RESULTS

Badami Study Area

Twenty-six fox dens were investigated in the Badami Study Area based on locations from previous studies (Fig. 2; Table 1). Twenty-five of the dens were previously recorded by Burgess and Banyas (1993) and Perham (2000). One newly discovered, active den (den 212) was located on a high streambank approximately 10 km southwest of the Badami development. Thirteen den sites (50%) were active (Table 2); one of which was abandoned. Thirteen dens (50%) were inactive. The distances of dens from the Deadhorse Airport averaged 35 km (range 12 km to 52 km) (Table 1). The density of arctic fox dens in the Badami study area was 1 den/41 km^2.

Pingos, mounds consisting of a core of ice covered by an outer layer of soil, were the predominant den site habitat in the Badami Study Area (Fig. 3). Sixty-nine percent of active dens (9 of 13 dens) in the Badami Study Area were located on pingos. Dens in the Badami Study Area were located on pingos, banks along waterways, sand dunes and at lake margins (Table 1). The majority of den sites (17 of 26) in the Badami Study Area had an eastern or southeastern orientation (Fig. 4; Table 3).

The majority of the dens surveyed (19 of 26) appeared to be old or mature sites (Table 3). It was difficult to distinguish between mature and old sites because some dens had characteristics of both categories. No dens appeared to have extensive, collapsed burrows, a characteristic of old den sites, and many had burrows surrounded by rich vegetation, a characteristic of mature dens.

Refuse found at 3 den sites consisted of non-food items (Table 4). Den site distances from nearest human activity varied from 20 m to approximately 8 km. The only active industrial site in the study area was the Badami facility; den 83 was located 20 m north of the pad.

Bullen to Staines Study Area

Seven arctic fox dens, located in previous studies, were investigated in the Bullen to Staines Study Area during 2000 ground surveys (Table 1, Fig. 2). Four dens (57%) were active, of which 1 den was apparently abandoned, and 3 dens (43%) were inactive. Arctic fox dens were concentrated in the northeast corner of the Bullen to Staines Study Area (Fig. 2). The distances of dens in the Bullen to Staines Study Area from the Deadhorse Airport averaged 80 km (range 58 km to 88 km) (Table 1). Density of fox dens was 1 den/91 km^2, while fox den density throughout the combined study area was 1 den/51 km^2 (Table 5).

Four dens (217, 218, 219, and 220) were found during the 2000 Point Thomson Unit denning habitat survey (Fig. 6). Den 217 was located on a streambank south of the Point Thomson Unit and den 218 was located on a peat mound approximately 5 m from the Point Thomson Unit #1 Pad. It was unclear if the den site was located on a natural mound, perhaps a remnant of a pond shore, or an artificial mound created by the construction of the pad. Den 219 was located 70 m east of den 203 on the same oxbow streambank. Den 220 was located in coastal sand dunes approximately 2 km northwest of the Staines River #1 Pad. Adult foxes were observed at 3 den sites (dens 217, 218, and 220). Juvenile foxes were observed at 2 dens (dens 217 and 218) (Table 1).

Streambanks were the predominant denning habitat in the Bullen to Staines Study Area (Table 3). Fifty percent of active dens (2 of 4 dens) in this study area were located on streambanks. With the possible exception of den 218, all observed arctic fox den sites were located in natural habitats. Burrow entrances for the majority of the den sites (6 of 7) had an eastern or southeastern exposure. A large proportion of the dens appeared to be old or mature and the remaining were classified as youthful den sites (Table 3).

Refuse was found at 4 den sites (Table 4). As with the Badami Study Area, refuse found in the Bullen to Staines Study Area were non-food items. Den site distances from the nearest human-impacted area ranged from 5 m to approximately 1.9 km.

Aerial Survey in the Point Thomson Unit

Based on the aerial search for denning habitat in the PTU, approximately 45 km of coastline and shoreline along 100 km of watercourses were searched in the PTU for denning habitat. Approximately 30% (30 km of 100 km) of streambank habitat appeared suitable for den sites (Fig. 5). Denning habitat along the watercourses appeared to have little relief (<1 m). Coastal environments containing sand dunes and elevated areas also appeared suitable for den sites.

Live-capture of Arctic Foxes

Four arctic fox were live-captured between 31 August and 5 September 2000 (Fig. 6; Table 6). Fifty-two trap-nights were recorded during the trapping session at 7 known active dens (Fig. 2). One male adult (AF001) was live-captured from den 212 on 1 September (Fig. 7). AF001 was subsequently killed by a vehicle on 6 October 2000 near Pump Station 3 at milepost 396 on the Dalton Highway approximately 80 km from its capture site, and apparently was in the process of dispersing. At least 3 foxes were observed at this den during the trapping session. Two juvenile foxes, 1 female and 1 male were captured from den 217 on 2 September. Up to 5 foxes were observed at den 217 during the trapping session. On 3 September, 1 adult male (AF004) was captured at den 218. No other foxes were observed at den 218. Body measurements and weights of captured arctic foxes were within the normal range of measurements reported by Garrott and Eberhardt (1987). Results from rabies tests were not yet available.

DISCUSSION

The proportion of active dens in the undeveloped region between the Sagavanirktok and Staines rivers, the combined study area, varied little from 1999 (46%) to 2000 (52%). Active dens in the Badami Study Area also varied little from 1999 (44%) to 2000 (50%). The consistency of proportions of occupied dens in 1999 and 2000 suggested the fox population may be stable in the study area during this period. While den sites in this study were located in an undeveloped area, Ballard et al. (2000) documented a stable fox population with similar occupancy rates in the developed PBOF

(occupancy rates of 57% in 1992 and 49% in 1993). Contrary to the findings of this study, other researchers have indicated that den occupancy fluctuated annually in undeveloped regions of the arctic (Macpherson 1969; Chesmore 1969; Speller 1972; Eberhardt et al. 1983b). During a five-year study, Eberhardt et al. (1983b) documented fluctuations in den occupancy that ranged from 6% to 55% on the Colville River delta. Ballard et al. (2000) reported that den occupancy rates fluctuated from 54% in 1992 to 15% in 1993 on a remote portion of the PBOF. However, Ballard et al. (2000) suggested that the difference may have been due to different survey methodologies between the 2 years. Perhaps with a larger sample encompassing multiple years, the fox population between the Sagavanirktok and Staines rivers may fluctuate as well. However, if an apparent stable fox population is an indicator of food availability, conceivably foxes in this area could be supplementing their natural diet by foraging using anthropogenic sources in the developed areas to the west.

The change in the arctic fox den density in the combined study area between 1999 and 2000 was a reflection of the addition of 5 new found dens in the Badami Study Area and the Bullen to Staines Study Area (Table 5). The 2000 density estimate was a minimum estimate because it was likely that not all dens in the study area were located.

The 2000 den density estimates for the Badami Study Area, the PTU, and the combined study areas were within the range of estimates for other undeveloped regions on the Arctic Coastal Plain (Table 7). Density estimates for this study were lower than densities of fox dens in developed portions of the PBOF (Eberhardt et al. 1983b; Burgess et al. 1993; Ballard et al. 2000) (Table 7).

Den density data from the Badami Study Area and Bullen to Staines Study Area in 1999 and 2000 suggested that regional differences in density can occur. Den sites between the Sagavanirktok and Staines rivers appeared to be clustered in the Badami Study Area, rather than uniformly distributed. Although the Badami Study Area and the Bullen to Staines Study Area were adjacent, den density in the Badami Study Area was twice as high as in the Bullen to Staines Study Area. The density estimate in the Bullen

to Staines Study Area (1 den/91 km^2) was less than half of the densities compared to other areas recorded in the Arctic (Macpherson 1969; Urquhart 1973; Smith et al. 1992).

The lower density of fox dens in the Bullen to Staines Study Area may reflect differences in availability of suitable habitat. Den placement is thought to be determined by ice-free soils above the permafrost layer and water levels, which facilitate excavation (Garrott 1980). Den sites throughout the arctic region are generally clumped where such denning habitat exists (Macpherson 1969). In the Bullen to Staines Study Area, landforms suitable for den excavation, such as pingos, appeared to be less abundant than in the Badami Study Area (Perham 2000). For example, a majority of the Bullen to Staines Study Area, was located on the Canning River alluvial fan. This area provided limited denning habitat because it was generally flat and poorly drained, contained few pingos and waterbodies, and included no large river systems. Although, the Badami Study Area was also poorly drained, it contained several large river systems and many pingos, which served as additional habitat for den sites. In addition, the habitat search in the PTU, within the Bullen to Staines Study Area, verified that various forms of suitable denning habitat occur in the Bullen to Staines Study Area, but this type of habitat appeared limited. Although additional fox dens may exist in the PTU, the majority of the dens have probably been located.

Refuse documented at den sites in 1999 and 2000 as far east as the PTU suggests that foxes throughout the region have access to refuse from human activity areas, including possible past transient activity, such as game hunters or seismic exploration trains. The origin of the refuse at the den sites could not be determined. Foxes can react to strange or unfamiliar objects, such as non-food items (e.g., bird wings, plastic), during foraging activities (Burgess 1984). Refuse can be cached for future use, including play. Fine (1980) and Burgess (1984) observed adult and juvenile foxes playing with cached non-food items. Lightweight materials, such as styrofoam, may have been wind-blown across the tundra. Heavier objects could have been collected by foxes on the tundra while foraging near human-affected areas throughout the region. Dens 83 and 202, cleared by researchers of debris in 1999, had accumulated additional refuse, presumably collected by foxes using these dens between the 1999 and 2000 surveys. These dens were located

50 m and 2.2 km, respectively, from the Badami development. However, they were also located near the coast and refuse could have been acquired along the coastline as well. Den 218, 5 m from PTU #1 Pad, also contained an abundance of refuse, probably from activities associated with the PTU #1 pad when it was in operation. Refuse found at den sites was most likely an indicator of the proximity to human activity during normal foraging activities, rather than evidence of a reliance on anthropogenic food sources.

Efforts to examine possible den site fidelity of foxes were confounded by low sample size (n=4 live-captured foxes). Natural fall dispersal coupled with timing of the trapping session likely contributed to the low number of trapped individuals. Although family units remained in some dens (dens 212 and 217), other dens had already presumably been abandoned (dens 218 and 90). A large-scale tagging effort would be necessary to fully assess den fidelity. The quantity of future information derived from color-coded collars will depend on future trapping effort and success, as well as researcher observation time spent at the den sites observing marked individuals.

The movement of AF001 suggests that foxes in undeveloped regions of the North Slope can access developed areas. Eberhardt and Hansen (1978) suggested that individual foxes can travel an average of 24 km per day straight-line distance during dispersals. Den 212, capture site of AF001, was located in the Badami Study Area. It was approximately 42 km from the eastern edge of the PBOF (Table 1). The farthest den in the study area from the PBOF was approximately 90 km to the east (den 204). Travel time from den 204 to PBOF would be estimated at approximately 3 days using Eberhardt and Hansen's (1978) estimate. This suggests that foxes inhabiting the PTU could travel past and possibly access portions of the PBOF during dispersal. Food scarcity was generally thought to trigger seasonal movements of foxes (Chesemore 1968; Bannikov 1970). The influences of the PBOF on dispersing arctic foxes are largely unknown. However, supplemental food sources associated with development activities may minimize dispersal of foxes and allow them to remain in areas of development throughout the winter (Fine 1980; Eberhardt et al. 1983a). Supplemental food sources as a result of industrial activity in the Prudhoe Bay area may have been the cause for the apparent fidelity to den sites and home range in foxes observed by Eberhardt et al.

(1983b). Consequently, industry-induced fidelity to den sites may increase fox productivity and ultimately survival by reducing spring search time for a den. Future evidence of den site fidelity, or lack of, in undeveloped areas, such as the Sagavanirktok to Staines Study Area may help explain the importance of den sites in undeveloped areas and how fox population dynamics may change as an area becomes developed.

CONCLUSIONS

The undeveloped Bullen to Staines Study Area, the area most likely influenced by development of the Point Thomson Unit, had a lower density of arctic fox dens than the adjacent undeveloped Badami Study Area. The availability of suitable habitat expressed by variation of topography between the two regions may be one factor limiting available denning habitat. Low pre-development densities of fox dens for the PTU and the Bullen to Staines Study Area suggest that fox populations appear to be low in this area.

Fox den activity between 1999 and 2000 suggests a stable population between the Sagavanirktok and Staines rivers. Continued monitoring of den activity and density will be necessary to determine the stability or fluctuations of fox populations and their productivity prior to development as it occurs.

Four new dens and suitable denning habitat were identified and mapped in the PTU. Additional fox dens may exist in the PTU, but the small amount of available denning habitat suggests that most dens have been documented.

Current practices already in place by oil field companies to minimize fox access to refuse and food (e.g., animal-proof garbage containers and an information and education system for slope workers), combined with the naturally low number of dens in the PTU should help reduce human/fox interactions if the PTU were to be developed. However, even with deterrent practices in place, it is possible that human activity in the PTU could attract foxes to the region. Regular inspections of refuse disposal areas and food transfer sites may be necessary to ensure compliance and further reduce interactions.

Foxes may use man-made shelters as denning habitat (Burgess and Banyas 1993; Burgess et al. 1993), although the use of man-made structures by foxes for denning has

not been documented in the Badami development. Information on the influence of outlying developments, such as Badami, on local arctic fox populations may provide insight into the potential problems associated with future developments, such as the PTU, and help develop effective mitigation actions.

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