Selection of calving sites by Porcupine herd caribou

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Characteristics of 305 calving sites used by 131 different radio-collared caribou (*Rangifer tarandus*) cows from the Porcupine herd in northeastern Alaska and the northern Yukon Territory were investigated between 1983 and 1990 to determine the factors influencing calving site selection. Cows selected areas north of the foothills primarily to reduce exposure of calves to predators. Sites dominated by *Eriophorum* tussocks were selected secondarily for access to newly emerging vegetation. Highest calf mortality occurred in years when snowmelt was relatively late and calving occurred closer to the foothills and in Canada. Industrial development of the coastal plain of the Arctic National Wildlife Refuge could increase calf mortality if calving were displaced south and east of potential development areas.

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Les caractéristiques de 305 sites de mise-bas utilisés par 131 femelles du Caribou (*Ranfiger tarandus*) munies d'un collier émetteur, au sein du troupeau de Porcupine, dans le nord-est de l'Alaska et le nord du Yukon, ont été relevées de 1983 à 1990 afin de déterminer quels facteurs influencent le choix du site de mise-bas. Les femelles choisissaient des zones situées au nord des contreforts surtout pour diminuer l'exposition des petits aux prédateurs. Les endroits dominés par les touffes d'*Eriophorum* étaient choisis ensuite parce qu'ils permettaient l'accès à de la végétation fraîche. La mortalité des petits s'est avérée particulièrement élevée au cours des années où la fonte des neiges s'est produite relativement tard et où la mise-bas s'est faite plus près des contreforts et à l'intérieur du Canada. Le développement industriel de la plaine côtière de la réserve Arctic National Wildlife Refuge pourrait bien augmenter la mortalité des petits caribous si la mise-bas est déplacée vers le sud et vers l'est des zones potentielles de développement.

[Traduit par la rédaction]

Introduction

The U.S. Congress directed the U.S. Department of the Interior in 1980 to conduct biological and geological studies on the coastal plain of the Arctic National Wildlife Refuge (ANWR) in northeastern Alaska to provide information necessary for future management of the area. The "1002 area" of the coastal plain contains important fish and wildlife habitats, including the most frequently used calving and post-calving habitats for the Porcupine caribou herd (PCH; *Rangifer tarandus granti*). Unfortunately, the coastal plain is also generally considered the most promising onshore petroleum exploration area in the United States (Clough *et al.* 1987). After completing a 5-year baseline study program, the Department of the Interior concluded that major impacts to the PCH could occur if a major oil discovery is located and developed in the 1002 area (Clough *et al.* 1987).

The U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game have conducted cooperative studies since 1982 on the PCH (n = 178 000, 1989) and the adjacent Central Arctic herd (CAH, n = 13 000, 1983) to assess the potential effects of petroleum exploration and development on caribou. A major concern based on studies of the CAH (e.g., Whitten and Cameron 1983; Dau and Cameron 1986) is that development of the 1002 area can displace parturient cows from traditional calving areas, thereby increasing mortality on calves or reducing foraging opportunities for cows and calves. The purpose of this study was to determine why PCH caribou select certain areas for calving and thereby provide information for assessing and mitigating potential effects of oil development on the PCH during the calving period.

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Methods

The PCH annually migrates between winter ranges in northeastern Alaska and northwestern Canada and its calving grounds along the Beaufort Sea coast. Detailed descriptions of the range and seasonal movement patterns of the PCH can be found in Garner and Reynolds (1986) and Fancy *et al.* (1989).

Caribou capture and radio-tracking flights

Beginning in 1981, standard VHF radio-collars were deployed on adult and yearling female caribou using methods described by Fancy *et al.* (1989). Beginning in April 1988, however, all adult caribou were immobilized, using a mixture of 3 mg carfentanil citrate (Wildlife Laboratories, Fort Collins, CO) and 7.5 mg acepromazine maleate with Naloxone (450 mg, Wildlife Laboratories) as the antagonist. Individuals were recaptured as needed every 3–5 years to replace transmitters before batteries were exhausted.

Mortality-sensing transmitters were deployed on 118 calves on 2–3 June 1988, using methods described by Garner *et al.* (1985). Previous experience with capturing calves (K. R. Whitten, G. W. Garner, F. J. Mauer, and R. B. Harris, unpublished data) indicated that calves that were abandoned at the time of capture subsequently died within 48 h. Because we could not distinguish between natural and capture-induced abandonment, and inclement weather precluded observations of collared calves for 2 d following capture, we excluded the 14 calves that died within 48 h of capture from further analysis.

Satellite transmitters compatible with the Argos Data Collection and Location System (Fancy *et al.* 1988, 1989) were deployed on 33 PCH cows between April 1985 and August 1990. Data were received monthly from Service Argos (Landover, MD) and processed as described by Fancy *et al.* (1988, 1989). The satellite transmitter package (Telonics, Inc., Mesa, AZ) weighed 1.6 kg (including a VHF radio transmitter to locate the caribou from an aircraft) and had a 1-year battery life. Individual caribou were monitored for ≤5 years by replacing their transmitters annually. Transmitters were programmed to operate 6 $h \cdot d^{-1}$ or 6 $h \cdot 2\ d^{-1}$, and provided three or four locations per

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day of operation. Mean location errors were 760 m for generation 2 transmitters (68% of locations used in this study) and 480 m for the newer generation-3 transmitters (32% of locations, Fancy *et al.* 1989).

Radio-collared cows (n = 131, including those also monitored by satellite) were observed from a fixed-wing aircraft at 1- to 3-d intervals between ca. 28 May and 30 June each year to determine date and location of calving and the fate of their calves. Calving dates and neonatal survival for calves of collared cows were determined from a combination of criteria, including presence of a calf at heel, presence or absence of hard antlers, udder distention, or observations of cows standing over dead calves (Whitten 1991). Cows not showing any overt signs of pregnancy, but not obviously barren (e.g., already possessing velvet antlers), were relocated at least weekly until 30 June to ensure that no births were missed. Each cow that had apparently lost her calf was observed at least one additional time during the calving period to confirm that no calf was present.

We conducted radio-tracking flights covering the entire range of the PCH, using a fixed-wing aircraft to relocate collared caribou, ca. 2–5 times each year between October and early May. Locations during the period between early January and early April, when cows were most sedentary (Fancy *et al.* 1989; S. G. Fancy and K. R. Whitten, unpublished data), were classified into one of three categories (Alaska, Richardson Mountains, or Ogilvie Mountains) to determine relationships between wintering areas and calving sites. For the purpose of this analysis, all wintering locations in the Yukon that were south and west of the Porcupine and Eagle rivers were included in the Ogilvie Mountains category, whereas locations east of the Eagle River and along the axis of the Richardson Mountains were included in the Richardson Mountains category.

Calving distribution

Locations where radio-collared cows were first observed with a calf during intensive monitoring flights each year were used as calving sites. Calving sites were digitized and entered into the ARC/INFO geographic information system (GIS) for analysis of calving distribution and calving site selection. Calving sites for 54 cows that calved in widely scattered locations in the mountains or west of the Katakturuk River were excluded from analysis. We tested the hypothesis that the distribution of calving sites on the coastal plain was random by arbitrarily partitioning the coastal plain into six blocks of similar area (Fig. 1, blocks A–F) to determine the number of calving sites per square kilometre expected within each block, if sites were evenly distributed. Blocks were delineated on the east and west by major rivers or the Alaska–Yukon border and on the north by the coastline. The southern boundaries of the blocks were drawn where the coastal plain and foothills give rise to the mountains of the Brooks and British ranges. The area within each block was determined using the ARC/INFO geographic information system.

Calving site selection

Factors influencing calving site selection were determined by comparing attributes of calving sites for 1983–1990 with those of randomly selected sites within the area bounded by the outermost calving sites (including those in the mountains, but excluding two cows that calved with the CAH; see Fig. 1). We excluded sites where 16 cows were first observed with their calves because each calf was estimated to be >5 d old (based on their size and behavior) and might have been born several kilometres from the location. (These 16 cows were used in the calving distribution analysis above because they were located within the same block before and after calving.) Logistic regression analyses (McDonald *et al.* 1991) were conducted to determine which attributes best discriminated between 305 sites selected for calving and 305 randomly selected sites on the calving grounds.

We determined the elevation, percent slope, and landcover type for each calving site and random site using digital maps with a resolution (i.e., pixel size) of 50 × 50 m in Alaska (U.S.G.S. Eros Data Center, Anchorage, AK; Garner and Reynolds 1987, p. 60) or 100 × 100 m in Canada (Nixon *et al.* 1991). Landcover maps in both Alaska and Canada were based on LANDSAT multispectral scanner data; however, the use of different classification algorithms for each map precluded direct comparisons. Snow cover at each site on 1 June each year (i.e., <25, 25–75, and >75% snow cover) was determined from TIROS-N AVHRR imagery (Eastland *et al.* 1989). For each site, we also recorded latitude and longitude (in UTM coordinates), shortest distance to the coast, shortest distance to a major river, shortest distance to the foothills (i.e., the southern boundary of the blocks in Fig. 1), proportion of area within a 1-km radius that was dominated by tussock tundra, and proportion of area within a 1-km radius that contained landcover types dominated by *Dryas* vegetation types. Distance to the foothills was negative for sites south of the foothills line. *Dryas* vegetation types included dry prostrate dwarf scrub and moist prostrate dwarf scrub types in Alaska and the *Dryas* sedge type in Canada.

Calving site fidelity

We determined whether individual cows showed fidelity to calving sites in different years by comparing distances between all calving sites for each radio-collared cow between 1983 and 1990 with a distribution of distances for random sites obtained through computer simulation. The number of calving sites for each cow varied from 1 to 7 (mean ± SD = 2.24 ± 1.45, n = 131); separate analyses were required depending on the number of calving sites included. We calculated the shortest distance between any two calving sites and the shortest distance connecting all calving sites for each cow. Then we generated 8000 sets (i.e., two to seven locations) of random sites from an area delineated by the outermost calving sites (Fig. 1) and calculated the above distance parameters for each simulation. Differences between cumulative frequency distributions of observed and simulated distances were compared using the Kolmogorov–Smirnov test for goodness of fit (Sokal and Rohlf 1969, p. 573).

Calf mortality

Relationships between habitat and mortality risk were investigated by comparing attributes of sites where radio-collared cows were observed with live calves with attributes of sites where cows lost calves. The site where a cow lost a calf was considered to be the site where she was first observed without a calf. We excluded all locations in Canada from this analysis because (*i*) if displacement occurred, it would most likely be to areas immediately south and east of the 1002 boundary; (*ii*) different landcover classification schemes were used in Alaska and Canada, precluding direct comparisons of landcover data; (*iii*) no landcover data were available in Canada for the area north and west of the Malcolm River; and (*iv*) digital elevation and slope data were not available for the northern Yukon, and obtaining these data directly from maps for all locations in Canada could be a very time-consuming process. We randomly selected only one location each year during late May through June 1983–1990 where each cow was first observed with a calf, because serial observations of individual cows with calves may not be independent.

Results

Calving distribution

The distribution of calving sites among the six designated blocks (Fig. 1) on the coastal plain in 1983–1990 was nonrandom (Table 1, X^2 = 77.0, df = 5, P < 0.0001). The area between the Hulahula River and the international border (Fig. 1, blocks B, C, and D) contained 1.5 times as many calving sites per square kilometre as expected, whereas the coastal plain east of the international border contained only 0.7 times as many sites as expected. Selection for areas west of the Aichilik River in Fig. 1, blocks B and C, where much of the area is at higher latitude, appears strong even though complete snow cover remains near the coast in most years. A greater proportion of the coastal plain east of the Aichilik River is snow-free or has mottled snow during the early calving period (Eastland *et al.*, 1989; S. G. Fancy and K. R. Whitten, unpublished data).

The east–west distribution of calving sites was related to the herd's winter distribution. Cows that wintered in the Richardson

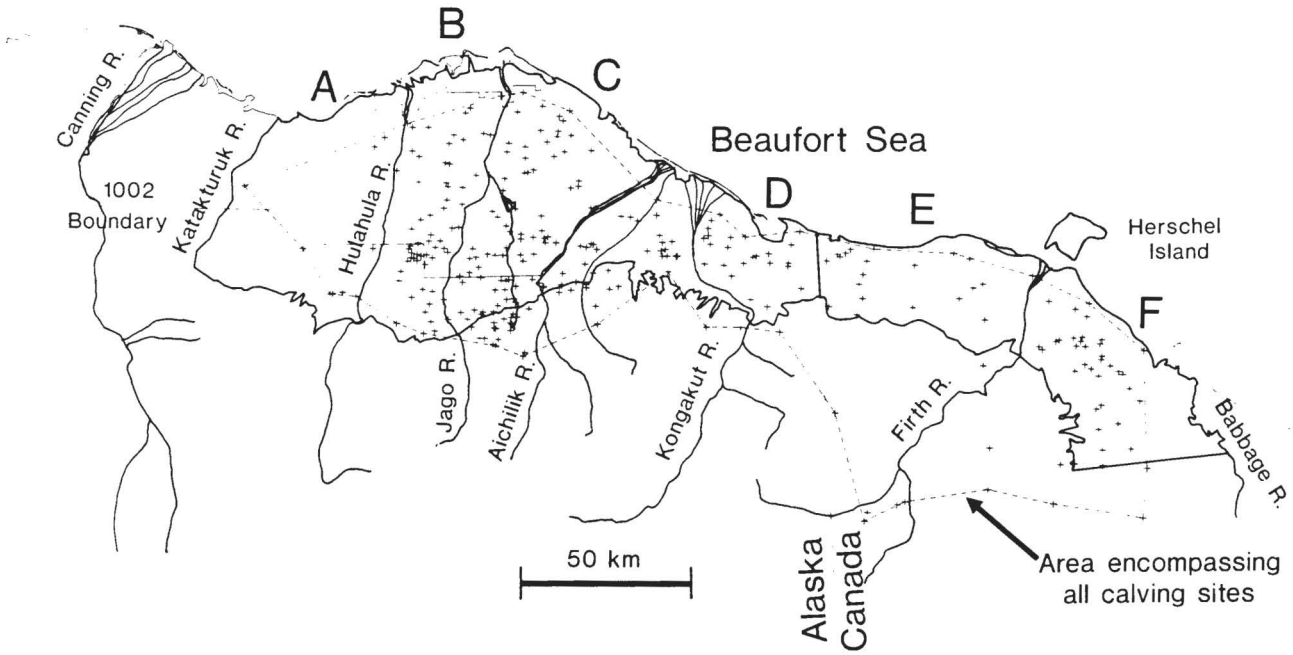

FIG. 1. Calving grounds of the Porcupine herd, showing areas used in analyses of calving distribution, calving site selection, and fidelity. Blocks A–F were used to test for random distribution of calving sites on the coastal plain. The area encompassing all sites where radio-collared cows were first observed with a calf in 1983–1990 (sites are marked by crosses; area is delineated by a dash–dot line) was used in analyses of calving site selection and fidelity.

TABLE 1. Distribution of 267 calving sites in 1983–1990 on the coastal plain of northeastern Alaska and northern Yukon

Block	% of area	Sites observed	Sites expected	Observed: expected	Selection probability[a]
A	21.37	11	57.1	0.19	0.032
B	15.61	66	41.7	1.58	0.259
C	19.26	70	51.4	1.36	0.223
D	16.03	65	42.8	1.52	0.249
E	12.49	18	33.3	0.54	0.088
F	15.24	37	40.7	0.91	0.149

NOTE: Blocks A–F refer to areas shown in Fig. 1.
[a]Relative probability that block will be selected as a calving site.

Mountains calved farther west than those that wintered in Alaska or the Ogilvie Mountains (Fig. 2). In most years, the windswept ridges of the Richardson Mountains allow caribou to begin spring migration and arrive on the calving grounds earlier than cows wintering in other areas with deeper snow (Thompson 1978). We found a significant correlation between date of arrival on the calving grounds and longitude of calving sites (early arriving cows calved farther west) for cows tracked by satellite (Spearman's rank correlation; $n = 39$, $r = 0.646$, $P < 0.001$). However, we found no relationship between arrival date on the calving grounds and date of calving (Spearman's rank correlation; $n = 39$, $r = 0.25$, $P > 0.20$).

Calving site selection

The movements of pregnant cows tracked by satellite between 1985 and 1989 averaged >10 km · d^{-1} in a northwest direction during the 12-d period before calving (Table 2). During the 6-d period beginning at calving, cows moved <5 km · d^{-1} and movement direction was random. Daily relocations of radio-collared cows indicated that most cows selected a calving site on or 1–3 d before their calving date and remained in that general area for 1–2 weeks. The 24-h activity index, an independent measure of caribou movement (Fancy *et al.* 1989), followed a pattern similar to rates of movement (Table 2).

Selection for landcover types characterized by *Eriophorum* tussock tundra was apparent in both Alaska and Canada (Table 3). In Alaska, 55% of calving sites were located in moist graminoid tundra or mesic erect dwarf scrub types characterized by *E. vaginatum* (Garner and Reynolds 1987, p. 60), whereas only 40% of the randomly selected sites were located in these types. In Canada, 54% of calving sites were located in tussock tundra types, compared with 30% for randomly selected sites. When landcover types in both Alaska and Canada were reclassified as tussock versus nontussock types and combined, we found a highly significant selection for tussock types at calving (Fisher's exact test, $P < 0.0001$).

Logistic regression was used to determine the set of attributes that best discriminated between sites selected for calving and randomly selected sites. Attributes were included in the model if their regression coefficient was significantly different from zero

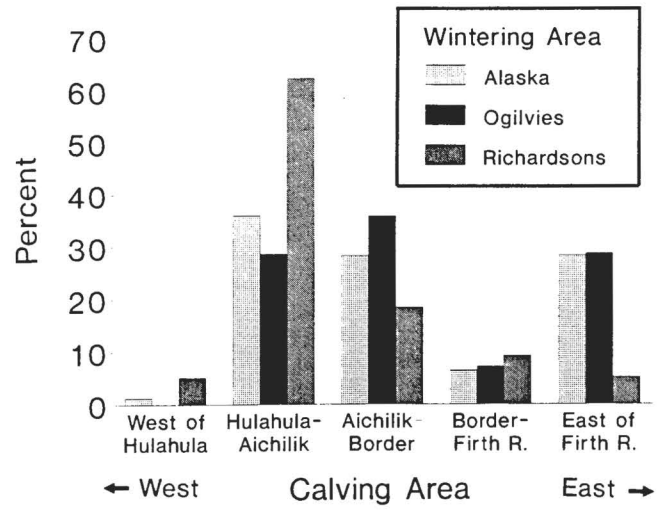

FIG. 2. Relationship between locations of calving sites for 131 individual cows and their previous wintering area.

TABLE 2. Movement and activity (mean ± SE) of parturient cows during 3-d intervals relative to their date of calving

Days relative to calving date	n	Distance travelled (km/d)	24-h activity index	Mean direction (°)	
				Azimuth	P
−12 to −10	42	12.8±1.7	13 713 ± 1270	339	***
−9 to −7	42	13.0±1.5	13 508 ± 1338	326	***
−6 to −4	42	11.9±1.1	13 469 ± 1298	303	***
−3 to −1	42	10.3±1.0	11 917 ± 1098	289	***
0 to +2	40	4.7±0.5	8 316 ± 882	290	ns
+3 to +5	41	4.2±0.6	7 524 ± 839	111	ns
+6 to +8	41	6.9±2.3	10 037 ± 1179	244	ns
+9 to +11	39	5.4±0.5	11 382 ± 1223	212	ns
+12 to +14	38	7.0±0.7	12 700 ± 1347	233	ns
+15 to +17	35	9.0±1.2	14 443 ± 1533	261	ns
+18 to +20	34	9.3±0.9	15 634 ± 1552	270	ns
+21 to +23	33	10.9±1.0	16 994 ± 1924	308	**
+24 to +26	30	13.9±1.2	19 624 ± 1999	317	ns

NOTE: Data were collected between 1985 and 1989 using the Argos Data Collection and Location System (Fancy *et al.* 1989). ns, direction not significant; Rayleigh test (Batschelet 1981, p. 54); **, $P < 0.005$; ***, $P < 0.001$.

at the 95% confidence level (χ^2-test with df = 1; BMDP 1988). The analysis yielded the model (χ^2 = 53.84, df = 3, $P <$ 0.0001)

$$w(x_1,x_2,x_3) = \exp(1.571x_1 + 0.015x_2 - 2.830x_3)$$

where x_1 is the proportion of area within 1 km of a site dominated by *Eriophorum* tussocks, x_2 is the distance between a site and the foothills, and x_3 is percent slope. This selection function can be solved for any site to determine the relative probability of that site being selected for calving (McDonald *et al.* 1991). For example, a site 20 km north of the foothills characterized by 100% tussock tundra within 1 km and a slope of 2% is 29 times more likely to be selected for calving than a site 20 km south of the foothills line that has no tussocks and a slope of 45%. Compared with randomly selected sites, calving sites were significantly farther west, farther north, at lower elevations on gentler slopes, closer to major rivers, farther from the foothills, and had more snow and tussock tundra (Table 4).

TABLE 3. Percent occurrence of landcover types at calving sites and randomly selected sites in Alaska and Canada

Location	Randomly selected sites (n = 277)	Calving sites (n = 284)
Alaska		
Barren floodplain	1.7	0.4
Barren scree	1.7	0.4
Dry prostrate dwarf scrub	6.9	3.0
Moist prostrate dwarf scrub	22.4	20.4
Mesic erect dwarf scrub[a]	18.4	24.3
Moist graminoid tundra[a]	21.3	30.9
Moist–wet tundra complex	13.8	10.9
Wet graminoid	10.3	8.3
Very wet graminoid	0.0	0.9
Scarcely vegetated	3.5	0.5
Canada		
Dryas–sedge	5.8	3.7
Dense shrub slope	2.9	1.9
Open shrub heath	12.6	20.4
Low shrub tundra	1.0	0.0
Lichen–barren	30.1	9.3
Tussock tundra with 0–15% shrubs[a]	10.7	22.2
Tussock tundra with 16–25% shrubs[a]	12.6	24.1
Tussock tundra with 26–35% shrubs[a]	6.8	7.4
Unvegetated	16.5	7.4
Alluvial	1.0	3.6

NOTE: No landcover data were available for the area in Canada west of the Malcolm River.
[a]Landcover types dominated by tussock tundra.

Fidelity to calving sites

Although PCH cows showed a high fidelity to the calving grounds between the Katakturuk and Babbage rivers, they did not return to the same sites on the calving grounds each year to calve (Table 5). None of the cumulative frequency distributions of distances between calving sites were different (Kolmogorov–Smirnov test; $P > 0.20$) from the distributions for randomly selected sites. Thus, although cows select areas with certain characteristics (e.g., away from the foothills, tussock tundra) for calving, annual variation in wintering areas and migration routes used by individual cows and variation in snow cover during migration and on the calving grounds make it unlikely that a cow will calve near the same exact location each year.

Calf mortality

Fourteen (13.5%) of 104 calves collared in 1988 that survived >48 h after capture died by 30 June (Table 6). As in previous years, June mortality for calves of radio-collared cows in 1988 was higher than that for collared calves. This result is expected as calf mortality is greatest within 48 h of birth, and many calves are stillborn or die before they can be collared. After adjusting for perinatal moralities (i.e., excluding deaths that occurred <48 h after birth), similar rates of death were obtained for collared calves and calves of collared cows (Table 6).

In our 1988 study of collared calves, no significant difference (χ^2 = 0.85; $P > 0.10$) was found between mortality of calves originally collared within the 1002 area (9 of 55) and those collared south and southeast of the 1002 area (5 of 49). Snowmelt on the coastal plain in 1988 was the latest on record (Eastland *et al.* 1989; S. G. Fancy and K. R. Whitten, unpublished data), and a relatively high proportion of calves present

TABLE 4. Characteristics (mean ± SE) of 305 calving sites and 305 randomly selected sites within the calving grounds, 1983–1990

Variable	Random sites	Calving sites	P^a
Longitude (UTM)	706 393 ± 4065	682 689 ± 3805	0.0001
Latitude (UTM)	7 717 719 ± 1505	7 725 461 ± 1252	0.0001
Elevation (m)	365 ± 18	260 ± 14	0.0001
Slope (%)	9.0 ± 0.7	4.9 ± 0.4	0.0001
Snow cover (class)	2.3 ± 0.1	2.1 ± 0.1	0.0017
Distance to coast (km)	30.2 ± 1.0	30.5 ± 1.1	0.817
Distance to river (km)	4.1 ± 0.3	2.9 ± 0.2	0.002
Distance to foothills (km)	7.4 ± 1.2	14.7 ± 1.0	0.0001
Tussocks <1 km (%)	35.0 ± 1.9	48.6 ± 2.0	0.0001
Dryas <1 km (%)	20.5 ± 1.2	20.7 ± 1.1	0.899

NOTE: No vegetation data were available for 21 calving sites and 28 randomly selected sites.
[a] *t*-test for difference between means.

TABLE 5. Comparisons of distances (mean ± SE) between calving sites of radio-collared cows located in 2–7 different years with distances between randomly selected sites

No. of years	n	Shortest distance between two sites (km)			Shortest distance connecting all sites (km)		
		Observed	Random	D_{max}[a]	Observed	Random	D_{max}[a]
2	43	67.1±49.1	93.6±59.7	0.097			
3	19	27.9±12.0	38.9±21.7	0.266	125.0±58.7	145.3±55.1	0.111
4	7	26.2±10.0	26.2±14.3	0.202	192.8±27.4	179.2±48.5	0.184
5	6	17.6±8.6	19.8±10.7	0.145	179.6±47.9	206.7±43.8	0.201
6	5	7.2±2.7	15.7±8.4	0.297	176.3±28.5	229.7±42.6	0.373
7	2	5.9±1.4	13.2±7.1	0.424	229.1±105.3	250.6±42.2	0.498

NOTE: Cumulative frequency distributions of distances between calving sites and 8000 sets of randomly selected sites were compared using the Kolmogorov–Smirnov test (Sokal and Rohlf 1969, p. 573).
[a] All values are nonsignificant ($P > 0.10$); Kolmogorov–Smirnov test statistic.

within the snow-covered 1002 area was captured compared with those captured outside the 1002 area.

Locations where cows that lost calves were first observed without a calf were significantly farther south and closer to the foothills than locations where cows were observed with live calves (Table 7).

Discussion

Concentrations of cows have used the coastal plain between the Hulahula and Aichilik rivers for calving in 17 of the past 19 years, but the location of areas having the highest concentration of caribou during calving varies annually. We believe that most of this annual variation can be explained by variation in snow cover, both on the calving grounds and on winter range. In years of relatively early snowmelt, the highest concentration of calving sites has consistently been located in Alaska west of the Aichilik River and close to the coast, whereas in all years when snowmelt was relatively late, calving sites were concentrated east of the Aichilik River or in the foothills.

Primary wintering areas for the PCH occur in areas of relatively shallow snow, and snow has been shown to influence the initiation and progress of spring migration (Thompson and Roseneau 1978; Garner and Reynolds 1986; D. E. Russell, A. M. Martell, and W. A. Nixon, unpublished data). Cows wintering on wind-blown ridges of the Richardson Mountains are least likely to encounter deep snow that may delay arrival on the calving grounds; these cows tend to calve farther west than cows wintering in Alaska or the Ogilvie Mountains. Cows delayed by deep snow during spring migration may calve before they reach an area with the combination of factors (e.g., greater distance from foothills, tussock tundra, lower elevations, gentler slopes) associated with most calving sites.

Once they reach the coastal plain, parturient cows continue to

TABLE 6. Percent mortality of collared calves or calves of collared cows during late May and June 1983–1990

Year	Calves of collared cows		Collared calves (adjusted[a])
	Overall	Adjusted[a]	
1983	35 (20)	7 (14)	9 (59)
1984	16 (25)	10 (21)	7 (60)
1985	35 (43)	10 (30)	15 (60)
1986	—	—	—
1987	34 (41)	18 (33)	—
1988	31 (71)	12 (51)	13 (104)
1989	26 (58)	9 (47)	—
1990	9 (54)	0 (52)	—

NOTE: Data for 1983–1985 were obtained from K. R. Whitten, G. W. Garner, F. J. Mauer, and R. B. Harris (unpublished data). Relocations in 1986 were too infrequent to calculate death rates. Values in parentheses are sample sizes.
[a] Adjusted mortality includes only those calves known to have been >48 h old when last observed alive. Perinatal and possible perinatal mortalities are excluded.

TABLE 7. Characteristics (mean ± SE) of sites within Alaska where calves of radio-collared cows were observed alive and sites where cows that lost calves (including perinatal mortalities) were first observed without their calf during late May and June 1983–1990

Variable	Cows with calves (n = 263)	Lost calves (n = 42)	P^a
Longitude (UTM)	648 849 ± 2442	655 658 ± 4800	0.211
Latitude (UTM)	7 732 351 ± 1160	7 725 792 ± 2513	0.034
Elevation (m)	272 ± 15	316 ± 35	0.292
Slope (%)	6.6 ± 0.8	4.8 ± 1.2	0.194
Distance to coast (km)	31.9 ± 1.2	38.0 ± 3.0	0.065
Distance to river (km)	2.5 ± 0.1	2.0 ± 0.3	0.129
Distance to foothills (km)	18.4 ± 1.1	10.4 ± 2.1	0.001
Tussocks <1 km (%)	45.0 ± 2.2	45.9 ± 5.3	0.881
Dryas <1 km (%)	26.1 ± 1.1	19.7 ± 2.5	0.041
Wet–very wet graminoid <1 km (%)	23.8 ± 1.8	26.2 ± 4.2	0.618
Barrens <1 km (%)	5.0 ± 0.6	8.2 ± 1.7	0.068

[a] t-test for difference between means.

travel 10–12 km·d^{-1} until they bear their calf. In most years, they appear to follow a band of advancing partial snowmelt towards the north and west, and we believe that the apparent selection for areas dominated by tussock tundra during calving is an artifact of their association with this band of mottled snow. The microtopography of *Eriophorum* tussocks promotes melting, evaporative loss of snow cover, and early growth of vegetation (Lent 1980), and in most years when cows arrive on the coastal plain, the northernmost patches of bare ground are associated with tussock tundra landcover types (Eastland *et al.* 1989). Areas north of the melt line are probably not used because foraging is difficult through the heavy, wet snow, and green vegetation and dry sites for calving are lacking.

Our results are consistent with the hypothesis that within the constraints of snow cover and the timing of their arrival on the calving grounds, cows select calving sites primarily to reduce exposure of calves to predators. There is a secondary benefit in being able to take advantage of the first green vegetation (primarily *Eriophorum vaginatum*) and bare patches available on the coastal plain. Bears (*Ursus arctos*), wolves (*Canis lupus*), and golden eagles (*Aquila chrysaetos*) appear to be more abundant in the foothills and mountains than on the coastal plain during the calving season (S. G. Fancy, personal observation), and radio-tracking studies of predators have confirmed that most predators remain south of the coastal plain during calving (Young *et al.* 1990). Our results and those of an earlier calf mortality study (K. R. Whitten, G. W. Garner, F. J. Mauer, and R. B. Harris, unpublished data) indicate that mortality risk (i.e, the probability of a calf dying) during June is higher for calves that spend time closer to foothills or mountains than for those farther north on the coastal plain.

The rate of calf deaths is greatest within 48 h of birth (K. R. Whitten, G. W. Garner, F. J. Mauer, and R. B. Harris, unpublished data; this study).This perinatal mortality appears to be influenced more by maternal or fetal condition and behavior than location of the calving sites. Roffe (1990) found that 78% (43/55) of PCH calves (<48 h old) for which he determined cause of death were stillborn or died of emaciation or malnutrition. However, his results may underestimate predation as a mortality factor during the perinatal period because only carcasses that were largely intact were necropsied, and all carcasses were collected from a relatively predator-free calving concentration area on the coastal plain. The association of perinatal and other calf mortalities with the foothills that we found may be partly explained if cows in poor condition or with poor maternal instincts tended to calve on the periphery of the main calving concentration. However, very young calves are particularly vulnerable to predators (Miller *et al.* 1988), and perinatal deaths in the foothills and mountains could also have been due to predation. Following the prenatal period, predation is involved in the majority of calf mortalities in the PCH. K. R. Whitten, G. W. Garner, F. J. Mauer, and R. B. Harris (unpublished data) reported that predation was involved in 13 of 18 collared calf mortalities, and mortality sites where predators were involved were at higher elevations than sites where calves died for other reasons (e.g., disease, drowning, malnutrition).

Our contention that cows select calving sites primarily to reduce exposure of calves to predators and secondarily for their nutritional value is based on several factors. During calving, barren cows and bulls occur closer to the foothills and mountains where plant phenology is more advanced and foraging opportunities are presumably superior (Whitten and Cameron 1980). Furthermore, in years of relatively early snowmelt, as in 1990, many cows calve north of areas dominated by tussock tundra, thereby decreasing foraging opportunities but increasing the distance from predators. Finally, simulation studies indicate that cows have an energy deficit during early calving because the biomass of *Eriophorum* and other forage species is low (Fancy 1986).

However, tussock tundra may provide the best foraging opportunity among vegetation types available on the coastal plain. Flower buds of *E. vaginatum* are highly digestible and may be an important source of nitrogen and minerals for parturient cows (Kuropat and Bryant 1980; Fancy *et al.* 1989; D. E. Russell, A. M. Martell, and W. A. Nixon, unpublished data). The biomass and digestibility of *Eriophorum* within the 1002 area are higher than in peripheral areas to the south and east (Felix *et al.* 1989; White *et al.* 1989; Christensen *et al.* 1990).

The selective advantage of calving in the northwestern portion of the calving grounds is reflected in annual rates of calf death. Snowmelt on the Alaskan portion of the calving grounds in 1988

and 1987 was the latest and second latest, respectively, recorded in 20 years. In 1987, >67% of calves were born in Canada, and calves born in Alaska were born relatively close to the foothills. In 1988, most calving occurred in the foothills and mountains south of the 1002 area boundary. In contrast, calving in 1989 and 1990 was concentrated north of the foothills and west of the Aichilik River. Snowmelt in 1990 was the earliest ever recorded; by 28 May, the entire coastal plain was >95% snow-free. Overall and adjusted rates of death for calves during 1987 and 1988 were greater than in 1989 and 1990, when calving was concentrated farther from the foothills (Table 6).

Our results suggest that displacement of calving caribou from the 1002 area towards areas of higher predator abundance could result in increased calf mortality. However, if the PCH continues to increase without a proportional increase in predator numbers, the proportion of calves killed by predators could decrease even if calving were displaced closer to areas of higher predator abundance. Additional studies are needed on the relationship between caribou distribution during calving and the potential numerical and functional response of predator populations. Results will be used in simulation models of PCH population dynamics to estimate the potential effects of an oil and gas leasing program in ANWR on the PCH.

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2/10/92 Don Young Predators

Bears

① rel. abundance bears wolves eagles
② distbn ~~change~~ independent from caribou > good data for bears
③ quantify use of caribou as food

states - entering 1991 data
no work on eagles in 1991
trying to maintain sample size of collars

in 1992 test techniques for estimating predation rates Betty dbs, supercub

still doing analysis of bear - caribou locations

do not know if radio collared bears are representative of the popn
same with wolves - need to mark transient wolves

no info on subadult eagles

need density estimates

all predators use caribou for food

thinks you need to address all three because
~~all~~ don't know which predator has the
biggest impact

Collaring of eagles is feasible now
collar on the nest, program to start operating the
next year

eagle predation prob. would not

need 1/2 marked bears to do the density estimate
(not using satellite anymore)

need density & predation rates to make predictions.
↓
need to ~~ca~~ put out more collars

pilot study for 1992 on habitat - really just test methods.
to index performance on the refuge
wt gain cow
wt gain calf

how they get the weight is it related to habitat

habitat use availability analysis
relocate many times over the summer

have GPS in 185, + hand held w/in 100 m
collapse classes to 5 or 6

<biomass in each class, etc.>

* tame animals in 5 or 6 classes - will examine
fistula
how do calves learn to forage?
what are they eating?
bite rates

fecal pellet analysis?

Feb 25 - caribou investigators meeting
ADFG, FWS, CWS
are we going to drop our funding of CATH work?

need to address the interim ~~rep~~ report + progress issue

Insect Relief IIIc now funded

her report 1st cut @ it

dry prostrate dwarf scrub - 116

should look @ values of habitat & what happens when can't get there

predation risk from the predator study

2/11/92 Caribou.
Tom, Brad, Noreen

1991 - captured 16 CAH + 27 PCH cows
farthest west calving grand
census - still counting, b
survival + fecundity → still growing

1992 - March Survey on wintering
April - recollar, & new collars PCH
May-June - calving surveys →
skip perinatal survival - just
go back @ 30 days
may do census over?
← test techniques for habitat work

Wade Unit IA → complete
1991 CAH - 19,000 - got a good count stratified census
Ib. density - using collared cows → to estimate
calving area size
harmonic mean
Kernal Estimator - includes variance

drop the 72-82 data

Summary of 1991 field season:

April capture of CAH and PCH cows (16 + 27)
May-June calving survey - parturition and mortality "normal", calving ground farthest west recorded
July census and classification - counts in progress
No major change from previous years - no surprises

Plans for 1992 field season:

March survey flights with YTDRR, adult survival estimates
April capture of PCH cows - baseline maintenance
May-June calving survey - no perinatal survival estimates, but 30 day survival estimates for calves
Repeat of July census possible but unlikely
Test of concept of field methods for initiation of habitat work if funded

I. Potential impacts of petroleum exploration and development on the **numbers, distribution and status** of caribou on the Arctic coastal plain.

a. Determine the size, productivity, and age/sex structure of the Porcupine and central arctic caribou herds.

Status:

Completed.
Routine monitoring for PCH necessary to maintain baseline.

Results:

a. PCH in 1989 - 178,000
observed rate of increase 79-89 = 5%

b. CAH in 1991 - 19,100
observed rate of increase 83-91 = 5%

c. PCH parturition rate 81%

d Calf:cow ratios

CAH (June)	67:100
PCH (July)	54:100

b. Determine calving densities within the "concentrated" calving area and peripheral calving areas on the refuge coastal plain.

Status:

Data collected, analyses in progress.
Routine monitoring for PCH necessary to maintain baseline.

Results:

a. 62% of collared cow calving sites occur in $\pm$ 30% of Harmonic Mean "Calving Ground"; Core includes a segment in Canada; Core encompasses coastal plain, foothills and mountain zones. Densities will be back calculated from biennial censuses.

c. Determine the rates, causes, locations, and variation in caribou mortality.

Status:

Completed.
Routine monitoring of early survival of calves and annual survival of others necessary to maintain baseline.

Results:

a. PCH 30-day calf survival 73%
nutrition and predation each 50% of this
perinatal = mostly nutrition
post-perinatal = mostly predation
ANWR = 59% of annual calf mortality summer

b. PCH annual calf survival 54%
41% of total annual calf mortality occurs in Canada late summer winter

c. PCH annual adult ♀ survival 85-90%
most adult mortality occurs in Canada

d. Inverse relationship between % collared cows calving in 1002 and post-perinatal calf mortality.

d. Determine the seasonal distribution and movements of the Porcupine and central arctic caribou herds.

Status:

Completed.
Routine monitoring for PCH necessary to maintain baseline.

Results:

a. No difference in daily movement rates of PCH and CAH in summer or winter.

b. Daily movement rates of PCH much greater than CAH during migration.

c. Annual distance moved:
PCH = 4355 km
CAH = 3031 km

II. **Habitat requirements** and potential impacts of oil development on caribou.

a. Determine the effects of existing oil development on the North Slope on the distribution, movements, body condition, and productivity of the **central arctic herd**.

Status:

Completed - results equivocal.
Possible role for continuation - will require substantial funding.

Results:

a. Heavier females:

are more likely to conceive
have calves earlier (CAH but not PCH)
have calves more likely to survive the first 48 hours

b. For CAH females west (with development) and east (without development) of the Sagavanirktok River:

No significant differences in:
successive parturition rate (70%)
perinatal calf survival (86%)
summer of fall body weight
summer or winter weight change

b. Determine relationships between present habitat availability and quality, caribou body condition, and reproductive performance (e.g calf production, calf survival) to better understand the impact of the loss of or displacement from habitat on the population.

Status:

Not addressed, not funded for PCH.
Most important area for future emphasis.

An important area stressed by WMI review.

c. Evaluate the effectiveness of mitigation measures implemented for protection of the **central arctic herd** and identify those measures that may be applicable to the Arctic Refuge.

Status:

Cooperative work in progress with ADFG/Industry.

CONCLUSIONS REGARDING:

Will development of 1002 Area affect PCH?

PCH and CAH have both increased in past 10 years at approximately the same rate.

Gross implication is that there have not been major impacts on CAH but pre-development data is lacking and result must be taken cautiously.

Furthermore observations from CAH may not apply directly to PCH

large difference in herd size, group size
possible differences in winter range quality
displacement of CAH can be to a large area of habitat similar to that occupied by development infrastructures
displacement of PCH may be to area of quite different habitat quality
cumulative impacts of development of large portion of calving/summer habitat of difficult to predict.

should we do crossing studies sans pipeline.

Don Russell - energetics model
we are - popn. model - still working on (Naeem)
@ some point they will model
put confidence limits on stochastic popn model

FUTURE DIRECTION:

This plan heavily influenced by recommendations of WMI review team - stresses integration of multiple causes of habitat use and resultant value.

Shift emphasis from population dynamics to habitat interactions.

Among
1) calving areas used annually
2) concentrated calving area
3) peripheral calving areas
4) unused areas

What is the value of different refuge habitats to PCH caribou in terms of
nutrition,
insect relief,
predation?

What is the contribution of Alaska habitat to the annual energetics cycle of PCH caribou?

How important is the Refuge calving ground to PCH?

<u>Approach:</u>

What are the annual patterns in summer (Alaskan) weight gain of cows and calves of PCH?

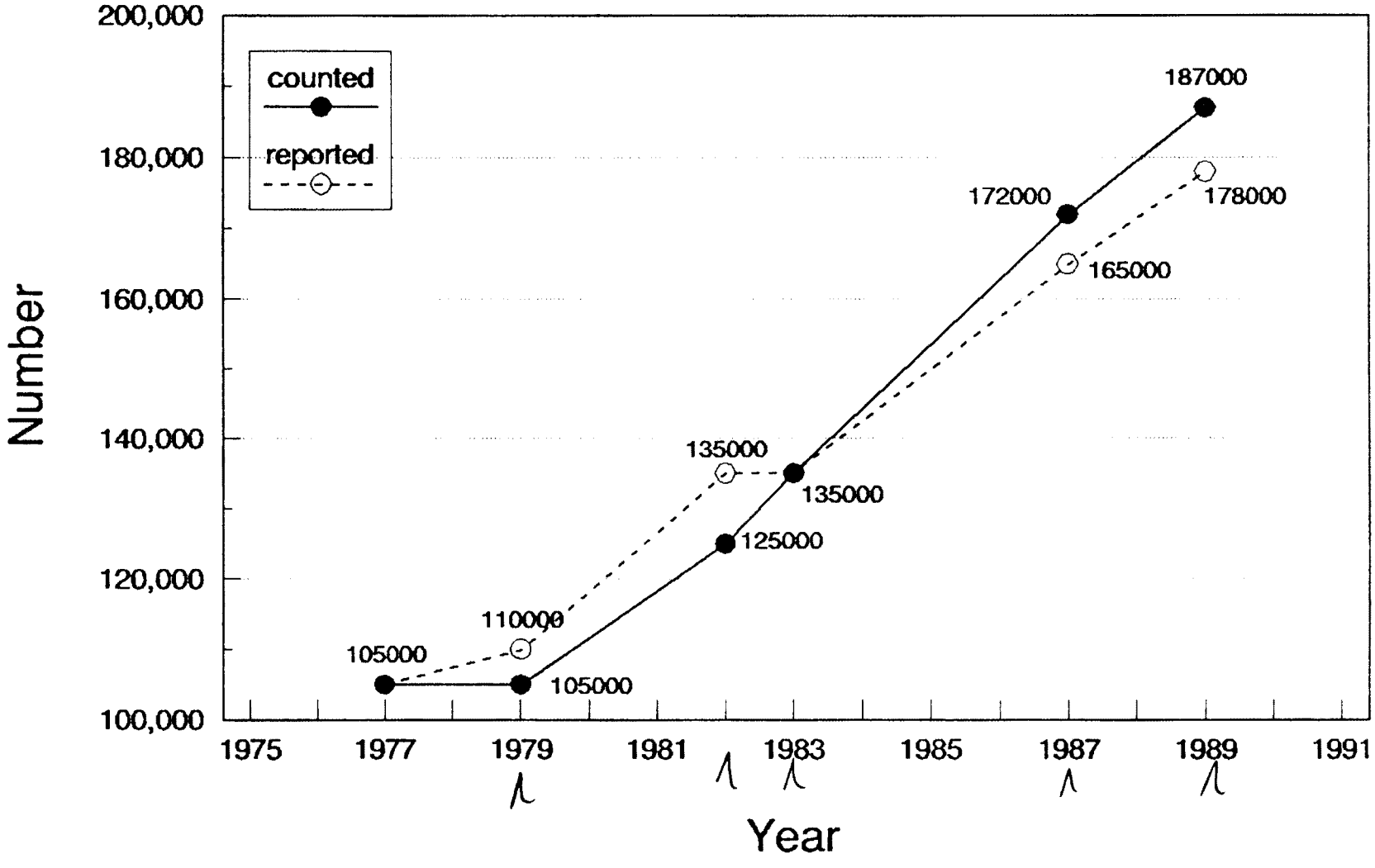
How does this weight gain contribute to annual energetic balance?

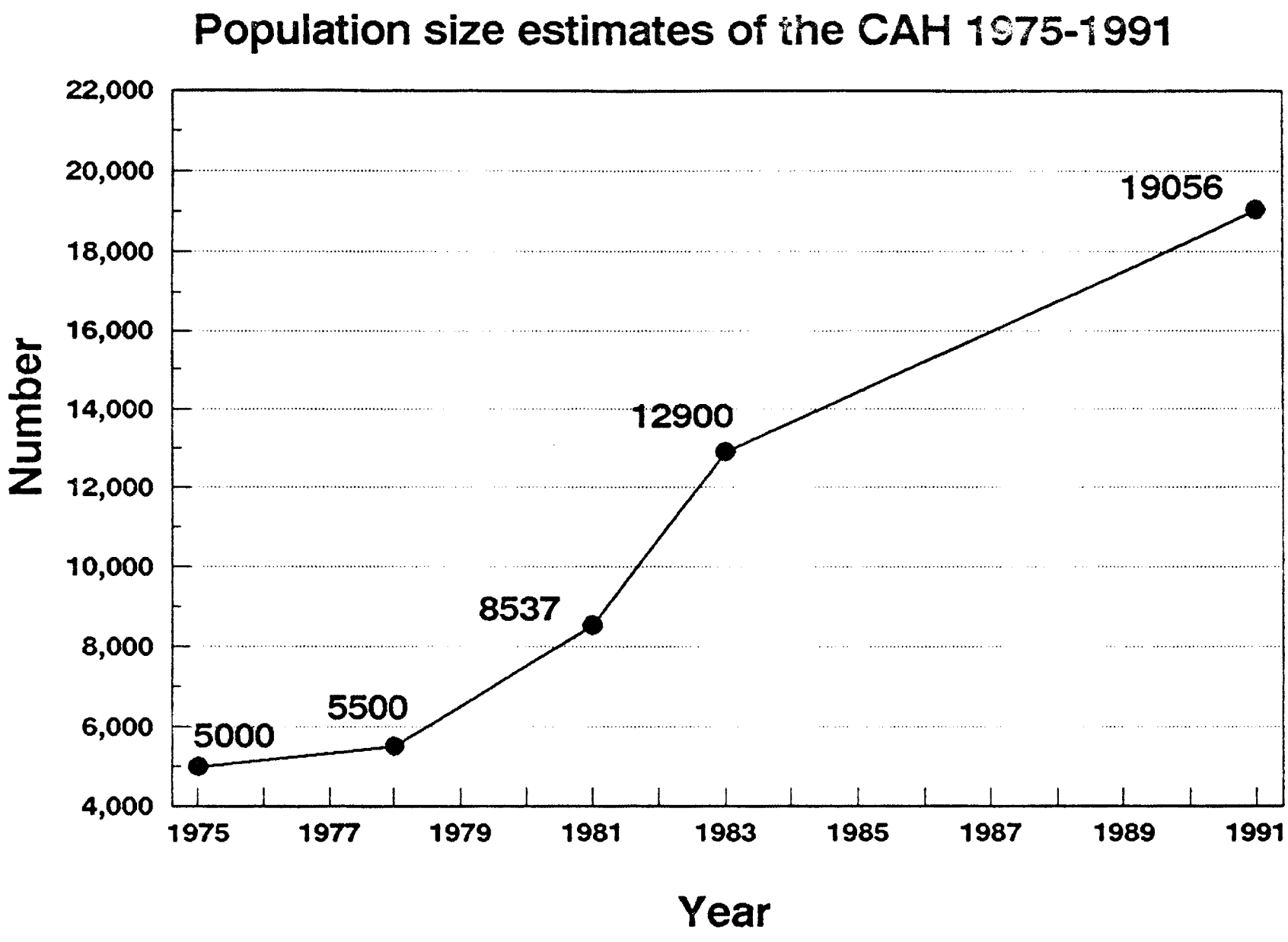
How does this weight gain influence survival, fecundity, and population dynamics?

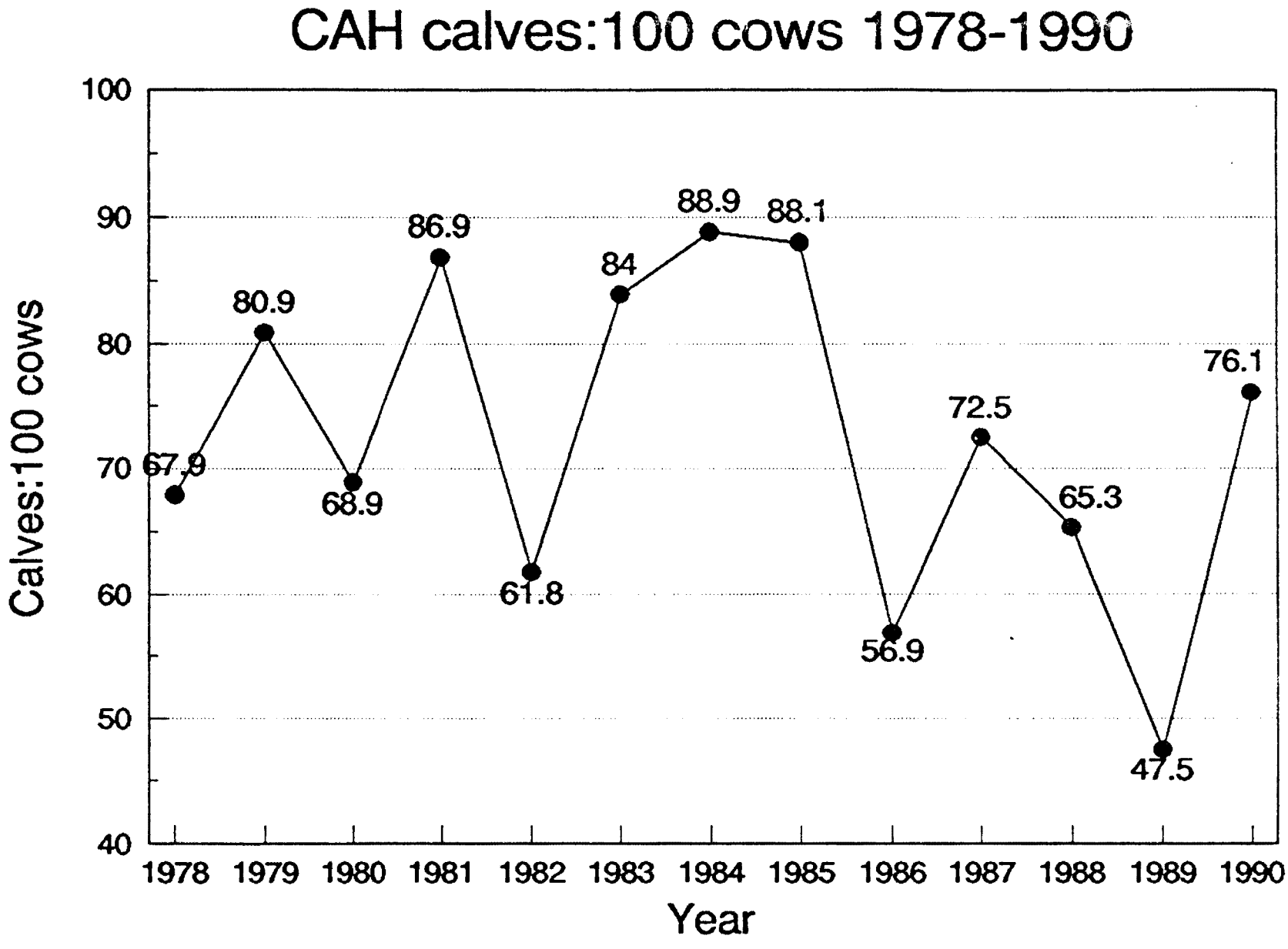
What habitats on the Refuge contribute to this weight gain?

This will identify important habitats for mitigation attention.

Population size estimates of the PCH 1977-1989

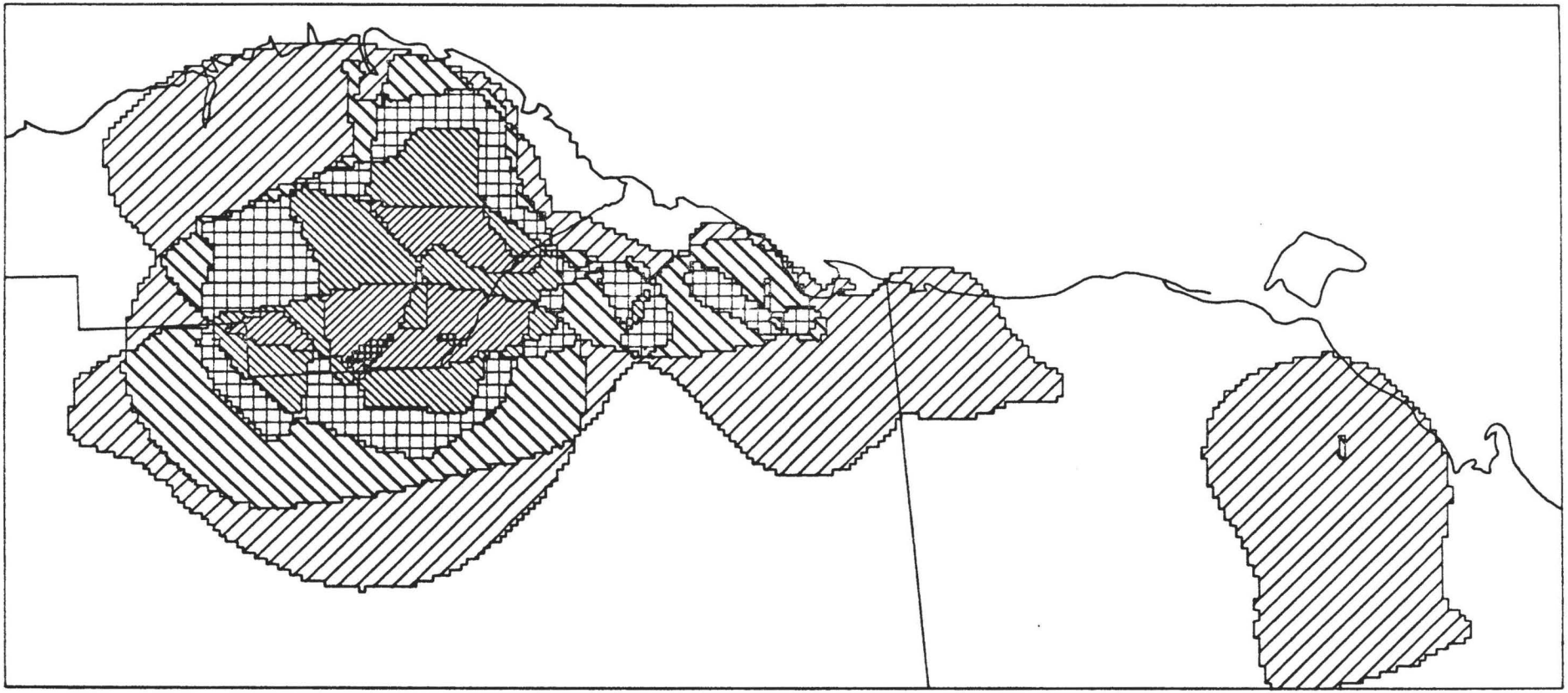



Population size estimates of the CAH 1975-1991
Number
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
5000
5500
8537
12900
19056
1975
1977
1979
1981
1983
1985
1987
1989
1991
Year


CAH calves:100 cows 1978-1990
Calves:100 cows
100
90
80
70
60
50
40
67.9
80.9
68.9
86.9
61.8
84
88.9
88.1
56.9
72.5
65.3
47.5
76.1
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
Year

HARMONIC MEAN CORE CALVING AREAS

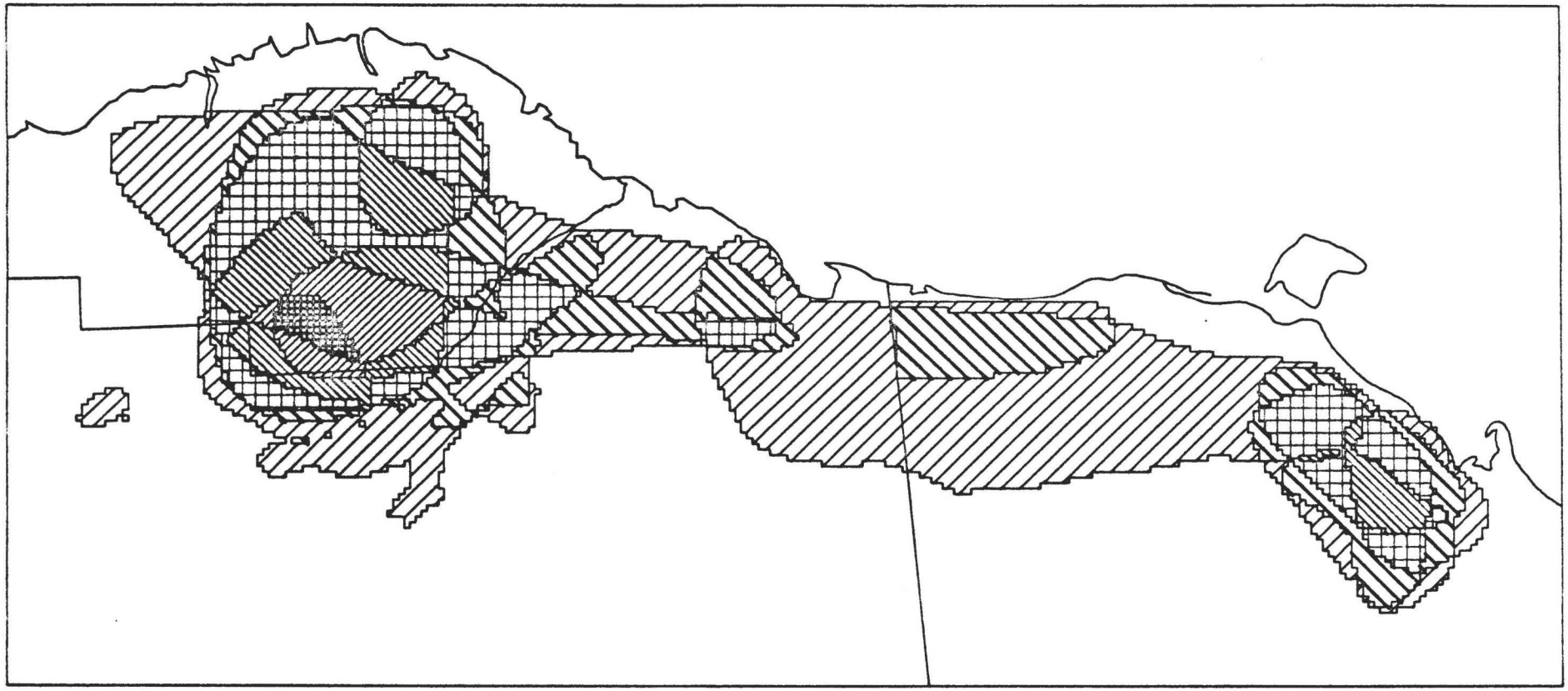
PCH 1983 - 1990



YEARS OF CALVING

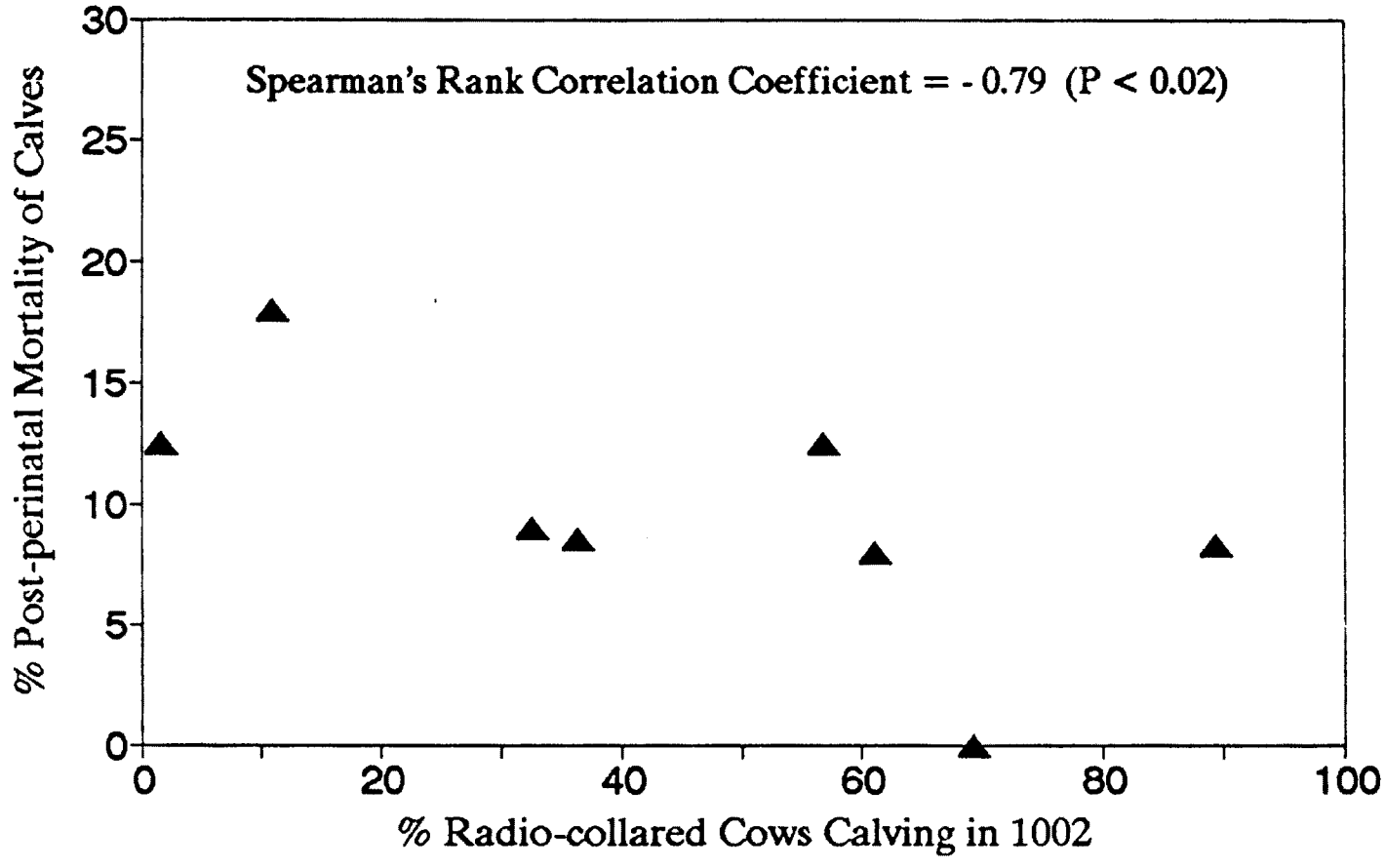
HAND DRAWN MAJOR CALVING AREAS

PCH 1983 - 1990



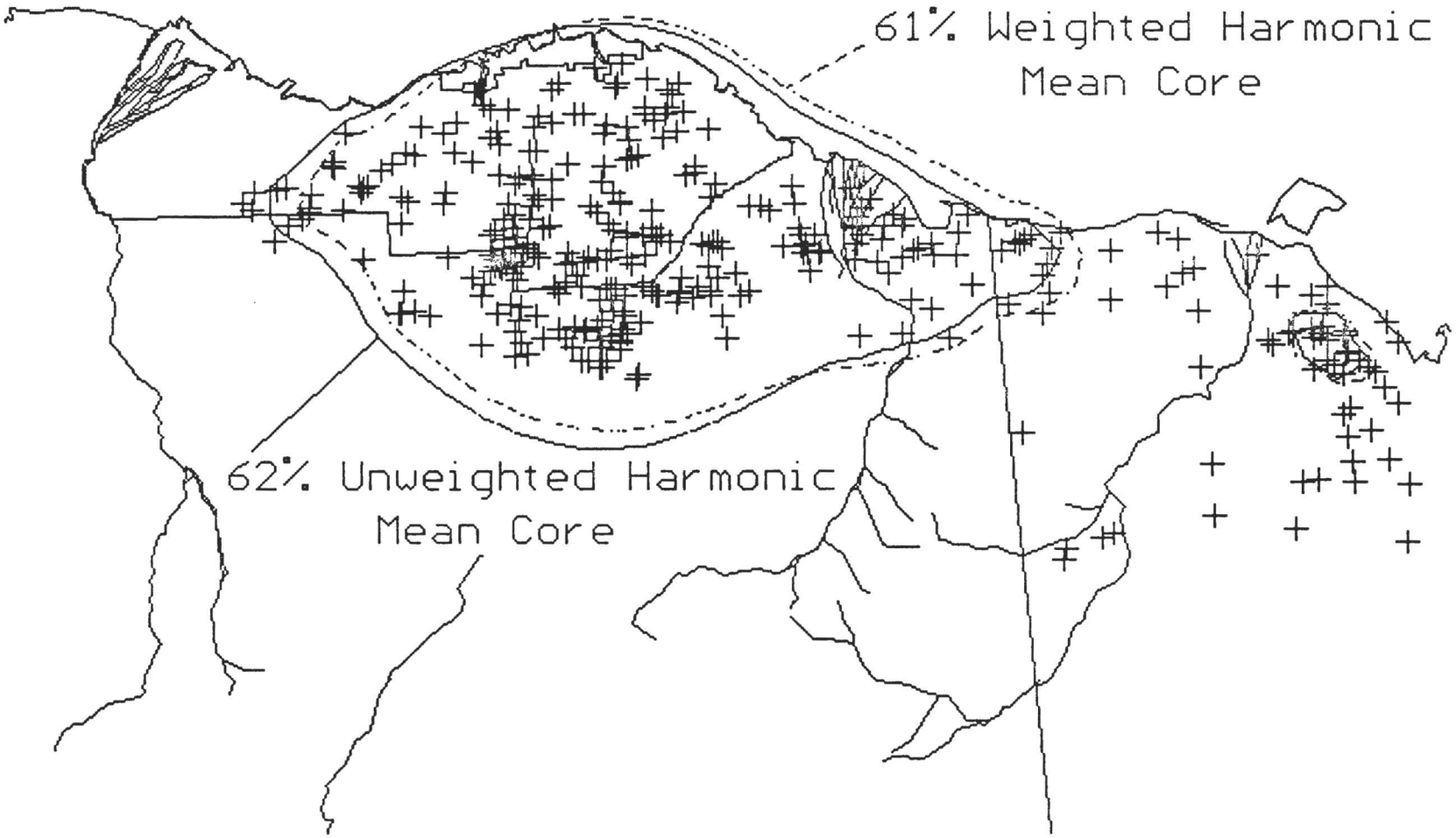
YEARS OF CALVING

PCH - Relationship of Calving Site and
Post-perinatal Calf Mortality, 1983-91



Collared cows

1983-1991 Porcupine Caribou Herd Calving Sites (n=352)



I see ~~caribou~~, polar bears, snow goose
coastal fish & water falling out

I see caribou continuing
muskox
seismic
any fish work @ all should be done on
Hulahula, Canning.

no work on water w/out policy decision on
water rights application

93
94
95

Proposals:

(1) caribou surveillance
(1) caribou - habitat
(2) predators
(3) muskox 1 — habitat
(4) muskox 2 - petroleum
(5) snow goose?
(6) salt marsh
(7) Seismic - 1994 - big next year

(8) inland fish
  (1) spawning popns. char
  (2) arctic grayling overwintering

(9) Coastal fish
  (1) fyke nets
  (2) hydro
  (3) arctic disco lab studies

Continuations:

Unanswered questions
what do caribou eat?
the big rivers

(10) water
  (1) lakes
  (2) reservoirs sites
  etc.
  etc.

?? Issues

should we keep giving Amstrup $32K for denning studies?
how to ensure our projects funded by ARW
keep getting funded - muskox, snow goose monitoring
continuing habitat, vegetation map on to Prudhoe Bay?
what the heck can be done w/ fisheries synthesis?
find out date of Arctic Fish conference
Talk to Monty Millard on fish issues.
very unclear why NOAA cannot finish their analysis of meterological/oceanographic data
continued funding of CAH work (to keep us @ the table)
water right issue
report issue

1002 Project Office
Recent and Planned Activities

Summary of Activities:

- Mitigation Planning - Conduct review of species/issue status and mitigation efforts to date in order to initiate development of comprehensive stipulations for protecting fish and wildlife in the 1002 area. Draft report on snow goose completed and undergoing review by snow goose principal investigator.

- Litigation - Consolidated lawsuits filed against the government in 1989 charged that the 1002 Report/LEIS was insufficient under NEPA and, further, should be supplemented. An administrative record was compiled and briefs written. The case was presented to the court on December 19, 1991, and a ruling is pending.

- Legislation - A broad energy bill, which included authorizing leasing of the 1002 area, was passed by the Senate Energy Committee in the latter half of 1991. The bill was not brought to a vote in the Senate due to insufficient support to override a threatened filibuster. An energy bill is expected to be debated in 1992 but 1002 opening legislation might be handled separately. A wilderness bill was reported by the Senate Committee on Environment and Public Works but no vote is scheduled.

- 1992 Activities - Completion of 1002 study program review, mitigation planning, organization/synthesis of 1002 geographic information system (GIS) data.

Mitigation Planning

The purpose of the mitigation planning project is to assess the existing information and begin drafting preliminary wildlife and habitat protection measures specifically applicable to the 1002 area. In the event Congress authorizes opening legislation, mitigation stipulations or plans will afford the Service a head start for an expected short time-frame to develop an Environmental Impact Statement, and will be essential to management of development in the 1002 area. Draft reports on each issue will summarize the current status and research on the species/issue, mitigation stipulations that have been implemented and their track record, and suggested protective measures for the 1002 area. These reports are subject to review by principal investigators, species experts and managers within the Service. Eventual establishment of a team of technical and management experts to work with the 1002 Project Office in developing specific stipulations is envisioned. To date, a draft mitigation planning report for snow goose has been distributed for initial

review and a mitigation planning report for polar bear is in draft.

Ligitation

The Natural Resources Defense Council (with eight additional environmental groups) and the Gwich'in Steering Committee (representing subsistence users of the Porcupine caribou herd) filed lawsuits against the Department of the Interior in August 1989. Plaintiffs contend that the Department's 1987 1002 Report/ Legislative Environmental Impact Statement (LEIS) was not adequate under the standards for an EIS set forth in the National Environmental Policy Act (NEPA). Plaintiffs further contend that NEPA requires the Department to supplement the LEIS based on events subsequent to issuing the report. In order to respond to the lawsuit, the Department assigned the Service lead responsibility for compilation of an Administrative Record (Record) on the preparation of the 1002 Report/LEIS. A draft annotated index to all of the identified documents was prepared by the 1002 Office in 1990 (based on ProCite, a computerized bibliographic data base).

The case has been procedurally complex. In July 1991 the court dismissed the part of the case that alleged that the Department's 1002 Report/LEIS violated ANILCA, but the court found that there may be a valid argument over whether NEPA was violated so the court ordered the parties to provide briefs on the remaining issues and submit the administrative record to the court. [The court also held that the BLM's April 1991 update of the 1002 area mineral resource assessment constituted significant new information and held that the Department violated NEPA by not circulating the update as a Supplemental Environmental Impact Statement. This ruling is on appeal.]

To respond to the court's stringent briefing schedule, the 1002 Office diverted staff efforts almost exclusively toward litigation activities for the latter half of 1991. This included locating and entering all pertinent documents into a final annotated Administrative Record Index, sorting, copying and transporting the documents to Washington, D.C., and working with the Department's Solicitor and the Department of Justice to address the government's case. Staff at Arctic NWR and Northern Alaska Ecological Services were instrumental in providing information to ensure the accuracy and thoroughness of Administrative Record and brief. The Department's 121-page brief was filed on November 20, 1991, and oral argument before the Judge Joyce Green of the District Court in Washington, D.C., was heard on December 19, 1991.

Legislation

Bills on both sides of the 1002 issue were considered by Congress in 1991. Commenting on draft testimony, responding to numerous and assorted Congressional and correspondence inquiries, and

providing briefing material for hearings were among the tasks completed by the 1002 Project Office. Legislative activities dominated 1002 staff efforts from February through June. Species for which the most questions were posed during the legislative session were caribou (size, calving, migration, and protective management zone) and polar bear (number of dens on the 1002 area and importance of those dens to the population). Other areas of interest to Congressional committees and the Department this year included muskox, impacts on birds, mitigation for wetland losses, habitat impacts (extent and restoration), Kaktovik Inupiat Corporation well site revegetation, and the endangered species petition on eiders.

BILL (INTRO-DUCED)	TYPE	SPONSOR	REFERRED TO	ACTION
S.39 (1/14)	Wildern.	Roth	Environ.	4/11 hearing; passed Comm.
S.109 (1/14)	Leasing	Murkowski	Energy	
S.570 (1/25)	Leasing	Department		
S.341 (2/5) (S.1220)	Natl. Energy Security Act	Johnston	Energy	3/12 hearing on 1002 leasing; passed Comm.
H.R.39 (1/3)	Wildern.	Udall	Interior	
H.R.759 (1/30)	Leasing	Young	Interior & MM&F	
H.R.1320 (3/7)	Leasing (Natl. F&W Enhancement Act)	Jones	MM&F	Hearings 5/1 and 6/11 in D.C.; 8/7 in Anchorage

Title IX of S. 341 would authorize leasing on the coastal plain and was included in the energy bill reported to the Senate by the Energy Committee. The Senate Environment Committee passed a wilderness bill in October concurrent with the plans to bring the Senate Energy Committee bill to a floor vote. Threats of a filibuster by wilderness proponents lead to a cloture vote (i.e., a vote to limit the filibuster). After failing to get the 60 votes required to invoke cloture and limit filibuster, S. 341 was withdrawn from Senate floor action. The bill may be brought up for a floor vote in 1992, but the 1002 provision may be removed from the bill and handled separately. The disposition of 1002 legislation for the balance of 1992 is unknown.

1992 Activities

In 1992 the 1002 Project Office will be completing a comprehensive review of the five-year 1002 study program undertaken in 1988. Findings from the review will be provided to the Regional Director with recommendations regarding continuation or initiation of further 1002 studies. Depending on the outcome of litigation, the 1002 Office will concentrate on mitigation assessment and planning. The 1002 Office will continue to respond to legislation requests as necessary.

The 1002 Office received approximately $250,000 in an increase package for FY 1992 to address 1002 GIS data. The package was developed to improve access and coordination of 1002 data, particularly for the formation and application of mitigation measures and multi-species issues or impacts. In February IRM is reviewing the 1002 database as the first part of a broader, regional review that is to aid the integration and greater use of data from throughout the Region. Based on that review, the 1002 Project Office will proceed with the enhanced GIS function.

To facilitate access to 1002 information, note that reports or other documents held by the 1002 Office are listed in an annotated index to the 1002 Report/LEIS Administrative Record and a listing of all documents in the 1002 library is in the ProCite bibliographic data base. The 1002 Office staff is available to assist you in using these reference or background materials. Any 1002 studies which similarly catalogue their information sources may notify the 1002 Office so that cataloging efforts can be coordinated.

Notes on 1991 activities, status and recommendations for future studies following meetings with investigators

TERRESTRIAL RESEARCH PROGRAM

Caribou. Tom McCabe, Brad Griffith, Noreen Walsh, Alaska Fish and Wildlife Research Center, Fairbanks.

change method of describing location of calving
pilot study on habitat methods
continued funding of CAH work
propose to work in future on habitat relationships, could be expensive.

Predators. Don Young, They need to put out more collars on bears to do the density estimate and to find out if collared bears are representative of all bears. need info on subadult eagles, could collar on nest, technology possibly feasible now. Still do not know which predator is the most important on caribou.

Muskox. Pat Reynolds, Arctic National Wildlife Refuge, Fairbanks. Need to revisit the muskox map. she's working on papers. Why are animals leaving when it appears that there is vacant habitat? two new study plans: 1) habitat, using new vegetation map, 2) petroleum area. the basic radio-collaring work is fund by ARW--need to reinforce importance to ARW so they will keep doing it. get Muskox book called On the Brink

Polar Bear. Steve Amstrup, Alaska Fish and Wildlife Research Center, Anchorage. Basically, the maternity denning work unit is completed. Data on denning will continue to be collected in the course of work on other work units (primarily dealing with bear-sea ice relationships). Three papers are in the works: 1) ecology, 2) ANWR dens, 3) reactions of bears to disturbances. They should be done soon. Discussed that bullets are most serious impact--legislation should possibly include provision amending MMPA such that no hunting, even by Alaska Natives, is allowed in area of oil development. Steve feels we know enough to protect bears should development be authorized.

Snow Goose. Jerry Hupp, Alaska Fish and Wildlife Research Center, Anchorage. In 1991, work continued using captive geese to observe feeding behavior. Habitat work continued. They have developed logistic regession equations that use site moisture and percent cover of carex and shrub to estimate the probability that a site will be suitable for feeding on angustifolium. This model was tested using captive geese in feeding enclosures. These trials also showed the importance of dominance relationships among the geese (less dominant groups fed in lower value habitats). The availability of areas with suitable angustifolium feeding habitat within a 5km square study area was only 1.5 percent. Regrowth of angustifolium biomass 2 years after removal was negligible. The widespread distribution of geese across the refuge follows from the observation that their feeding habitats are widespread and highly local. Disturbance studies of other geese at Teshekpuk and Izembek may not be particularly applicable to snow geese staging on the coastal plain because in those areas food is highly concentrated. (costco, 7-11 analogy).

Sedinger has completed his work on the metabolism using the captive geese, and there are only about 10 birds left. Unclear whether any captive birds will be used on the refuge this summer. In 1992, the primary focus of the work will be on habitat questions, particularly on determining on a large scale what areas have the most potential for angustifolium feeding. They would like to

also attempt some disturbance work, but with only one helicopter and pilot, this may be difficult. Relative to the disturbance questions, Hupp has decided that the best approach is to do census type work where you fly over an area with geese, noting the distance of flocks from the transect line, then repeat, to see if the distances increase with the number of overflights. The important question is "Does aircraft disturbance displace geese?" At this point, he feels it is more important to study that question than the energetic consequences of disturbance.

Interim report is in process of revision. Lyman McDonald has reviewed, but he has not yet seen the comments. Dirk will be proceeding with the peer review, including outside reviewers, to be done in late spring sometime. He wants questions from us.

REFUGE STUDIES

Port Site Birds. Mark Willms. final report almost done. contaminant data still being interpreted, will be reported on by Elaine in the contaminant studies. Proposed salt marsh study.

Weather. Mark Willms, Arctic National Wildlife Refuge, Fairbanks. passed reins to Mark. Everything seems to be working ok now., visit stations in spring and fall at beginning and end of the helicopter contract.

Seismic Study. Janet Jorgenson, Mike . next sampling will occur in 1994, follow up on state allowing seismic work in the summer at Prudhoe, get the Arctic and Alpine research paper. intense seismic work in Prudhoe Bay.

Habitat Map. Janet Jorgenson, Pete Joria. Map for the east side is almost done. can now sample by vegetation type. In 1992 will finish ground checking the satellite map ground dta between Canning and Sagavanirktok. Need to decide about continuing on towards Prudhoe Bay and getting more seriously into 1002 studies using the map.

ENHANCEMENT STUDIES

Fisheries Synthesis. Randy Bailey, Fisheries Management Services, Anchorage. A draft report by the contractors was completed in 1988. The distribution data apparently are digitized and stored on tape. No progress towards completing this project was made in 1991. An additional four years of data have been collected since the draft report, and ideally, these data will be added. Unclear how this report will be completed.

Inland Fisheries. David Wiswar, Fisheries Assistance Office, Fairbanks. In 1991, this project conducted additional survey work. Eighteen lakes deeper than 9 feet were surveyed for fish. They found that lakes with a river connection had grayling and some char, while lakes without a river connection only had ninespine stickleback. They also surveyed a number of tundra streams that flow directly into the ocean (so-called "fishless" streams); about half had juvenile arctic char. These streams have been nominated for inclusion in the State of Alaska Anadromous Waters Catalog. The report on 1990 field studies is in final review and should be available soon. The report on 1991 field work should be complete in September, then a final report, synthesizing all the inland fisheries work will be prepared. Wiswar will be presenting a paper at the Arctic Fish Conference in Fairbanks in May. In addition to reports on inland fisheries, he is also working on a paper on Oruktalik lagoon fish studies. Wiswar recommends that future studies look at 1) spawning

populations of arctic char, and 2) identification of arctic grayling overwintering areas.

Coastal Fisheries. Tevis Underwood, Judy Gordon, Mitch Osborne, and Laurie Thorp, Fisheries Assistance Office, Fairbanks. The 1991 field season was the last scheduled for this project; all efforts are currently devoted to data analysis and report writing. The report on the 1990 field season is under review (due back to Regional Office on Feb. 28), and the 1991 report is in draft. The investigators will spend the spring completing the 1991 report and preparing for the Arctic Fish Conference in May. Following that, they will turn their efforts to a final synthesis report, tentatively scheduled for completion in March 1993. However, they feel without additional staff, the report could not realistically be completed by then.

Reports on the oceanographic data for 1988 and 1989 are completed. Data for 1990 have been analyzed, but the report has not been written due to pending RIF of the investigator at NOAA. The 1991 data have not been analyzed or dumped. Because the data were collected and analyzed under contract, unclear why NOAA cannot finish the work??? Each report will basically describe the oceanographic and meteorological conditions of a particular year.

Unclear how or if an integration of fish and oceanographic data will ever occur. [Randy says he has been told (by Rowan?) not to attempt this part of the project.]

Investigators recommend future studies, including 1) continuation of the fyke netting operations (to recommence in 1993), 2) continued collection of hydrographic data (including CTD casts outside the barrier islands), and 3) laboratory studies of the temperature and salinity tolerance of young-of-the-year arctic cisco.

Water Resource Inventory. Steve Lyons, Water Resources Branch, Anchorage. Gaging continued in 1991. This year had low flows, but also a single flood event that was estimated to be a 15-25 year flood. The flood washed out the gage on the Sadlerochit and required that new profiles be established to correctly calibrate post-flood water flows. The report on 1991 is almost done. In 1992, gaging will continue, but a reduced budget will require a minimal field presence (set up gages in June, skip July, return for August and September). Lake elevations have still not been taken, and budget will not allow in 1992 either. Except for the lake data, we have enough information now to apply for water rights on nine streams (Tamayariak, Akutoktak, Itlikyariak, Sadlerochit, Niguanak, Sikrelurak. . .). We do not have flow information for the large rivers (Canning, Hulahula, Jago) because gaging of these rivers would require trolley cars. A briefing for the RD on this topic is in order. Recommended future studies include: 1) lake elevations, 2) identification of possible reservoir sites, 3) quantification/description of sheet flow relative to road construction and wetlands recharge, 4) lake recharge (pump one dry and see how long it takes to refill).

Feb 10 1992

Port Site Birds Mark Willms & Glenn Elison

final report being revised, almost done
contaminant data still being interpreted - Elaine will report on
9 birds clean
benthic samples some contaminants

proposal to refuge studies work on salt marshes $40K on a couple of years.
① identify locations
② quantify area

brant/shorebirds

ocean-riverine habitats in his scheme
salt marsh is a vegetation type under Janets scheme
pixel size >
plus each salt marsh is different, uniques

possible paper on oldsquaw
Bird Conference Paper
possibly invertebrates too

-2-

2/10/92

Pat Reynolds Muslox

should revisit the map of musheox distribution

working on papers

why are animals leaving when it appears that there is vacant habitat?

group dynamics = size & how long they stay together

2 new study plans

(1) habitat

(2) petroleum area - animals moved to the west

200 between Sag + Canning, Franklin Bluffs

1 mixed sex group on the park - Toolik River

could tag next fall - collars last 2 years -

Bear predation on in spring cows/calves lone bulls in summer

habitat plan using new vegetation map

the inventory (inc. radio collaring) is part of regular refuge budget - funded by ARW need to reinforce

also applies to caribou

could use a technician!!

On the Brink muskox book

subsistence species under state law (but now federal mgmt)

Preliminary study plan: Muskox distribution and movements near developed petroleum fields.

Objectives:

1. Determine seasonal movements, distribution, and activity patterns of muskoxen in relation to developed petroleum fields and associated facilities

   H1 = Seasonal home ranges and movements are larger for muskoxen living near oil field facilities than for muskoxen living in other areas with similar habitat.

   H2= Muskoxen living near oil field facilities are more active and make more movements in winter than muskoxen living in other areas with similar habitat.

2. Determine population size, composition, and dynamics of groups of muskoxen living near developed petroleum fields and associated facilities

Justification

Because muskoxen live in arctic areas which are largely undeveloped and have low human populations, the effects of petroleum exploration and development on muskoxen are difficult to predict (Garner and Reynolds 1986). In recent years, mixed-sex groups of muskoxen from the Arctic National Wildlife Refuge (ANWR) have been dispersing into areas west of the refuge. In October 1991, almost 200 animals were counted between the Canning River and Kuparak River west of the refuge (Reynolds 1991). Some of these of groups are now living in close proximity to developments and adjacent facilities associated with the Prudhoe Bay and Kuparak oil fields and the Trans-Alaska pipeline. This provides us with a unique opportunity to monitor the distribution and movements of muskoxen in relation to oil field pump stations, the Dalton highway with its high level of truck traffic, the oil pipeline, major airports, and other oil field facilities.

Mitigation of possible impacts to muskoxen resulting from petroleum exploration and development will require knowing if muskoxen avoid oil field facilities, how readily they cross roads and pipelines, and what size of buffer zone may be needed if permanent facilities are placed in or near areas used by muskoxen. This study will determine how and at what distance muskoxen react to petroleum facilities and related activities, and how these responses may affect distribution, movements, activities and local population dynamics.

Methods:

The study area is located on the arctic coastal plain in northeastern Alaska between the Kuparak River and the Canning River. The area is bound on the north by the Arctic Ocean Beaufort Sea and on the south by the mountains of the Brooks Range.

Physiography, geology, climate, and vegetation of the central part of the study area are described by Garner and Reynolds (1986).

Satellite collars on cow muskoxen will be used to obtain detailed information on the movements and distribution of mixed-sex muskox groups. Three cows will be collared from groups wintering on the Ivishak River near Pump Station No. 2 or on Franklin Bluffs adjacent to the Dalton Highway. Three cows will be collared from groups living along the Kavik River or Shavioviak River. Information from these animals will be compared with data collected from satellite-collared muskoxen living in ANWR as part of on-going studies of seasonal distribution and movements. Information on distribution, home range size and seasonal movements and activity patterns will also be compared with data collected during earlier studies of ANWR animals.

Animals be darted from a helicopter and drugged with carfentanil and xylazine. Immobilized muskoxen will be measured, photographed, ear-tagged with numbered cattle tags in addition to being fitted with satellite collars. Satellite-collar batteries will last for two years.

Satellite-collared muskoxen will be monitored six hours every other day. Tapes containing location and activity information from satellite collars will be initially processed and formatted for use with a computerized geographic information system (GIS).

Satellite-collared muskoxen will be visually relocated from fixed-wing aircraft in early and late winter, spring and summer. Numbers of muskoxen in the study area will be determined during pre-calving surveys in late March. Composition of mixed-sex groups will be determined from ground observations in June.

If a vegetation map is completed for this area, percentages of cover and terrain types will be calculated for seasonal home ranges of groups living west of ANWR and compared with similar information obtained for muskoxen living in ANWR.

Locations of satellite-collared individuals and directions of movements in relation to the haul road, pipeline, and the Prudhoe Bay complex will be mapped by season. Rates of movement and sizes of seasonal home ranges, mean activity scores, population size, productivity, survival and average group size will be compared for muskox populations living near oil field facilities and those living in undisturbed areas.

Schedule:

1992	Summarize existing data
1993	Collar cow muskoxen; population and composition counts; relocate collars
1994	Data collection, analysis, preliminary write-up
1995	Final data collection; final report preparation

Staffing:

Patricia Reynolds, Arctic National Wildlife Refuge

Cost Estimates (in $1K)

	1993		1994		1995	
	#	$	#	$	#	$
Equipment						
Satellite collars						
new($3500@)		3	10.5			
refurb($700@)		3	2.1			
Aircraft						
Helicopter($500/hr wet)						
capture		6	3.0			
composition		4	2.0	4	2.0	4 2.0
Fixed-wing($80/hr wet)		15	1.0	15	1.0	15 1.0
Data processing						
Satellite collars						
$4000/ptt-yr		2.3	9.2	3	12.0	.75 3.0
Miscellaneous						
Capture drugs		6	.6			
$100/ox						
Travel/other			1.5		1.0	1.0
Totals			29.3		16.0	7.0

Literature cited:

Garner, G.G. and P.E. Reynolds. eds. 1986. Final report baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildl. Serv. Anchorage, Ak. 695pp.

Reynolds, P.E. 1991. Arctic National Wildlife Refuge 1991 Muskox Survey and Inventory Report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Unpub. Rep. 8 pp.

Preliminary study plan: Muskox habitat use in and near the 1002 area of the Arctic National Wildlife Refuge

Objectives:

1. Quantify habitat elements in areas used seasonally by muskoxen in the ANWR 1002 area and in newly colonized areas.

2. Determine the availability of muskox habitat in and near the ANWR coastal plain.

Justification

Muskoxen were returned to their former range in the Arctic National Wildlife Refuge in 1969-1970 and are year-round residents of the 1002 area. The population increased rapidly between 1974 and 1985, reaching a maximum in the fall of 1985 (Reynolds 1987). High productivity and low mortality during these years indicate the presence of high quality habitat which was documented by Robus (1984) on the Sadlerochit River. After 1986, numbers of muskoxen on the coastal plain of the refuge declined and stabilized at about 350-400 as animals dispersed from the refuge (Reynolds 1987). Productivity may also be declining (Reynolds 1991). This suggests that carrying capacity is being attained in portions of the refuge.

Mitigation of potential impacts of petroleum exploration and development on muskoxen requires the identification of seasonal habitat characteristics which are needed to predict alternative habitats available to muskoxen if they are displaced, and to understand the relationship between habitat and population dynamics. These characteristics can be identified from areas used heavily by muskoxen during the past decade, and areas into which animals are dispersing.

Methods:

The study area is located on the arctic coastal plain in northeastern Alaska between the Kuparak River and the Kongakut River. The area is bound on the north by the Arctic Ocean Beaufort Sea and on the south by the mountains of the Brooks Range. Physiography, geology, climate, and vegetation of the central part of the study area are described by Garner and Reynolds (1986).

Location data from satellite collared and radio-collared muskoxen acquired during on-going and previous studies of seasonal distribution will be used to delineate seasonal areas of high muskox use and areas not used by muskoxen within geographic regions of the ANWR coastal plain, and to document new areas being colonized west of the refuge.

On a regional scale, habitat elements will be determined for land cover and topography using a computer-based geographic GIS (eg Map Overlay Statistical System or ARC/INFO) in conjunction with Landsat imagery and digitized terrain data. Percentages of land

cover and terrain types will be calculated for identified high use, new use and no use areas. Indices of diversity for both land cover and topographic features will be developed. Comparisons will be made between geographic regions and seasons as well as between categories of use.

On a local scale, habitat elements in high use areas will be mapped with the use of aerial photography. Randomly selected ground sites will be stratified by vegetation type, geographic region, and season. At summer use sites, photo-interpretation will be ground-truthed and local topography will be categorized. At winter sites, in November and March, snow depth and hardness will be measured along transects where animals are feeding. Types of vegetation utilized in winter will be documented by examining feeding craters and tracks, and observing animals feeding. Winter fecal pellets will be collected at feeding sites. Availability of winter forage (Salix sp., sedges) will be measured by marking shrubs and tussocks in summer and determining the percentage of markers uncovered in winter (Schwab and Pitt 1987). Winter sites will be re-visited in summer to ground-truth photo-interpretation, categorize local topography,and mark vegetation. Habitat maps will be used to determine percentages of vegetation types and topographic features present in high use areas. Diversity indices will also be developed for vegetation types and topographic features in high use areas.

Information collected at ground sites will be used to refine regional definitions of land cover and topography associated with muskox high use areas. Habitat elements repeatedly found to be associated with muskoxen will be used to predict the availability of muskox habitat on a regional scale, using a GIS system, Landsat data and digitized terrain data.

Schedule:

1992: preliminary identification of muskox seasonal use areas from existing data acquired in 1982-1991.

1993: Regional habitat mapping using vegetation map + terrain data
Ground truth vegetation data

1994: Ground truth vegetation data; data analysis

1995: Data analysis, final report preparation

Staffing:

Patricia Reynolds, Arctic National Wildlife Refuge
1 Wildlife Biologist GS-5 term appointment
2 Biological Technicians GS-4 seasonal appointments

Cost Estimates (in $1K)

	1993		1994		1995	
	#	$	#	$	#	$
Aircraft						
Helicopter($410/hr wet)						
veg sites	24	9.8	24	9.8		
Equipment		5.5		1.5		
Travel						
$500/per trip	8	4.0	8	4.0		
Technicians' salary						
GS-05 $1754/mo	12	21.1	12	21.1	12	21.1
GS-04 $1250/mo	6	7.5	6	7.5	4	7.5
Totals		47.9		43.9		28.6

Literature cited:

Garner, G.G. and P.E. Reynolds. eds. 1986. Final report baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildl. Serv. Anchorage, Ak. 695pp.

Reynolds, P.E. 1987. Status of a transplanted muskox population in northeastern Alaska. Paper presented at the Second Inter. Muskox Symposium, Saskatoon, Saskatchewan, Canada. Oct 1-4, 1987.

Reynolds, P.E. 1991. Arctic National Wildlife Refuge 1991 muskox survey and inventory report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Unpub. rep. 8 pp.

Robus, M. A. 1984. Summer food habits of muskoxen in northeastern Alaska. Pages 81-85 in D.R. Klein, R.G. White and S. Keller eds. Biol. Pap. Univ. Alaska Spec. Rep. No. 4. Fairbanks, Ak. 218p.

Schwab, F.E. and M.D. Pitt. 1987. Comparison of a direct and an indirect method for estimating available winter browse. Wildl. Soc. Bull. 15:544-548.

2/10/92 Seismic

Janet Jorgenson, Mike E

1991 big field season

important to sample to again in 1994
some plots are still showing mod → high levels of disturbance

so 1994 to sample points to estimate % of seismic trails still disturbed
(~~dis~~ don't bother w/ the photointerpretation)
so do sample points & plots in same year
so for next year is data analysis & writing
95

92 - $50 analysis,
93 - $0
94 - $195
95 - $60 analysis

traffic pattern makes a big difference
narrow camp more trails are the worst

state now allows summer seismic in Prudhoe area ?!?

green trails → brown trails
w side had much higher disturbance, less snow

Arctic + Alpine paper just out this month
then report on 1991
then another paper including 1991 data
intense seismic work w/in Prudhoe —
no one's looking at it.

2/10/92 Habitat

map for east 1/2 almost done

Can now sample by vegetation type

3-4 yrs sampling by vegetation type

1992 - finish up ground checking for satellite map
ground data between Canning + Sagavanirktok

need to decide about continuing on towards
Prudhoe or getting more seriously into
1002 studies using the map

Could use a link between Fbx + Anchor
computers

Seismic Study

Percentages and ratios of plots showing levels 2–3 disturbance in 1991

	Disturbance level		Ground visibility		Aerial visibility	
	ratio	%	ratio	%	ratio	%
Total	**40/104**	**38**	**25/104**	**24**	**40/104**	**38**
Moist sedge	7/21	33	5/21	24	8/21	38
Wet graminoid	4/10	40	4/10	40	5/10	50
Graminoid barren	9/21	43	4/21	19	9/21	43
Tussock–tundra	9/20	45	4/20	20	10/20	50
Shrub tundra	4/10	40	2/10	20	1/10	10
Riparian shrub	3/12	25	3/12	25	3/12	25
Dryas terrace	4/10	40	3/10	30	4/10	40

Rough plant community recovery percentages in intensive plots

Totals	**67–100% recovery** 6/37	**33–66% recovery** 20/37	**0–32% recovery** 11/37	**% of characteristics showing recovery but not yet statistically significant** approx. 10%
Moist sedge and wet graminoid	3/12	6/12	3/12	< 5%
Graminoid barren		4/7	3/7	5–10%
Tussock tundra Shrub tundra	1/10	5/10	4/10	15–20%
Riparian shrub and Dryas terrace	2/8	5/8	1/8	5–10%

Review of the 1002 muskox studies
Patricia Reynolds
10 Feb.1992

Work Unit IV: Potential effects of petroleum exploration and development on muskox using the 1002 area

Studies

IVa: Winter distribution, movements, and habitat use of muskoxen potential lease areas of ANWR

IVb: Population dynamics of muskoxen on the arctic coastal plain

IVc: Winter habitat use: UAF master's degree project

Review of Objectives

Objective 1. to delineate winter use areas and movement patterns of muskoxen and compare them to their summer use and movement patterns in undisturbed conditions

A. Overview

I have analyzed results based on seasonal movements and distribution through 1990 and have found that cow muskoxen in mixed-sex groups have high fidelity to geographic areas. Many live in different home ranges in winter and summer and reduce their movements and the size of their home ranges in winter. Important wintering areas have been identified. I have completed analysis of location and movement data through 1990.

B. Expected status by end of FY92

I will complete a statistical analysis of seasonal changes in distribution, movements and activity patterns including data through the winter of 1991-1992.

C. Continuing study needs

Mitigation of potential impacts on muskoxen will required continued documentation of where animals are located in winter and what areas are most important to the majority of the population so that these areas can be avoided, if possible, during the location of permanent facilities. A comparison of changes in seasonal distribution over time needs to be finished.

Objective 2. Determine the size, productivity, dispersal rate, and population growth rate of the muskox population on the Arctic Refuge.

A. Overview

I have analyzed population data for the past several years and have generated a simple population model which is being revised. The muskox population in ANWR is no longer rapidly growing, but appears to be stabilizing or growing very slowly. Numbers of animals east and west of the refuge are increasing. Productivity and survival of calves, yearlings and adult cows varies annually. Productivity within the 1002 area may be declining.

B. Expected status by the end of FY92.
I will have revised the population model based on suggestions from statisticians and incorporate 1992 data. Professional papers on group dynamics and mortality factors will be finished.

bear predation?

C. Continued study needs
Mitigation of potential impacts on muskoxen will require up to date information about population status. Dispersal of animals needs further analysis as this appears to be a major factor influencing population numbers in ANWR. This can be done by examining changing patterns of distribution in relation to local population density, productivity in local areas, group dynamics and seasonal shifts in distribution. The effects of weather on annual variations in productivity and survival needs to be analyzed.

Objective 3. To determine whether suitable wintering habitat is limiting population expansion.

A. Overview:
A study of winter habitat use of muskoxen in eastern portion of the 1002 area has been completed by UAF graduate student Ken Wilson. Results show that snow depth and hardness is an important factor in selection of winter habitat. Muskoxen are feed in sedge communities in winter in this part of the refuge. (eastern 1/2)

B. Expected status by the end of FY92
Wilson is in the process of finalizing his thesis and plans to graduate this semester.

predict where low snow cover is

C. Continuing study needs
Availability of winter habitat for the entire 1002 area needs to be estimated on a regional scale using the vegetation map (when it is finished) and digitized terrain classes. See first part of study plan entitled "Muskox habitat use in and near the 1002 area of the Arctic National Wildlife Refuge".

Objective 4. To determine the effects of disturbance on the displacement and distribution of muskoxen

A. Overview
This objective was originally designed to be part of the student study under a UAF contract. There was never enough money or man-power available to do anything on this objective. The idea of disturbing muskoxen with snowmachines to see how they respond will not, in my opinion, tell us much about how muskoxen will respond to oil and gas development.

B. Expected status by the end of FY92: none

C. Continuing study needs: see study plan "Muskox distribution and movements near developed petroleum fields"

IDENTIFICATION AND QUANTIFICATION OF SALTMARSH HABITAT ALONG THE BEAUFORT SEA WITHIN THE ARCTIC NATIONAL WILDLIFE REFUGE

Arctic National Wildlife Refuge

Problems Addressed: Saltmarshes are important habitats for several migratory bird species. However, because of their 1) small size, 2) irregular distribution, and 3) close contact with marine waters, they could receive a disproportionate share of potential impacts originating from offshore oil contamination and coastal development activities.

Objectives: The primary objective of this study is to locate and quantify the amount of saltmarsh habitat present on the Arctic National Wildlife Refuge (ANWR). Specific objectives within and adjacent to the 1002 area of the arctic coastal plain include:

1) Identify and map saltmarsh locations along the Beaufort Sea coast.

2) Quantify the amount of land area on the ANWR coastal plain occupied by saltmarshes.

Justification and Background: Saltmarshes are unique wetland habitats which consist of moist-saturated (i.e. standing water) brackish-subsaline sediments due to irregular contact with marine waters. Because these areas lack standing water greater than 15 cm, they might be better described as being halophytic wet meadows (Murphy et al. 1988). Dominant plant species of these areas on ANWR include *Carex subspathacea, Puccinellia phryganodes, Stellaria humifusa, P. Andersonii* and *Dupontia fisheri* (Meyers 1985). Because of the specific conditions required for their development and maintenance, these wetlands are restricted to occupying low-lying areas situated near the coast which permit irregular inundation by high tides or storm surges. As a result, they have an uneven distribution along the Beaufort Sea coast and occupy only a tiny fraction of total land area present on the coastal plain. However, it is precisely these factors restricting their size, distribution, and proximity to coastal waters which also increase their vulnerability to disturbance from development related activities. The most comprehensive information available on saltmarsh habitats in ANWR consists of a study characterizing the dominant plant communities and the topographic features influencing the distribution of these halophytic species along the coast (Meyers 1985). However, no attempt was made in this study to identify all saltmarsh locations on the refuge or quantify their areal extent.

Because of limitations involving pixel size, habitat heterogeneity, and the types of broad vegetation classes utilized, the refuge's LANDSAT-TM habitat map will probably not be able to adequately separate a vegetation subclass such as saltmarsh. Similar problems with scale or timing of imagery

limits the utility of other currently available in-house references such as aerial photos or maps.

On the North Slope, coastal saltmarshes have been shown to be extremely important for breeding and migrating brant (Bergman et al. 1977). They were also used extensively as brood-rearing habitats by snow geese near Prudhoe Bay (Murphy et al. 1988), and as staging habitats by several shorebird species near the Canning River delta (Martin and Moitoret 1981). Densities of brant, pintail, dunlin, western sandpipers and several other waterfowl and shorebird species averaged 479 birds/km in saltmarsh habitats near Icy Cape, Alaska, with the greatest use occurring during spring and fall migration (Lehnhausen and Quinlan 1981). As a result of their importance as staging areas, loss of saltmarsh habitat could have a negative impact on the abundance of these bird species over the entire coastal plain of Alaska and Canada. Information identifying precise locations of these habitats, particularly the more extensive sites, is necessary for mitigation planning should development occur on the refuge.

Methods or General Approach: Initial identification of potential coastal saltmarsh locations on the refuge will be completed using existing sources of information, including the new LANDSAT-TM vegetation map for the refuge, true color aerial photographs, marine charts, and topographic maps. A few saltmarsh locations are already known. Because of the unique physiognomic features required for saltmarsh development and maintenance, a list of potential sites will be generated by process of elimination using the existing sources of material listed above. Unfortunately, none of these methods will be able to provide a definitive list. Consequently, the actual habitat type present at each potential site will need to be verified in the field.

The verification phase of the project will be made easier by the distinctive reddish-brown color of *Puccinellia phryganodes* and *Carex subspathacea* in mid-late August. This color pattern and the associated "lawn-like" appearance of saltmarsh vegetation will be used to aid in the identification of saltmarsh locations from the air using a helicopter. Sites in which the habitat type or dominant plant communities cannot be readily distinguished from the air will be visited on the ground. Known saltmarsh locations will be used to check the accuracy and thoroughness of these surveys.

All known saltmarsh locations will be mapped and the habitat boundaries drawn. These boundaries will roughly follow the greatest inland extent of the 2 dominant indicator species, *Carex subspathacea* and *Puccinellia phryganodes*. Each site will be mapped on topographic maps and its total area estimated. This will provide estimates of the areal coverage of saltmarsh habitat in comparison to all other habitats present on the coastal plain of ANWR.

Anticipated Results and Discussion: This study will produce a document quality vegetation map depicting all known locations of saltmarsh habitat present on the ANWR coastal plain. Knowledge of these locations, their areal extent, and proximity to one another will provide valuable baseline information if future mitigation and development related decisions on the refuge should be required.

Cooperators and Responsibility: This study will be closely coordinated with the Alaska Fish & Wildlife Research Center (AFWRC). Information obtained on saltmarsh habitats, their plant communities, and/or physical attributes will be made available to the 1002 habitat mapping project.

Responsibility -	Glenn Elison	Project Leader, ANWR
	Greg Weiler	Assistant Refuge Manager
	Mark A. Willms	Principal Investigator, Wildlife Biologist, ANWR

Schedule:

FY 1993

Commence investigation of possible saltmarsh sites	1 April
Complete list of potential saltmarsh sites	15 July
Complete logistical preparations for field work	25 July
Commence field work verifying saltmarsh habitat	10 August
Complete field work	1 September

Cost: FY 1993

Personnel	
Term Biologist GS-9 (6 months)	20,000
Transportation	
Airfare to/from BTI (1 person)	500
Helicopter time (3 days/30 hrs flight time)	13,000
Housing at BTI (6 days)	300
Supplies	500
FY 1993 Total	34,300

FY 1994

Personnel	
Term Biologist GS-9 (3 months)	10,000
Supplies	500
FY 1994 Total	10,500

Reports and Publications:

Complete Final Report and Map 1 January 1994

Literature Cited:

Bergman, R.D., R.L. Howard, K.F. Abraham, and M.W. Weller. 1977. Water birds and their wetland resources in relation to oil development at Storkson Point, Alaska. U.S. Fish & Wildlife Service Resour. Publ. 129. 38pp.

Lehnhausen, W.A. and S.E. Quinlan. 1981. Bird migration and habitat use at Icy Cape, Alaska. U.S. Fish & Wildlife Service unpublished report.

Martin, P.D. and C.S. Moitoret. 1981. Bird populations and habitat use, Canning River delta, Alaska. U.S. Fish & Wildlife Service unpublished report.

Meyers, C. 1985. Vegetation of the Beaufort Sea coast, Alaska: community composition, distribution, and tidal influences. M.S. Thesis, University of Alaska-Fairbanks. 206pp.

Murphy, S.M., B.A. Anderson, C.L. Cranor, and M.T. Jorgenson. 1988. Lisburne terrestrial monitoring program - 1988: the effects of the Lisburne development project on geese and swans. Fourth annual rep. prepared for ARCO Alaska, Inc., Anchorage, AK by Alaska Biological Research, Fairbanks, AK 254pp.

Prepared by: Mark A. Willms Date: 2/5/92

Project Leader: [signature] Date: 2/5/92

Biological Study
Review Panel: _____ Date: _____

Assistant Regional
Director: _____ Date: _____

2/10/92 Weather Cathy Curby + Mark Willms

By summer 1991 started to get good data
replaced chips, battery should last to end of winter
6 sites
go back in May, September (beginning + end of contract)

Tamayariak
Marsh Creek
Jago
Okeokok (original was lost, later found
Aichilik
Barter Island

Noreen would like to put at soil temp + moisture probes

inherited Wyoming Snow fences @
Barter Island.

there is weather from Komakuk DEW line

they were there during snow geese season —
could have done a survey

2/11/92 Elaine Contaminants

foxes - crash green
moss - lichens - get all nutrients fr air
as indicators of air pollution

nutrient analysis

data is entered, proofed
quality ~~ass~~ assurance computer program
Patricia for metals.

qa/qc
1. duplicates (precision)
2. accuracy - spikes - 80-90% recovery
3. std. reference materials.
4. ~~[illegible]~~ blanks (not contamination after they got)

by catalog

leading ⊙ variation in other studies like this

high N + P in water in calving area
talking to Tom about joint study

Sulphate reducing bacteria cause corrosion

hard foam roads - Norwegians

2/11/92 NAES discussion

E.S.C. Can get rid of most contamination w/ stips (point source)
pseudo pavement
Kuparuk pads dont have pits now
cuttings may still be a problem for exploratory wells.
- grind & reinject

Canning may be only river w/ enough water to support reservoirs ?!?

gravel sources - major arguments @ Prudhoe

they need Habitat values.

only a few key references for decisions

Bergmann etc.

take old bird data + new map — Russ Oates, Dave Douglas

small plots in homogenous habitats

Advanced Identification Map - Caluille
trade-off decisions - how would we make them?
get accused changing 1° to fight different projects (inconsistency) need decision tree

aesthetic ??

pentroads

if disturbed habitats get used by critters – how can we reject?

natural diversity – as a matter of policy try to maintain

need different type of oceanographic ~~data~~ than are collected

West Dock breach only to get Pt. Mc not because they ~~the~~ argued that impact

directional drilling from shore – so need to

can we lowball the causeway concern? (if we say there won't be causeways)

check bathymetry

if subsea pipeline – need causeway d in the transitional zone

industry will avoid causeways because of all the hoopla

should start tally of industry

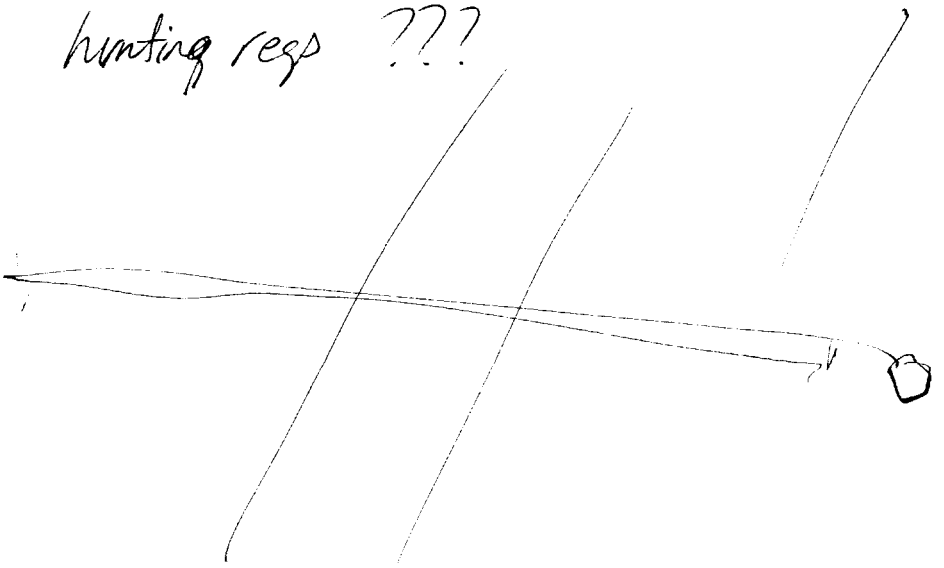
pre-app meeting on ANWR? now - would be illuminating

muskox - river issue

Public Birds hard to show 2° effects to shorebirds & waterbirds so habitat loss the big?

movement is still an issue

hunting regs ???



→ tunnels ←

Wrap-up -

Glenn - sequencing of studies as an approach to priority studies
defer site specific data which can burden industry with them

Hulahula, Canning data missing

postung Region 7 - 8 vis a vis caribou

Habitat in veg. $ → Caribou. $

Carlson - Canadians have lots $, state will have some
we need to stay in there -
thinks they Canada - State are off on a bit of a tangent - we need to be in there to keep things on track, plus our own responsibility to PCH
good old boys network - State - UAF - Canada

R.T. Do we need to know why? or can we get by by just knowing what?

2/7/92 Polar Bears

trying cluster analysis to identify denning areas frequently used (Camden + Pokok)

50/50 onshore/offshore on last 10 years

recruitment from ANWR dens important

possibly 2-4 dens on ANWR each year

12% of radiocollared bears denned on ANWR

---

feels like maternity denning work unit done - will continue to collect data as animals den but not a work unit

3 papers

1. bears biology/ecology
2. reactions to humans
3. ANWR den

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most important effect is bullets

amend MMPA as part of leasing legislation

PREPARATION FOR POLAR BEAR
1002 PROGRAM STUDY REVIEW

Objectives of Study (1988)

- To define the size and distribution of the polar bear population affected by proposed and ongoing exploration on and adjacent to the Arctic Refuge.

- To characterize maternity den sites and define the available denning habitat within the Arctic Refuge.

- To assess the impacts of displaced denning by contrasting the success of land, near shore, and offshore maternity dens.

- To determine the potential cumulative impacts of offshore petroleum exploration and development on bears and their prey.

Funding by Year

YEAR	1988	1989	1990	1991	1992
AMOUNT ($1,000)	$ 462.	$ 452.	$ 424.	$?	*

* Note: **- 1988** and **1989 Work Plans** show $ 32 K from Refuges base, $ 255 K from Research base, $ 150 K from the Congressional add-on that originated in 1988, and $ 25 K from MMS in 1988 and $ 15 K in 1989.

- 1990 Work Plan showed $ 31.5 K from Refuges base, $244.7 from Research base, and $148.1 K from Research add-on, with no funding from MMS.

- 1988, 1989, and 1990 Work Plans all note that the 1002 polar bear study is part of a larger study.

- 1991 Work Plan showed the same $32 K from Refuges that has been put into polar bear work since at least 1988. It did not show total going to polar bear work.

Reports Completed (list--title, author, date) (annotate)

Amstrup, S.C. and C. Gardner. 1988. Polar bear killed by improper use storage, or disposal of hazardous material. USFWS. 2 pp.

Amstrup, S.C. 1988. Polar bear maternity denning in Alaska: 1988, Report of annual progress on polar bear work sub-unit no. 3: "The reproductive significance of maternity denning

on land with special reference to iol and gas exploration on the Arctic National Wildlife Refuge." U.S. Fish and Wildlife Service, Anchorage, Alaska. 22 pp.

Amstrup, S.C. 1989. Polar bear research in the Beaufort Sea, Operations Report: Spring 1989. U.S. Fish and Wildlife Service, Anchorage, Alaska. 32 pp.

Non-FWS publications:

Amstrup, S.C. 1987. Marine denning of polar bears in Alaska. Seventh Biennial Conference on Biology of Marine Mammals.

Amstrup, S.C. 1988. Polar bear Ursus maritimus. Pp. 39-56 in J.W. Lentfer, ed. Selected Marine Mammals of Alaska: Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Amstrup, S.C. and C. Gardner. 1989. Philopatry in maternal denning of polar bears in the Beaufort Sea. Eighth Biennial Conference on Biology of Marine Mammals.

Amstrup, S.C. (1992 draft) Interactions between human activities and denning polar bears with special reference to the Arctic NWR, Alaska. (to be submitted to Arctic)

Between 1981-1991, 125 polar bears radiocollared in the Beaufort Sea region were followed to maternity den sites. 43% of dens on the mainland of Alaska or Canada were within the bounds of ANWR. These dens comprised 17% of all dens located and confirmed by radiotelemetry. 12% of all dens and 31% of those on the mainland were located within the bounds of the 1002 area of ANWR. More polar bears den in teh ANWR area than would be expected if dens were distributed evenly across the observed denning range. Extrapolations of the percentages of collared bears denning on ANWR to the estimatmed Beaufort Sea population suggest that up to 24 and 17 bears may den annually wihtin the bounds of ANWR and 1002. Considering the annual increment of adult females in polar bear populations, bears denning on ANWR are important to the welfare of the Beaufort Sea population. Concern over exposure of denned bears to potential development activities of aircraft and over-snow vehicle traffic. [based on a few incidental observations. . .] Observations of denned polar bears exposed to aircraft and on ground disturbances suggested considerable tolerance as well as seasonal and individual variation in responses. Polar bears appear more resilient to perturbations late in the denning season which may be an invnestment in denning effort which increases with time spent in the den. Spatial restrictions on human activities would prevent exposure of many bears, and some bears exposed will not be significantly affected. Tempporal restrictions might reduce the significance of exposure to human perturbations for other bears. Recommends initiating human activities in October and November in order to minimize their potential for disruption of critical phases of denning and reproductive process.

Amstrup, S.C. and C. Gardner. (1992 draft) Temporal and geographic variation of maternity denning among polar bears of the Alaskan Beaufort Sea. (to be submitted to J. WIldl. Manage.

Between 1981-1991, 125 polar bears radiocollared in the Beaufort Sea region were followed to maternity den sites. 62% of the dens located were on drifing

pack ice, 33% were on land and 5% on land fast ice. Proportion of dens on land appears to have increased in recent years. Bears denning on sea ice drifted as far as 997 km (average=385 km) while in dens. Shifting sea ice exposed denned bears to hazards that culd threatn survival of new cubs, but differences in production of land and pack ice dens were not detected. Mean den entry and exit dates for successful land and fast ice denning bears were 11 Nov. and 7 Apr. Mean entry and exit dates for successful pack ice denning bears were 22 Nov. and 9 Apr. (differences in dates not significant). Female polar bears of the Beaufort Sea appeared to be reproductively isolated from bears east of Cape Bathurst, Canada. Movements to den sites west of the Beaufort Sea were more common, but bears captured in northern Alaska seldom denned in Soviet territory. Radiocollared polar bears denned along the mainland coasts of Alaska and Canada from 127 - 167 degrees longitude, but 80% denned in the 23% of that range from 137 - 146 degrees (Arctic Refuge is between 141 - 146 degrees. Bears that were followed to more than one den did not return to the same site on subsequent denning attempts, but instrumented bears were faithful to the substrate and general geographic area of the previous den.

[pre-1002:

Amstrup, S.C. 1985. Research on polar bears in Alaska, 1983 1985. Pp. 85-115 in: Polar bears, Proceedings of the ninth working meeting of the IUCN/SSC polar bear specialist group. Edmonton, Alberta, Canada.

Amstrup, S.C., I. Stirling, and J.W. Lentfer. 1986. Past and present status of polar bears in Alaska. Wildl. Soc. Bull 14(3):241-254.]

Objectives Completed

(now and by October 1992, describe any problems, constraints, or limitations to the data)

- dens have been consistently located on the 1002 area; den location data is in GIS

- good progress appears to have been made on the first three objectives

- has there been any update, reconfirmation to Amstrup et al., 1986, estimate that 140 adult females within the Beaufort Sea should be pregnant and enter dens each year? (note, per Scott Schliebe's study, appears that polar bear harvest has great annual variation with the recent (harvests) from Kaktovik of: 1990-91 (3); 1989-90 (0); 1988-89 (10); 1987-88 (6); 1986-87 (3). Total harvests from the five villages harvesting animals from the Southern Beaufort Sea polar bear population ranged from: 1990-91 (22); 1989-90 (21); 1988-89 (59); 1987-88 (30); 1986-87 (41). Under a 1988 Agreement, the allocated harvest guideline is 38.

Unmet Objectives

(should include consideration of future need to meet them or constraints which make them unfeasible or no longer necessary)

- 1991 Work Plan said that the program was meeting objectives and that spring aerial surveys (done in 1988, 1989, and 1990) specifically to search for land dens would be discontinued; additional collars would be deployed.

- Objective to determine potential cumulative impacts of offshore petroleum exploration and development on bears and their prey appears not to have yet been addressed, other than through incidental observations of bears near petroleum activities. Status in coming year?

Future Study Needs
(questions to consider based on preliminary findings)

- now have 10 years of good denning data, where to go next? modeling? how to more systematically gather disturbance data or determine cumulative impacts?? GIS and modeling??

misc. thoughts--
Note--what percent of suitable denning habitat might be lost each year if didn't minimize activities in Oct. and Nov. and bears were therefore unlikely to den in areas with human activities?

- given nature of exploration, seismic activities shouldn't occur before about January, so that'll meet Steve's concern, and monitoring in fall should help find some dens so could avoid those areas. Could id better habitats and work with seismic operators to minimize their access there--problem, they'll probably want access along the river corridors which may offer the topographic relief that makes for good denning habitat.

- exploratory well operations would also probably not need to be ongoing until after bears have denned

- in an actual development stage, assume we'd have more money for more intensive surveys to try and locate dens and thus establish denning areas with spatial restrictions on activities

- given nature of ports and their use during brief ice-free season, should be able to restrict activities there to avoid conflicts with denning bears

- primary problems will probably be with increase in coastal activities from off-shore, cumulative developments

Status and 1002 Office Recommendations, 11/90 Review

- 1002 Office concurred that the project should continue as proposed.

1002 Office Recommendations, 2/92 Review

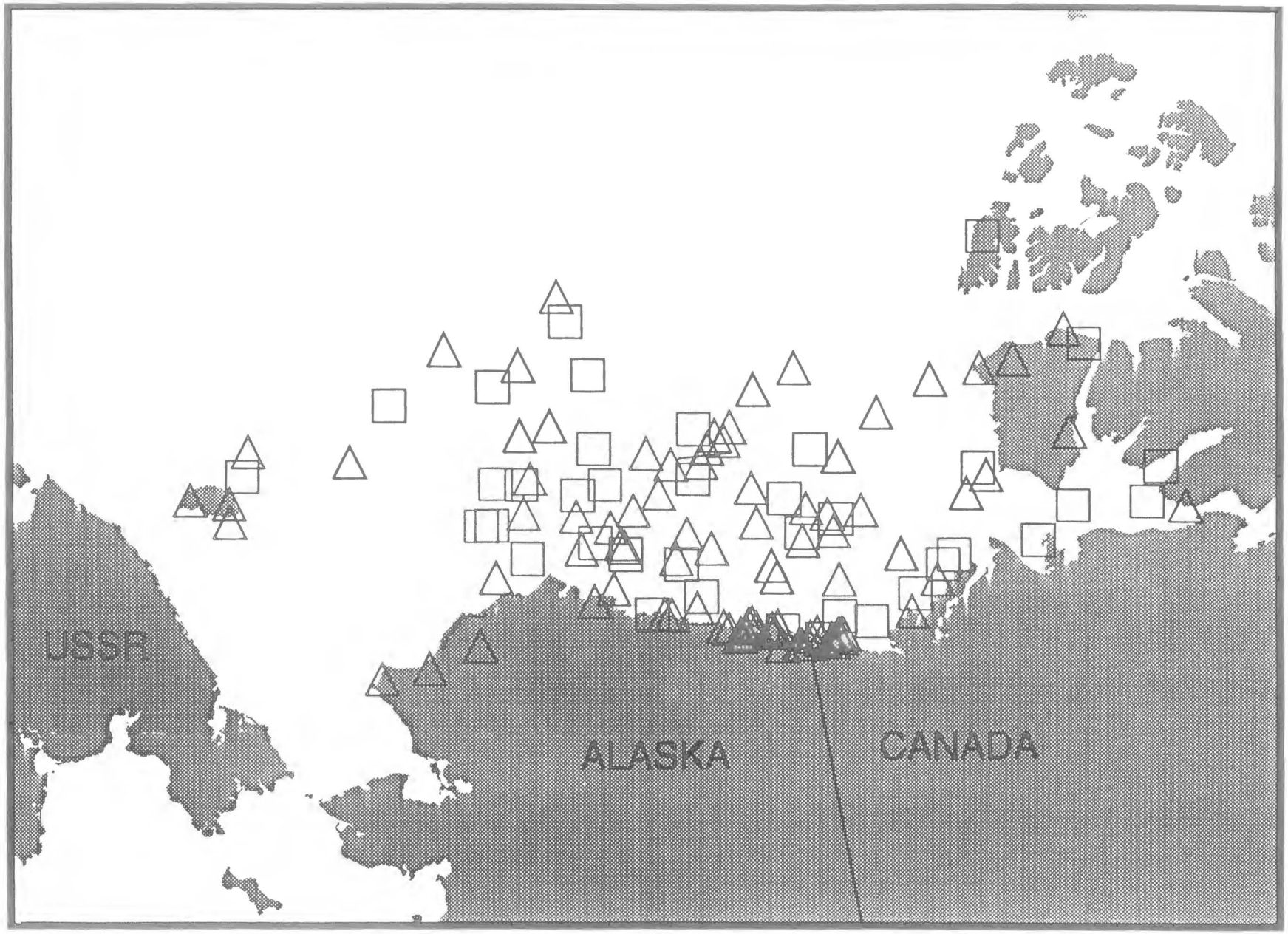

FIGURE 3. Distribution of polar bear maternity dens located by radiotelemetry between 1981-1991. Squares represent suspected dens, and triangles represent dens that were confirmed.

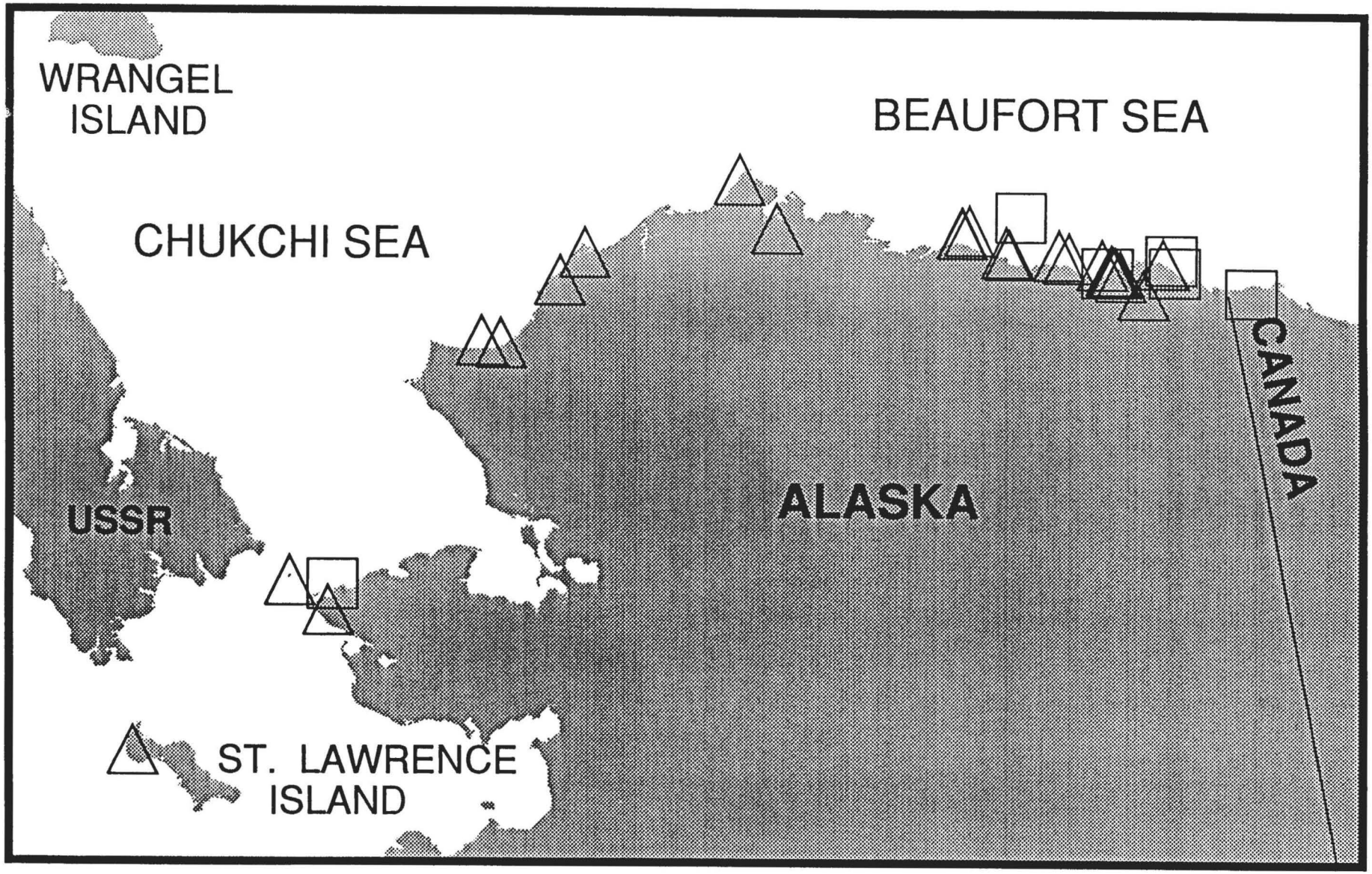

FIGURE 5. Map illustrating approximate locations of suspected (squares) and confirmed (triangles) dens located without the aid of radiotelemetry. Dens shown were discovered by project personnel incidental to capture activities, and during aerial surveys specifically disigned to find maternity dens, or reported to project personnel by local residents or people working or visiting northern Alaska.

PREPARATION FOR MUSKOX
1002 PROGRAM STUDY REVIEW

Objectives of Study (1988)

- To delineate winter use areas and movement patterns of muskoxen and compare them to their summer use and movement patterns in undisturbed conditions.

- To determine the size, productivity, dispersal rate, and population growth rate of the muskox population on the Arctic Refuge.

- To determine whether suitable wintering habitat is limiting population expansion.

- To determine the effects of disturbance on the displacement and distribution of muskoxen.

Funding by Year

YEAR	1988	1989	1990	1991	1992
AMOUNT ($1,000)	$ 110.	$ 78.	$ 58.9	$ 45.	$

Reports Completed (list--title, author, date) (annotation)

Potential effects of petroleum exploration and development on muskoxen using the arctic coastal plain, annual progress report: Work Unit IV. P.E. Reynolds and T.R. McCabe. Pp. 93-106 in: Terrestrial Research, 1002 Area - Arctic NWR, Annual Progress Report, Field Season - 1988. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 7/89.

WORK SUBUNIT IVa: Winter distribution, movements, and habitat use of muskoxen on potential petroleum lease areas of the Arctic NWR. Concern that disturbance of muskoxen during winter, when forage availability is limited and activity patterns are reduced, may have a negative impact on physiological condition of the animals, which may ultimately affect productivity and survival. So objectives were to compare habitat used by muskoxen in winter and summer; and to determine seasonal movements and activity patterns of muskoxen. Satellite and conventional collared muskox were monitored year-round with ground observations made in August 1988. By September 1988 there were 23 collared muskoxen (3 bulls and 20 cows), of which five had satellite collars. Preliminary analysis of satellite-collared muskoxen indicated that areas used by muskoxen in winter were relatively small and that some individuals reused the same areas during two consecutive winters. Radio-tracking flights in 1987 and 1988 also showed many mixed-sex groups remaining confined within small areas from November into February and March. Some groups remained in their wintering area through calving in May. Some of the wintering areas along the Sadlerochit River and creeks south of Camden Bay and west of the Tamayariak River used in 1987-88 and 1988-89 had also been used in previous winters.

WORK SUBUNIT IVb: Population dynamics of muskoxen on the Arctic coastal plain: Productivity and dispersal as a natural regulator of population size in the 1002 area of ANWR. Objectives were to (1) estimate size and composition of muskoxen population in and adjacent to 1002 area to determine status and trend changes; (2) estimate productivity of muskoxen in different geographic regions of the 1002 area to determine if local carrying capacity may be attained or exceeded; (3) calculate dispersal rates of muskoxen from the ANWR; and (4) determine rates of muskoxen population growth in an undisturbed environment based on observed rates of productivity, mortality and dispersal. Used aerial surveys and collared animals. Had noted decline in muskoxen population on ANWR between 1986 and 1987. Results of April 1988 survey were of 419 muskoxen between the Sagavanirktok River in northcentral Alaska and the Firth River in northwestern Canada. Of these, 355 were on the ANWR coastal plain. From 1987 to 1988, annual rate of increase was 0.03 for the entire area and 0.10 for the ANWR coastal plain compared with rates of increase of 0.13 - 0.32 for the muskox population on the ANWR coastal plain in 1973-86. Between 1986-87, numbers of muskoxen on the ANWR coastal plain declined by 22% and the total population including animals to the east and west showed no growth that year. Distribution of muskoxen on the ANWR coastal plain and adjacent areas was similar in 1988 to that observed in 1987 and 1986. Concludes that muskox population in and near the ANWR coastal plain is currently undergoing change. Decline in numbers within the refuge, due to dispersal in 1986, and lower productivity in 1986 and 1987, and low rate of growth seen in 1988, suggest that numbers of muskoxen within the refuge coastal plain may be reaching an upper limit.

Potential effects of petroleum exploration and development on muskoxen using the arctic coastal plain, annual progress report: Work Unit IV. P. Reynolds and T.R. McCabe. Pp. 86-104 in: Terrestrial Research, 1002 Area - Arctic NWR, Annual Progress Report, Field Season - 1989. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 3/90.

WORK SUBUNIT IVa: Winter distribution, movements, and habitat use of muskoxen on potential petroleum lease areas of the Arctic NWR. Objectives as in 1988 with relocation of satellite and radio-collared animals throughout the year. Preliminary analysis indicated that during winter (November to February) satellite radio-collared muskoxen, and the groups with which they were associated, remained within restricted areas. Throughout most of pre-calving, calving and post-calving period, March - June, most satellite-collared muskoxen remained in their wintering areas. In summer (July - October), muskoxen home ranges appear to be larger than in winter, and long range movements occurred more frequently. Suggests that this may be related to food availability, summer food requirements, and social behavior during the rut. Reuse of some areas in consecutive winters suggests that at least some animals have fidelity to winter home range.

WORK SUBUNIT IVb: Population dynamics of muskoxen on the Arctic coastal plain: Productivity and dispersal as a natural regulator of population size in the 1002 area of ANWR. Objectives and methods as in 1988. Precalving survey in early April 1989 was of 506 muskoxen between the Sagavanirktok River in northcentral Alaska and the Firth River in northwestern Canada. (Another group of 12 muskox seen a few weeks later, west of the Sag River.) Of these, 359 were on the ANWR coastal plain. Calculated negative growth within the refuge since 1986 due to dispersal of muskoxen into areas east and west of ANWR in 1986 and 1989. Suggests that lower calving success and lower survival of young-aged animals following winter of 1988-89 could be attributed to severe winter weather conditions--muskox cannot get to food if snow is too deep. Thus lack of food in late winter may have contributed to increased neonatal mortality and overwinter mortality of young animals. Distribution of animals similar in 1989 to that observed in 1987 and 1988, but has changed since 1982 when intensive studies of muskox began on the coastal plain.

Conclusions as in 1988, above, with lack of population growth noted in 1988, also seen in 1989.

RESEARCH WORK ORDER 29: Assessments of the characteristics of muskox winter habitat in potential lease areas of the Arctic NWR, Alaska. K. Wilson, D.R. Klein, and P.E. Reynolds. Pp. 117-123 In: (above) Objectives are (1) to determine whether snow characteristics at known feeding sites of muskoxen are significantly different than adjacent or random sites on the coastal plain; and (2) to determine the vegetation composition at known feeding sites as compared to non-feeding sites on the coastal plain. Twenty winter feeding sites were located between the Jago and Kongakut rivers, late March - early April, 1989, by observations. Snow depth and hardness were measured in the feeding site, adjacent area, and nonfeeding area. Fecal pellet samples were collected. Sites were relocated in July and vegetation cover data were collected. Snow depth was significantly shallower in feeding areas than in adjacent (by an average 17.4 cm) or random (by an average 20.6 cm) areas ($p<0.00001$). Inland snow depths were significantly deeper than coast and foothills snow depths. Snow hardness in feeding areas was significantly less than in adjacent and random areas. Snow hardness at the coast and inland sites was not significantly different, but both had significantly higher values than the foothills sites. Vegetation data being analyzed.

Potential effects of petroleum exploration and development on muskoxen using the arctic coastal plain, annual progress report: Work Unit IV. P.E. Reynolds and T.R. McCabe. Pp. 133-166 in: Terrestrial Research, 1002 Area - Arctic NWR, Interim Report - 1988-1990. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 12/90.

WORK SUBUNIT IVa: Winter distribution, movements, and habitat use of muskoxen on potential petroleum lease areas of the Arctic NWR. Mixed-sex muskox groups were found in specific drainages on the ANWR coastal plain from November through February in 1988-90. The Sadlerochit River drainage was the most consistently used (by 70-100 animals); the Kongakut River was important to 40-50 animals in 1987-88 and 1989-90. Other areas were consistently used by smaller groups. Numbers of animals observed along drainages varied from year to year indicating that not all individuals wintered in the same location each year. Muskox wintering on the Kongakut remained there during calving in all three years. Muskox wintering near Red Hill on the Canning River also calved near there in all three years. Distribution of muskoxen in summer showed a major shift of animals from the Kongakut River to the Aichilik, Niguanak and Jago rivers and from the Sadlerochit River to forks of the Tamayariak River and the Canning River delta. Preliminary data analysis supports hypotheses of others that in winter, muskoxen minimize forage requirements and maximize energy conservation. Fidelity to specific wintering areas indicates that these locations are very important to the well-being of the ANWR muskox population. Recommends that areas that support a relatively large proportion of the population and are used year after year should receive special mitigation emphasis re disturbance. Suggests that if muskox are disturbed in winter and increase their daily activity or make long movements, their energetic requirements will increase. If energy requirements exceed the limited energy intake from winter foods, nutritional decline and lack of recovery in summer may result in decreased productivity and survival. Recommends siting of facilities in locations far from wintering areas, and continued monitoring of distribution to maintain current knowledge of important winter use areas.

WORK SUBUNIT IVb: Population dynamics of muskoxen on the Arctic coastal plain: Productivity and dispersal as a natural regulator of population size in the 1002 area of ANWR. Results of April 1990 pre-calving survey were of 495 muskoxen between the Sag River in Alaska and Firth River in Canada; of these, 348 were observed on the ANWR coastal plain. After rapid population growth

through 1986, muskox numbers in the ANWR decreased and then stabilized at about 350 animals as numbers of muskoxen east and west of the refuge increased. A population model was used, after it provided estimates that were not significantly different from actual estimated numbers, to predict that the ANWR population may grow slowly for the next decade. It also suggested that population numbers will decline if recruitment and survival of cows, yearlings, and calves decline by as little as 3%. Conclusion noted that lower productivity and survival of calves and yearlings and adult cows occurred during the winters of 1985-86 and 1988-89. Snow fall was heavy then, suggesting that annual variations in productivity and survival are related to winter conditions. Occurrence of the most noticeable changes in distribution in 1986 and 1988-89 suggests that dispersal of animals may also be triggered by such conditions. Lack of significant long term decline in productivity or survival suggests that major decreases in availability or quality of forage have not occurred. Suggests that if winter weather or other short term environmental factors influence annual variations in productivity and survival of both young and adult muskoxen, then if they coincide with perturbations such as impacts of oil and gas development, effects are likely to be cumulative. This may result in short term reductions in productivity and survival and long term decreases in population size. Recommends continued monitoring and analysis of population size and composition.

RESEARCH WORK ORDER 29: Assessments of the characteristics of muskox winter habitat in potential lease areas of the Arctic NWR, Alaska. K. Wilson, D.R. Klein, and P.E. Reynolds. Pp. 257-278 In: (above) Study addressed combined effects of snow and vegetation on foraging patterns of muskoxen with objectives as above. March 8, 1990, started 6-wk field season, including locating of collared muskox. Foraging site defined as area where muskox had fed upon vegetation as evidenced by cratering activity, and included unused areas surrounding actual area of use. Within a foraging site, feeding crater defined as a continuous area of snow disturbance caused by food search efforts of at least one muskoxen. Fecal pellets collected and July field classification of physical features and dominant vegetation type on feeding sites, as above. Looked at 24 feeding zones and 5 groups of muskox. Evidence that muskoxen returned to some foraging sites used in 1989--reaffirms Reynolds findings, thus indicative that muskox exhibit selection for specific habitat characteristics. Within feeding zones, snow was shallower and softer in the microsites where muskoxen fed. In 1989 and 1990, snow depth and hardness was significantly less in the feeding zones than in the paired adjacent zones, and total vascular cover was significantly greater in feeding zones than in paired non-adjacent zones. There was a relatively high proportion of sedges and mosses in all late winter samples and lower proportions of sedges in the winter-type samples. Willow was greater in the winter-type than late winter samples. Rumen and fecal analysis is continuing. Because of behavioral, morphological, and physiological adaptations, muskoxen are constrained by snow characteristics and geographic distribution of habitat types, but are less constrained than caribou by forage quality. This study supports hypothesis that muskox selection for shallow snow operates on at least three scales (broad ares, foraging sites, and microsites) and that selection operates progressively toward shallower depths. Hardness was significant factor in 1990 when snow was shallower and softer. Study indicated that muskox use windswept vegetated ridges in late winter which are concentrated along creeks, rivers, and the coast. Study proposes model of muskox foraging behavior which predicts selection of areas where snow depth is slightly departed from the average, and where, for that particular time, vegetation is more exposed than on average. If such areas are the preferred foraging sites, then the relative abundance of these sites is probably quite low. Appears that muskoxen are using riparian areas in late winter because of their topographic relief and the availability of windblown vegetated habitats. Muskoxen have dispersed east and west, but suggests their lack of movement south, into the foothills and Brooks Range, may be associated with the probability of increased predation, as well as the effect of deep soft snows in the narrow valleys in restricting movements. Provides three explanations of why muskoxen made greater use of sedges and sedge habitat, and less use of willows and willow

habitat during this study than in 1982 and as was predicted by previous authors: 1) habitat type availability differed in this study area as compared to earlier studies; 2) earlier study was of pellets from both early and late-winter foraging, so this study showed late winter habitat shift away from low lying willow stands that accumulate greater amounts of snow as winter progresses; and 3) effect of increasing muskox density on the coastal plain has led to depletion of traditional winter habitat and resulted in both dispersal of animals into less productive habitats within winter ranges and colonization of new ranges believed to be less productive (new ranges have fewer willows available and for the few areas that do have extensive stands of willows, they became inaccessible in late winter, especially during the deep snows of 1989). Study results suggest that these three conditions are occurring simultaneously and that the severe winter of 1989 precipitated this event. Additional study recommendations/findings are: (1) to determine effects of different amounts of willow in the winter diet of muskoxen on their productivity and the response of willows to browsing pressure through controlled studies of muskox-willow interactions (notes that willows on the coastal plain were not subjected to muskox browsing for over a 100-year period prior to their reintroduction); (2) effect of displacing animals into the foothills and Brooks Range is unknown but thought to be detrimental because of increased predation, decreased mobility due to deep snows in valleys, and uncertain forage resources; (3) effect of dispersing east and west from 1002 area is unknown, but oil development might speed up that dispersal, or loss of a traditional area for a source popoulation might slow long-term recolonization of the rest of the North Slope; (4) there could be significant accidental loss of animals through road kills, poaching, etc.; and (5) development would reduce possiblity of the narrow coastal plain serving as a movement corridor between Canadian and Alaskan muskox populations. Suggests evaluation of mitigation procedures prior to development, e.g., restoration of disturbed areas, overpasses or underpasses for roads and pipelines; mapping and protecting from disturbance the windblown vegetated areas identified as critical winter habitat, and protection of access routes between these areas; need continued close monitoring of herd population status to clarify present uncertainty re population trends. [NOTE: 1002 Office has not yet seen the full report, MS thesis from this study.]

Non-FWS publications:

Reynolds, P.E. 1989a. An experimental satellite collar for muskoxen. Can. J. Zool. Vol. 67, pp. 1122-1124.

_____. 1989b. Status of a transplanted muskox population in northeastern Alaska. Proceed. 2nd Inter. Muskox Symposium, Oct. 1-4, 1987, Univ. Saskatchewan, Saskatoon, Canada. Canadian J. Zool. 67(5) A26-A30.

Objectives Completed

(now and by October 1992, describe any problems, constraints, or limitations to the data)

- Study findings appear to provide a reasonable baseline of information on the first two study objectives re delineating winter use areas and movement patterns (although the sample size of satellite-collared animals has been small); and determining the size, productivity, dispersal rate, and population growth rate of the muskox population.

Unmet Objectives

(should include consideration of future need to meet them or constraints which make them unfeasible or no longer

necessary)

- Due to funding constraints, objective of determining availability of preferred habitat was eliminated, per FY 1990 Work Plan. Is this objective the same as that regarding determining whether suitable wintering habitat is limiting? How does this fit in with habitat map being developed?

- Status of master's project on winter habitat use that 11/90 study review said was to be completed 6/91, but '91 interim reports mentions some continuing analyses?

- Unclear whether any progress has been made on determining effects of disturbance on displacement and distribution of muskox, although hypotheses are made in interim report, and apparently a suitable population model exists.

Future Study Needs

- 1988 study report said that preliminary vegetation sampling in selected riparian areas was proposed for summer 1989 to augment existing gaps in ground data needed for development of habitat map and to assess habitat quality in areas used by muskoxen during past several years.

- Continue population size, composition, and distribution monitoring and analysis to more accurately predict additive effects of development and identify critical levels.

- Has muskox distribution data been put on GIS system? Need to get it on 1002 Office GIS system, and have Pat Reynolds work with 1002 Office GIS person to delineate key habitat areas, so mitigation can be addressed.

Status and 1002 Office Recommendations, 11/90 Review

- 1002 Office concurred with recommendation that muskox study be funded at $ 45,000 in FY 1991, and that habitat use and dispersal of muskox toward Prudhoe Bay studies would be deferred until 1992.

1002 Office Recommendations, 2/92 Review

Table 1. Pre-calving population estimates of muskoxen in northeast Alaska and northwest Canada, 1972-1990.

Year	West of Canning R.	ANWR	East of USA border	Total	Notes
1972		29		29	a
1973	1	27	6	34	a
1974		25	2	27	b
1975		14		14	b
1976		51	1	52	b
1977		71	1	72	c
1978		86		86	c
1979		112		112	c
1980		148		148	c
1981		186		186	c
1982		219		219	d
1983		257		257	d
1984	8	293		301	d
1985	5	347		352	d
1986	9	399	0	408	d
1987	65	320	22	407	d
1988	55	355	9	419	e
1989	130	359	29	518	f
1990	122	348	25	495	e

a Adults seen in summer (Roseneau and Warbelow 1974).
b Adults seen in summer (U.S. Fish and Wildlife Service 1982).
c Refuge surveys (Ross 1978, 1979, 1980, 1981).
d USFWS-ANWR baseline studies.
e Current USFWS-ANWR study.
f Includes 12 animals west of Sagavanirktok seen by ADFG.

Table 2. Rates of increase of re-established muskox populations in and near the Arctic National Wildlife Refuge, 1982-1990.

Area	1972-1976	1977-1981	1982-1986	1987-1990
ANWR	0.141	0.241	0.150	0.028
West			0.000	0.890
East			1.122	
All areas	0.146	0.255	0.157	0.080

From: 1988-90 interim report

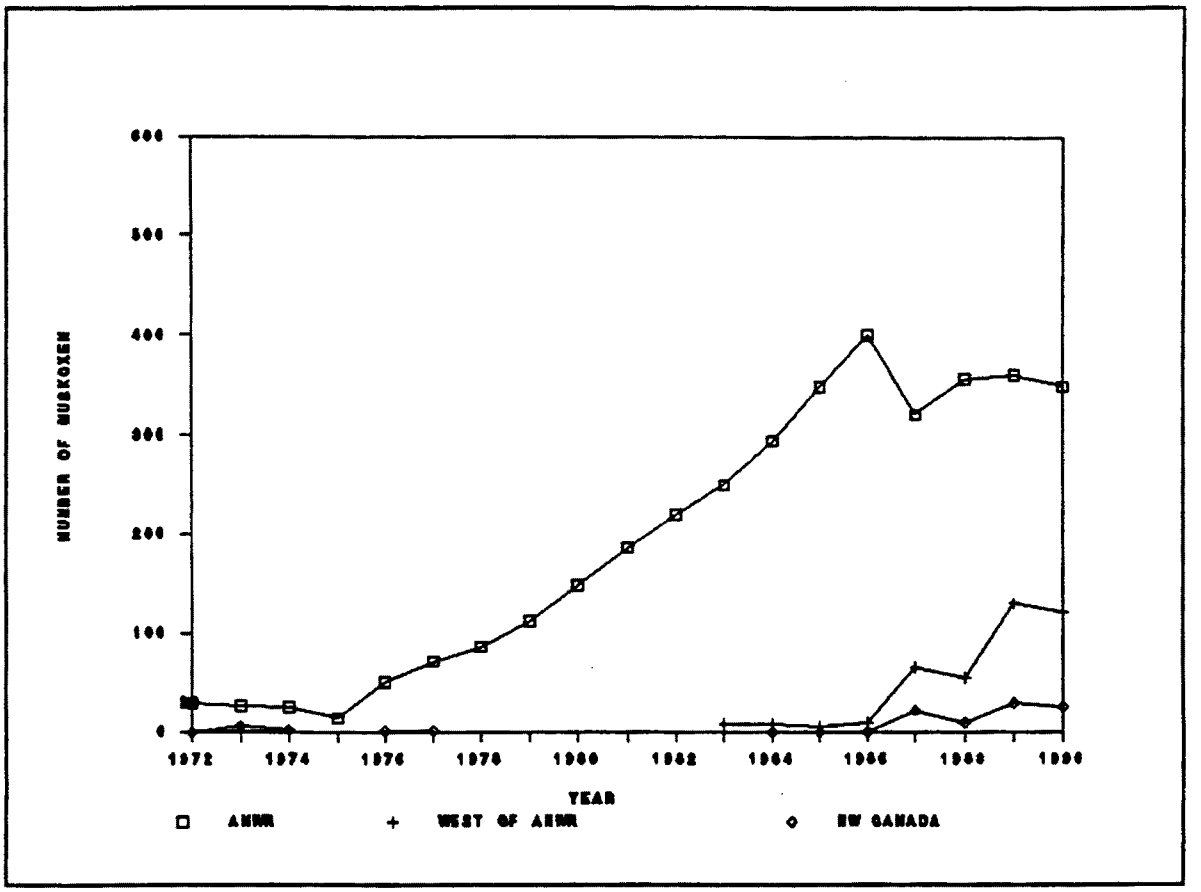

Figure 2. Size of muskox population in the Arctic National Wildlife Refuge and adjacent areas, 1972-1990.

population in 1990 indicate that calf mortality was negligible between 1989 and 1990 and that survival was about 100%. Mortality of yearlings was estimated to be about 12% between 1989 and 1990 (Table 5). Calf and yearling survival were both lowest in 1986 and 1989 which reflected mortalities during the winters of 1985-86 and 1988-89 respectively. Yearlings and 2 year olds comprised 17% and 12% of all animals classified in 1990 (Reynolds 1990). Similar percentages (13-17% for yearlings and 9-14% for 2 year olds) were seen during 1983-1990 (Reynolds 1989b).

Survival of muskox cows, based on percentages of radio-collared cows dying each year, was lowest in 1985-86 and 1989-90 when 20% mortality was observed (Table 6). Survival was estimated to be 90-100% during most other years and averaged 88%. Eighteen radio-collared cows have died since the onset of muskox studies on the refuge in 1982. Mean age at death for 5 known-aged individuals was 13.8 years (range = 9-19). At least 14 of the 18 were a minimum of 7 years of age or older.

From: 1988-90 interim report

Hypotheses

The following hypotheses were developed to test the effects of snow and vegetation on forage site selection by muskoxen:

Hypothesis 1 - Muskoxen select areas of shallow snow in which to feed.
Prediction 1

Scale 1: Within feeding zones, snow depth will be shallower in specific microsites used for feeding (on least disturbed edges of feeding craters or on tops of areas of microrelief) than in random locations.

Scale 2: Snow depth in feeding zones will be shallower than in paired adjacent zones.

Scale 3: Snow depth in feeding zones will be shallower than in paired non-adjacent zones.

Hypothesis 2 - Muskoxen avoid feeding in areas of hard snow.
Prediction 2

Scale 1: Within feeding zones, snow hardness will be less in specific microsites used for feeding than in random locations.

Scale 2: Snow hardness will be greater in paired adjacent zones than in feeding zones.

Scale 3: Snow hardness will be greater in paired non-adjacent zones than in feeding zones.

Hypothesis 3 - Muskoxen feed where biomass of plant species is greatest.
Prediction 3

Scale 2: Given similar snow characteristics among feeding and paired adjacent zones, there will be greater biomass of vascular plant species in feeding zones.

Scale 3: Given similar snow characteristics among feeding and paired non-adjacent zones, there will be greater biomass of vascular plant species in feeding zones.

Hypothesis 4 - Muskoxen feed where biomass of favored plant species is greatest.
Prediction 4

Scale 2: Given similar snow characteristics among feeding and paired adjacent zones, there will be greater biomass of preferred species in feeding zones.

Scale 3: Given similar snow characteristics among feeding and paired non-adjacent zones, there will be greater biomass of preferred species in feeding zones.

Muskox Winter Distribution

In 1989, field work began on 15 March and it continued for 4 weeks. In 1990, a 6 week field season commenced on 8 March. Muskoxen were located from fixed-wing aircraft at the beginning and midpoint of each field season by flying systematic transects over the study area. In addition, groups containing radio-collared individuals were located and identified. Locations were recorded on 1:63,360 scale USGS topographic maps.

Known muskox locations were later relocated on the ground. Rather than displacing

From: 1989-90 interim report

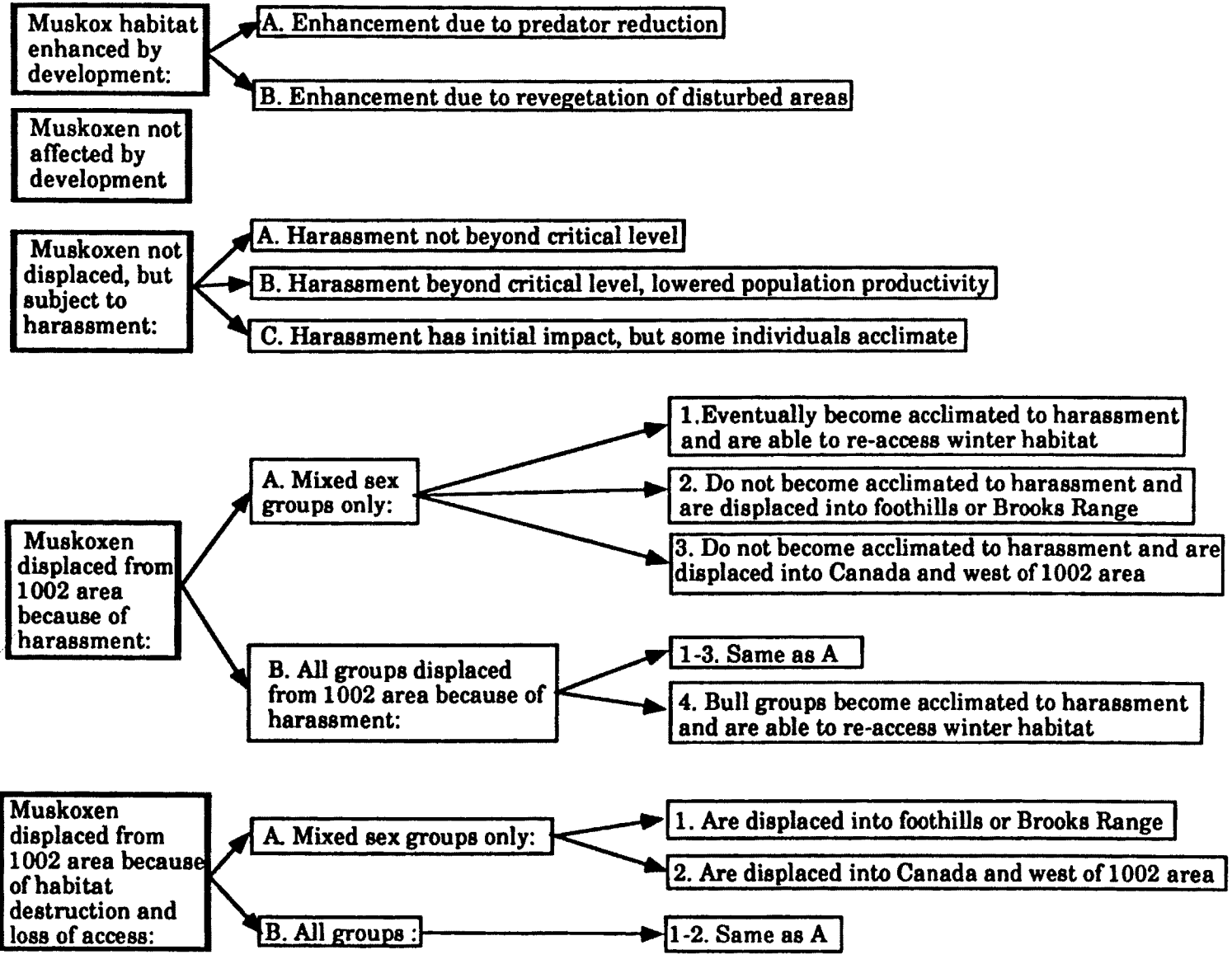

Figure 2. Outline of the Possible Effects of Development on Muskoxen.

PREPARATION FOR SEISMIC FOLLOWUP
1002 PROGRAM STUDY REVIEW

Objectives of Study (1988)

- To determine the extent and rate of recovery for vegetation subjected to varying levels of disturbance resulting form winter seismic exploration.

- To provide a basis for development of effective stipulations to minimize or avoid future vegetation disturbance caused by oil exploration and development.

Funding by Year

YEAR	1988	1989	1990	1991	1992
AMOUNT ($1,000)	$ 150.	$ 83.	$ 45.	$ 150.	

Reports Completed (list--title, author, date) (annotate)

Long-term effects of winter seismic exploration on the vegetation of the coastal plain of the Arctic NWR, annual progress report. N. Felix. Pp. 33-59 and 70-114 (second half of report, under ANWR, 1990 Studies) in: Terrestrial Research, 1002 Area - Arctic NWR, Annual Progress Report, Field Season - 1988. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 7/89.

January to May, 1984 and 1985 seismic program resulted in 2,000 km of seismic line, in a 5 x 20 km grid. Series of studies to document initial effects of winter seismic exploration conducted in 1984 and 1985. Permanent plots established on trails and initial changes in plant cover, nutrient levels of plants, thaw depths, track depression, and trail visibility were recorded. Aerial photo interpretation used to assess disturbance at many sites to determine effects of different trail types and relative sensitivities of vegetation types. Relationship between snow depth and initial trail disturbance examined. Permanent plots were reevaluated in 1988 [and in 1991] and aerial photos retaken. Objectives are to: (1) determine recovery time to pre-disturbanc econditions needed in arctic coastal plain habitats following different levels of disturbance due to winter seismic exploration; and (2) provide a basis for development of effective stipulations to minimize future vegetation disturbance caused by oil exploration and/or development on the arctic coastal plain or similar habitats. 37 intensive study plots and 66 photo-trend plots were evaluated in 1988. Found that seismic trails remained visible at most study plots in 1988, 4 or 5 seasons after initial disturbance. However, trails were generally less visible fromthe air and ground than in the initial years. Decreased visibility was most apparent on wet graminoid and moist sedge-shrub trails with low levels of disturbance, which were visible as green trails in the initial years. By 1988, standing dead litter on trails had increased, and visibility of trails decrease substantially. Trails in riparian shrubland, dryas terrace, and moist graminoid/barren tundra were also less visible dur to recovery of plant cover on trails, and weathering of exposed soil and litter to a lighter color. Cover of vascular and nonvascular

plant species remained lower on most seismic trails in 1988, but recovery of some species occurred at a numbe of plots. Shrub height of riparian willows remained significantly lower on all disturbed plots. Variety of species found recolonizing bare areas--generally those species most common in adjacent undisturbed plant communities. Plant productivity generally higher on disturbed plots in both 1985 and 1988. N and P concentrations of shrubs higher on disturbed plots, but lower in sedge and cottongrass. Thaw depths significantly greater on over half of disturbed plots in all vegetation types and at all levels of disturbance. Track depression remained significant at the 4 moist sedge-shrub plots where it was initially measured. Long-lasting changes expected at trails with significant track depression, as vegetation type has changed from moist sedge-shrub tundra to wet graminoid tundra. Intensive and photo-trend plots scheduled for reevaluation in 1991 (done) and 1994. Aerial photography to be retaken in 1993, with ground verification.

- No write-up was included in the 1989 field season report.

- No write-up was included in the 1988-90 interim report.

Other FWS reports subsequent to the 1002 report/baseline series:

Felix, N.A. 1988. Long-term effects of winter seismic exploration on the vegetation of the Arctic National Wildlife Refuge coastal plain. Unpublished report. USFWS, Fairbanks, Alaska. 25 pp. [1002 does not have?]

Felix, N.A., H.A. Haid, J.S. Christiansen, and K.E. Dubois. 1989. Detailed methods of data collection on intensive and photo-trend plots, 1989. Unpublished report. USFWS, Fairbanks, Alaska. [1002 does not have?]

Felix, N.A., M.K. Raynolds, J.S. Christiansen, and K.E. DuBois. (no date?). Response of tundra plant communities to disturbance by winter seismic vehicles. Unpublished report. USFWS, Fairbanks, Alaska.

Raynolds, M.K. and N.A. Felix. 1988a. Effects of winter oil and gas exploration on visual resources, vegetation, and surface stability of the coastal plain of the Arctic NWR, Alaska, 1986 and 1987. ANWR Progress Report No. FY86-1. USFWS, Fairbanks, Alaska. 23 pp.

Raynolds, M.K. and N.A. Felix. 1988b. Accuracy assessment of airphoto interpretation of vegetation types and disturbance levels on winter seismic trails, Arctic NWR, Alaska. ANWR Progress Report No. FY86-2. USFWS, Fairbanks, Alaska. 17 pp.

Raynolds, M.K., J.S. Christiansen, and C.H. Curby. 1989. Accuracy assessment of airphoto interpretation of disturbance levels on winter seismic trails, Arctic NWR, 1989. ANWR Progress Report FY89. USFWS, Fairbanks, Alaska. 11 pp.

Non-FWS publications:

Felix, N.A., and M.K. Raynolds. 1989a. The effects of winter seismic trails on tundra vegetation in northeastern Alaska, U.S.A. Arctic and Alpine Research 21(2):188-202

Established 34 permanent study plots after 1984 and 1985 seismic exploration. Plant cover was lower on most disturbed plots than on their adjacent controls, with decreases as high as 87% the first summer after disturbance. The species most sensitive to disturbance were evergreen shrubs, followed by willows, tussock sedges, and lichens. Willow height in riparian shrubland plots was significantly reduced by 5 to 11 cm. Little recovery of plants occurred in the second or third summers after disturbance. Track depressions ranging form 5 to 15 cm occurred at three plots in moist sedge-shrub tundra and increased significantly at one plot between the first and third summers following disturbance. Study is continuing.

Felix, N.A., and M.K. Raynolds. 1989b. The role of snow cover in limiting surface disturbance caused by winter seismic exploration. Arctic 42(1):62-68.

Established 90 study plots on seismic lines and camp moves in tussock tundra and moist sedge-shrub tundra. Total snow depth and its components, slab layer and depth hoar, were measured during the winter. Plant cover changes, tussock disturbance, visibility and disturbance levels were determined at the study plots in the summer. Disturbance was found to be generally lower when snow depths were greater. In tussock tundra, plots with snow depths over 25 cm had significantly less disturbance than those with under 25 cm. Relationship less clear (held, but not significantly) in moist sedge-shrub tundra. Slab depth, which does not include the loose layer of depth hoar, provided a better measure of protective snow cover in moist sedge-shrub tundra, as slab depths over 20 cm resulted in significantly less disturbance. Moderate-level disturbance (25-50% decrease in plant cover) did not occur in trails where snow depths were at least 25 cm in tussock tundra and 35 cm in moist sedge-shrub tundra. Low-level disturbances (less than 25% decrease in plnat cover occurred in trails with snow depths as high as 45 cm in tussock tundra and 72 cm in moist sedge-shrub tundra.

Felix, N.A., and D.L. Binney. 1989c. Accuracy assessment of a Landsat-assisted vegetation map of the coastal plain of the Arctic NWR. Photogrammetric Engineering and Remote Sensing. Vol. 55(4):475-478.

Overall map accuracy was 37% based on ground data collected at 126 sites. Majority of errors (27%) were between closely related land-cover classes. Clear disagreements between map classification and plant community on ground were 22%. Concluded that the LANDSAT MSS [the original mapped classification] map provides information on distribution of general vegetation types across the coastal plain, but not of site-specific vegetation data.

Raynolds, M.K. and N.A. Felix. 1989. Airphoto analysis of winter seismic disturbance in northeastern Alaska. Arctic Vol. 42(4):362-367.

Used air photos to quantify extent of disturbance from 1984-85 seismic program. Used ground data from 194 sites to develop photo interpretation key. 14% of points had no disturbance (level 0), 57% had level 1 disturbance (low), 27% had level 2 (medium), and 2% had level 3 (high). Wet or partially vegetated areas were least susceptible; vegetation types with mounds, tussocks, hummocks or high-centered polygons and dryas terraces were more heavily disturbed. Camp move trails and overlapping seismic and camp move trails created in 1984 caused more disturbance than other trail types due to

multiple passes of vehicles over narrow trails. FWS monitors were more successful at minimizing disturbance in 1985 by requesting avoidance of multiple passes on the same trail, sensitive vegetation thypes and areas of low snow cover.

Objectives Completed

(now and by October 1992, describe any problems, constraints, or limitations to the data)

- 1990 Work Plan says project was continuation of past study with costs varying on a 3-year cycle. Development of operating stipulations was dropped.

- 1991 Work Plan noted that data on recovery was scheduled to be collected in 1991 and it was.

- Should discuss status of KIC well revegetation and FWS followup efforts on that. 1991 activities and result?

- Objectives (other than development of operating stipulations) are being met, on time.

Unmet Objectives

(should include consideration of future need to meet them or constraints which make them unfeasible or no longer necessary)

- 1991 was the intensive field study year for this project on its 3-year cycle, so a detailed report would be expected soon?

Future Study Needs

- Development of operating stipulations--should be done in conjunction with the 1002 Project Office and Ecological Services.

Status and 1002 Office Recommendations, 11/90 Review

- Concurred in conducting work as proposed; project has been fully funded and intensive field studies completed in 1988 (and 1991) as scheduled.

1002 Office Recommendations, 2/92 Review

- Generally appears to be one of the most on-target and on-schedule of the followup studies. Has resulted in numerous in-house reports and publications in peer-reviewed journals. Moreover, preliminary results (in 1984) were used to further minimize potential impacts of seismic operations in 1985.

Table 1. Disturbance levels of seismic trails in vegetation types of the coastal plain, Arctic National Wildlife Refuge, Alaska, 1988.

Dist. level	Description
Aquatic graminoid tundra	
0	No impact.
1	Decrease in emergent vegetation.
Wet graminoid tundra	
0	No impact. May have a few widely scattered scuffed microsites.
1	Some scuffing of higher microsites. May be slightly greener or darker than surrounding area.
2	Trail appears wetter than surrounding area. Common scuffing of microsites and compression of mosses.
3	Obvious track depression. Standing water apparent on trail that is not present in surrounding area during wet years.
Moist sedge-shrub tundra	
0	No impact. May have a few widely scattered scuffed microsites.
1	Some scuffing of higher microsites. May be slightly greener or darker than surrounding area. Less than 25% decrease in shrubs or mosses.
2	Trail appears wetter than surrounding area. Common scuffing of microsites and compression of mosses. Small patches of soil may be exposed. 25-50% decrease in shrubs or mosses. May have visible increase in sedge cover or flowering of sedges.
3	Obvious track depression. Standing water apparent on trail that is not present in adjacent area during wet years. Vegetation type changing to wet graminoid, with increased sedge cover and decreased shrub cover. Where track depression has not occurred, over 50% decrease in vegetation or shrubs.
Moist graminoid/barren tundra complex	
0	No impact to slight scuffing of microrelief.
1	Up to 25% decrease in vegetation cover. Scuffed or scraped mound tops still visible, but with common recolonization. 0-5% soil exposed.
2	Vegetation decrease 25-50%. Scraped mound tops common. Exposed organics or mineral soil 5-15%.
3	Over 50% decrease in vegetation cover. Nearly all mound tops scraped. Over 15% soil exposed.
Moist sedge tussock tundra	
0	No impact to slight scuffing of tussocks. 0-4% decrease in vegetation cover.
1	5-25% decrease in vegetation cover in tracks or whole plot. Scuffed or crushed tussocks still visible, but with common recolonization. Exposed soil <3%.
2	25-50% decrease in vegetation cover in tracks or whole plot. Over 30% of tussocks still have evident damage. Exposed organics or mineral soil 3-15%.
3	Vegetation decrease over 50% in tracks or whole plot. Destruction of tussocks or mound tops nearly continuous. Ruts may have formed. Exposed soil over 15%.
Moist shrub tundra	
0	No impact to slight scuffing of microsites.
1	5-25% decrease in vegetation or shrub cover. Damaged tussocks or hummocks have common recolonization.
2	25-50% decrease in vegetation or shrub cover.
3	Over 50% decrease in vegetation or shrub cover.

Table 1. Continued.

Dist. level	Description
Riparian shrubland	
0	No impact to slight decrease in shrub cover.
1	Less than 25% decrease in vegetation or shrub cover. Little change in ground cover.
2	Vegetation or shrub cover decrease 25-50%. Some disturbance to ground cover.
3	Over 50% decrease in vegetation or shrub cover. Substantial damage to ground cover.
Dryas terrace	
0	No impact to a few widely scattered scuffed microsites.
1	Less than 30% decrease in vegetation cover. Less than 5% soil exposed.
2	30-60% vegetation decrease. Little disruption of vegetative mat. 5-15% soil exposed.
3	Over 60% vegetation decrease and vegetative mat mostly disrupted. Over 15% soil exposed or over 50% increase in bare ground.

Plant species recolonizing disturbed areas were recorded in the following categories:

- common - commonly found on disturbed areas throughout plot
- occasional - 4-15 plants in plot
- trace - 1-3 plants in plot

Plot data was tabulated by vegetation type, and species were ranked by frequency of occurrence:

t - trace number of plants occurred at less than 25% of plots
1 - common or occasional colonizer at 1-24% of the plots
2 - colonizer at 25-49% of the plots
3 - colonizer at 50-74% of the plots
4 - colonizer at over 75% of the plots

Major plant species were collected for biomass and nutrient analyses at 3 wet graminoid or moist sedge-shrub plots (M1, T32 and O11), and 3 tussock or shrub tundra plots (S4, M2 and S8). Biomass only was obtained for species from plots O11 and S8, as the samples were mistakenly thrown away prior to nutrient analyses. Three-way analyses of variance of biomass, nitrogen and phosphorus concentrations, and total nitrogen and total phosphorus by treatment (disturbed and control), year (1985,1988) and plant part (stems and leaves) were conducted for each species in each plot (MANOVA; SPSS Inc. 1988). When treatment by plant part or treatment by year interaction was significant, contrasts with Bonferroni's correction were conducted for individual plant parts or years (ONEWAY; SPSS Inc. 1986). Two-way analyses of variance were conducted for leaves of *Ledum palustre* ssp. *decumbens* and

From 1988 Field Season Report

Table 2. Mean disturbance levels and air and ground visibility ratings on seismic trails, coastal plain, Arctic National Wildlife Refuge, Alaska, 1988.

Vegetation type	N	Disturbance level 1985	Disturbance level 1988	Ground visibility 1985	Ground visibility 1988	Air visibility 1985	Air visibility 1988
All plots	100	1.9	1.6**	2.1	1.8**	2.1	1.7**
Wet graminoid	11	2.2	2.0	2.3	1.9	2.5	2.1
Moist sedge-shrub	20	1.9	1.4*	2.0	1.3**	2.2	1.7*
Moist graminoid/barren	18	2.0	1.7	1.9	1.8	1.8	1.5
Tussock tundra	20	1.9	1.9	2.2	2.2	2.2	1.9
Shrub tundra	9	1.8	1.9	1.8	2.2	1.7	1.8
Riparian shrubland	12	1.8	0.8**	2.0	1.7	1.9	1.5
Dryas terrace	10	2.0	1.3**	2.3	1.8	2.3	1.5

*,** indicate a significant difference between 1985 and 1988 at 0.05, 0.01, respectively (paired t-test with correction for continuity).

Most vegetation types showed decreases in visibility, although not all were significant (Table 2). Both air and ground visibility showed significant decreases in moist sedge-shrub tundra, and ground visibility also decreased in wet graminoid tundra. In the initial years after disturbance, trails in these vegetation types were clearly visible due to compression of standing dead vegetation. Four or 5 growing seasons after disturbance, the standing dead on the trail has increased, and subsequently the visibility of trails has decreased substantially. Trail visibility increased on a few moist sedge-shrub plots tundra plots which developed track depression by 1988.

Both air and ground visibility decreased significantly in riparian shrublands, due primarily to regrowth of willows. Air visibility decreased significantly in dryas terrace and moist graminoid/barren tundra. These changes in visibility can be attributed to some recovery of plant cover, and weathering of litter and bare soil to a lighter color.

Plant Cover Changes

Wet Graminoid and Moist Sedge-Shrub Tundra: Cover of vascular plants was higher on the disturbed trails than in adjacent controls at half of the 12 plots at all levels of disturbance in 1988 (Table 3, Appendices 2-13). Cover of nonvascular plants was significantly lower on 9 plots; the 3 plots with no significant differences had recovered from a level 1 disturbance to level 0 by 1988. Plot 012 had significant decreases in nonvascular plants in the initial years, but not in 1988, indicating that recovery had occurred.

PREPARATION FOR HABITAT
1002 PROGRAM STUDY REVIEW

Objectives of Study (1988)

- To determine biomass and nutrient content of major forage species by vegetation type.
- To quantify snow melt patterns and timing.
- To determine differences in vegetation between traditional calving areas in the 1002 and adjacent areas.
- To develop and evaluate a vegetation classification scheme for assisting in mapping habitats within the 1002 and adjacent areas.
- To evaluate methods for producing a vegetation map for wildlife research and management needs.
- To produce and verify digital vegetation maps for the Arctic Refuge coastal plain and the PRudhoe Bay developemnt area.
- To delineate important insect-relief areas and movement corridors, and establish the relative value of different insect relief habitats to the Porcupine caribou herd.

Study was to focus on habitats used by herbivorous species such as caribou, muskoxen, and snow geese and provide data for determining whether critical habitats are limited or whether traditional use areas have unique biological and physical characteristics. Availability and quality of key forage species, a primary component of habitat selection, to be determined. Goal is to understand the abundance, distribution and use of key habitats so that appropriate mitigation measures can be designed.

Funding by Year

YEAR		1988	1989	1990	1991	1992
AMOUNT ($1,000)	(habitat)	$ 200.	$ 225.	$ 324.	$ 520.(?)	$ *
	(GIS)	70.	30.			

* Note: Habitat funding may be mixed in with caribou and GIS funding at some points??
- **1988 Work Plan** lists two accounts, $70 of add-on and $30 of base funding for the GIS analyses related to habitat, and $1027 total ($107 base, $200 add-on (that may be what corresponds with the habitat, above), and $620 add-on, and $100 State
- **1989 Work Plan** combines caribou and habitat into one project funded by $332 base from Refuges and $702 base from Research

- **1990 Work Plan** combines caribou and habitat into one project funded by $324 base from Refuges and $672 base from Research
- **1991 Work Plan** unclear; one version showed $520 for habitat ($250 for operations and $270 fixed) which is more than McCabe listed in his breakdown, see last page

Reports Completed (list--title, author, date) (annotate)

The distribution and seasonal quality of habitat available for key wildlife species of the Arctic coastal plain, annual progress report: Work Unit III. Pp. 61-92 in: Terrestrial Research, 1002 Area - Arctic NWR, Annual Progress Report, Field Season - 1988. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 7/89.

WORK SUBUNIT IIIa: Snow melt, plant phenology, and seasonal availability of forage nutrients and biomass in concentrated and peripheral calving areas of caribou on the Arctic coastal plain. N. Felix, W. Regelin, and T.R. McCabe. Objectives were to (1) determine if plant biomass and phenology of major forage species differ between concentrated caribou calving area and peripheral area, and between concentrated and peripheral areas in Kuparuk oil field; determine nutrient values of major forage species at each phenological stage; (3) gather quantitative vegetation map using Landsat thematic mapper (TM) data; and (4) determine cover/biomass relationships for major plant species on the Arctic coastal plain. This was pilot year of study, so determined reasonable sampling scheme. Eriophorum vaginatum (cottongrass) was main species showing phenological development during June, moving to early flowering stage as soon as the snow melted. Ptarmigan were common and grazed these flowers as soon as they were visible. Numbers and biomass of E. vaginatum flowers and leaves were higher in the concentrated calving area of ANWR than in the peripheral area in all 3 time periods sampled between June 11 - July 10. Biomass of a willow species was higher in the peripheral area. However a large sample size is needed to show significance. Biomass of Pedicularis spp. was significantly higher in the peripheral area than in the concentrated calving area during the last time period, in the Kuparuk study area. Based on field observations, key forage species in the Kuparuk area may differ from those on ANWR--E. vaginatum was uncommon and S. planifolia ssp. pulchra was less common than other willow species. Mean phenological stages of sedge, cottongrass, and willow were significantly more advanced in the peripheral area than in the concentrated calving area of ANWR during a portion of the time period studied. In Kuparuk study area, none of the key species showed significant differences in phenological stages between the concentrated and peripheral calving areas, but sample sizes were very low. While there were not significant differences in nutrient levels between the concentrated calving and peripheral areas in ANWR, nutrient levels varied among phenological stages for Carex, Eriophorum, and Pedicularis and between location for Pedicularis, in the Kuparuk area. Significant relationships for most species, re plots with higher cover values expected to have higher biomass. In 1989 will focus on snow and phenology data, and biomass of E. vaginatum flowers in order to attain adequate sample sizes. Because of high level of variability, will emphasize developing vegeation classification system and map, using TM data. Recommends study to determine which plant communities are preferred by caribou for feeding during calving and post-calving periods so can determine their distribution and focus on them.

WORK SUBUNIT IIIb: Comparison and implementation of classified vegetation maps derived from LANDSAT-TM and SPOT satellite imagery data bases for delineating wildlife habitat availability and distribution. D. Douglas and T.R. McCabe. Existing maps do not adequately delineate vegetation

communities. Study applies state-of-the-art data, collected by satellite. First, assessed capability of LANDSAT Thematic Mapper (TM) and SPOT data to cost-effectively map vegetation communities with sufficient accuracy. Second phase will develop map of coastal plain between Prudhoe and the Canadian border, to the foothills, for analysis with wildlife distribution data using GIS. LANDSAT TM data acquired in July 1985, east of the Sadlerochit River, and July 1986, west of the Sadlerochit River; SPOT data collected July 1987. Ground data (see Subunit IIIa, above, collected during vegetation field studies to interpret and refine classes. Preliminary map generated using TM data for east of the Sadlerochit; it contained 62 spectral classes, sixteen of which represented ice or water. Refinement of foothill and some wetland and riparian classes resulted in total of 123 classes. LANDSAT TM and SPOT data overlaid and mapped together in an area on the Canning River--SPOT has higher spatial resolsution (10 m compared to 30 m for TM). Analysis show that LANDSAT TM provided more refined delineation than existing maps. Technique of merging SPOT and TM data provides even greater resolution, but gauged inadequate to map entire area because of greater cost and time, and lack of complete SPOT data. Anticipated extensive gound sampling in 1989; expedited schedule was expected for the study.

The distribution and seasonal quality of habitat available for key wildlife species of the Arctic coastal plain, annual progress report: Work Unit III. Pp. 65-85 in: Terrestrial Research, 1002 Area - Arctic NWR, Annual Progress Report, Field Season - 1989. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 3/90.

WORK SUBUNIT IIIa: Snow melt, plant phenology, and seasonal availability of forage nutrients and biomass in concentrated and peripheral calving areas of caribou on the Arctic coastal plain. J.S. Christiansen, M.K. Raynolds, and S.C. Bishop. Objective in 1989 was to determine if plant biomass and phenology of four major forage species differed between the historic concentrated caribou calving area and a peripheral area during the calving period. Snow melt proceeded rapidly over the first two weeks of June study period. Average snow cover was not significantly different between the 1989 intensive calving area and the less-used area, however distribution of snow cover was different. No significant differences in biomass measures or phenology of 4 species sampled, calving as compared to peripheral area. However E. vaginatum flowers had significantly greater density and biomass in the intensive calving area. Compared to the peripheral area, the historic concentrated area had greater percent cover of tussock tundra (35% vs. 26%) and moist sedge shrub tundra (31% vs. 21%), types important for caribou forage. The 1989 intensive calving area had much higher percent cover of tussock tundra than the less-used ara (56% vs. 15%), but lower percent cover of moist sedge shrub tundra (19% vs. 31%). Preliminary results support 1988 conclusion that some differences may exist between historic concentrated calving and peripheral areas, e.g, vegetation type distributions; however no significant differences in forage availability were found between the historic concentrated area and the peripheral area, but that may be becasue the part of the peripheral area sampled did not accurately represent the whole peripheral area. Field studies in 1990 will include the whole study area and sampling will be stratified by vegetation types.

WORK SUBUNIT IIIb: Comparison and implementation of classified vegetation maps derived from LANDSAT-TM and SPOT satellite imagery data bases for delineating wildlife habitat availability and distribution. J.S. Christiansen, D. Douglas and M.K. Raynolds. Point-frame cover and composition data as well as community descriptions at 32 study areas on the coastal plain and adjacent foothills were collected during the 1989 field season. Species composition and landform data collected at 41 sites between the Sadlerochit and the Canadian border. 1989 data used to refine and improve the 1988 geobotanical vegetation classification scheme, and the LANDSAT-TM maps to be

produced to delineate Level-C vegetation classes. Revised maps to be prepared for final evaluation during 1990 field season.

The distribution and seasonal quality of habitat available for key wildlife species of the Arctic coastal plain, interim report: Work Unit III. Pp. 90-132 in: Terrestrial Research, 1002 Area - Arctic NWR, Annual Progress Report, Interim Report - 1988-1990. Alaska Fish and Wildlife Research Center and Arctic NWR, USFWS. 12/91.

WORK SUBUNIT IIIa: Snow melt, plant phenology, and seasonal availability of forage nutrients and biomass in concentrated and peripheral calving areas of caribou on the Arctic coastal plain. J.C. Jorgenson and M. Udevitz. In 1990, plant biomass and phenology data were collected similar to the 1989 study; plant nutrient content analyses were as in 1988. Snow melted early in 1990 allowing caribou to disperse and calve further north. 1990 intensive calving area had higher percent cover of lowland vegetationtypes such as wet sedge (11% vs. 4%) and moist sedge tundra (43% vs. 20%) and lower percent cover of tussock tundra (26% vs. 34%) than did the less-used area. E. vaginatum and S. planifolia had significantly greater biomass in the historicl concentrated area than in the peripheral area during at least one of the sampling periods. There was a higher percent cover of C. aquatilis in the intensive calving area during the last sampling period. Phenological development tended to be somewhat slower in the historical concentrated and 1990 intensive use areas than in the historical periphery and 1990 less-used areas. The historic concentrated area had significantly higher levels of nitrogen and phosphorus and significantly lower levels of acid detergent fiber than the historic periphery for full flower and/or seed stage E. vaginatum. The same significant differences held between the 1990 intensive and less-used areas. Biomass, density and cover measures varied greatly between vegetation types. Concludes that the past three years of study indicate that significant differences in vegetation characteristics exist between the historical concentrated calving area (the Jago River area used in 17 of the past 19 years) and the adjacent area that has the highest probability of being used for calving if displacement from the preferred area occurs due to human activity. Snow-melt patterns are apparently a major determinant of the distribution of calving, as snowmelt controls initiation of plant growth and phenological development, thus influencing forage quantity and quality. This study represented known extremes of snow-melt conditions on the calving grounds: in 1988 the coastal plain was snow covered throughout the calving period and calving occurred in snow-free areas in the mountains south of the 1002 area and on the coastal plain in Canada; in 1989 there was patchy snow cover in the historical concentrated calving area during the peak of calving while the upper foothills were snow-free and the rest of the coastal plain was snow-covered (probably a normal year) and calving was mainly in the historical concentrated area; in 1990, the coastal lain was mainly snow-free aby the start of calving and the caribou calved further north on the coastal plain, as well as in the concentrated area. In 1990, the only year in which the whole concentrated and peripheral areas were sampled with adequate sample sizes to detect differences, the concentrated area had significantly higher biomass of important forage species, E. vaginatum and S. planifolia. Few significant differences were found between the 1990 intensive calving and the less-used area--but because only half of the 1990 calving area was within the study area, sampled sites may not adequately represent the whole area. Different vegetation type distributions may explain most of the differences found in forage quantity and quality between the areas, e.g., the significantly greater biomass of flowers in the concentrated area in 1990 depended on the greater cover of tussock tundra, not on any difference between tussock tundra in the two areas. In sum, loctaio of concentrated calving is greatly influenced by vegetation type distributions and snow-elt patterns across the Arctic coastal plain. These factors determine quantity and quality of forage available to caribou during calving and post-calving periods and are related to other important factors, such as availability of dry sites for calving and terrain

featuress providing relative safety from predators. Vegetation types and snow-melt patterns are interrelated--both are determined by topographical location, moisture regimes and climate. Snowmelt varies from year to year while vegetation type distributions integrate many years of climatic information. Thus a reliable vegetation map will enhance future studies. Concludes that distribution of tussock tundra in the area causes the concentated calving area to have greater quantity and quality of E. vaginatum flowers, the only readily-available forage during the peak of calving. Studies during calving period were to be repeated in 1991. More extensive studies needed to documetn relationships between phenology, quantity, and quality of forage on the coastal plain throughout the summer. When LANDSAT-TM vegetation map is completed, it will be used to stratify sampling by vegetation type, to reduce amount of variability in the data, and allow extrapolation of results to the whole coastal plain.

WORK SUBUNIT IIIb: Comparison and implementation of classified vegetation maps derived from LANDSAT-TM and SPOT satellite imagery data bases for delineating wildlife habitat availability and distribution. J.S. Christiansen, D. Douglas and M.K. Raynolds. Vegetation map of the coastal plain based on digital classification of LANDSAT satellite multi-spectral scanner data in 1982. An accuracy assessment of the 1985 map of the entire refuge found that it provided information ont he distribution of general vegetation types across the coastal plain, but did not delineate vegetation types adequately enough for site-specific wildlife habitat studies. For current LANDSAT-TM mapping, ground-truth data were acquired at 896 plots in 50 intensive study areas on the coastal plain and adjacent foothills in 1989 and 1990. Systematic vegetation sampling done to provide statistical estimates of habitat distribution across the coastal plain, and to assess accuracy of the LANDSAT-TM map. All vegetation study plots sampled for various botanical studies on the coastal plain from 1984 to 1990 were assigned a vegetation type based on the improved classification. The most common vegetation trypes are moist sedge shrub tundra (30%), tussock tundra (24%), hummocky sedge tundra (10%) and wet sedge tundra (10%). Data set was used in analysis of caribou calving areas (Subunit IIIa). Analyses of 1985 and 1987 ground-truth data showed that the preliminary LANDSAT-TM vegetation map had 79% agreement with the very broad Level-B vegetation classes, but less than 50% agreement with Level-C classes. Current map produced by USFWS personnel had 129 spectral classes, reduced to 110 classes by combining water and ice classes. Accuracy of sub-classes defined was 50-70%. Analysis to be repeated with topographical data to improve sub-class accuracy. Concludes that analyses to date indicate that a vegetation map of the coastal plain based on LANDSAT-TM data will be capable of identifying important components of wildlife habitat. Says that schedule for developing a vegetation map will be expedited due to its importance for other studies. Analysis of LANDSAT-TM spectral classes using ground-truth vegetation data, photo-interpretation and topographical data will continue. Data such as surficial geology and wetlands classification may be incorporated into the analysis. When the map of the eastern refuge coastal lain is completed, the most useful methods will be used to construct maps to the west.

Raynolds, M.K. 1990. Classification of vegetation types on the ANWR coastal plain, 1990. ANWR Progress Report FY90. USFWS, Fairbanks, Alaska. 26 pp.

Documents method used during past six yeras to develop and refine a vegetation classification of the ANWR coastal plain.

Objectives Completed
(now and by October 1992, describe any problems, constraints, or limitations to the data)

- status of the LANDSAT-TM map? status for completing the

project, as it sounds like it is behind schedule? how does this affect caribou, muskox, and snow goose habitat work?

Unmet Objectives

(should include consideration of future need to meet them or constraints which make them unfeasible or no longer necessary)

- 1989 Work Plan said fiscal restraints were causing deferral of studies on snow melt and forage characteristics in concentrated and peripheral calving areas; importance of insect relief habitats and access corridors relative to development.

- 1990 Work Plan said fiscal restraints had eliminated studies on snow melt and forage characteristics in concentrated and peripheral calving areas; and importance of insect relief habitats and access corridors relative to development.

- 1991 Work Plan siad the caribou calving grounds (IIIa) study was partially completed and data form the habitat map was needed to complete it. Status?

- 1991 Work Plan said the habitat map (IIIb) was behind schedule and that the initial map was needed in winter 1990-91.

- 1991 Work Plan said that the insect relief study (IIIc) was partially met and a report was in production.

- when will the map be done, and considered accurate enough for use by other studies?? of east side? of west side?

Future Study Needs

Status and 1002 Office Recommendations, 11/90 Review

At that time, Research (McCabe) provided 1002 office with figures that $153 K was needed for FY-91 O&M costs, and $347 K was needed for field work. The map project required a total of $200 K, the snow melt, phenology, etc. in caribou calving areas needed total of $220, determining forage value by vegetation type for mitigation required $50 K and impacts of competition for key forage species during calving required $30 K. Unclear origin for the last two of those four habitat studies. 1002 office concurred with program recommendation that the habitat map was a high priority and the next phase of the map refinement was to be completed by 2/15/91.

1002 Office Recommendations, 2/92 Review

PREPARATION FOR BASELINE CONTAMINANTS
1002 PROGRAM STUDY REVIEW

Objectives of Study (1988)

- To obtain baseline information on water quality, metal levels, and nonvolatile hydrocarbon levels in aquatic environments prior to oil and gas development

- To obtain baseline information on hydrocarbon andm etal levels in a variety of biota including Daphnia, pectoral sandpipers, rock ptarmigan, vegetation (Eriophorum and Carex), and bottom dwelling fish (arctic flounder and four-horned sculpin).

Funding by Year

YEAR	1988	1989	1990	1991	1992
AMOUNT ($1,000)	$ 263.	$ 429.	$ 105.	$	*

* Note: funding for this study comes from a special contaminants fund in the Central Office.

Reports Completed (list--title, author, date) (annotate)

Aquatic contaminant baseline study on the Arctic coastal plain 1002 area, ANWR, Alaska, 1988, DRAFT. E. Snyder-Conn. USFWS, Northern Alaska Ecological Services, Fairbanks. 5/89. 20 pp.

Objectives Completed
(now and by October 1992, describe any problems, constraints, or limitations to the data)

- Field work has been completed for some time, but only one (draft) progress report has been completed to date?

Unmet Objectives
(should include consideration of future need to meet them or constraints which make them unfeasible or no longer necessary)

- 1989 and 1990 Work Plans said terrestrial study had been deferred pending analytical results of 1988 samples.

- Elaine has been working on several papers for this study, but her efforts have been currently redirected elsewhere.

Future Study Needs

Status and 1002 Office Recommendations, 11/90 Review

1002 Office Recommendations, 2/92 Review

Ia Caribou Popn

- need 1991 map of calving for 1002 GIS
- when will 1991 PCH count be available?
- status of CAH census
- status of model
- what changes for future? [100 cows, bulls?]

Ib Displacement

Completed? [interim report is basically the calving site selection paper]

Ic Predators

Future?

IIa Reproductive Performance

how much $ to we give this study?
status of RWO 30 A Ann Allye-Chin
30 B Karen Gearhart

Digestibility - Bob White
Smith - inland/coastal

IIb Infrastructure / mitigation

status of mitigation project

~~IIIa~~ Habitat

status? continuing

~~IIIb~~ Map

IIIc Insect Relief

what next? report said - basis for future studies

Study Review Schedule
February 1992

February 3	MONDAY	February 10 Frbks., Fed. Bldg. Library ---------- 9:30am Port Site 10:30am Muskox 11:30am Predators 1:30pm Seismic 2:30pm Habitat 3:30pm Open
February 4 Anch., RO, Sm. Conf. Rm. ---------- 9:45am Fish 2:00pm Water Resources	TUESDAY	February 11 Frbks., Fed. Bldg. Library ---------- 8:30am Weather 9:30am Caribou 10:30am Caribou 12:30pm NAES 1:30pm NAES 2:30pm NAES 3:30pm Wrap Up
February 5	WEDNESDAY	February 12
February 6 Anch., RO, Sm. Conf. Rm. ---------- 2:00pm Snow Goose	THURSDAY	February 13
February 7 Anch., RO, Sm. Conf. Rm. ---------- 1:00pm Polar Bear	FRIDAY	February 14

1/28/1992

Following an executive summary, more detailed descriptions of the status of each project are presented. Recommendations are those of the project leaders.

EXECUTIVE SUMMARY

Caribou Population Dynamics:

The objectives of this study (Ia) have been met for the Porcupine Caribou Herd (PCH), and population studies on the PCH can now move into a maintenance mode. For the Central Arctic Herd (CAH), the objectives of the study have also been met except that a total population count has not been obtained since 1983. Cow:calf ratios for the last two years suggest that the CAH may be growing at a slower rate than it has in the past.

Two work units were devoted to investigating how displacement of calving caribou from the 1002 area would affect the PCH. Work Unit Ib, concerning displacement and calf mortality, has essentially been completed; further intensive work may be required. Work Unit Ic, concerning displacement and predators, has provided data on general movement patterns and distribution of bears, wolves and eagles in and near the 1002 area. At its current funding level, however, this study cannot fully meet its objective of defining the precise relationship between the PCH and its predators at calving time.

Caribou Habitat:

Work Unit IIa was designed to investigate the relationship between habitat quality and population dynamics by studying maternal body condition; most of the objectives of this study are being met. Completion of a simulation model, which will predict how displacement of caribou to areas of lower habitat quality will ultimately affect the population, requires data not yet collected by the habitat quality study (IIIa). Comparison of the condition of females using coastal and inland habitats for insect relief has not occurred.

Studies started in the late 1970s to document the response of CAH caribou to oil development have been continued by this project. Satellite telemetry was used to augment data on distribution and movements collected by helicopter transects and road surveys; these data await analysis. A paper summarizing 13 years of road survey data is in progress.

An evaluation of the effectiveness of caribou mitigation measures implemented to date in the Prudhoe Bay oil fields has not yet been started; an effort to involve the Alaska Oil and Gas Association in the study is stalemated over a data sharing issue.

Habitat Quality and Distribution:

A vegetation classification system for the 1002 area has been developed. Initial studies of the vegetation and phenology in the concentrated calving area and in peripheral areas have been done and need to be repeated. Field work to quantify snow melt, biomass and nutrient relationships awaits completion of the LANDSAT-TM habitat map so that sampling can be stratified by map classes.

Progress on the LANDSAT-TM habitat map has been slowed by inadequate computer resources. Ground data to verify the map have been collected. Three studies--caribou habitat (IIa), habitat quality (IIIa) and muskoxen (IVa) are dependent upon completion of the map to meet their objectives, and delays in the completion of the map will affect these studies.

Analysis of existing data on use of insect relief habitats by the PCH has only recently begun; field work is proposed for 1991.

Muskoxen:

The muskoxen project is meeting its objectives to document the distribution, movements, habitat use and population dynamics of muskox residing on the coastal plain of ANWR (IVa and b); because the distribution of resident ANWR muskox continues to change, continued study is required. A master's project on winter habitat use funded by the FWS will be completed in spring 1991 (IVc).

The original study proposal included a work unit (IVd), not yet funded, to study the muskoxen that have dispersed from ANWR and are now living near the Prudhoe Bay oil field. This study should facilitate design of mitigation measures for muskoxen in ANWR by learning how muskoxen are responding to oil field development.

Polar Bear:

Because the 1989 and 1990 spring aerial surveys for land dens were unsuccessful, further aerial surveys are not planned at this time. The monies formerly spent to conduct the surveys (about $20 K) will most likely be used to purchase additional satellite and radio collars. A major paper on maternity denning is in progress.

Snow Goose:

This project is meeting its objectives to determine the foraging ecology and energy requirements of snow geese staging on the coastal plain; captive geese have been instrumental to this effort. Microhabitat use within riparian terrace and water track terrains is being documented. Whether the study will generate data to allow the LANDSAT-TM habitat map (IIIb) to be used to assign snow goose habitat values to particular vegetation classes is unknown. For a variety of reasons, data on the effects of aircraft disturbance on snow geese have not yet been collected. These data are likely to be collected in 1991, the last field season for this project, only if weather conditions are suitable, and concentrations and distribution of snow geese are conducive to experimental overflights. Data on the response of snow geese to aircraft are available in an earlier study conducted on the Canadian coastal plain.

Seismic Trails Recovery:

Ground data at 34 intensive study plots and 68 photo trend plots are scheduled to be collected during 1991 to document recovery of areas disturbed by the 1984 and 1985 winter seismic programs. If the plots are not revisited and remarked in 1991, the plots may never be exactly located again. Data collected in 1991 will identify those vegetation types with low recovery potential and thereby strengthen our ability to prevent impacts in future seismic programs.

Port Site Birds:

Field work was completed this summer, and the final report is scheduled for completion in September 1991. The $100 K needed to analyze data and write the report were not identified in the FY 91 budget, however, and the future of the project is uncertain until this budgeting uncertainty is resolved.

Tundra Swans:

Field work for this doctoral project on the reproductive ecology of tundra swans was completed in 1990, and further funding will not be required.

Annual Wildlife Inventories:

Currently, annual surveys of the PCH and muskoxen are conducted by the relevant studies within the Terrestrial Research Program. Snow geese surveys will now be conducted by Migratory Bird Management staff using a refuge plane and pilot. Tundra swans were surveyed most recently in 1989. Responsibility, funding and need for future tundra swan surveys is unclear.

Weather Stations:

Six weather stations are now deployed on the coastal plain, and data are available for use by 1002 projects. Thus far, the coastal fisheries and terrestrial research studies have requested data from the weather stations. Project leaders are currently being surveyed to determine their need for weather station data. Survey results will be used to determine the level at which continued deployment of the stations will occur. Continuation at the present level will require an estimated $34 K annually.

Fisheries Synthesis:

A draft report prepared under contract by the Arctic Environmental Information and Data Center was completed in 1989. Additional funds, possibly $25 K, are required to finish work on the maps, which are a critical part of the report, and to pay publication costs. The support of the Information Resources Management, Branch of Geographic Analysis is needed to complete the maps.

Inland Fisheries:

This study continues an inventory of fish distribution in 1002 area lakes, streams and rivers. In 1989-1990, this study conducted intensive survey work on the Okpilak, Akutoktak, Katakturak and Jago rivers; few fish were found. In 1991 and 1992, this study is scheduled to survey 20 lakes and 20 additional streams.

Coastal Fisheries:

This project is meeting its objectives to document the distribution, abundance and biology of fish in the lagoons and unprotected nearshore waters of the 1002 area. NOAA has been contracted for preliminary analysis of how meteorological conditions affect the physical and chemical oceanography of the study area. The project is currently starting analyses to determine how oceanographic conditions affect the distribution and abundance of fish. Three field seasons have been completed; one more is planned.

Winter Water Availability:

Field work has been completed, and final reports are completed or in preparation.

Water Resource Inventory:

Three years of gaging data on six rivers in the 1002 area have been collected; two more years are planned. If the three years for which gaging data have been collected are found to be "drought years," based on comparison with long term data collected on the Sagavanirktok and Kuparuk rivers, additional years of gaging data (beyond the two years planned) may be needed to characterize the hydrological regime of the 1002 area.

Baseline Contaminants:

This project, funded separately, is in the data analysis phase. The first of several reports expected from this project should be completed during FY 91.

Kaktovik Subsistence:

The ADF&G recently completed projects, partially funded by the FWS, on Kaktovik caribou and fish harvests. Due to the change in subsistence management in Alaska, ADF&G does not expect to have enough funding to continue its own studies of Kaktovik, where most harvest occurs on federal lands. The ADF&G recommends that the FWS begin to develop internal expertise on Kaktovik subsistence and is very interested in pursuing a cooperative study program in support of that objective.

STATUS OF THE 1002 STUDY PROJECTS

The study projects are discussed in the following order:

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TERRESTRIAL RESEARCH PROGRAM

I. Caribou Numbers, Distribution and Status.

Ia. Population Dynamics of the PCH and CAH. Steve Fancy, AFWRC, Fairbanks, and Ken Whitten and Ray Cameron, ADF&G, Fairbanks.

Porcupine Caribou Herd (PCH). For the PCH, the objectives of this study have been met. Methodology for censusing the PCH is standardized and produces counts

[1]The Terrestrial Research Program comprises the six work units described in the proposal document prepared by the Alaska Fish and Wildlife Research Center in January 1988. Although the AFWRC has primary responsibility for these studies, two work units (muskoxen and habitat quality) involve ANWR personnel, and the Terrestrial Research Program is a joint ANWR-AFWRC endeavor.

with a low margin of error (Objectives 1A and 4). Radio collaring has produced data on parturition rates, neonatal survival and mortality rates (Objectives 1C and 2B). Composition counts (sex and age) are conducted by the Canadian Wildlife Service, and data on harvest within Canada is collected (Objectives 1D and 2A).[2] A population model has been developed (Objective 1E). Satellite-collared animals have provided data on distribution and movements (Objective 3).

Studies undertaken to determine the absolute density of caribou on the core calving area and in peripheral areas (Objective 1B) produced results of limited value, and Fancy recommended that further work on this objective be reconsidered.

At this point, work on the population dynamics of the PCH can move into a maintenance mode. Ideally, we should keep radio collars on about 100 PCH caribou, including some bulls. Currently, only 60 PCH caribou, all cows, are collared.

Central Arctic Herd (CAH). Except for a total population count, the objectives of this study have been met for the CAH. The CAH has not been censused since 1983 because the portion of the herd that generally summers east of the Sagavanirktok River has mingled with PCH caribou east of the Canning River before the CAH was suitably aggregated. To overcome this problem, a plan for a stratified census of the eastern portion of the CAH has been developed and will be implemented in 1991. If the animals aggregate properly, a photocensus will be conducted as well. Recent data on parturition rates and neonatal survival (calves per 100 cows) obtained by helicopter transects suggest that the population may be growing at a slower rate than it has in the past.

Ib. Displacement and Calf Mortality (PCH). Steve Fancy, AFWRC, Fairbanks and Ken Whitten, ADF&G, Fairbanks. This study had the single objective of determining if displacement of calving caribou from the southeastern portion of the 1002 area would increase predation on calves. Calf mortality rates were studied by determining the fates of radio-collared calves and calves of radio-collared cows. In addition, necropsies of very young calves were performed. This study has documented the importance of perinatal mortality and to the overall population dynamics of the PCH. The results of this study also indicate that displacement of calving caribou from the 1002 area will most likely result in increased predation on calves.

Additional data on calf mortality relative to calving location will be collected through the PCH radio-collaring program.

Ic. Displacement and Predators (PCH). Don Young, AFWRC, Fairbanks. This study is not meeting its original objectives due primarily to insufficient funding. Using satellite and

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[2]The harvest of PCH animals in Alaska has not been quantified because the community of Arctic Village has not agreed to a harvest survey; community consent is a prerequisite to all subsistence studies.

radio-collared bears, wolves and eagles, this study was designed to determine whether displacement of caribou from the 1002 area would increase predation risk.[3] The specific objectives are to: 1) compare the relative abundance of predators within the traditional caribou calving area and peripheral areas, 2) determine the factors affecting predator abundance in these areas and how they are related to predation on calving caribou, and 3) quantify use of caribou as a prey species and its relation to predator productivity.

This study has been funded at about $65 K, which is about half the funding requested in the original study proposal. The current funding is apportioned as follows: bears, $40 K; wolves, $10 K; eagles, $15 K. This funding allows:

1) replacement of radio collars on bears and aerial surveys of radioed bears to determine distribution and movements primarily during the summer;

2) replacement of collars in known wolf packs; and,

3) one aerial survey per year of known eagle nests.

This study has gathered data on movements and distribution of radio-collared bears which they plan to relate to movements and distribution of radio-collared caribou. This analysis may detect an association between bear and caribou distributions, but without predation rate data, the analysis will not be able to determine whether the "association" is due to bears preying on caribou (i.e., cause and effect). Conceivably, bears seek out the concentrated caribou calving area for other reasons, e.g. vegetation.

At the current funding level, this study can continue to collect data about bears, wolves and eagles in and near the 1002 area, but the study will not be able to delineate the quantitative impact of predators on caribou.

II. Caribou Habitat. Steve Fancy, AFWRC, Fairbanks, and Ray Cameron and Walt Smith, ADF&G, Fairbanks.

IIa. Reproductive performance in relation to habitat. This work unit was designed to investigate the relationship between habitat quality and population dynamics by studying maternal body condition; most of the objectives of this study are being met. Data demonstrating the relationship of maternal body condition to reproductive performance have been collected (Objectives 1 and 2). Under Research Work Order 30, Dr. Bob White and Ann Allaye-Chin are producing data on seasonal body condition patterns of reproductive and non-reproductive cows, and Ray Cameron and Karen Gerhart are developing methods for routine assessment of body condition using harvested and radio-collared animals (Objective 4).

[3]Although the original study proposal called for use of satellite transmitters on all three predator species, none have been deployed on wolves or eagles. Six were deployed on bears.

Objective 3, to demonstrate how changes in habitat could affect populations through changes in maternal body condition and subsequent reproductive performance, was to be met through simulation modelling. The basic structure of the model has been developed based on previous work by Fancy and others, but data on vegetation biomass and phenology and on the digestibility of key forage species were needed as model inputs. The digestibility studies have been conducted, but the biomass and phenology studies, which are a component of the habitat quality work unit, have not yet been done (see discussion of Work Unit IIIa). This work is tentatively scheduled to begin during the 1991 field season, pending completion of the LANDSAT-TM habitat map for the eastern portion of the refuge.

Also under Objective 3, the condition of female caribou using coastal insect relief habitats was to be compared with the condition of females staying inland during periods of insect activity. Work on this aspect of caribou habitat use has not been conducted.

IIb. Response of the CAH to development and mitigation.

Responses to oil development. This study, which continues work begun in the 1970s to document the response of the CAH to oil development, is meeting its objectives. Objectives 1 and 2 of this study concern the distribution and productivity of CAH caribou in relation to oil development infrastructure. Helicopter surveys have provided data on the calving distribution of CAH caribou relative to oil development infrastructure. The road surveys have provided detailed information about caribou distribution and the frequency of road and pipeline crossings within the Kuparuk oil field; a report summarizing results from 13 years of road surveys is in preparation. Under Work Unit IIa, maternal condition and reproductive performance of CAH caribou have been studied.

Satellite collars were deployed on CAH animals to document movements in areas with roads, pipelines and other structures (west) and movements in areas with no structures (east). Deployed for three years, the collars have all been retrieved, and there are no immediate plans to deploy more collars on CAH animals. Data from the satellite telemetry project have not yet been analyzed in detail; further work on these data will require additional funding.

Mitigation. Objective 3 of this study is to evaluate the effectiveness of caribou mitigation measures implemented to date in the Prudhoe Bay oil fields. This objective has not been met. As originally envisioned, a team of state and federal biologists, consultants, petroleum engineers and economists was to review and synthesize all studies on caribou mitigation at Prudhoe Bay to develop state-of-the-art development standards. Until the past few months, little progress was made toward securing a cooperative program for this objective. In February, the AFWRC approached the Alaska Oil and Gas Association (AOGA) about funding a literature review. AOGA was interested in the project and submitted a scope of work for a contract to be let to a consultant. AOGA requested complete access to all raw data collected by FWS and ADF&G on caribou responses to oil field structures. Negotiations are currently at an impasse over this data sharing issue.

III. Distribution and Seasonal Quality of Habitat for Key Wildlife Species.

IIIa. Caribou Calving Grounds. Janet Christiansen, ANWR. This study has three objectives. The first objective is to develop a vegetation classification system for the 1002 area; this objective has been met. The third objective is to determine if the vegetation differs between the concentrated caribou calving area and potential displacement areas; this objective has been partially met. Major effort was deferred until the vegetation map is available. Initial results indicate that significant differences exist between the two areas in vegetation types and quantity and quality of some important forage species. Differences that were significant only in one year must be tested in other years to confirm them.

The second objective of this study is to quantify snow melt patterns by area and phenology, biomass, and nutrient content relationships of major caribou forage species by vegetation class. Preliminary work on nutrient content and biomass was conducted in 1988. Further field work on this objective, originally scheduled for 1990, cannot be conducted until the LANDSAT-TM habitat map (see IIIb) is completed. The map is required so that sampling for biomass etc. can be stratified by map-defined vegetation classes, since results obtained at study sites will be extrapolated to the whole area using the map.

IIIb. Habitat Map. Janet Christiansen, ANWR, and Dave Douglas, AFWRC, Anchorage. The objective of this study is to produce and develop a digital vegetation map of the ANWR coastal plain using LANDSAT-TM (Thematic Mapper) satellite imagery, existing geobotanical classifications, ground data and aerial photographs that will meet the needs of caribou, muskox and snow goose research and management. This project is being conducted jointly by ANWR and the AFWRC. Dave Douglas of the AFWRC is responsible for the work involving the LANDSAT-TM imagery, and ANWR botanist Janet Christiansen is responsible for the ground data needed to verify the map. Currently, work is focused on a map of the eastern portion of the refuge from the Sadlerochit River to the Canadian border. Once this map is completed, work on a map of the western portion of the coastal plain can commence.

Although considerable progress has been made, the completion of this project has been significantly hampered by a lack of the appropriate computer hardware and software for analyzing the LANDSAT-TM data, and because of a lack of uninterrupted time to work on the map. These two factors are synergistic: if the needed computer resources were available, work on the habitat map could be more easily integrated with other duties. Planned acquisitions of computer equipment by the AFWRC may provide some relief. Alternatively, a request for use of the IRM Sun Sparcstation may be made. Unless the computer situation improves soon, the likelihood that the map will be completed in time to be used as the basis for 1991 field studies is low.

Ground data to develop the map of the eastern portion of the coastal plain were collected in 1989, and ground data to verify the western portion were collected in 1990. Systematic sampling of vegetation types was also conducted in both years to provide estimates of vegetation type distributions and a separate data set to be used to check the accuracy of the completed map.

Completion of the habitat map is required to satisfy objectives of two work units related to caribou and one work unit related to muskoxen. Objective 2 of Work Unit IIIa (caribou calving area) involves quantification of snow melt patterns, phenology, biomass and nutrient content relationships by vegetation class. The habitat map is needed to allow sampling of these variables by map class. These data will then be used in the simulation modelling of the relationship between habitat availability and quality and maternal body condition which is part of Work Unit IIa, Objective 3. The muskox study requires the habitat map to meet Objective 1 of Work Unit IVa concerning comparison of winter and summer habitat use. Thus, a delay in completion of the habitat map will affect the ability of these other studies to meet their objectives in a timely manner.

IIIc. Insect Relief (PCH). Steve Fancy, AFWRC, Fairbanks. The objective of this study is to delineate the insect relief habitats and access corridors used by PCH caribou by 1) using GIS to analyze movement data from satellite-collared animals and 2) field studies during the insect period (June 25 to July 10) to document caribou behavior. Until recently, no work had been done on this project. Noreen Walsh has been hired to work on this project, and she is analyzing existing data on use of insect relief habitats by PCH caribou. The field work portion of this project is proposed to occur during the 1991 field season. Whether funds are available for this work is not clear.

Under Research Work Order 32, Ray Cameron and Michael Smith are comparing the quality and quantity of forage in coastal and inland habitats used by CAH caribou during the summer mosquito season.

IV. Muskoxen. Pat Reynolds, ANWR.

IVa. Winter Distribution, Movements and Habitat Use. Satellite-collared and radio-collared muskox are being used to document the seasonal distribution, movements, activity patterns and habitat use of muskox on the ANWR coastal plain. Data collection on the distribution, movements and activity patterns is proceeding as planned; continued study is required as distribution patterns of muskoxen on the ANWR coastal plain continue to change. The habitat map (Work Unit IIIb) is required to complete the objective of defining habitat use and comparing winter and summer habitat use.

IVb. Population Dynamics. The objectives of this study are being met. The size, composition, productivity and dispersal rates of the ANWR muskox population are being documented. Population surveys should be continued to determine status and trend changes.

IVc. Winter Habitat Use. The objective of this study is to assess winter habitat use by muskoxen on the ANWR coastal plain. Work on this study is being conducted by UAF master's student Ken Wilson. Field work has been completed, and he is now analyzing data. His thesis should be completed in 1991.

IVd. Dispersal towards Prudhoe Bay. The objective of this study is to determine seasonal movements, distribution, activity patterns and habitat use of muskoxen that have dispersed from ANWR and are now living near the Prudhoe Bay oil fields. This study was proposed to

facilitate design of mitigation measures for muskoxen in ANWR by learning how muskoxen are responding to oil field development. Currently, over 100 muskox in mixed-sex groups are living between the Kavik and Sagavanirktok rivers, and some groups have been seen in the immediate vicinity of the Trans-Alaska Pipeline and Pump Station 2. Most of the data needed to meet the objectives of this study would be collected by deploying satellite collars. Winter habitat use would be studied using methods similar to those used in Work Unit IVc.[4] Funds have never been allocated for this study, thus the objectives of this study are not being met.

V. Polar Bear. Steve Amstrup, AFWRC, Anchorage. The majority of the work on the Beaufort Sea polar bear population is funded by Marine Mammal Protection Act funds. Currently, the 1002 program contributes $27.6 K annually from Refuges and Wildlife (1261) to this study which has a total budget of about $225 K. The total study includes work units on the population dynamics (Va) and feeding ecology (Vb) of Beaufort Sea polar bears. These work units have relevance for 1002 although they address much broader questions. Work Unit Vc is the most specific to 1002; the objective of this study is to assess the reproductive significance of maternity denning on land.

The most recent information generated by this project is presented in a report entitled: "Polar Bear Research in the Beaufort Sea, Operations Report: Spring 1990." This report includes a detailed account of the winter 1988-89 incident involving a seismic program which passed near two polar bear dens (one with a collared bear) on Flaxman Island. Amstrup will be spending the winter writing a paper on maternity denning. The paper will include discussion of this incident.

Amstrup does not currently plan to conduct a spring aerial survey for land dens in 1991. These surveys were initiated in 1988 to augment data on dens obtained by satellite and radio telemetry. The first survey, although hampered somewhat by weather, was considered successful. In contrast, the last two surveys were unsuccessful with no dens being found. In 1989, a warm year, the polar bears emerged prior to the time that the survey was scheduled, and the survey could not be rescheduled because no planes were available. In 1990, the survey was timed properly, but no dens were found. Amstrup has therefore concluded that the $20 K or so that the aerial survey typically costs would probably be better spent on additional satellite and radio collars.

VI. Snow Goose. Jerry Huppe, AFWRC, Migratory Bird Branch, Anchorage. The original study proposal for snow geese included work units addressing numbers of geese using the refuge (VIa), habitat and energetics (VIb), and the effects of aircraft disturbance (VIc). Work on the numbers of geese (i.e. surveys) was delegated to the refuge which had been conducting the surveys for years (see discussion under Refuge Studies, Annual Wildlife Inventories). The current objective of this study is an energetics model that will integrate the results from the habitat and energetics studies (VIb) with results from studies of the effects of aircraft disturbance (VIc). The model will describe the impact of aircraft disturbance in terms of changes in the proportion of individuals in the population that have lipid reserves below a minimum necessary for migration.

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[4]Some data on winter habitat use by muskoxen living near Prudhoe Bay are being collected now by a UAF graduate student.

VIb. Habitat, Food and Energy Requirements. The purpose of this work unit is to determine the habitat, food and energy requirements of staging geese and the availability and distribution of food and habitat resources on the coastal plain.

The objectives of this work unit relative to foods and energy requirements are being met. Because the period when geese are on the refuge is so short (2 to 3 weeks), captive geese are being used to accomplish much of the work relative to these objectives. Captive geese are being used in field trials and in the lab to study forage selection relative to forage availability, rate of forage intake in different habitats, and metabolic rates. Wild geese are being observed to determine time and activity budgets, habitat use, and feeding site characteristics. This study is also examining the energy value of primary foods and the effect of snow goose foraging on the subsequent productivity of sites where foraging has occurred.

Relative to overall habitat use, the study began in 1988 by analyzing the distribution of snow geese on the coastal plain, based on 1982-1987 aerial survey data, relative to broad physiographic features. In 1989, this study conducted a preliminary assessment of the potential of LANDSAT-TM imagery and National Wetlands Inventory (NWI) classifications for distinguishing snow goose feeding habitat. Both classifications were found to have the potential for assessing the distribution and availability of feeding areas across the coastal plain. However, the study concluded that more data on snow goose feeding sites was needed to further define the criteria that would be used to distinguish potential feeding areas from areas that are unlikely to be used for feeding.

The study is currently addressing microhabitat use within two terrain types: riparian terrace and water track tundra. Whether the study will generate data that will allow the habitat map being developed in Work Unit IIIb to be used to assign snow goose habitat values to particular vegetation classes will depend on the level of resolution possible with the LANDSAT-TM map.

VIc. Effects of Aircraft Disturbance. The original study plan proposed to study the effects of aircraft disturbance on snow geese activity patterns and habitat use. In 1988, this study attempted to capture geese using rocket nets to put activity transmitters on them. Data from the transmitters would have been used to assess the response of geese to aircraft. Rocket netting failed to capture any geese, so this approach was abandoned. Experimental flights over geese flocks were planned but were not conducted due to poor weather and low numbers of geese. Following the 1988 field season, it was decided to postpone further work on this objective until 1990. The 1990 study plan included work to determine the length of time that feeding of wild flocks was disrupted by a Bell 206B helicopter, but the work was not executed due to an unusually low number of snow geese on the refuge.

The aircraft disturbance objective is not being met for a variety of reasons. Relatively few geese have staged on the ANWR coastal plain during the past three years, and poor September weather has effectively precluded experimental flights. Work on this objective has been deferred also because work on habitat, foods and energetics was given a higher priority and because a better understanding of habitat use was desired to properly design the disturbance treatments. Whether data on aircraft disturbance will be collected during the

1991 field season, which is the last field season for this project, will depend on the numbers and distribution of snow geese on the refuge. A study of the effects of aircraft disturbance on staging snow geese on the Canadian coastal plain was conducted in the 1970s and provides much information relevant to ANWR.

REFUGE STUDIES

Seismic Trails Recovery. Cathy Curby, ANWR. The objective of this study is to document the recovery of coastal plain habitats following different levels of disturbance during the winter seismic programs of 1984 and 1985. This study has produced papers documenting the immediate effects of the seismic trails on tundra vegetation and on the role of snow cover in limiting disturbance. The work proposed for 1991 will provide data on how well various species and vegetation types have recovered to date; such data for the arctic tundra currently do not exist. Combined with our knowledge of the sensitivity of vegetation types to disturbance by various types of vehicles (produced by the study thus far), knowledge of recovery times will strengthen our ability to decrease impacts in future seismic programs by allowing us to control the amount and type of traffic in areas with both high sensitivity and low recovery potential.

The original seismic trail study plan proposed that field data on recovery be collected every three years, and 1991 is the next scheduled field season. The 34 intensive study plots and 68 photo trend plots established at the beginning of the study will be revisited. The field work is expected to cost about $150 K.

The plots required careful navigation to locate when last visited, and if they are not revisited and remarked in 1991, the plots will be nearly impossible to find in the future. Thus, a decision to defer this field work may foreclose our ability to document recovery using these study plots.

This study has relied on two methods of assessing disturbance to vegetation: the intensive and photo trend plots (discussed above) and air photo interpretation. The air photo work, originally proposed to occur every 5 years, was to allow assessment of the impacts and recovery of seismic trails over a wide variety of sites across the coastal plain. Air photo interpretation is expensive, and, based on the air photo work conducted in 1988, was found to have a low accuracy. Thus, further air photo work, next scheduled for 1993, is not recommended.[5] Instead, ground visits to randomly selected sites used in previous years in the photo-interpretation accuracy assessments are proposed to determine disturbance levels in 1993.

Port Site Birds. Mark Willms, ANWR. Field work was completed during the summer of 1990, and data analysis and report writing are underway. The final report is scheduled for completion by September 30, 1991.

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[5]See "Accuracy assessment of airphoto interpretation of disturbance levels of winter seismic trails, Arctic National Wildlife Refuge, 1989" by Martha K. Raynolds, Janet Christiansen and Catherine Curby, ANWR Progress Report FY 89, dated April 4, 1990, 11 pp.

The port site study includes analysis of some 2,500 samples of marine invertebrates. When analysis of the samples began last summer, the work went very slowly, and it appeared that the samples might take an additional year to analyze (see July 24, 1990 memo from Acting Refuge Manager Don Voros to ARD/RW analyzing options). With experience, the lab work has speeded up, and based on the current rate at which the invertebrate samples are being analyzed, the lab work should be completed late next spring, possibly by May 1. Thus, the invertebrate data should be available for inclusion in the final report next fall.

Due to an apparent oversight, the funding needed for data analysis and report writing for this project was not included in the FY 91 budget for the refuge. The total cost to complete the project is estimated to be $105 K. Until this budgeting shortfall is addressed, the future of this project is in unclear.

Tundra Swans. Matthew Monda, University of Idaho. The refuge has funded a doctoral project on the reproductive ecology of tundra swans (Research Work Order 12). The field work for this project was completed in 1990, and no further funding from the refuge will be required.

Annual Wildlife Inventories. The refuge conducts annual wildlife inventories for muskoxen, PCH caribou, snow geese and tundra swans as part of their annual work plan. Surveys of muskoxen and caribou have been conducted recently as part of the relevant studies within the "Terrestrial Research Program." Snow goose and tundra swan surveys have been conducted by refuge biologist Alan Brackney. His position was transferred this summer to the Fairbanks Migratory Bird Management (MBM) office with the understanding that he would continue to conduct the annual snow goose survey using a refuge plane and pilot. No similar agreement was made to cover tundra swan surveys, and plans for future tundra swan surveys are unclear. The most recent tundra swan survey was conducted in 1989. Until specific development proposals are made, surveys could be conducted on a biennial or triennial basis.

Weather Stations. Cathy Curby, ANWR. The refuge has set up six weather stations: one at Barter Island and five at various locations on the coastal plain. 1989 was the first year that the stations were operational. The computerized stations collect data on barometric pressure, relative humidity, temperature, wind speed and direction and solar radiation. At Barter Island, two Wyoming precipitation gauges have also been set up; otherwise, the stations do not collect precipitation data.[6] Snow transects will be conducted at all the weather station sites during planned late winter-early spring maintenance visits.

Annual maintenance costs for the stations are estimated to be on the order of $34 K, primarily for replacement parts and helicopter time. The refuge plans four visits to each station per year: two in spring to assess and make any repairs following the winter and two in late summer-early fall to assess and make any repairs before the winter. Except for the first spring trip, which will require a special helicopter charter, the trips will be made using the summer helicopter charter.

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[6]Quantification of precipitation on the coastal plain is problematic due to wind and the low level of precipitation; methods are unknown.

Thus far, only two 1002 research projects have requested data from the weather stations: the coastal fisheries project (which has also maintained two additional meteorological stations on the coast during the summer) and the caribou insect relief habitat project (Noreen Walsh). Many project leaders may be unaware that the weather data are now available; Curby has just completed a survey of 1002 project leaders to determine whether the weather stations are providing the data they need. Given the high costs of maintaining the weather stations, such a survey is necessary to determine the future of the weather station program.

ENHANCEMENT STUDIES

Fisheries Synthesis. Randy Bailey, Fisheries Management Services, Anchorage. The objective of this project is to synthesize information known through 1988 about freshwater and marine fish using the 1002 area. The majority of the work on this project was done by AEIDC under a contract completed in 1989. A draft report, which includes a literature review and maps showing fish distributions, has been completed. Before the report can be published, however, some additional work on the maps is required. Funding for completing the maps and publishing the report, estimated to cost about $25 K, has not been identified. The support of Information Resources, Branch of Geographic Analysis is needed to complete the maps.

Inland Fisheries. David Wiswar, Fisheries Assistance Office, Fairbanks. The objective of this study is to determine the distribution and biological characteristics of fish in 1002 area waterbodies. Fish will be surveyed using minnow traps and electroshocking, and biological data (i.e., length, weight, age, etc.) will be collected from the fishes caught. This study, which commenced in 1989, is expected to provide critical data on migration corridors of arctic fishes necessary for mitigation planning.

In 1989 and 1990, data were collected on fish in the Okpilak, Akutoktak, Katakturak and Jago rivers. A large number of sites were visited on each river, and the sites were surveyed in early, mid and late summer to detect seasonal changes in distribution within these river systems.

In 1991 and 1992, twenty additional streams and rivers will be visited: 13 streams which have never been surveyed for fish, and 7 streams that have been visited previously and were found to contain few if any fish. As in 1990, several sites will be surveyed on each river, and each site will be visited in early, mid and late summer. Twenty lakes with depths greater than 2 meters and where Water Resources personnel have observed fish will also be sampled.

Coastal Fisheries. Doug Palmer, Tevis Underwood and Judy Gordon, Fisheries Assistance Office, Fairbanks. The objectives of this study are to: 1) document the relative abundance, distribution and movements of fishes in the lagoons and unprotected nearshore waters of the 1002 area, 2) collect biological data (i.e., length, weight, age, etc.) from two anadromous species and three marine species, 3) determine the relationships between meteorological and oceanographic conditions, and 4) determine how oceanographic conditions affect the distribution and abundance of fish. 1990 marked the completion of the third field season for this project; one more field season is planned.

This study currently collects data in Camden Bay, Kaktovik Lagoon, Jago Lagoon and Beaufort Lagoon. Originally, the area offshore of Pokok Bluffs, a potential port site, was included in the study plan. Due to heavy ice conditions there in 1988, this study site was eliminated. As an alternative, Pokok Bay was studied in 1988; Beaufort Lagoon was added as a permanent replacement in 1989.

This study is primarily using fyke nets to sample fish. Gill nets deployed from a skiff are also used to sample offshore at the Camden Bay site, however, high winds often preclude their use. A larger boat would be needed to support regular sampling of fishes using waters a kilometer or more from shore.

This study is meeting its objectives to document the distribution, abundance and biological characteristics of fish in coastal waters (Objectives 1 and 2). To meet Objective 3, the study has contracted with NOAA. NOAA is responsible for preliminary analysis of the meteorological and oceanographic data; they have prepared a report on data collected during the 1988 field season. Work on Objective 4, integrating the oceanographic and meteorological data with the fish data, is just beginning. The Fairbanks Fisheries Assistance Office would like to hire a fisheries oceanographer to fill the vacated principal investigator position.

Winter Water Availability. Steve Lyons, Water Resources Branch, Anchorage. The objective of this study is to determine the location and quantity of water in 1002 area lakes and streams during both winter and summer.

Fish surveys of the Tamayariak, Jago and Katakturak rivers were included as part of this study in 1988 and 1989. In 1990, the fish survey work was transferred to the Fairbanks Fisheries Assistance Office and became the inland fisheries project described above.

This project has completed its work on winter water in lakes and streams, and final reports have been or are being prepared. Summer lake surveys were completed in 1990, and a report is in preparation. No additional field work is planned.

Water Resource Inventory. Steve Lyons, Water Resources Branch, Anchorage. To characterize the hydrological regime of the 1002 area, this study has operated gaging stations on six rivers: Tamayariak, Akutoktak, Itkilyariak, Sadlerochit, Niguanak and Sikrelurak. The gaging stations have been operated for three seasons now; two more seasons are currently planned. Flows appear to have been low during the last three years, however, and Lyons is currently comparing flow data for the ANWR streams to flow data for the Sagavanirktok and Kuparuk rivers, which are the closest gaged streams. USGS has operated gages on these streams since the 1970s. If the past three years were "drought" years for the Sagavanirktok and Kuparuk rivers, additional years of gaging data may be needed from the 1002 streams to document the full range of hydrologic conditions in the 1002 area.

The hydrologic data collected by this project will allow the FWS to quantify and assert Federal reserved water rights using the Tennant method; the data will not support an application using more rigorous methods. To apply for water rights for the lakes, precise elevations must be taken. This work, which must be conducted by licensed surveyors, can probably be contracted to the BLM, Cadastral Survey. The field work could probably be completed in a couple of weeks.

Baseline Contaminants. Elaine Snyder-Conn, Northern Alaska Ecological Services, Fairbanks. This study of baseline water quality and contaminant levels, which receives its funding from the Environmental Contaminants Division in Washington D.C., is proceeding on schedule. The field work and sample collection phase is complete, and catalogs for most of the chemical analyses have been returned. Snyder-Conn expects most of the sample data to be keypunched by the end of FY 90, and she will begin data analysis in FY 91. Through ANWR, Snyder-Conn has hired a Statistical Assistant (GS-7) to assist in data analysis, and the only funds requested for this project are to fund this Statistical Assistant position.

By the end of FY 91, Snyder-Conn expects to complete reports on water quality and contaminant levels in birds and lake sediments. Reports on contaminants in Daphnia, Carex aquatilis, and lagoons (which includes fish and sediments) will be completed in the following year.

Kaktovik Subsistence. Sverre Pederson and Terry Haynes, ADF&G, Fairbanks. In 1988, the FWS contracted with the ADF&G for a Kaktovik subsistence study. The ADF&G has completed two reports:

1) Caribou Hunting: Land Use Dimensions, Harvest Level, and Selected Aspects of the Hunt During Regulatory Year 1987-1988 in Kaktovik, Alaska. [This report will be published as Division of Subsistence Technical Paper No. 172 later this year.]

2) Assessment of the 1988-89 Kaktovik Subsistence Fishery.

With the completion of these reports, the initial contract, which was for $10 K, is satisfied.

A second contract for $19.8 K to continue study of Kaktovik subsistence fisheries and caribou harvest was proposed for 1990 but was apparently never finalized. The fisheries project which would have occurred in 1990 was part of a proposed five-year cooperative study. The goals of this project were to:

1) develop a collaborative working relationship on subsistence fishery research between ADF&G, FWS and the community of Kaktovik;

2) refine current subsistence harvest data collection measures used in Kaktovik by employing strategies involving and acceptable to the community; and,

3) link biological and subsistence fishery research efforts so that a database is developed which assesses the potential effects of industrial development on ANWR fishery stocks.

Currently, the ADF&G is continuing to monitor the fall caribou harvest. Due to the recent change in subsistence management on federal lands, the ADF&G will not have enough funds to be the sole support of additional studies of Kaktovik subsistence activities, which occur primarily on federal lands. The ADF&G remains interested in Kaktovik subsistence and will assist the FWS however they can. The ADF&G suggests that collaborative studies, such as the one proposed for fisheries, be

initiated. In this way, FWS personnel will begin to develop the relationships with Kaktovik residents which are a necessary prerequisite for subsistence studies.

SUMMARY OF QUESTIONS FROM 1991 CONGRESSIONALS, ETC. WHICH RELATE TO THE 1002 STUDY PROGRAM:

[question/topic, [date of question]
(source, date of answer, Archive document #)

Briefing paper prepared on Arctic NWR leasing:
-- Who has major control over leasing on Arctic NWR?
-- KIC lands within Arctic NWR
-- Revenues
-- What type of costs are charged/reimbursable for administering an oil and gas leasing program?
(Service Budget Office, 2/8 and 19/91, 91.007 and 91.015)

Briefing paper on Preliminary summary of the status of Northwestern Canadian oil and gas activities and sources for such information
(1/23/91, 91.016)

Briefing paper on U.S. Geological Survey/FWS interactions
(2/19/91, 91.017)

Arctic NWR Briefing Notebook
(Fax from Legislative Services, 2/20/91, 91.010)

Briefing book (also catalogued here by specific issue/question)
(Pre-hearing briefings, 4/25/91, 91.097)

POLAR BEAR

How much more productive are polar bear dens on land than are polar bear dens on ice?
(Turner followup questions, early 3/91, 91.012)

Update (since 1002(h) report) of current studies and findings regarding polar bear denning and the importance of the Arctic Refuge coastal plain for the Beaufort Sea polar bear population.
(Informal Q's from MMF, 4/7/91, 91.013)

Polar bear denning protective measures/stipulations: discussion of delineating measures that are specific to certain areas/zones as opposed to generic measures (e.g., development of marine facilitites must avoid polar bear denning, as identified by the Service, and seasonal restrictions will apply).
(Informal Q's from MMF, 4/7/91, 91.013)

Updated analysis of polar bear denning activities on the coastal plain for 1988-90 and most current estimates of polar bear population size. [3/25/91]
(Questions from HMM&F Comm. to Secretary, 4/5/91, 91.027)

Do male polar bears den?
(Followup to Questions originally due 3/13/91, 91.031)

How many dens have been found since 1986?
(Followup to Questions originally due 3/13/91, 91.031)

How many bears are collared?
(Followup to Questions originally due 3/13/91, 91.031)

Polar bear population size and status, dens on the 1002 area
(Pre-hearing briefings, 4/25/91, 91.097)

Polar bear population size and status, dens on the 1002 area, and denning distribution (update of 91.097, above)
(Prepared for Roger Herrera, BP, 7/12/91, 91.124)

How many polar bears den on the 1002 area each year? What relationship does this bear to the overall polar bear population in that part of the world (Beaufort Sea population)
(Anticipated questions, HMM&F hearing 5/1/91, 91.100

Polar bear population/use of Prudhoe Bay compared to 1002 area
(Sen. Stevens office, 7/9/91, 91.121)

Number of male/females in Beaufort Sea population? how many females den each year? estimated number of denning females on coastal plain each year? do logistical constraints still preclude surveying for a meaningful population estimate? update on polar bear dens, 1988-91? timing on denning? [10/23/91]
(HMM&F questions, 11/5/91, 91.126)

Harvest information; FWS comments on lease sales; efforts to develop polar bear conservation plan; essential habitat; preparation of polar bear interaction plans and regulations and monitoring; development of incidental take regulations.
(HMM&F questions, 10/28/91, 91.126)

Effects of oil and gas development on polar bears and possible mitigation, identification of important denning areas [9/17/91]
(Letter from Marine Mammal Commission, 10/17/91, 91.127)

Letter to Murkowski re news articles on potential impacts to polar bears from 1002 development
(10/17/91, 91.128)

CARIBOU

Discuss the differences in calf mortality rates between years when the Porcupine caribou herd calved on the 1002 area and years when the herd calved south or east of the 1002 area.
(Turner followup questions, early 3/91, 91.012)

Updated maps of the PCH concentrated calving area
(Informal Q's from MMF, 4/7/91, 91.013)

Based on the additional years of data since the 1002(h) report, describe a core calving area (in terms of acres)
(Informal Q's from MMF, 4/7/91, 91.013)

Updated analysis of calving and migration patterns for PCH, 1988-90, and current herd population estimate. [3/25/91]
(Questions from HMM&F Comm. to Secretary, 4/5/91, 91.027)

How does the size of the PCH compare with other caribou herds, worldwide and in Alaska.
(Followup to Questions originally due 3/13/91, 91.031)

PCH: herd size and status, concentrated calving area, migration and wintering, insect relief/free passage, calf mortality, prediction of impacts, protective management zone (H.R. 1320)
(Pre-hearing briefings, 4/25/91, 91.097)

Analysis of protective management zone relative to data on concentrated calving areas
(Thorson question to KO, 4/25/91, 91.098)

Jones bill calls for protecting specific areas for caribou calving and insect relief. Is there a specific "Insect Relief Area" that corresponds to the frequently used calving areas?
(Anticipated questions, HMM&F hearing 5/1/91, 91.100

This past summer population counts of caribou in Prudhoe Bay area found that their numbers had decreased
(Responses to Alaska Coalition 3/12/91 testimony to Senate Energy Comm. on S. 341, Title IX, 5/1/91, 91.101)

Number of caribou in concentrated calving areas
(Anticipated questions for S. Environment hearing, 5/10/91, 91.105)

"Special caribou insect relief coastal protective zone" to be created by HR 1320, do current data support establishment of this zone?
(Briefing paper, 4/12/91, 91.109)

PCH calving distribution report by BP and critique by ADF&G
(analysis for RD, 5/6/91, 91.116)

Calving update for PCH
(pre-hearing update for RD, 6/7/91, 91.119)

Where did caribou calve in 1991? where did they calve in concentration? how many calved in the 1002 area in 1991? status of radio-collared cows as of 6/9/91; what is normal parturition rate of PCH cows? what were snow conditions at Jago Bitty and the rest of the coastal plain? is there difference in forage quality between Jago Bitty area and Marsh Creek area? how many satellite collars are there?
(Info for RD prior to HMM&F hearing, 6/10/91, 91.120)

Canadian Wildlife Service commented on Turner's HMM&F testimony and expressed concerns (because of biological findings relative to 1002 development) over potential displacement of calving PCH caribou, problems to caribou in crossing oil-field facilities, and subsistence (6/18/91)
(Turner responded 8/14/91, 91.122)

1991 photocencus of PCH and CAH? new info on apparent decrease in CAH reproductive rate? location of 1991 calving concentration area? subsistence harvest for Gwich'in villages? synchrony of North Slope caribou herd populations?
(Questions from Randy Bowman, LS, 10/31/91, 91.129)

CAH
(Pre-hearing briefings, 4/25/91, 91.097)

Discuss the decreased productivity of Central Arctic herd caribou calving in the vicinity of oil development.
(Turner followup questions, early 3/91, 91.012)

Population estimate for CAH; Herrera statement that unusually severe winter of '89 caused/precipitated herd's low reproductive rate; difference in reproductive rate between Kuparuk and Bullen Point calving groups
(Pre-hearing questions, 4/26/91, 91.107)

Review of CAH reproductive information 1987-91
(HMM&F questions, 11/18/91, 91.126)

U.S. appointment of members to International PCH Board
(HMM&F questions, 10/31/91, 91.126)

MUSKOX

What is the present population of muskox?
(Followup to Questions originally due 3/13/91, 91.031)

Muskox
(Pre-hearing briefings, 4/25/91, 91.097)

Muskox population update
(pre-hearing update for RD, 6/7/91, 91.119)

Muskox population and use of Prudhoe Bay as compared to 1002 area
(Sen. Stevens office, 7/9/91, 91.121)

PREDATORS

What is current population of predators, in particular wolves and bears, in Prudhoe area? Has the number of predators in the Prudhoe area decreased since oil and gas development of the area began, and what effect, if any, has this had on the increase in the Central Arctic caribou herd?
(Questions from Studds, HMM&F, 5/28/91, 91.114)

Wolf population and use of Prudhoe Bay as compared to 1002 area
(Sen. Stevens office, 7/9/91, 91.121)

BIRDS

Snow goose
(Pre-hearing briefings, 4/25/91, 91.097)

Draft 1988 FWS report found destruction of habitat led to mortality and displacement of over 15,000 birds
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Oilfield activities have disturbed the only snow goose nesting colony in the U.S.
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Brant and snow goose populations and use of Prudhoe Bay area as compared to 1002 area
(Sen. Stevens office, 7/9/91, 91.121)

FISH

Fishery resources
(Pre-hearing briefings, 4/25/91, 91.097)

Intake from just one seawater treatment plant annually kills up to 400,000 larval fish
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

WETLANDS

Wetlands
(Informal Q's from MMF, 4/7/91, 91.013)

How would you minimize the loss of wetlands due to development in ANWR?
(Senator Wallop questions for John Turner, 3/28/91, 91.018)

How would Department minimize loss of wetlands due to ANWR development?
(questions for Schroth confirmation, 6/4/91, 91.117)

Wetlands and riparian areas
(Pre-hearing briefings, 4/25/91, 91.097)

State classified "widely scattered wetlands" on North Slope as "impaired" due to oil and gas activities
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

How can wetland losses be mitigated? What types of compensation could be done in the 1002 area: What about mitigation "banking"? How will we achieve the goal of "no net loss of wetlands" on the 1002 area?
(Pre-hearing questions, 4/26/91, 91.107)

CAUSEWAYS

Causeways
(Informal Q's from MMF, 4/7/91, 91.013)

Causeways have resulted in unacceptable impacts to fisheries habitats
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

What is Service position on causeways
(Pre-hearing questions, 4/26/91, 91.114)

HABITAT

Vegetation and footprint, vegetative recovery from 1984-85 seismic program, vegetative recovery at KIC well site, water resources
(Pre-hearing briefings, 4/25/91, 91.097)

Oil industry's "Footprint" on the Coastal Plain
(Responses to Alaska Coalition 3/12/91 testimony to Senate Energy Comm. on S. 341, Title IX, 5/1/91, 91.101)

Representative of the Alaska Coalition and the Audubon Society testified that environmental damage and/or loss of habitat would occur should development take place within the 1002 area of ANWR. Please provide the Committee with your response to their concerns.
(Senator Wallop questions for John Turner, 3/28/91, 91.018)

Expressed concerns about the ability to conduct restoration on the coastal plain. [4/3/91]
(Letter from Senator Jeffords to Secretary Lujan, 4/23/91, 91.021)

Pads, roads, pipelines and gravel mines have caused direct loss of over 11,000 acres of habitat at Prudhoe
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Thousands of additional acres lost due to indirect impacts
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Total area impacts at ANWR by development could exceed Prudhoe Bay
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

KIC well not revegetating well - only 6% of well site had vegetation last year - and revegetation efforts on thick gravel pads generally has been largely unsuccessful
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Vegetative recovery at KIC well site
(Info. for RD in prep for HMMF 5/1/91 hearing, 91.102)

Why has KIC well site not revegetated while reserve pit has? Were the two areas treated differently?
(Pre-hearing questions, 4/26/91, 91.107)

Did FWS ask for no revegetation or a different method of revegetation of the pad to have a "control" area?
(Pre-hearing questions, 4/26/91, 91.107)

Water quality/air quality standards [4/7/91]
(Informal Q's from MMF, 91.013)

AIR POLLUTION

FWS expressed concern about impacts of acidifying air pollutino of lichens
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Oil industry continues to emit "black smoke" in violation of state rules for smokeless flares
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

Impacts of air pollutants emitted by oil industry on sensitive arctic tundra not well studied and largely unknown
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

SOLID/LIQUID WASTE POLLUTION

Massive amount of waste - 3,000 cubic yards of drilling waste, 40 million gallons of produced waters, 40,000 gallons of liquid oily waste, and 300 cubic yards of oil contaminated solid waste/sludge are generated daily; produced waters disposed of via subsurface injection "without benefits of safeguards imposesd on hazardous waste injection"; injection of wastes in ANWR would be a problem due to thinner permafrost and faulted geology - no guarantee wastes would stay where injected
(Charges in NRDC, "Tracking Arctic Oil", 4/30/91, 91.099)

ENDANGERED SPECIES

The current petition to list the Spectacled Eider and Steller's Eider as endangered
(Informal Q's from MMF, 4/7/91, 91.013)

Petition to list eiders as endangered, status of eiders in 1002 area, effect of listing the eiders on implementation of an oil and gas leasing program for the 1002 area. [4/7/91]
(HMMF questions, 91.013)

MISC

Given the experience at Prudhoe Bay, your experience within Wyoming, and what I consider the insignificant amount of land impacted by exploration and development of ANWR, (.0007 of the area of the Refuge), can we produce oil from ANWR without an

impact to wildlife and the resources?
(Senator Wallop questions for John Turner, 3/28/91, 91.018)

In order to provide a level of environmental protection that you would feel comfortable with, is there anything in the Johnston/Wallop proposal that you would change? Would you please provide the Committee with the rationale on why the changes would be necessary?
(Senator Wallop questions for John Turner, 3/28/91, 91.018)

Is there anything in the Endangered Species Act or any other act that is the purview of the Fish and Wildlife Service which would cause you to take issue with any provision in the Johnston/Wallop proposal as it affects ANWR? If so, please explain.
(Senator Wallop questions for John Turner, 3/28/91, 91.018)

Please provide a list of other wildlife refuges where oil and gas development has taken place.
(Senator Wallop questions for John Turner, 3/28/91, 91.018)

Several environmental groups recently released a report, entitled, "Tracking Arctic Oil", which claims various adverse impacts from the existing North Slope oil fields. Much of their claims for impacts to wildlife seem to rest on 1987 draft FWS report which assessed predicted versus actual impacts of Prudhoe Bay development. Were conclusions in that draft report with respect to bird deaths or displacement scientifically verifiable? Was the report made available to Congress?
(Anticipated questions, HMM&F hearing 5/1/91, 91.100)

What have we learned since 1002 report
(Pre-hearing questions, 4/26/91, 91.115)

How would Department manage oil and gas leasing relative to respective roles/responsibilities of FWS and BLM?
(Questions for Schroth confirmation, 6/4/91, 91.117)

ANWR "Outreach" piece drafted by Department glossed over potential environmental impacts from 1002 development, particularly to the PCH, and piece asserts that development will not perceptibly impact global warming
(R7 commented on bias of piece and tried to correct it, 7/9/91, CCU, 91.3049)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. TUDOR RD.
ANCHORAGE, ALASKA 99503

IN REPLY REFER TO

JAN 28 1992

Memorandum

To: 1002 Study Program Investigators (Distribution List)

From: Associate Regional Director Ann Rappoport for Robyn Thorson

Subject: Schedule for Review of the 1002 Study Program

This is to follow up on my December 19, 1991, memorandum describing the evaluation of the 1002 study program and assessment of future 1002 study needs being undertaken by the 1002 Project Office. Through conversations with you or your supervisor, the attached schedule has been developed for the subject review.

As described in the December 19 memorandum, we will be looking to project investigators to provide us with an overview on the status of their project to date (relative to initial study objectives), expected status by the end of fiscal year 1992, and thoughts on any continuing 1002 study needs. We envision these meetings to be an informal, give and take opportunity. Staff from the 1002 Project Office will make one-on-one follow up contacts as necessary, and individual projects are encouraged to keep us up-to-date with ongoing findings.

We realize that dealing with the 1002 Project Office may sometimes be frustrating. Project leaders have consistently provided us, usually under a tight timeframe, with the information we need to answer agency, department, or Congressional questions, some of which may seem off-the-wall, and your assistance has been greatly appreciated. We realize that 1002 Project Office demands often conflict with your needs to prepare for busy field seasons, analyze data, and write timely reports. To help you better understand the constraints governing the 1002 Project Office, our shifting priorities, and where your assistance may be needed in the coming year, a briefing paper will be provided at the meetings.

We look forward to meeting with each of you in February. If you have any questions, please contact me at 786-3510 (FTS 869-3510).

Attachment

Distribution

Assistant Regional Director, Refuges and Wildlife
Assistant Regional Director, Enhancement
Director, Alaska Fish and Wildlife Research Center
Larry Pank, AFWRC
Steve Amstrup, AFWRC (Polar bear)
Dave Douglas, AFWRC (Habitat)
Dirk Derksen, AFWRC
Jerry Hupp, AFWRC (Snow goose)
Tom McCabe, AFWRC, Fairbanks (Terrestrial mammals, habitat, seismic followup, tundra swan, weather)
Brad Griffiths, AFWRC, Fairbanks (Caribou)
Noreen Walsh, AFWRC, Fairbanks (Caribou)
Don Young, AFWRC, Fairbanks (Predators)
Glenn Elison, ANWR (Refuge operations, wildlife inventories, seismic followup, contaminants, tundra swan, weather)
Mark Willms, ANWR (Migratory bird port site)
Pat Reynolds, ANWR (Muskox)
Janet Jorgenson, ANWR (Seismic followup, habitat)
Randy Bailey, Fisheries (Inland/coastal fish)
Steve Lyons, Enhancement (Water resources)
Monty Millard, Fisheries, Fairbanks (Inland/coastal fish)
Tevis Underwood, Fisheries, Fairbanks (Coastal fish)
David Wiswar, Fisheries, Fiarbanks (Inland fish)
Pat Sousa, NAES (North Slope activities, contaminants)
Elaine Snyder-Conn, NAES (Contaminants)