

**POPULATION GROWTH, MOVEMENTS, AND STATUS OF THE NUSHAGAK
PENINSULA CARIBOU HERD FOLLOWING REINTRODUCTION,
SOUTHWEST ALASKA, MARCH 1988 – MARCH 2000.**

**A Status Report of the Nushagak Peninsula Caribou Herd Monitoring Effort at
Togiak National Wildlife Refuge**

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SUMMARY

Barren ground caribou (*Rangifer tarandus*) were reintroduced to the Nushagak Peninsula, Alaska in February of 1988 after an absence of more than 100 years to reestablish hunting for local residents. Since reintroduction, herd growth and population dynamics has been monitored closely. At this time, there has been no significant dispersal from the Herds' core range. The Nushagak Peninsula Caribou Herd has grown rapidly from 146 reintroduced individuals to over 1,200 in 10 years at an exponential rate of $\bar{r} = 0.20$ or 29%. Dramatic growth during the first 6 years (1988-1994) of 38% ($\bar{r} = 0.317$) was attributed to the high percentage of females in the initial reintroduction, high calf production and survival, exceptional range conditions, few predators, and no hunting. However, the populations' exceptional growth appears to have slowed and stabilized with a 1% average growth rate between 1996 and 1998. Body condition and weights of calves captured in 2000 are significantly lower than those captured in 1995 and/or 1997. Although calf production has also decreased from close to 100% (1990-1995) to about 90% (1996-1999), overall calf survival and recruitment continues to be high. Legal subsistence harvest began in 1995 and approximately 3% of the population is reported being killed annually. Although brown bear and wolves are present, predation is not believed to be a major factor at this time. Mean home range of the NPCH is 674 km² and group sizes were greatest during post-calving aggregation in July ($\bar{x} = 127$). The caribou population density on the Nushagak Peninsula has also grown from 1.0 / km² in 1993 to 1.4 / km² in 1999. A range survey in 1994 noted only trace utilization was observed on the Peninsula with excellent range condition. As expected with a growing herd, subsequent surveys in 1999 indicate that the reintroduced herd is beginning to alter the range condition with 37% of plots noted with moderate to severe utilization. Preliminary results also indicate that lichen production has also decreased on 4 of 5 Peninsula study sites. During recent years, the herd has experienced decreased calf condition, reduced calf production, delayed calving and decreased range conditions. However, we suspect the reduced herd growth is attributed to increasing hunting pressure and some dispersal from the Peninsula, not reduced range condition. Recent population counts indicate that the Nushagak Caribou Herd has stabilized on the Peninsula and continues to do well. Continued intensive monitoring of both the herd and range condition is recommended.

INTRODUCTION

Historically, a large caribou population occupied the coast of the Bering Sea from Bristol Bay to Norton Sound and archaeological investigations suggest that caribou were important to the native population (Kotwa 1963). While still numerous in the upper Kuskokwim drainage (Capps 1929), caribou were noted as absent from the Togiak and Goodnews drainages as early as 1900 coinciding

with a period of human population growth and intense commercial trade. Reindeer were introduced into Bristol Bay in the early 1900's to provide the native community with an economic base, however, the industry failed by the 1940's (Alaska Planning Group 1974).

Togiak National Wildlife Refuge in southwest Alaska, established in 1980, was directed to reestablish caribou herds to historic levels (Alaska Department of Fish and Game 1976). As a result, Barren Ground Caribou were reintroduced to the Nushagak Peninsula (Fig. 1) in February 1988 with the goal of maintaining an expanding population with sustainable subsistence harvest.

STUDY AREA

The Nushagak Peninsula is located in the southeast corner of the Togiak National Wildlife Refuge and encompasses approximately 1,050 km². It is almost entirely lowland tundra with more elevational changes towards the northern portion. The weather is primarily maritime influenced and temperatures range from - 47° C to 33° C (Johnson 1994).

METHODS

Radio-collaring

Details of the reintroduction of the Nushagak Peninsula Caribou Herd (NPCH) are discussed in Hinkes and Van Daele (1994). Data collected during capture operations included weight, neck size, total length, girth, metatarsus, hindfoot and jaw length. Additional radio-collars were added in 1992, 1995, 1997, and April 2000.

Monitoring

Monthly flights to monitor radio-marked caribou began in 1988. Weekly flights during the calving period were initiated in 1991. When possible, visual confirmation of association with a calf was made, however, this is not possible during post-calving aggregations without major disturbance. Monitoring radio-marked caribou provides estimates of seasonal movements, distribution, dispersal, home range, calf production and survival, calving chronology, recruitment, and predation and hunting mortality.

Helicopter fall sex and age composition counts were conducted in 1992, 1994, 1997, 1998, and 1999. Population censuses were conducted in 1990 - 1993 and 1996 - 1998 using a total-count technique. Transects were flown over at 1.0 - 1.5 km intervals depending on snow, light, and wind conditions. Individuals have been noted off the Peninsula as early as 1988, including a small group (100+)

suspected to be part of the Nushagak Herd near the village of Twin Hills. Separate estimates for caribou on and off the Nushagak Peninsula began in 1996 when substantial numbers of caribou were noted west of Kulukak Bay, however, a proportion of those individuals are suspected to be part of the dispersing Kilbuck and/or Mulchatna Caribou Herds (Fig. 2).

Home Range, Movements, and Distribution

The Animal Movement Analysis extension for ArcView (Hooge and Eichenlaub 1997) was used to determine MCP (minimum convex polygon) home range size and calving distribution (Valkenburg et al. 1988), and distances moved between relocations. All statistical analyses were performed using *STATGRAPHICS Plus* (Manugistics 1998).

Range Condition

Severe overgrazing by caribou has been well documented in western Alaska during the early 1900's (Palmer and Rouse 1945). Subsequently, some lichen areas, the preferred winter forage, have not recovered (Reardon 1974). Because lichen communities are known to be sensitive to over-grazing and trampling (Klein 1967), a range condition study was initiated in 1989 to assist in management of the herd (Johnson 1994). Permanent transects and exclosures at 5 sites on the Nushagak Peninsula were established in 1993 and visited in 1994 and 1999 to monitor changes in vegetation production and cover over time. In addition, selected lichen – rich upland sites were surveyed for utilization in 1994 and 1999.

RESULTS AND DISCUSSION

Radio-collaring

A total of 146 caribou were successfully reintroduced to the Nushagak Peninsula in February 1988; 17 mortalities were noted during the relocation effort (Hinkes and Van Daele 1995). All were released at Kikertalik Lake (Fig. 1) on the Peninsula except for 8 that were released near Dillingham due to poor weather conditions. In 1988, 20 radio-collars were deployed and, since reintroduction, an additional 56 radio-collars have been added (16 in 1992; 10 in 1995; 20 in 1997; 10 in April 2000). In addition, body condition data was collected from 5 calves killed in both April 1995 and October 1998 to estimate the overall health of the herd and investigate the presence of lungworm.

Body Measurements

Adult caribou captured in 1992 (2-year-olds) were larger and appeared to be in better condition than 2-year-old caribou originally transplanted to the Peninsula in

1988. This enhanced body condition was most likely a direct result of abundant high quality forage (Hinkes and Van Daele 1995). In contrast, Nushagak Peninsula caribou calves (approx. 10 months old) captured in April 2000 were smaller than those measured in 1995 and appeared in poorer condition than those captured in both 1995 and 1997. The mean spring weights of calves captured in 1997 and 2000 were comparable ($x = 50.5$ kg, $SD = 5.0$, $n = 10$; $x = 48.8$, $SD = 6.1$, $n = 10$, respectively), but both were significantly ($P = 0.00$) lighter than captured calves in 1995 ($x = 56.6$ kg, $SD = 2.1$, $n = 15$). Further, the body condition index was significantly lower ($P = 0.00$) for Nushagak calves caught in 2000 ($CI = 2$) compared to those caught in both 1995 ($CI = 3$) and 1997 ($CI = 4$). Other body measurements (girth, mandible, and hindfoot length) did not differ significantly between the years. The lighter weights are comparable to calves in the Northern Peninsula Caribou Herd ($x = 50.9$ kg), the parent herd for the Nushagak population (Hinkes and Van Daele 1995). Also, the neighboring Mulchatna Caribou Herd showed a decrease in spring weights, though not significant ($P = 0.09$), between 1995 and 2000 ($x = 49.8$ kg, $n = 10$; 46.6 kg, $n = 11$, respectively) (P. Valkenburg, Pers. Comm.). Reduced calf weight and body condition may indicate that the Nushagak populations' health is declining, however, the winter of 1999 / 2000 has been one of exceptional snow accumulation and winter severity is an important factor affecting caribou survivorship (Russell and Martell 1984) and condition. Although there can be yearly fluctuations in body condition, increasing herd size in the Delta Caribou Herd coincided with reduced calf weights and condition which, subsequently, have not returned to the levels of the 1980's when herd size was low (Valkenburg et al. 1999).

Calf Production and Survival

Peak calving for radio-marked Nushagak caribou occurs in late May which is consistent with other caribou herds at similar latitudes in Alaska (Skoog 1968, Hemming 1971). Peak calving is defined as the date by which 50% of calving has occurred. The average progression of calving for radio-collared females from 1992-1999 are 7% by May 15th, 37% by May 22nd, 74% by May 27th, 89% by May 30th, and 99% by June 10th. However, in both 1998 and 1999, calving was delayed with only 79% having calved by June 3rd, compared to 1994 -1997 when approximately 95% had calved by May 30th. Preliminary surveys also suggest that calving in 2000 is also delayed with no radio-collared cows noted with calves by May 22nd and only 73% with calves by May 30th. Delayed calving is thought to indicate malnutrition (Boertje and Gardner 1999).

Calving grounds are perhaps the most predictably used portions of caribou annual ranges (Valkenburg et al. 1988), however, the calving area for the NPCH is difficult to identify. One female from the original reintroduction was documented as calving off the Peninsula in 1988, over 60 km from the release site two months earlier. Other than that individual, all radio-collared females calved on the Peninsula until 1994. From 1994 through 1998, one female was

observed calving west of Kulukak Bay. Three other radio-marked females also calved off the Peninsula between 1997 and 1999, though not consistently. The total calving distribution for the Nushagak Caribou Herd for all years occupied 760 km² (75% of the Peninsula). Examining calving areas showed that, on average each year, the calving area was approximately 330 km² (SD = 114 km², n = 11) and appeared to be expanding north since 1993. In comparison, Valkenburg et al. (1988) found two distinct calving areas (2,020 km² and 450 km²) for the Delta and Yanert Herds.

Natality estimates derived from radio-collared females have been found to be similar to estimates of the herd at large (Davis et al. 1991). In 1990, 1992, 1993, and 1995 all radio-collared females in the Nushagak Herd observed produced calves (100%). The production rate has since decreased (1996 – 1999), averaging 89.6%. However, the rates observed for the NPCH continue to be higher than rates for other populations (82% average pregnancy rate) (Bergerud 1980). Caribou do not generally come into estrus until 28 months of age (Skoog 1968, Bergerud 1971), although it has been noted that with good nutrition, caribou can conceive at 17 months (Bergerud 1980). All radio-marked NPCH cows estimated to be 2-years old (during 1992 capture) produced calves in 1992 (5 out of 5) (Hinkes and Van Daele 1995) compared to only 3 out of 13 (23%) in 1998. Overall calf survival and recruitment for the Nushagak Peninsula does continue to be high and the mean survival of calves associated with radio-collared cows from 1990 to 1999 averaged 65.3% (SD = 9.1; n = 9). In comparison, Davis et al. (1988) found an average calf survival rate of 56% (n = 9) in the Delta Caribou Herd.

Adult Mortality

Legal subsistence harvest of Nushagak caribou began in January 1995 with 43 caribou reported killed (including 5 for condition index). From 1995 to 1999, 3% - 4% of the Peninsula population has been taken each year during the reported subsistence harvest. Mortality causes of radio-marked caribou from 1988 to 1999 are as follows: 32% from unknown causes, 12% taken by hunters, and 3% by predation. Two other caribou were also documented as dead, one from birth related causes and the other locked antlers with another bull. An additional 17% are missing or had collars fail. The average age for caribou that died from unknown causes was 8.7 years (SD = 8.7, n = 21), by hunters was 5.4 years (SD = 0.9, n = 8), and by predation was 5.3 years (SD = 5.3, n = 2) suggesting no age specific mortality. Brown bears are common and wolves on the Nushagak Peninsula are rare. The extent of predation on Nushagak Peninsula caribou is unknown, but we do not believe it is presently a major factor in herd dynamics. However, sightings of brown bears on the Peninsula have increased since 1997, especially of sows with cubs.

Home Range, Movements, and Distribution

From March 1988 to March 2000, we obtained 3,683 relocations on 62 radio-collared caribou. The total number of relocations per radio-collared caribou averaged 59. Home range size was related to the number of telemetry locations at $n < 30$ ($R^2 = 0.55$). Two radio-collared caribou with ranges beyond the Nushagak Peninsula ($1,551 \text{ km}^2$ and $1,479 \text{ km}^2$) were also excluded from further analyses. With those exclusions, the average home range of Nushagak Caribou between 1988 and 2000 was 674 km^2 ($SD = 173$, $n = 48$) (Fig. 4). Home ranges were on average larger than previously noted in 1993 ($\bar{x} = 447 \text{ km}^2$, $SD = 168$, $n = 32$) (Hinkes and Van Daele 1994). In comparison, the average home range for females in the nearby Kilbuck Caribou Herd was $2,955 \text{ km}^2$ (Ernst 1996). The age of Nushagak caribou was not significantly related to home range size ($R^2 = 0.09$, $P = 0.842$).

Average yearly movements between relocations ranged from 11.5 km to 16.2 km (mean = 11.9 km). There was a significant linear relationship between average overall distances moved and home range size ($R^2 = 0.30$, $P = 0.00$). However, there was no relationship between the number of and distance between relocations ($R^2 = 0.07$, $P = 0.07$). Differences in movements between years were significant ($P = 0.01$), especially in comparisons with 1998 during which the greatest average movements occurred ($\bar{x} = 16.2 \text{ km}$). Average monthly movements were also significantly different ($P = 0.00$) and ranged from a low of 9.8 km in May to a high of 18.0 km in December ($\bar{x} = 13.7 \text{ km}$). Daily rates of movements for other Alaskan herds were found to be highest in July and lowest in February or March (Whitten and Regelin 1988).

Seasonal variation of group sizes in the Nushagak Peninsula Caribou Herd was significant ($P = 0.00$). Group size was greatest in July during post-calving aggregation ($\bar{x} = 127$) and decreased through September ($\bar{x} = 15$), remaining stable throughout the winter months (October – March) ($\bar{x} = 25$). The lowest average group size was reported in the spring (April – May) ($\bar{x} = 12$) as pregnant females dispersed to calve. Ernst (1996) reported that for the Kilbuck Caribou Herd, largest group sizes were found in January ($\bar{x} = 110$), decreased through May, and then increased slightly in June and July. Single caribou were also most frequently encountered in July and August. Group sizes for the Nushagak Herd were significantly different between years ($P = 0.00$) with the group size increasing on average from 1988 to 1999 (range 13 to 28 caribou) as the population increased (Fig. 3).

Caribou observations have been plotted by month and season, with no significant pattern noted. The caribou do appear to concentrate more in the center of the Peninsula during the calving and summer seasons and then expand towards the coast during the winter months. No significant dispersal from the Herds' "core range" on the Peninsula has occurred. Of over 3,600 radiolocations during tracking flights and surveys, 92% were observed on the Nushagak Peninsula.

This is compared to over 99% noted in earlier reports (Hinkes and Van Daele 1995).

Population Growth and Composition

The NPCH grew rapidly in the first 6 years following reintroduction (1988 to 1994) with an average growth of 38% (SD = 7.3, n = 6) or an exponential rate of increase $\bar{r} = 0.32$. This growth rate exceeds the maximum theoretical potential of $r = 0.29 - 0.30$ or about 35% as described by Bergerud (1980) and Bergerud et al. (1983). Bergerud (1980) also summarized that Alaska caribou herds without predators show rapid growth approaching $\bar{r} = 0.30$, while those with predators showed little or no growth. However, Davis et al. (1991) stated that only transplanted caribou herds approach this level and that growth over 20% is uncommon even under optimum conditions. The initial impressive growth of the Nushagak herd is attributed to the high percentage of females in the reintroduced herd, high calf production and survival, pristine range conditions, few predators, and little hunting (Hinkes and Van Daele 1994). Reintroduction of caribou in other areas of mainland Alaska has been less dramatic. Caribou transplanted to the Kenai Peninsula in the 1960's grew with annual rates of increase of only 13 - 17% (Spraker 1992a, 1992b).

Since 1996, the populations' exceptional growth has been slowing. Between 1996 and 1998, the Nushagak herd grew approximately 1% ($\bar{r} = 0.01$) bringing the overall population growth on the Peninsula for 10 years down to 29% or $\bar{r} = 0.20$ (Fig. 5). Though no known dispersal has occurred, there has been as many as 100+ individuals reported near the village of Twin Hills that are suspected to be from the Nushagak Herd (Fig. 3). Also beginning in 1996, caribou were noted off the Peninsula to the west in greater numbers, and although several collared Nushagak caribou have been observed in this area, many of those individuals are suspected to be from the dispersing Kilbuck and/or Mulchatna caribou herds. This is supported by confirmed locations of radio-collared Mulchatna and Kilbuck caribou near the village of Twin Hills.

Preliminary results indicate that some genetic divergence has occurred within the Nushagak Herd during the past decade as evidenced by observed genetic distances between the Nushagak and Northern Alaska Peninsula Herds, the parent population. The implications of this are uncertain; both populations (NPCH and NAPCH) may have had the potential for intermixing with the Mulchatna Herd, though none has been documented during the breeding period (P. Valkenburg, Pers. Com). Genetic divergence can also be the result of genetic drift.

The population density of the Nushagak Herd was estimated to be 1.0 caribou / km² in 1993. By 1999, the estimated density had reached 1.4 / km². It has been suggested that competition for food at densities approaching 2.0 caribou / km² will cause dispersal (Haber and Walter 1980) although dispersal (i.e. movement

of caribou from one calving range to another) has not been previously documented in caribou as a response to increasing densities (P. Valkenburg, Pers. Com.). Expansion of range, including calving areas has been documented in the George River and Avalon caribou herds (dispersing at 1.9 / km² and 2.1 / km², respectively) (Couturier et al. 1990, Mercer et al. 1986).

Herd composition of the NPCH changed dramatically in the first 5 years following reintroduction (Hinkes and Van Daele 1994). Initial herd composition was 82% cows, 10% bulls (12 bulls:100 cows), and 8% calves (10 calves:100 cows). Average herd composition from 1992 to 1999 (n = 5) was 45% cows, 27% bulls (60 bulls:100 cows), and 28% calves (63 calves:100 cows). Although the average of the male component of the Nushagak herd exceeds that of most hunted Alaskan populations (45 bulls:100 cows) (Leib et al. 1991), estimates have steadily decreased from a high in 1994/1995 (71 bulls:100 cows). The bull estimate for 1999 / 2000 was closer to the average for other Alaskan populations (48 bulls:100 cows) with averages for cows and calves remaining fairly consistent since 1992/1993.

Range Condition

Climax lichen communities, used primarily for winter feed, have been found to be the most sensitive to grazing by caribou. The slow growth rates of lichens, and caribou selection for lichens in winter, make lichens susceptible to overgrazing and trampling. Snow may also strongly limit caribou access to lichen during some winters (Boertje et al. 1996). A range condition inventory on the Nushagak Peninsula in 1994 noted only trace utilization by the reintroduced herd, and only in very sensitive areas, such as lichen tundra uplands. Results indicated that the range was in excellent condition and showed very little degradation, including damage caused by trailing, in the six years following reintroduction (Johnson 1994). A second monitoring effort in 1999 suggests that range condition is beginning to be altered by the Nushagak Caribou Herd. Of 154 plots surveyed on the Peninsula, only 39% were described in the trace to slight utilization classification. Thirty-seven percent of the plots received a moderate to moderately heavy/severe classification and two locations were rated as severely heavy or severe. Preliminary results of changes in lichen production on the permanent transects also showed a decrease on 4 of the 5 study sites in 1999 compared to 1994. However, preliminary results of cover trends do not suggest an overall increase in vascular or moss cover (or consequently a decrease in lichen cover). The increased utilization does not suggest any specific patterns on the Peninsula, however, the areas of moderate to severe use tend to be more prevalent in the southern half.

MANAGEMENT IMPLICATIONS

The management plan for the Nushagak Peninsula Caribou Herd estimated that the Peninsula could support a maximum of 1,000 caribou assuming that good range conditions could support a stable density of 1 caribou / km² without significantly impacting the range (Hinkes and Van Daele 1995). However, a variety of factors can cause a surge or drop in numbers and rapid declines can occur from the synergistic effects of adverse weather and increased predation (Boertje et al. 1996). While the population dynamics of the Nushagak Peninsula Caribou Herd continue to be similar to other reintroduced herds with abundances of high quality forage and few predators (Hinkes and Van Daele 1995), its exceptional growth has slowed. Decreased calf condition, reduced calf production, delayed calving, and decreased range condition all suggest that the herd is reaching a plateau. This is supported by Peninsula population counts in 1996, 1997, and 1998 indicating a population that has reached a stable level (1255, 1275, and 1281 caribou respectively). Modeling the population with overall average natality and reported harvest rates (~ 3%) result in projections indicating the population will increase 13% (to over 3,500 caribou) in the next 5 years (1999 – 2005) for an overall average rate of 22% since reintroduction (Fig. 6). However, we suspect that harvest of the population may be as much as two to three times that of the reported rate with twelve percent of the radio-marked mortalities related to hunting. Population models with increased mortality closely resemble the observed total population counts for 1996 (1376 vs. 1304), 1997 (1517 vs. 1429), and 1998 (1424 vs. 1381) (Fig. 7). Given this model, the Nushagak Herd is predicted to slowly decline to 1096 caribou between 1999 and 2005 (- 4% growth) for an overall average growth rate of 13% (1988 – 2005).

Movements off the Peninsula are becoming more common for radio-collared individuals. In conjunction, an increased number of caribou are also being counted off the Nushagak Peninsula, however, what proportion of those individuals are from the expanding Mulchatna and/or Kilbuck Caribou Herd is unknown. It has been documented that the Mulchatna Caribou Herd increased its growth rate by over 10% from 1992-1994 resulting in part from expansion onto new range (Van Daele 1995). Similar results are possible for the Nushagak Peninsula Caribou Herd if it begins to disperse off the Peninsula. Whereas growth of the NPCH verifies the success of the reintroduction, increasing densities, low dispersal, and higher potential for overgrazing, presents managers with increasingly hard decisions.

We continue to recommend a conservative, however, more intensive, approach to managing the herd:

1. Initiate calf captures each spring to measure body weight and condition. This will allow for monitoring of the Herds condition and

identification of downward trends independent of yearly weather fluctuations.

2. Continue to monitor the range condition and initiate yearly or every other year range utilization surveys to monitor potentially increasing impact.

3. Increase education and law enforcement efforts to promote better compliance with hunting regulations, especially reporting requirements.

4. Continue to regulate harvest on the Nushagak Peninsula in order to encourage growth and expansion beyond the Peninsula.

5. Continue to monitor the NPCH monthly during non-calving and weekly during calving as well as continue with fall composition and yearly population counts, including maintaining at least 20 active radio-collars.

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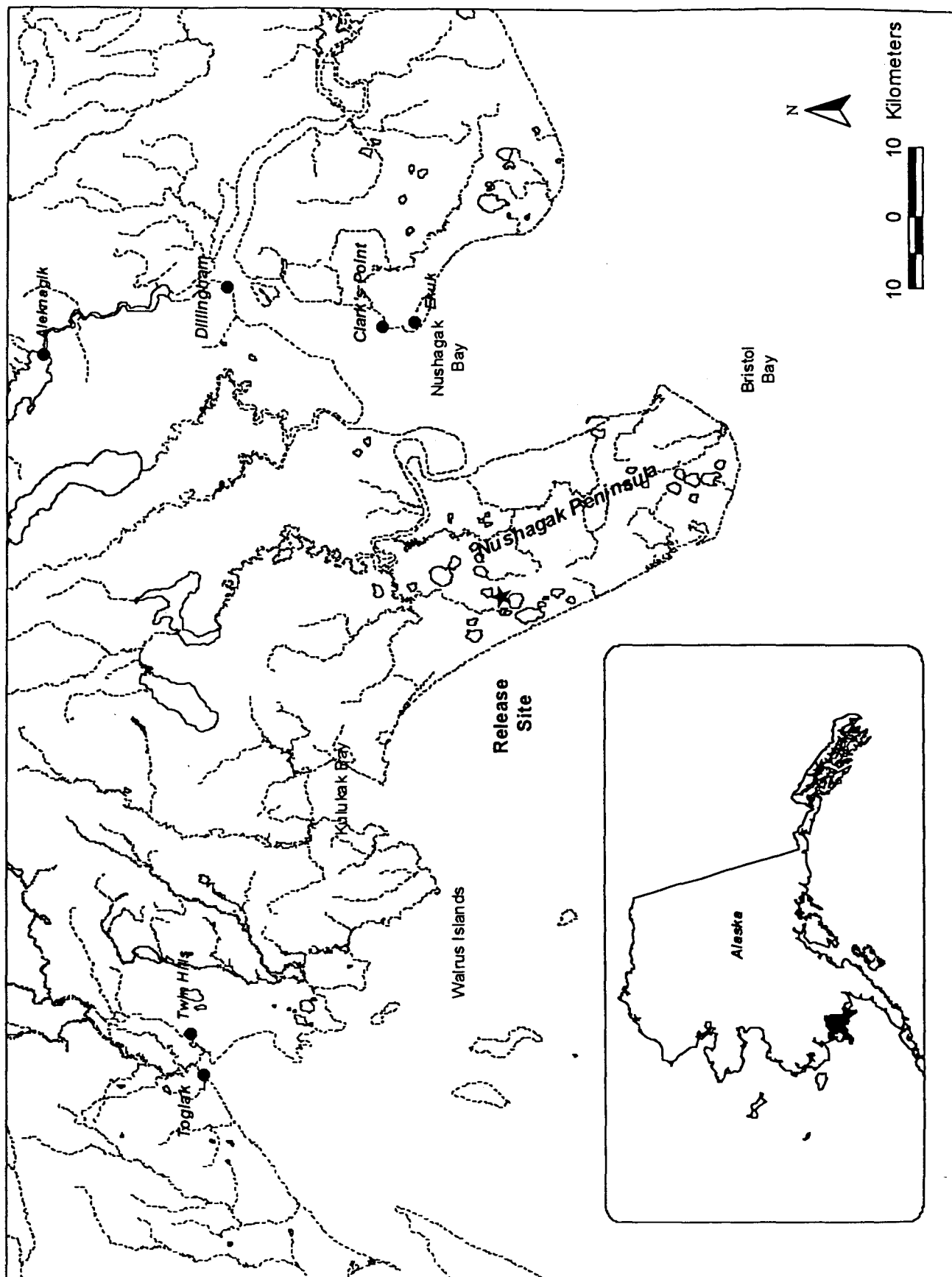


Figure 1. Location of release site for the reintroduced Nushagak Peninsula Caribou Herd, southwest Alaska.

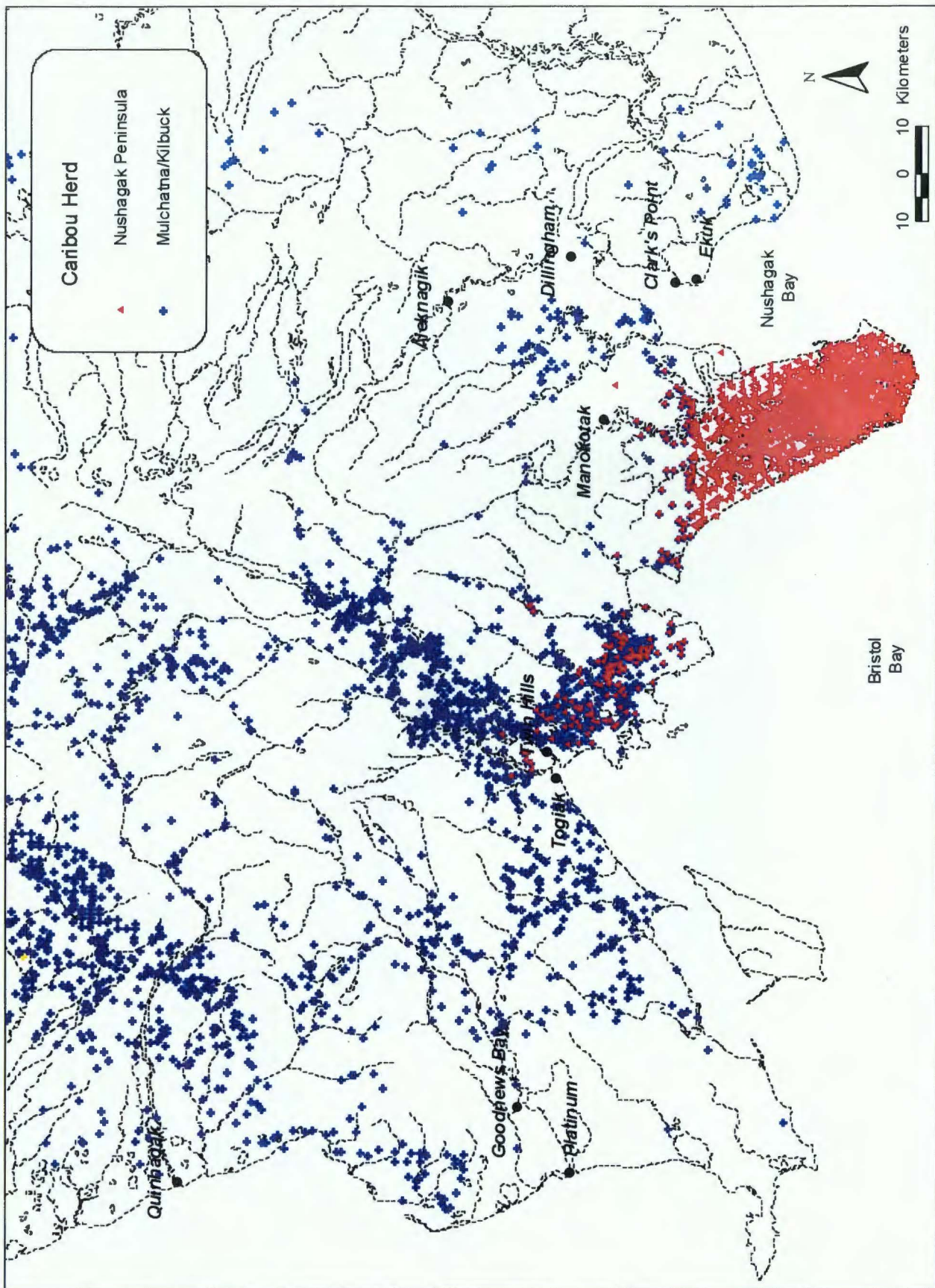


Figure 2. Distribution of Nushagak Peninsula and Mulchatna/Kilbuck caribou observed on the Togiak National Wildlife Refuge, March 1988 to March 2000.

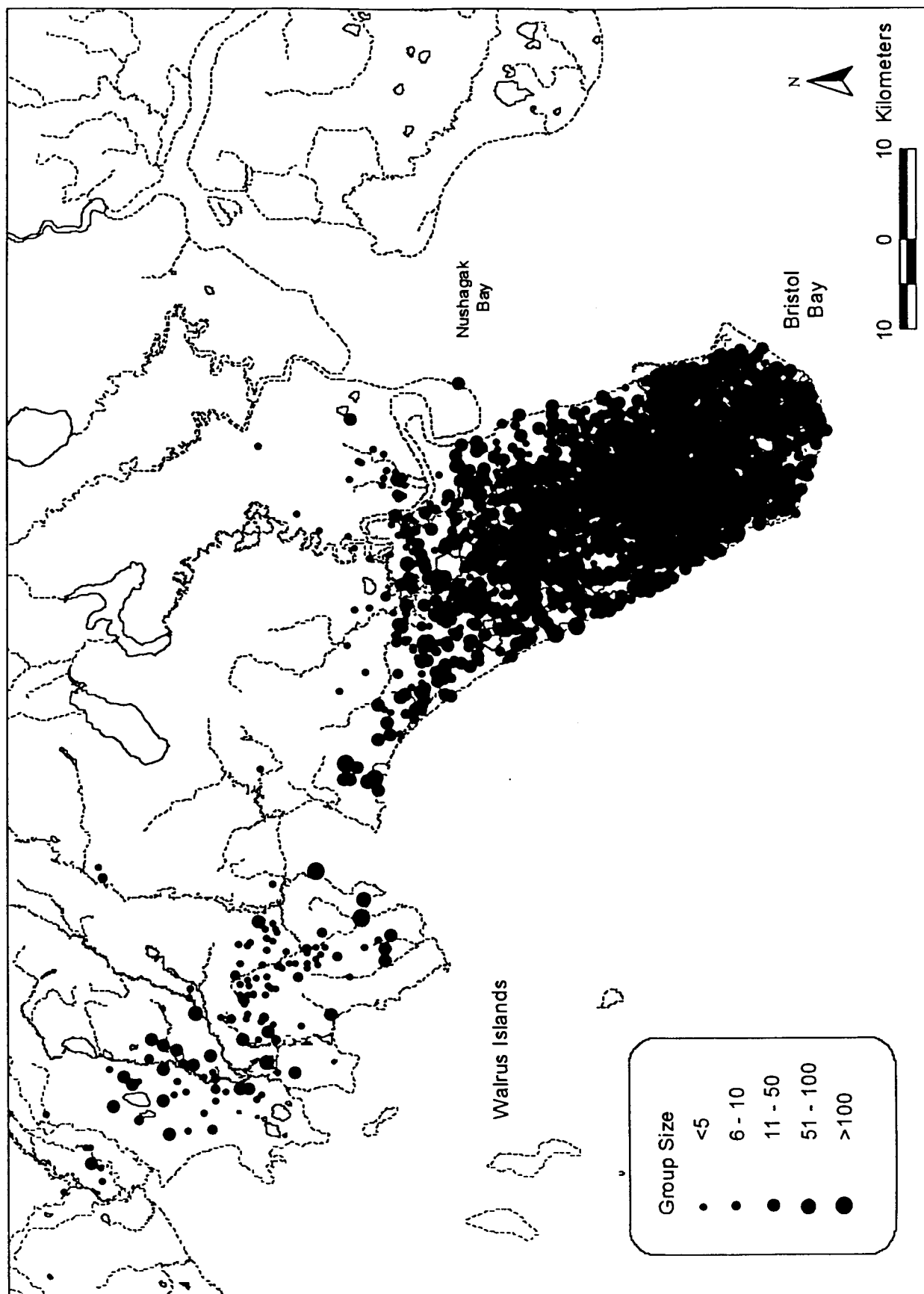


Figure 3. Distribution of caribou groups observed during aerial surveys from the Nushagak Peninsula Caribou Herd, southwest Alaska, March 1988 to March 2000.

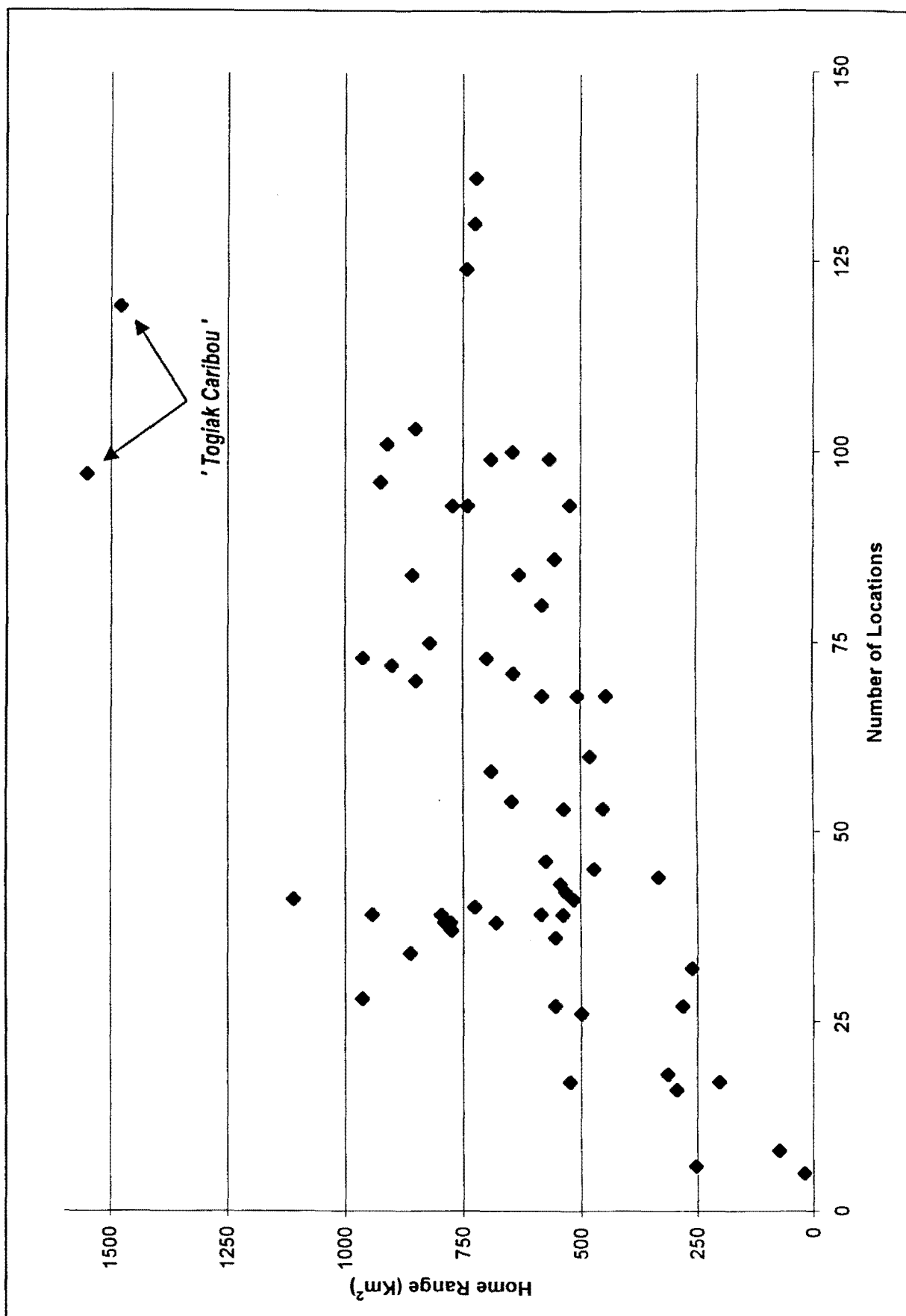


Figure 4. Home Range and Number of Relocations, March 1988 to March 2000, Nushagak Peninsula Caribou Herd

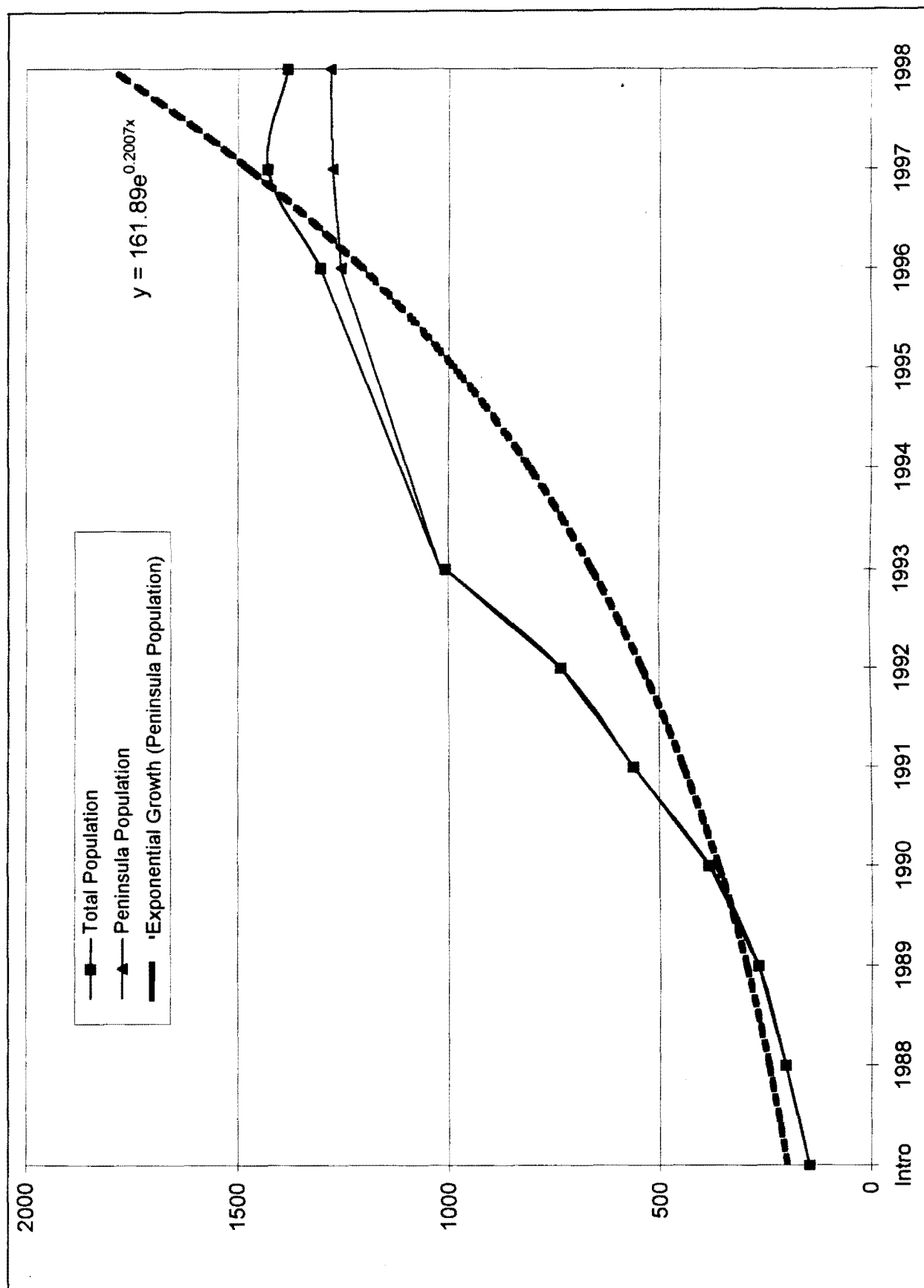


Figure 5. Growth of the Nushaqaq Peninsula Caribou Herd, 1988-1998

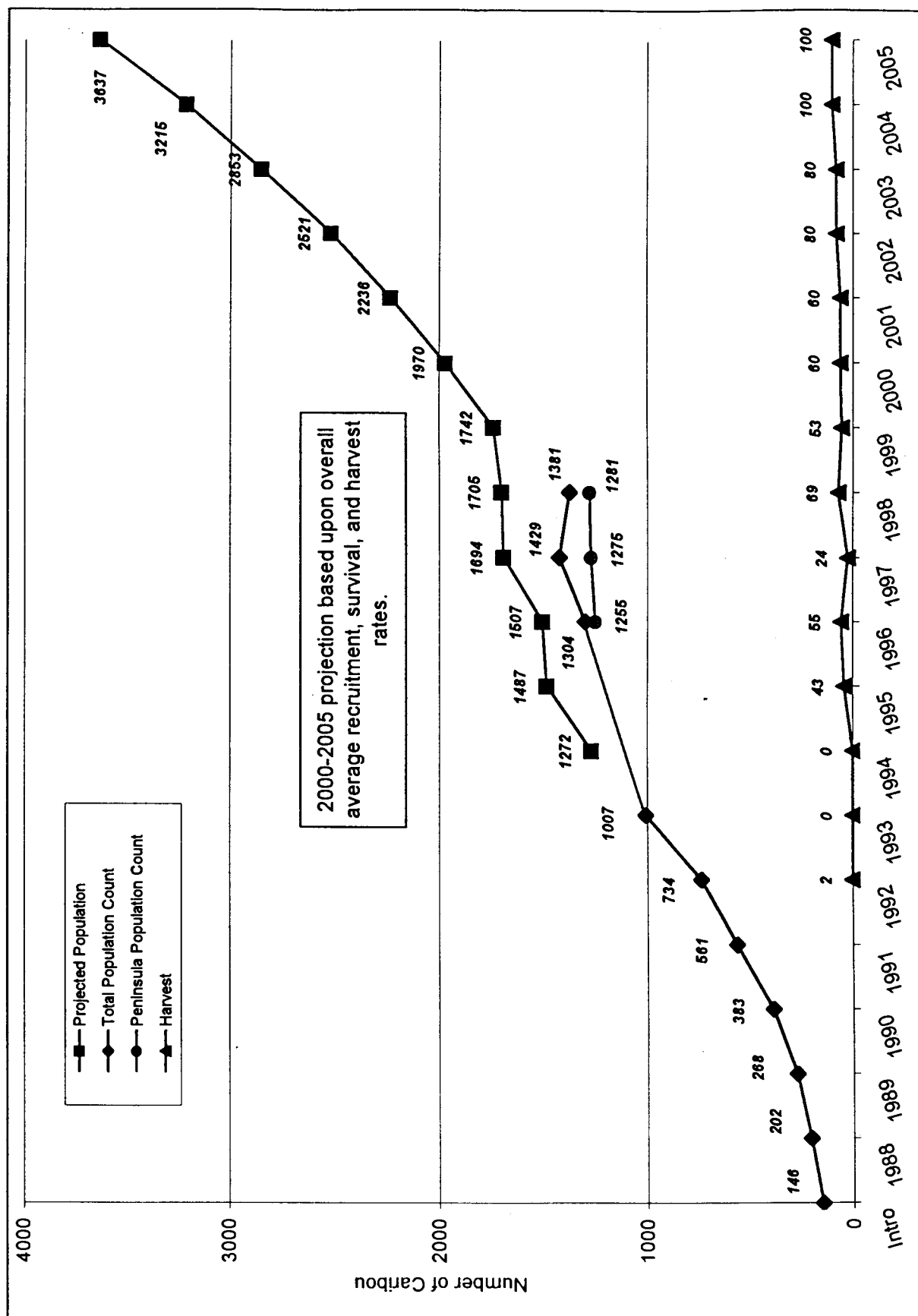


Figure 6. Population growth and projection of the Nushagak Peninsula Caribou Herd at average rates, 1988-2005

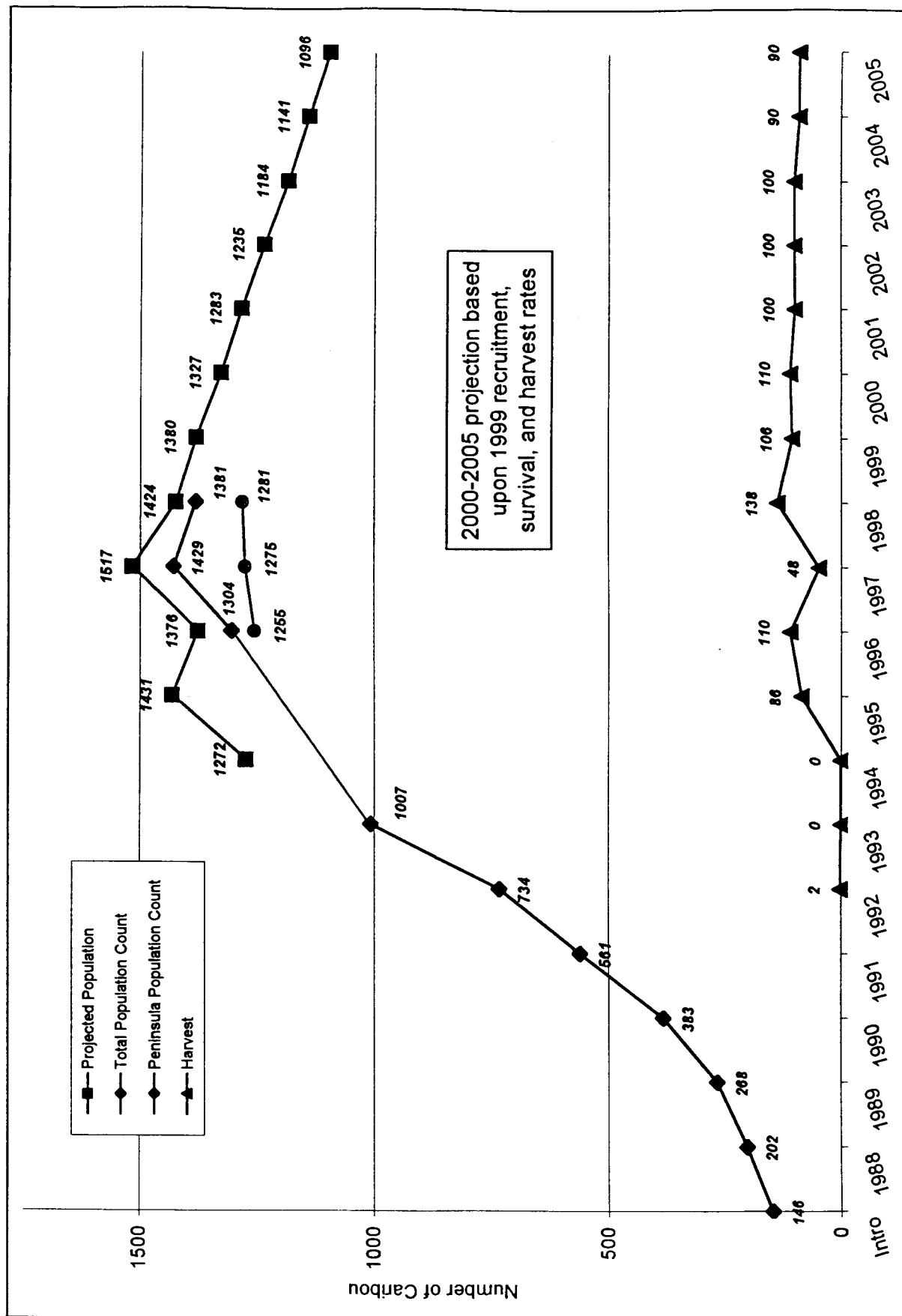


Figure 7. Population growth and projection of the Nushagak Peninsula Caribou Herd at 2x reported harvest rate, 1988-2005.