Arctic Fox, *Alopex lagopus*, Den Densities in the Prudhoe Bay Oil Field, Alaska

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Studies conducted in the Prudhoe Bay, Alaska area since the 1970s suggested that Arctic Fox (*Alopex lagopus*) populations may have increased as a result of oil field development. During 1993, we estimated fox den densities within the Prudhoe Bay area and compared our estimates with those made previously in the same area and from other Arctic areas. The number of natal fox dens was stable between 1992 (n = 25) and 1993 (n = 26), as was mean litter size (4.6 and 4.4 pups per litter in 1992 and 1993, respectively). Fox den density was greater (1/15.2 km^2) within developed areas than on adjacent undeveloped tundra (1/28.1 km^2), and foxes used culverts and road embankments as den sites in addition to natural dens. Densities of fox dens in Prudhoe Bay development area and adjacent tundra were within the range of density estimates found in other Arctic areas.

Key Words: *Alopex lagopus*, Arctic Fox, den densities, oil development, Alaska.

Studies conducted since 1970 suggested that oil development in Purdhoe Bay, Alaska had no deleterious effects on Arctic Fox (*Alopex lagopus*) populations (Eberhardt et al. 1982; 1983a, b), and provision of a stable food source may have had some beneficial effects (Bousfield and Syroechkovskiy 1985). Recent work by Burgess et al. (1993*) further supports the contention that an increased, sustained anthropogenic food supply in developed areas may promote and maintain higher fox densities than would be expected in undeveloped areas.

The possibility that artificially high fox populations may lead to (1) abnormally high predation of tundra bird populations, and (2) increased human exposure to rabies, prompted BP Exploration (Alaska) Inc. (BPX) to initiate a study in 1991 of the Arctic Fox in the Prudhoe Bay area (Burgess and Banyas 1993*; Burgess et al. 1993*; Rodrigues et al. 1994*; Robards et al. 1996*). The purpose of our study was to document the densities of Arctic Fox den sites within the Prudhoe Bay Oil Field in 1993 and compare these densities with Arctic Fox populations found in other Arctic areas.

Study Area

The study area included the Prudhoe Bay Oil Field Unit (PBU [805 km^2]) and portions of an adjacent undeveloped area (760 km^2). The area was bounded on the north by the Beaufort Sea and the northern boundary of Township 12 North, on the east by the Sagavanirktok River delta, on the west by a line south from Milne Point, and on the south by the southern boundary of Township 9 North (within 147°50′ – 149°10′ N longitude and 70°25′ – 70°10′ W latitude). The area has been described by Pollard et al. (1986a,b).

Methods

Aerial surveys were conducted in May 1993 using fixedwing aircraft (Piper PA18) flying at 50 to 100 m above ground level. Transects were spaced 1.6 km apart and flown in a northsouth direction in a grid fashion following U.S. Geologic Survey section lines. A Trimble *Pathfinder* Global Positioning System (GPS) was used to navigate the aircraft and to determine the location of den sites. This time period was selected because snow was still present and fox activities (digging and tracks) at den sites were conspicuous from the air (Garrott 1980; Burgess et al. 1993*). Fox dens were classified as active if there were signs of use, and inactive if there were not.

Aerial surveys were repeated on 13 July 1993 to determine if sites identified in May were active and to attempt to identify additional sites. Determining the status of fox dens in July was more difficult than in May because, although both active and inactive dens were relatively conspicuous due to enhanced growth of vegetation (Chesemore 1969; Garrott 1980; Smits et al. 1988), evidence of recent fox activity was difficult to distinguish from the air.

*See Documents Cited section.

Ground surveys of fox dens accessible from the road system were conducted daily from 29 June to 31 July 1993 to determine the status of each den. Observations were made with binoculars or spotting scopes at all hours of the day and night. Observation time ranged from 10 minutes to 2 hours depending upon whether the observer was confident that all pups had been counted. Dens were considered active if there were signs of current use, such as fresh digging and wellworn trails. Active dens were considered to be natal dens if pups were present, small feces or tracks were present, or by presence of abundant prey item remains (Burgess et al. 1993*). Nonnatal dens, to which pups were moved after whelping, were classified as secondary dens.

Dens were classified as natural or artificial. The status of natural dens was designated as natal, secondary, active nonnatal (i.e., signs of activity by adults only), inactive, or status unknown. The status of artificial dens (i.e., dens associated with manmade structures such as culverts, under trailers, or burrows in gravel road banks) was designated as active or inactive. A number of new dens were located during this process, both natural and artificial. All artificial dens were considered to be secondary dens based upon the relative size of pups.

Results

Fifty-three natural Arctic Fox dens (1 den/15.2 km^2) were located in the PBU in 1993 compared to 44 dens (1 den/18.3 km^2) in each of the previous two years (Table 1). Natal dens comprised 57% of total number of natural dens in 1992 and 49% in 1993. The status of most dens in 1991 was unknown. Inactive dens comprised 41% and 28% of the total number of natural dens in 1992 and 1993, respectively. For all natural dens, secondary and active nonnatal dens were not identified in 1992, but comprised 15% of the total in 1993.

In the remote portion of the study area, 26 natural fox dens (1 den/29.2 km^2) were located in 1993 compared to 25 dens in each of the previous two years (Table 1). The percentage of natal dens was higher in 1992 (54%) than in 1993 (15%). The percentage of inactive dens was higher in 1993 (54%) than in 1992 (38%). The status of most dens was unknown in 1991.

A higher number of artificial dens was found in the PBU in 1993 than in 1992 (Table 1). No artificial dens were identified in 1991. There was no evidence of whelping at artificial dens and none were considered to be natal dens. Three artificial dens located in 1992 were known to be active in 1993, and 16 new artificial dens were located in 1993.

For the entire study area in 1993, at least one fox pup was observed at 23 of the 30 natural dens classified as natal. Mean litter size at these 23 dens was 4.4 pups. These counts must be considered minimum estimates of litter size because of the difficulties in obtaining complete counts as pointed out by Eberhardt (1977), Fine (1980), and Burgess et al. (1993*). Bear (*Ursus arctos*) predation was suspected at two natal dens, and there were signs of bear activity at two other dens.

Discussion

Eberhardt et al. (1983a) reported family occupancy of dens in the Prudhoe Bay Unit to fluctuate between 18% and 74% over a five-year period (1975–79), and 6% to 55% in the Colville River delta (1976–1980). Chesemore (1969) reported that only 2 of 50 dens (4%) in the Teshekpuk Lake region in 1962 had signs of recent use by Arctic Fox pups. Macpherson (1969) reported family occupancy rates of 12 to 40% during four years of study in the Northwest Territories, and Speller (1972) reported rates from 0 to 43% in the same area over a three-year period. Bannikov (1970) reported similar occu-

TABLE 1. Number of Arctic Fox dens located in the Prudhoe Bay Area, Alaska during 1991–1993. Data from 1991 and 1992 from Burgess and Banyas (1993*) and Burgess et al. (1993*).

		Year		
Den location	Den type	1991	1992	1993
Within PBU	Natal	7	25	26
	Secondary			4
	Active Non-natal			4
	Inactive	5	18	15
	Status unknown	32	1	4
	Active Artificial		8	19
	Total	44	52	72
Outside PBU	Natal	3	14	4
	Active non-natal			4
	Inactive	9	14	
	Status unknown	22	2	5
	Total	25	25	27

pancy rates for Arctic Fox dens in Russia. Numbers and percentages of natal dens in the PBU in 1992 (57%) and 1993 (49%), suggested a stable fox population over this two-year period.

The low occupancy rate of dens in the remote portion of the study area in 1993 (15%) compared to 1992 (54%) may be related to lack of ground reconnaisance. Aerial surveys are an efficient and accurate means of locating fox dens (Garrott et al. 1983). However, Garrott (1980) reported that, while occupancy of den sites was easily determined during ground surveys, few reliable determinants of fox activity could be observed during aerial surveys, particularly during June and July.

The density of natural dens in the PBU in 1993 (1 den/15.2 km^2) was higher than the density of dens in the remote portion of the study area (1 den/29.2 km^2). Some of this difference may be related to intensity of search effort. The road system in the PBU allowed us daily access to that portion of the study area, thus increasing our chances of locating new dens. We also learned of new den locations from conversations with oil field workers and other environmental scientists. Conversely, only two aerial surveys of the remote portion of the study area were conducted during the field season and no new dens were located. The two new dens located in 1993 were near the boundary of the PBU and were the result of ground reconnaissance in the area. Consequently, a much more intensive survey effort was conducted in the PBU.

The density of fox dens for the PBU in the current study (1 den/15.2 km^2) was similar to densities reported by other workers for the Prudhoe Bay area. Eberhardt et al. (1983a) reported that the density of fox dens in the Prudhoe Bay area (1 den/12 km^2) was approximately three times that of the Colville Delta (1 den/34 km^2). They reported a higher percentage of dens of recent origin in the Prudhoe Bay area than in the Colville Delta, and that a dampening of fox population fluctuations which occurred in the Prudhoe Bay area during a year of low lemming (*Lemmus sibiricus*) density was not observed at the Colville Delta. They suggested that garbage in the Prudhoe Bay area provided foxes with an added food supply that accounted for these differences. In Norway, Strand et al. (1999) indicated that increased pup production was associated with years of high rodent abundance, but that adult fox numbers were not associated with rodent abundance. Fine (1980) reported a fox den density of 1 den/15 km^2 in the PBU, but he suspected that not all dens had been located. The density of fox dens in the PBU was also similar to the density of fox dens reported by Dementyeff (1955) on a 1200 km^2 study area of the Bolshezemelskaya tundra of Russia (1 den/16 km^2).

The density of fox dens in the PBU was also higher than those reported for a number of other areas. Garrott (1980) reported 1 den/42.5 km^2 on the Colville Delta, but felt that not all dens in the study area had been located. Urquhart (1973*) reported a density of 1 den/37 km^2 on Banks Island in the Canadian Arctic, and Macpherson (1969) reported a density of 1 den/36 km^2 near Aberdeen Lake in the Northwest Territories. Angerbjorn et al. (1991) reported a density of 1 den/22.2 km^2 for their entire study area in Sweden, although, like us, they found 1 den/16.7 km^2 in areas where den searches were more intensive.

Higher Arctic Fox den densities than those found at PBU have been reported elsewhere. Anthony et al. (1985) reported a fox den density of 1.03 dens/km^2 on a 37 km^2 study area near Kokechik Bay, Alaska. Some Russian studies (cited in Bannikov 1970; Garrott 1980; and Burgess et al. 1993*) have also reported high fox den high densities, but Garrott (1980) suggested these densities may have been inflated.

The use of artificial dens by Arctic Fox in the Prudhoe Bay area has been noted by others (Eberhardt 1977; Fine 1980; Eberhardt et al. 1983a; Burgess et al. 1993*), and has been reported in Canada at seismic camps and associated staging areas (Urquhart 1973*). Although more active artificial dens were documented in the PBU in 1993 than 1992, it is difficult to draw conclusions from this. The increase could have been related to search effort.

The litter size of 4.4 pups for the study area in 1993 compares closely with the value of 4.6 pups per litter reported in 1992 by Burgess et al. (1993*). Eberhardt (1977) and Garrott (1980) reported mean litter sizes of 8 and 6.1 pups per family group in their North Slope study areas. During feeding experiments, Angerbjorn et al. (1991) reported litter sizes of 5.2 and 5.7 in experimental and control groups in Sweden. Frafjord (1992) reported litter sizes of 11 to 13 at Arctic Fox dens in Scandinavia, and 4 to 8 in Svalbard. In reviewing Russian literature, Bannikov (1970) stated that Arctic Fox litters averaged 8 to 12 during years of food abundance, but occasionally were as high as 20 to 22. During years of food scarcity the average number of pups per litter was 3 to 5.

The higher density of fox dens, and apparent stability of the fox population in the PBU, may be related to the availability of a stable food source in the form of garbage, refuse, and handouts from oil field workers. However, due to the lack of any predevelopment data on fox den density for the PBU, it is not possible to conclude with certainty that the fox population is currently higher than it was prior to oil field development.

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