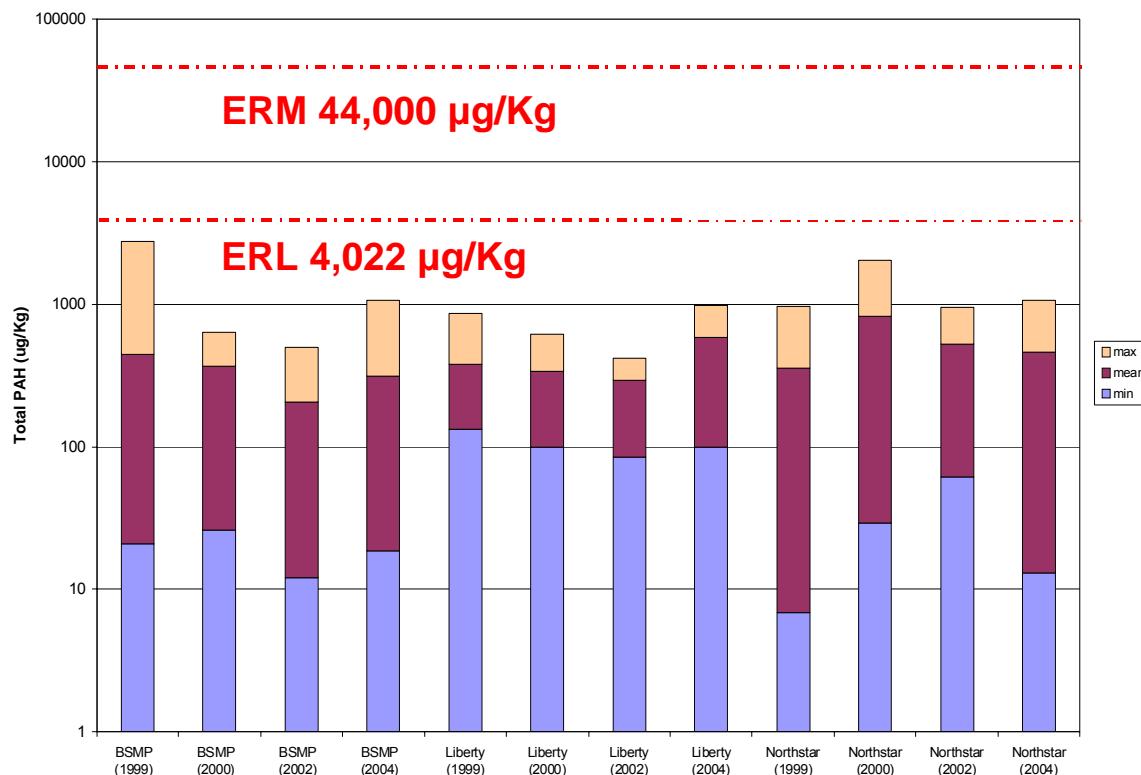
Figure 2.5-8
Map Showing Sampling Stations and Table Showing Concentrations for 2000 of Total Polynuclear Aromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbons (PHC), and Steranes/Triterpanes (S/T) for Clams (*Astarte* and *Cyrtodaria*), Amphipods (*Anonyx*) for the Coastal Beaufort Sea, Including Foggy Island Bay
Source: Brown et al. (2004)
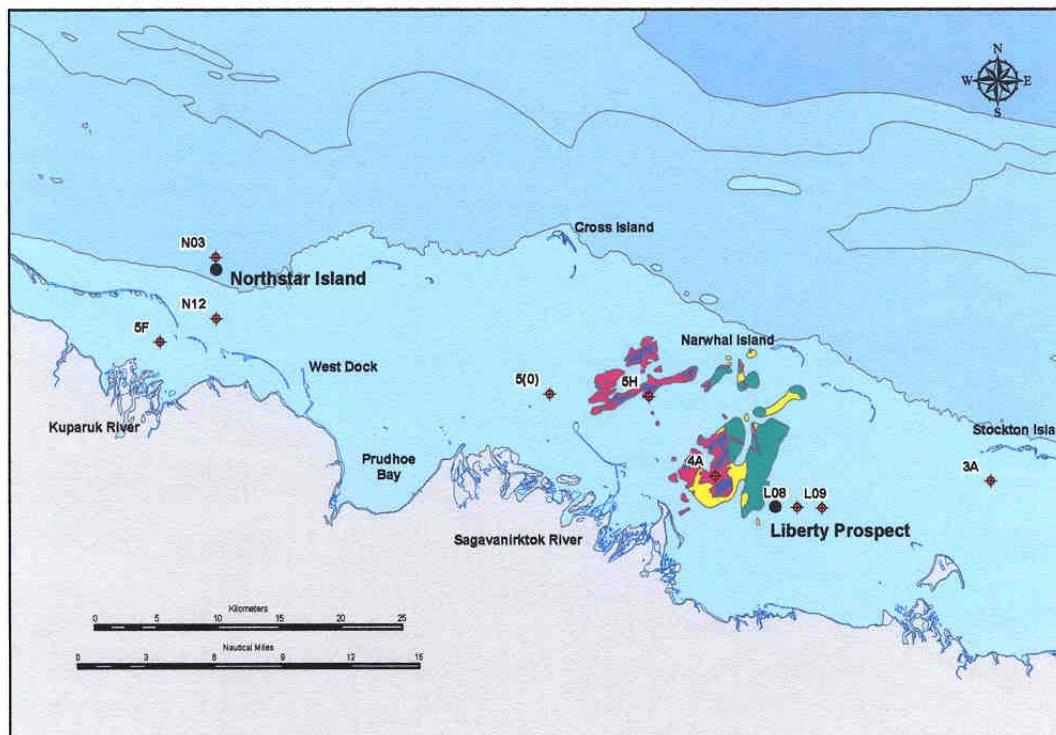
Station	Species	Total PAH (μg/kg wet weight)	Total PHC (mg/kg wet weight)	Total S/T (μg/kg wet weight)
Summer - 2000				
N03	*Anonyx*	23	12	8.1
N12	*Anonyx*	16	26	3.2
N13	*Anonyx*	14	14	4.1
N18	*Anonyx*	12	15	2.8
L08	*Astarte*	13	ND	2.7
L09	*Astarte*	16	ND	2.5
3A	*Astarte*	7.4	1.6	2.0
4A	*Anonyx*	18	ND	2.4
5(0)	*Anonyx*	20	ND	2.0
5F	*Cyrtodaria*	39	4.4	3.6
5H	*Astarte*	15	ND	4.0

Anonyx (an amphipod), *Astarte* (a clam), *Cyrtodaria* (a clam).

ND – Not detected.

Figure 2.6-1
Mean Daily Discharge, Sagavanirktok River near Pump Station 3, 1983-2005
Source: USGS 15908000 SAGAVANIRKTOK R NR PUMP STA 3 AK" found at
http://waterdata.usgs.gov/ak/nwis/dv/?site_no=15908000
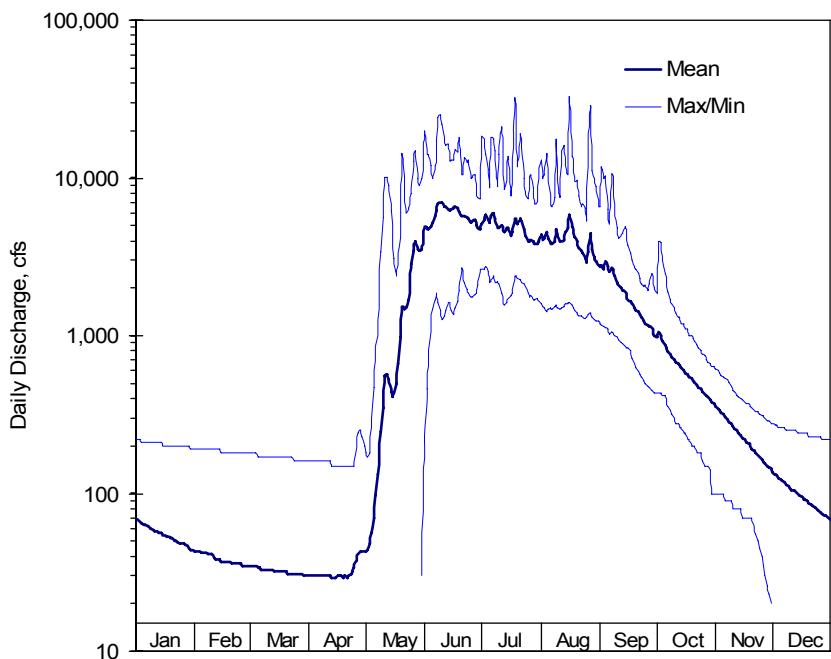
Figure 2.6-2
Flow Distribution in the Sagavanirktok River Delta, 1982 to 1990
Source: PND (2006b)
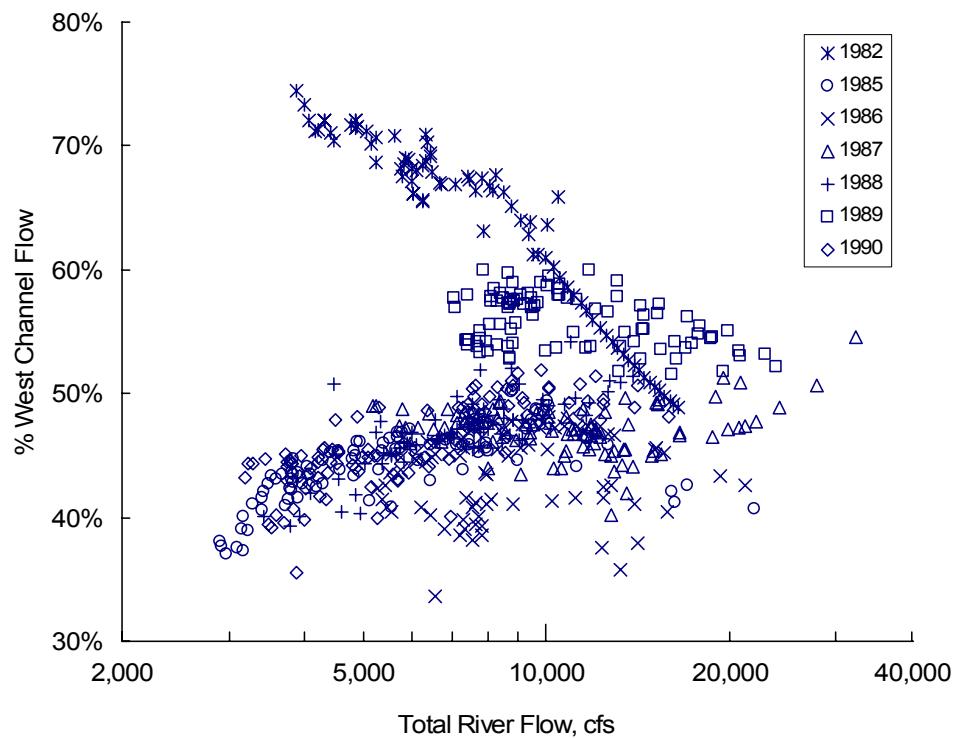
Figure 2.6-3
Flood Frequency at the Sagavanirktok River West Channel (Endicott Road) Bridge
Source: PND (2006b)
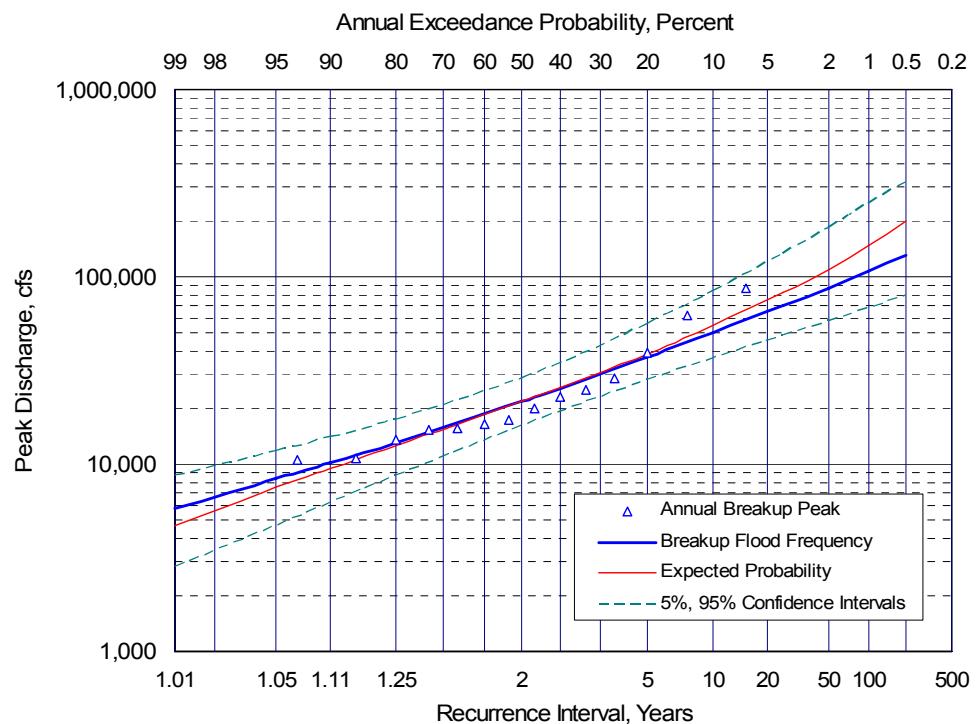
Figure 2.7-1
The Stefansson Sound Boulder Patch

Rock Cover in Stefansson Sound, Alaska
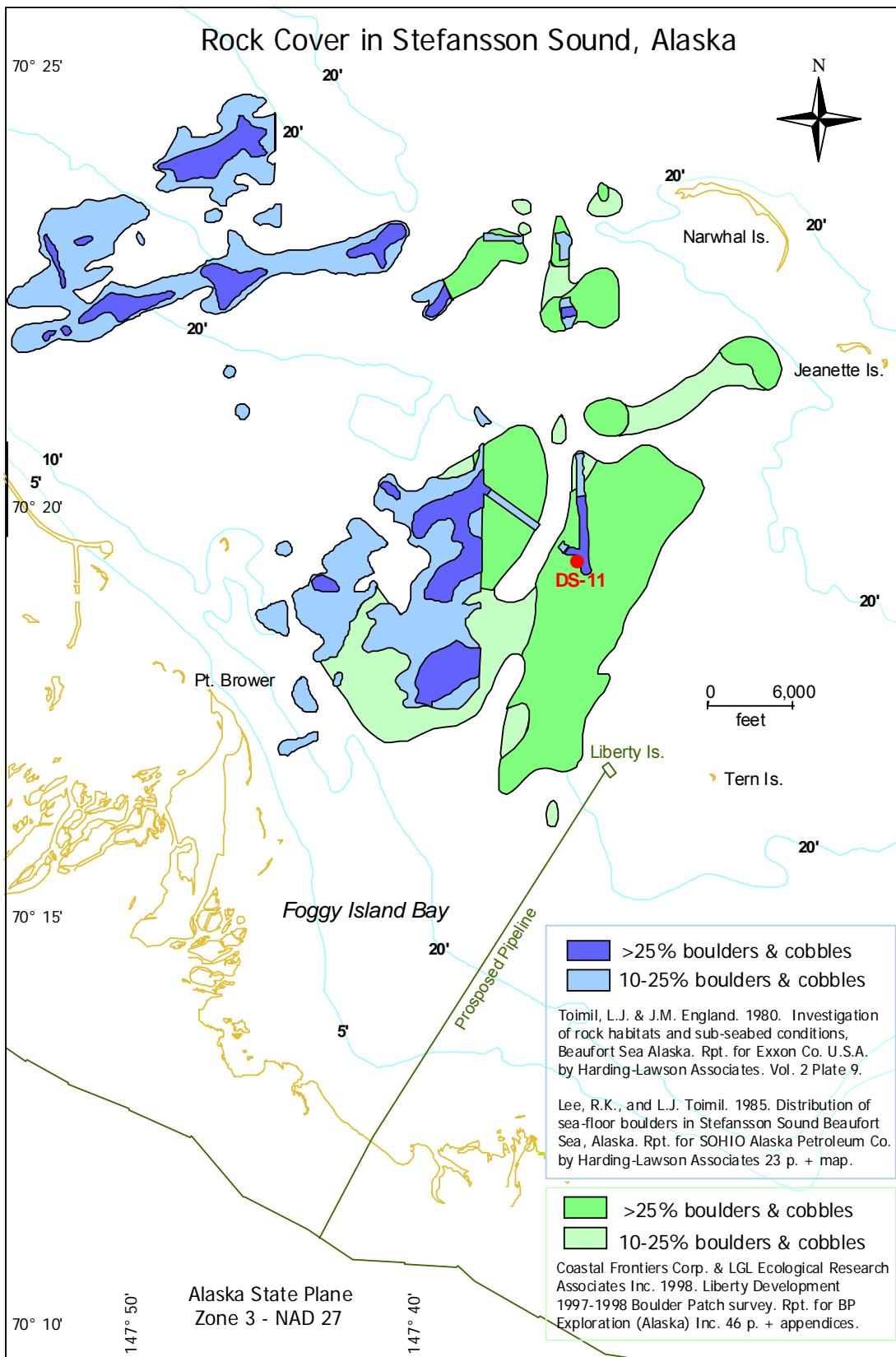
Figure 2.7-2
Relative Contribution (% total biomass) of the Predominant Epilithic Flora and Fauna
Collected in 0.05-m² Rock Scrapes in the Boulder Patch, Stefansson Sound, 1979-1980.

Source: Dunton and Schonberg (2000)
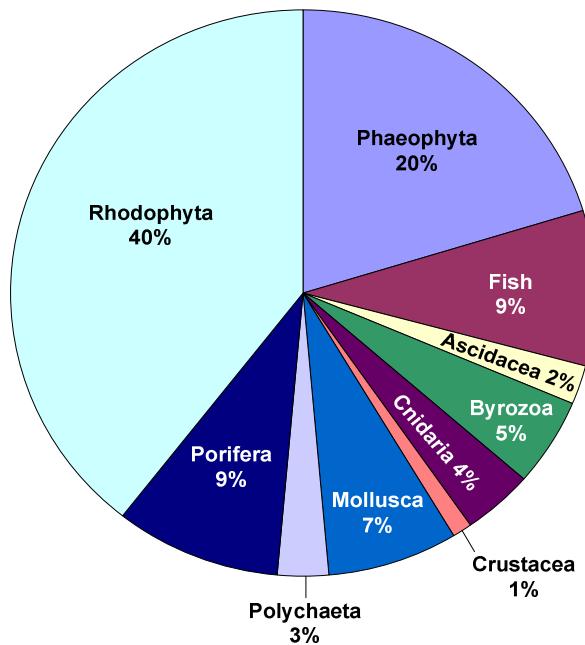
**Figure 2.7-3**
Annual Linear Growth of *Laminaria solidungula* Blades for 8 Years at 7 Sites in Stefansson Boulder Patch

Compiled from Aumack (2003)

Values are Mean ± SE (n=15 to 30)
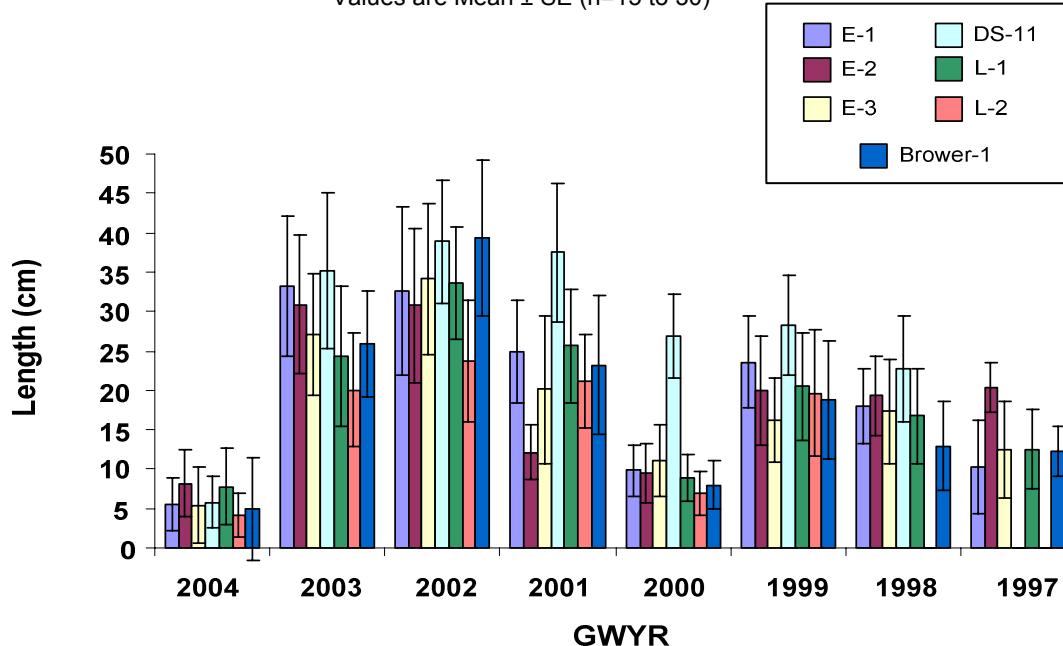
Figure 2.10-1
Snow Goose, Brant and Common Eider and Glaucous Gull Nesting Areas
Sources: Johnson (2000b); Sedinger and Stickney (2000); Noel et al. (2005); Rodrigues, McKendrick, and Reiser (2006)
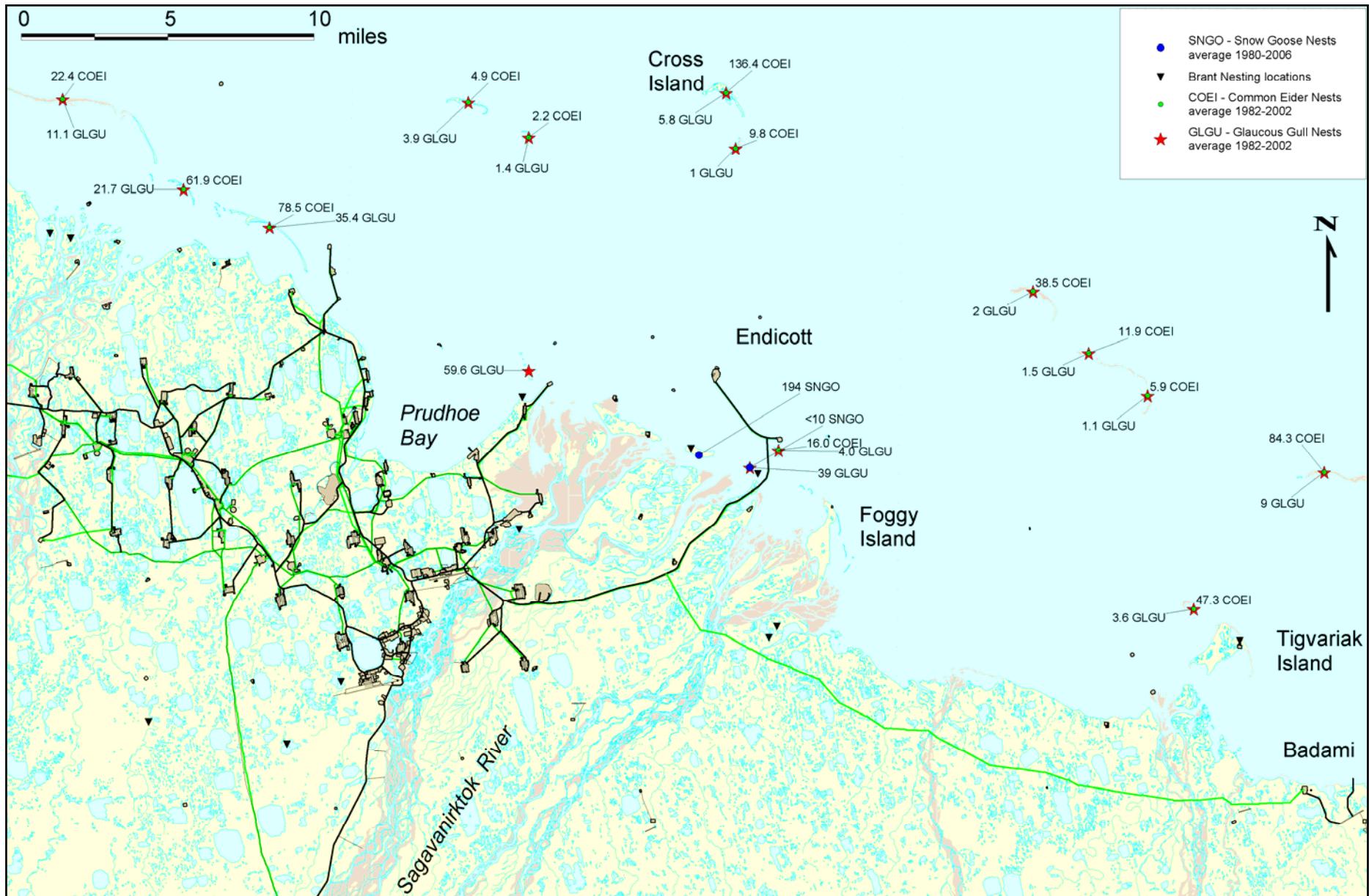
Figure 2.10-2
Snow Goose, Brant and Tundra Swan Brood-Rearing Areas
Sources: Noel et al. (2005), LGL unpublished data (2002, 2006)
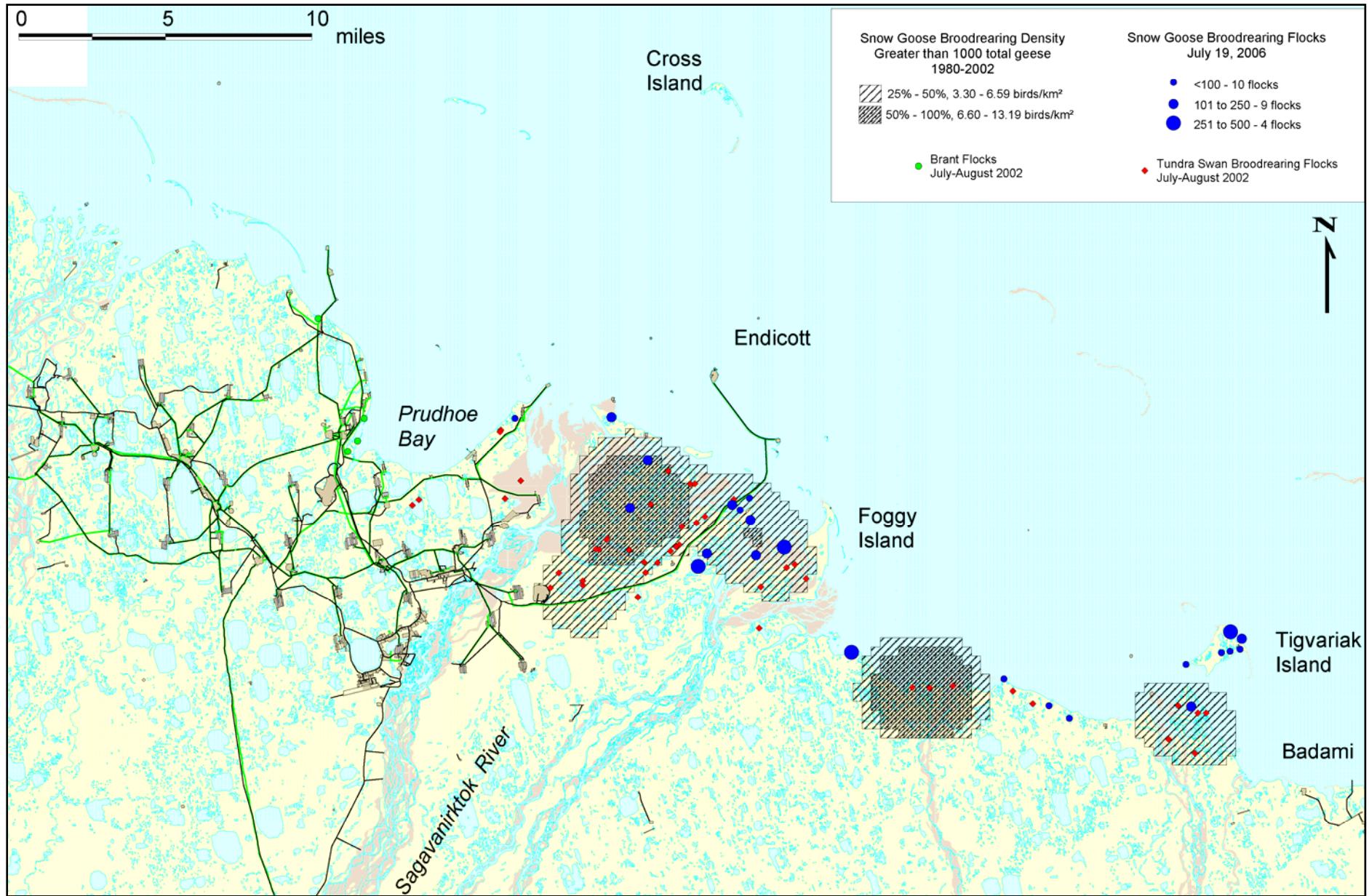
Figure 2.10-3
Long-tailed Duck, Eider and Scoter August Concentration Areas in Lagoons 1999-2002, and
Offshore Distribution and Abundance June to September 1999-2001

Sources: Fischer and Larned (2004); Noel, Johnson, and O'Doherty (2005)
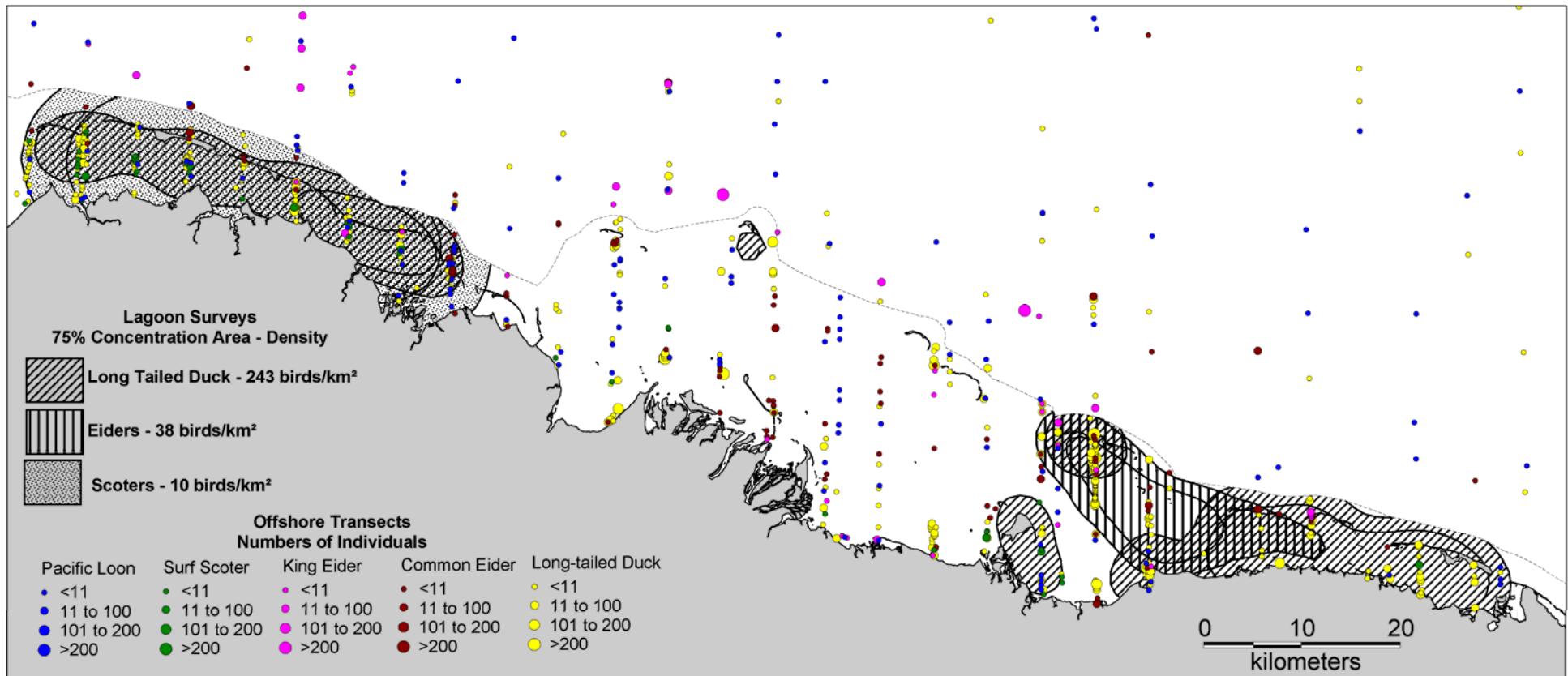
Figure 2.11-1
Seasonal Range of Central Arctic Caribou Herd
(Source: Arthur and Del Vecchio, 2004)
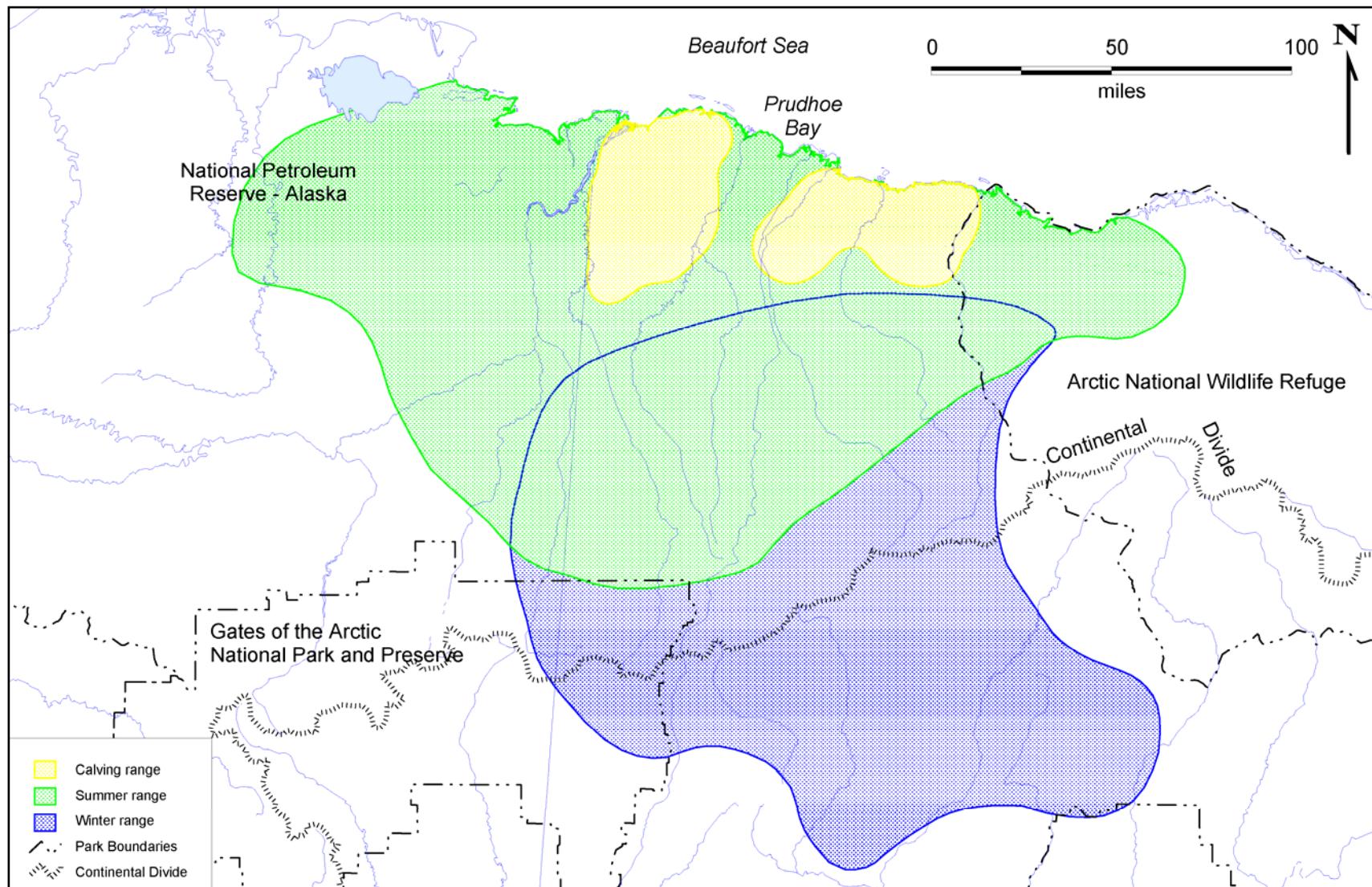
Figure 2.11-2
Caribou Calving Densities and Summer Large Group Distributions 1998-2003
Sources: LGL unpublished data (1998-2002); ENTRIX unpublished data (2003)
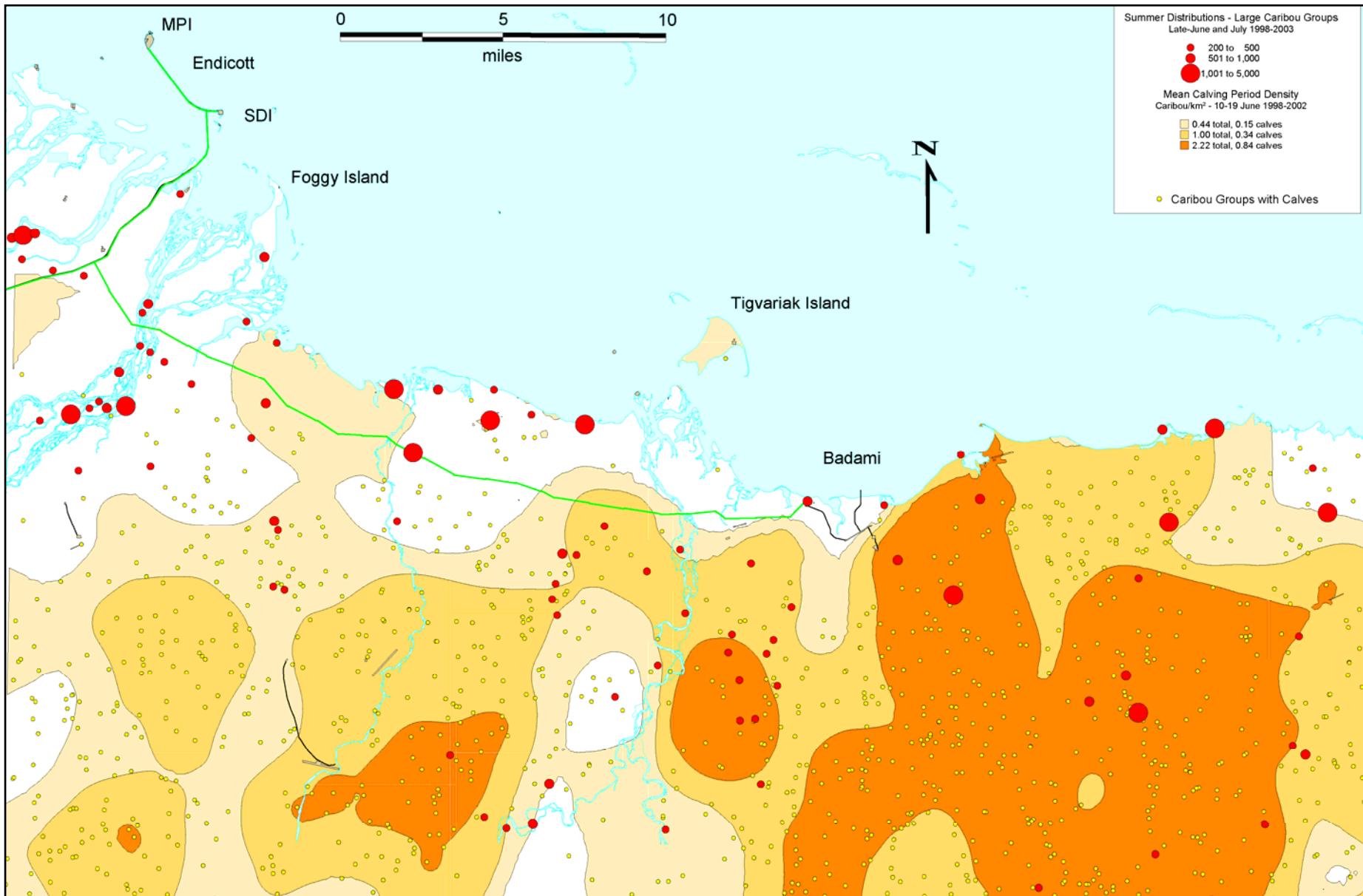
Figure 2.11-3
Terrestrial Mammals and Den Sites
Sources: Burgess and Banyas (1993); USDOI, MMS (1998); LGL unpublished data (1998-2002); ENTRIX unpublished data (2003)
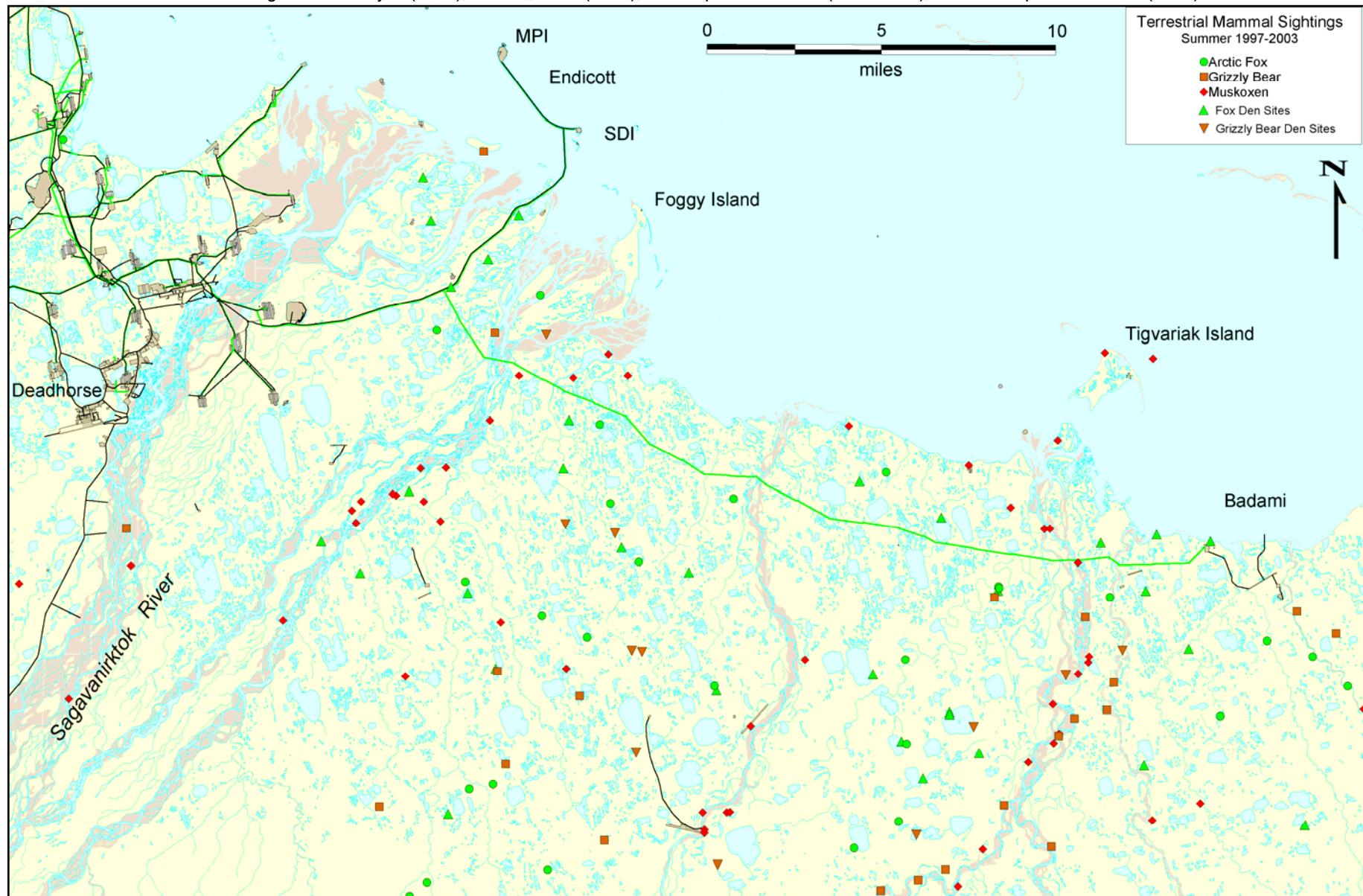
Figure 2.13-1
Relative Abundance of Spectacled Eiders in the Liberty Area
(Detail Based on Larned, Stehn, and Platte [2005])
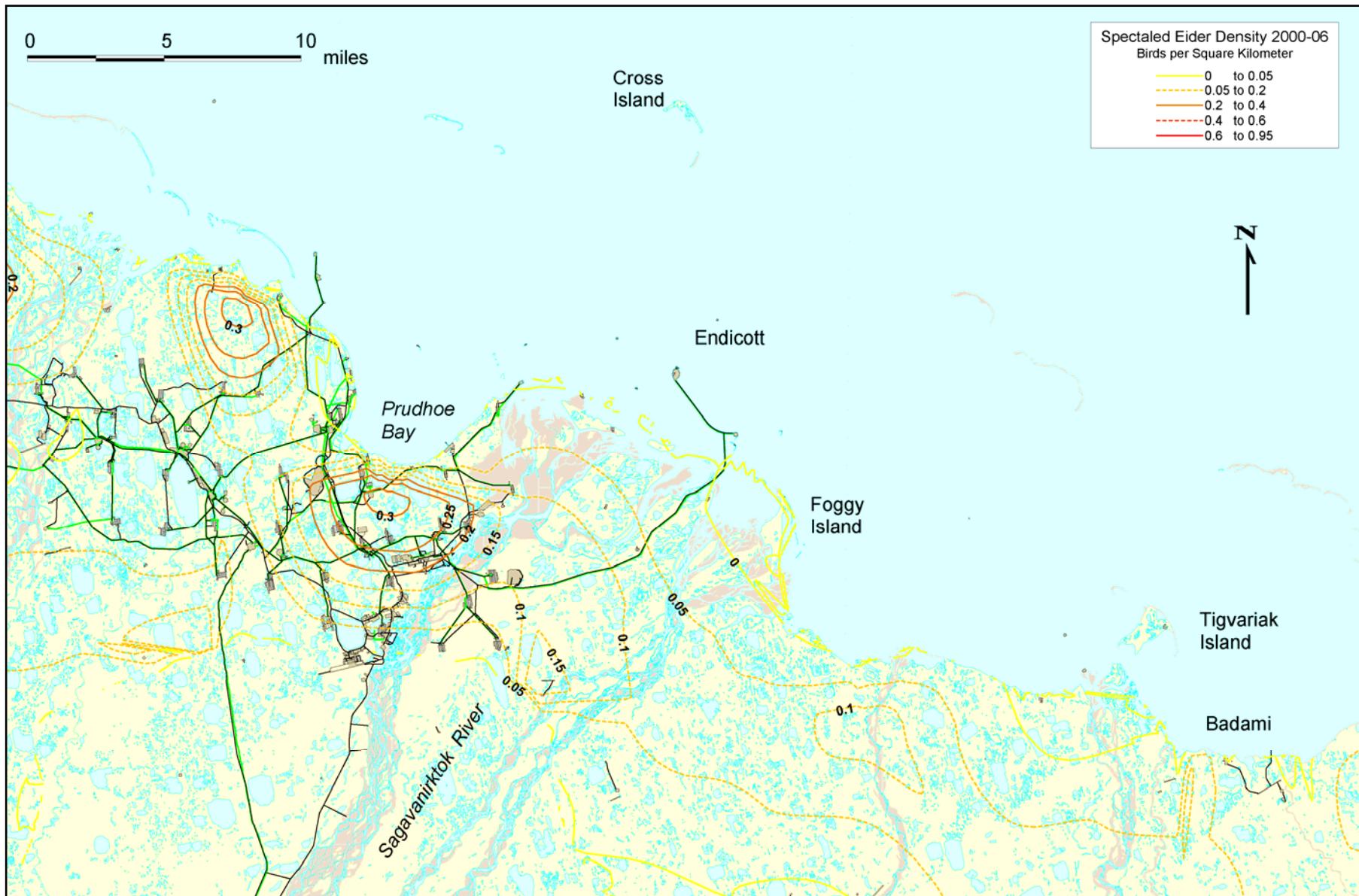
Figure 2.15-1
Nuiqsut, Barrow and Kaktovik Lifetime Subsistence Use Areas

Figure 2.15-2
Nuiqsut Subsistence Land Use, 1973-1986

Figure 2.15-3
Selected Nuiqsut Subsistence Harvests in Per Capita Pounds for the 1985, 1992, and 1993
Study Years
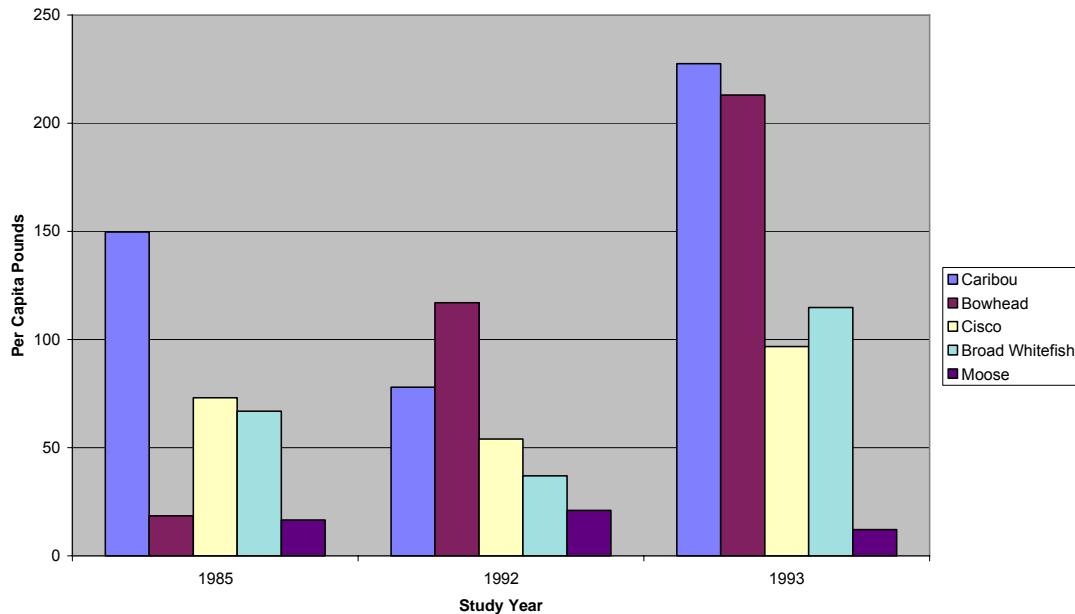
Sources: ADF&G 2001; Fuller and George, 1999

Figure 2.15-4
Selected Nuiqsut Subsistence Harvests in Percent of Total Harvest for the 1985, 1992, and
1993 Study Years
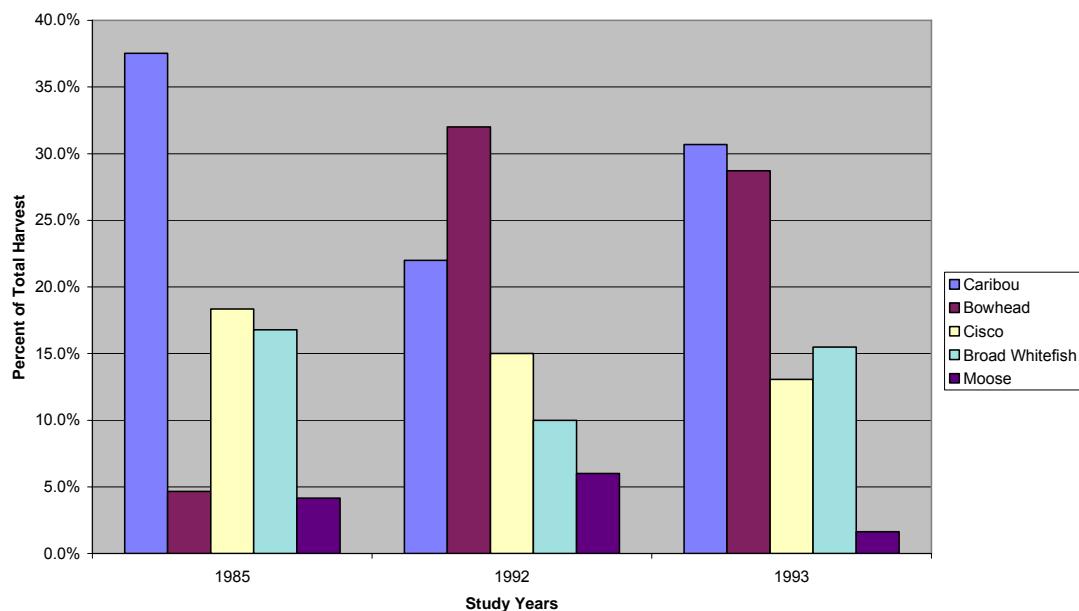
Sources: ADF&G 2001; Fuller and George, 1999

Figure 2.15-5
Nuiqsut Subsistence Whaling Near Cross Island: 2001, 2002, 2003

Figure 2.15-6
Estimated Fishing Effort in the Colville River Delta
Fall Subsistence Fishery in Net-Days, 1985-2002
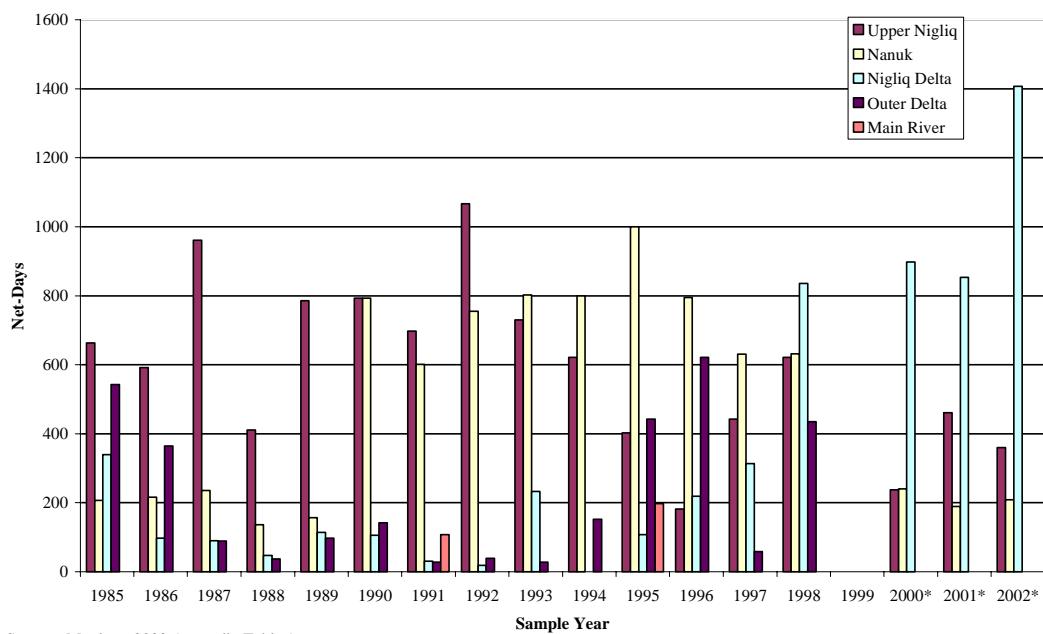
Source: Moulton, 2002:Appendix Table 1.

Stephen R. Braund & Associates, 2005.

* Harvest numbers represent only the Nigliq Channel harvest.

Figure 2.15-7
Estimated Whitefish Harvests for the Colville River Delta
Fall Subsistence Fishery, 1985-2002
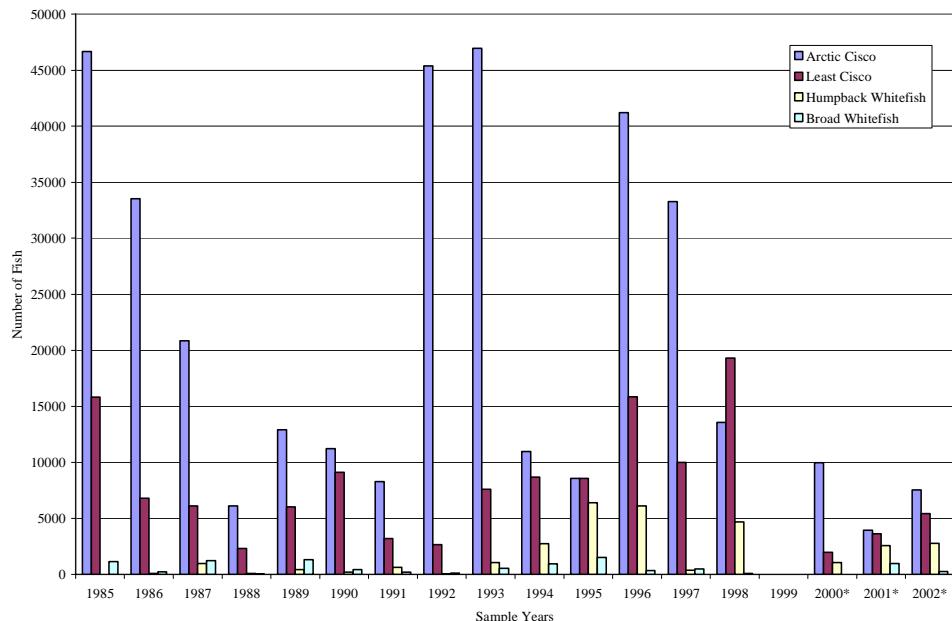
Source: Moulton, 2002:Table 6.

Stephen R. Braund & Associates, 2005.

* Harvest numbers represent only the Nigliq Channel harvest.

Figure 3.4-1
Process for Estimating the Risk of an Oil Spill Using Historical ANS Spill Data
See Appendix A for detailed methods and results.
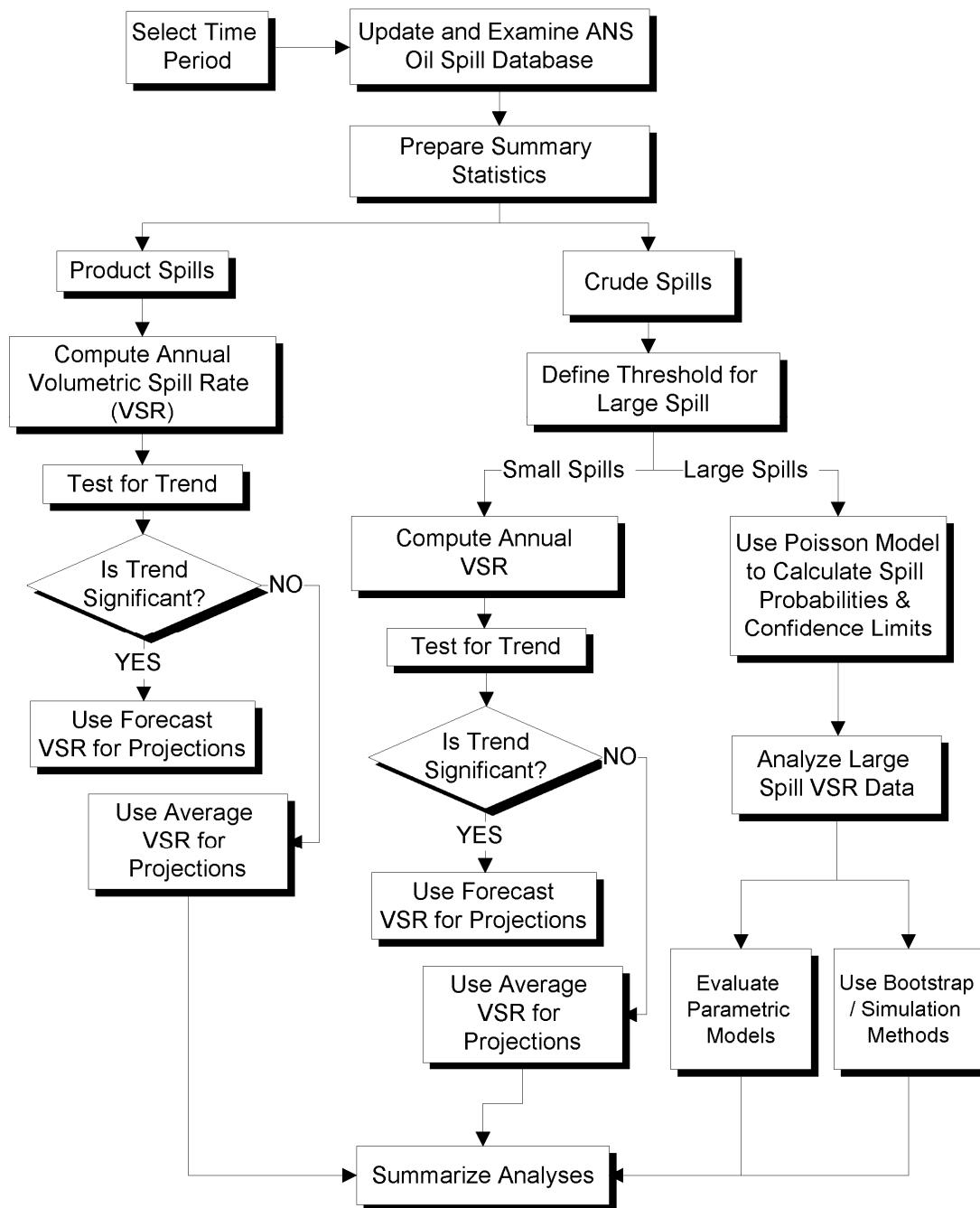
Figure 3.4-2
GNOME Model Oil Trajectory Plot for 24 Hours

Model Mode: Standard Estimate for: 08/01/06 24-hr Duration Prepared: 02/23/07	Model Name: Liberty

This trajectory was created using climatological currents from a GNOME Location File and is unlikely to represent conditions existing at any particular time at the depicted location.

Stefanson Sound
Sag River speed 0.5144 m/s
Shaviovik River speed: 0.5144 m/s
Canning R. West speed: 0.5144 m/s
Canning R. East / Tamayariak R. speed: 0.5144 m/s
Wind: Constant 10 knots from ENE
Number of Spills: 1
Spill Location: Latitude 70°19.22'N Longitude 147°51.67'W
	Black Splots: Best Guess, Red Splots: Uncertainty
	Splot Mass Balance Totals (Best guess):
	  Released: 999 bbl
	  Evaporated and Dispersed: 227 bbl
	  Beached: 575 bbl
	  Off Map: 0 bbl
	  Floating: 197 bbl	

Figure 3.4-3
GNOME Model Oil Trajectory Plot for 72 Hours

Model Mode: Standard Estimate for: 08/01/06 72-hr Duration Prepared: 02/23/07	Model Name: Liberty

This trajectory was created using climatological currents from a GNOME Location File and is unlikely to represent conditions existing at any particular time at the depicted location.

Stefanson Sound
Sag River speed 0.5144 m/s
Shaviovik River speed: 0.5144 m/s
Canning R. West speed: 0.5144 m/s
Canning R. East / Tamayariak R. speed: 0.5144 m/s
Wind: Constant 10 knots from ENE
Number of Spills: 1
Spill Location: Latitude 70°19.22'N   Longitude 147°51.67'W

Black Splots: Best Guess, Red Splots: Uncertainty
Splot Mass Balance Totals (Best guess):
  Released: 999 bbl
  Evaporated and Dispersed: 383 bbl
  Beached: 587 bbl
  Off Map: 0 bbl
  Floating: 29 bbl