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EFFECTS OF PREDATION ON BLACK-TAILED  
DEER POPULATION GROWTH

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## PROGRESS REPORT (RESEARCH)

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Job Title: Effects of  
Predation on  
Black-tailed Deer  
Population Growth

Period Covered: 30 May 1984-30 June 1985

## SUMMARY

During the period 1968-74, wolf (Canis lupus) and deer (Odocoileus hemionus sitkensis) populations in GMU 3 declined from high densities to levels which are among the lowest in their sympatric range. Since the mid-1970's both species' populations appear to have been relatively stable. The proximate cause of the deer decline was severe winter weather, but wolf predation and habitat alteration may have aggravated losses. Wolf numbers declined following the reduction of their primary prey resource, but even the current low densities appear capable of limiting deer population recovery. In addition, predation by black bears (Ursus americanus) on fawns is known to occur and may now be a significant factor in limiting deer numbers.

Established monitoring of deer densities using nightcounts and pellet group counts should be expanded and intensified. Limited efforts to evaluate the degree of bear predation on fawns should be continued on an opportunistic basis. Telemetry should be used to enhance wolf census activities.

**Key words:** Alaska, Canis lupus, Odocoileus hemionus, sitkensis, predator-prey relationships, population dynamics, fawn mortality.

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## BACKGROUND

The Sitka black-tailed deer (Odocoileus hemionus sitkensis) is the primary big game species pursued by hunters in Region I, and it provides significant "nonconsumptive" use as well. Deer have been identified as a "Management Indicator" species by ADF&G and the USDA Forest Service, and deer habitat requirements are better understood than those of any other mammal species in the area. Ironically, however, in many areas south of Frederick Sound (GMU's 1-3) low density deer populations which are believed to be well below range carrying capacity do not appear to be increasing despite favorable weather conditions and conservative harvest strategies.

The lack of response of these deer herds to mild winters and restrictive seasons and bag limits has created a management problem with both short- and long-term consequences. Of immediate concern is the fact that the opportunity for human uses of deer is severely reduced. Deer hunting has been completely prohibited in most of GMU 3 for over 10 years. Recent public testimony to the Board of Game has demonstrated frustration with the Department's failure to deal with this problem. In a broader, and more important sense, public support of programs designed to protect or enhance deer habitat, with consequential benefits for other old-growth-dependent species, can be expected to decline as public

opportunity for hunting or other uses of deer decreases. For example, the Forest Service is currently using the recent low figures on hunter success as 1 estimate of "Hunter Demand" in a model designed to calculate the amount of winter range to be retained in future timber sales (Prather 1981). If the causes of suppressed deer populations and the means of increasing deer numbers cannot be identified, not only will a few years' hunting opportunities be forfeited, but the habitat base for deer and many other species may be permanently lost.

To a large segment of the local public, the cause of the deer population decline and subsequent lack of recovery is seemingly obvious: predation by wolves (Canis lupus). This opinion is based on several pieces of circumstantial evidence. First, during the 1950's the federal government conducted wolf control in the area, using poisons which effectively reduced some wolf populations (Rausch and Hinman 1977; Borch, pers. commun.). Following control, deer populations in many areas increased significantly (Wright, pers. commun.). In fact, on some islands where Klein (1965) had previously indicated that wolves were maintaining deer populations below range carrying capacity, deer began to deplete winter range forage along established condition and trend transects by the mid- to late 1960's (D. Zimmerman, pers. commun.). Second, following the declines in coastal deer populations that resulted from severe winter weather in 1968-69, 1970-71, and 1971-72, populations in GMU's 4, 6, and 8, where wolves are absent, have increased to high levels. In other units where wolves exist, deer declined to much lower levels and failed to increase in the late 1970's (Olson 1979).

Although these public perceptions may seem simplistic and largely ignore the effects of weather and habitat variability, there is an increasing amount of scientific information, both theoretical and empirical, to substantiate the fact that wolf predation is an important factor in the current suppression of deer populations in portions of GMU's 1-3. Two of the earliest studies that provided information on wolf-deer relationships were completed in GMU 3. The first of these studies was primarily designed to evaluate deer-range relationships. Klein (1965) compared body size and productivity of deer on Coronation Island, where the herd was at ecological carrying capacity (sensu Caughley 1976), with deer on Woronkofski Island where the herd was below carrying capacity. He found that deer which were not forage-limited grew larger and were more productive. The principle differences between the 2 study areas were that Coronation Island had milder winters, less diverse range, and no wolves, while Woronkofski Island had greater snowfall, more productive alpine summer range, and an abundant wolf population. Although Klein (1965:268) stressed the importance of the influence of range condition on demography in the 2 deer herds, he concluded that "wolves had also been a factor in controlling the deer on Woronkofski

Island." Thus, the potential role of wolves in keeping deer below ecological carrying capacity should not be discounted.

In a subsequent study, wolves were introduced to Coronation Island as part of an "experiment" to evaluate wolf-deer relationships (Merriam 1964). Within a few years following introduction of wolves to the island, deer were nearly eliminated from the island. As the deer population declined wolves increasingly fed on seals and marine carrion, and cannibalism was documented. Eventually, wolves totally disappeared from the island, and the remnant deer herd increased. Although this study lacked a "control" and the small size of the island (approximately 70 km<sup>2</sup>) prevented eventual stability of a predator-prey system, the rapid decline of deer following wolf introductions indicates the potential effects of wolves on insular deer herds.

More rigorous analyses of deer-wolf systems have been conducted in Ontario (Pimlott et al. 1969, Kolenosky 1972) and northern Minnesota (Mech 1972, 1973, 1975, 1977a, b, c; Van Ballenberghe and Mech 1975; Seal et al. 1975; Van Ballenberghe et al. 1975; Hoskinson and Mech 1976; Mech and Karns 1977; Mech and Frenzel 1981; Fritts and Mech 1981; Nelson and Mech 1981). These reports stress that wolf predation can limit white-tailed deer (Odocoileus virginianus) numbers under a variety of circumstances and that the behavioral evolution of deer has been largely shaped by the need to avoid predation by wolves.

Biologists studying deer-wolf relationships on Vancouver Island have come to similar conclusions. Scott and Shackelton (1980), Hebert (1981), Hebert et al. (1982), Jones and Mason (1983), and Hatter (1984) clearly documented the role of wolves in reducing and limiting deer (O. h. columbianus) in ecosystems similar to those in southern Southeast Alaska. Ongoing research on Vancouver Island is designed to assess methods of wolf management and response of deer populations to wolf control (Atkinson 1985).

Van Ballenberghe and Hanley (1982) synthesized the existing knowledge of deer/wolf systems into a conceptual model applicable to the old-growth forest ecosystem of Southeast Alaska. Their model interrelates various deer productivity and mortality rates, kill rates for wolves, and influence of hunter harvest on deer recruitment. It then calculates wolf:deer ratios required to maintain equilibrium of both populations. Using this approach, these authors concluded that it is highly likely that wolves are capable of limiting deer populations in this area. They further suggest that in view of the detrimental effects of logging and hunter harvest on deer productivity, further depressive effects of wolf predation are probably inevitable unless wolves are also managed. In addition to the potentially adverse effects of logging on deer

productivity through reduced carrying capacity, fragmentation of deer winter range into isolated unharvested blocks of old growth may alter wolf-deer relationships by concentrating the prey. Such concentrations would increase vulnerability and intensify the suppressive influence of predation.

Two possible weaknesses exist in the conceptual model developed by Van Ballenberghe and Hanley (1982). First, the model may be criticized for failing to address the potential for cycles wherein once wolves deplete deer, wolf populations decline and deer subsequently rebuild. Support for this hypothesis may be drawn from the results of the Coronation Island "experiment." However, as Van Ballenberghe and Hanley (1982) point out, on larger islands alternative prey sources may serve to buffer the wolf decline and sustain enough wolves to hold deer at low numbers. This situation may have occurred on Revillagigedo Island where wolf numbers declined from an estimated 70-90 in 1971, to 30-40 in 1982 (ADF&G, unpubl. data) following the deer population crash. (Deer numbers on Revillagigedo are currently low and stable.) In view of the very low wolf:deer ratios that are suggested as being capable of holding deer in check, wolves may have to decline significantly more to permit a deer population "rebound." Furthermore, evidence of continuing low deer numbers in both Minnesota (Nelson and Mech 1981) and in GMU's 1-3 following wolf population declines, attest to the potential for these species to coexist at low, relatively stable levels.

Another criticism of Van Ballenberghe and Hanley's model is that it does not explicitly address the potential effects of other types of predation, notably bear predation on fawns. Results of recent studies of neonate elk (Cervus canadensis) (Schlegel 1976) and moose (Alces alces) (Ballard et al. 1980, Franzmann et al. 1983) indicate that both black bears (Ursus americanus) and brown bears (Ursus arctos) can significantly reduce recruitment in these prey species. Ozoga and Verme (1982) demonstrated that black bear predation can affect white-tailed deer recruitment, at least in an enclosed population. However, deer populations in GMU's 4 and 8 have increased dramatically in the presence of brown bears (which should be potentially as effective predators as black bears in GMU's 1-3); black bears were not implicated in deer-wolf studies in Minnesota or Ontario; and black bears were not found to be important predators of radio-collared neonate black-tailed deer fawns on Vancouver Island (Hatter 1984), implying that bears may not be a major consideration in deer population regulation in GMU's 1-3. Nevertheless, in view of the variability of predator-prey systems and the potential for underestimation of bear predation (Wilton, in press), bears should be considered in the analysis of predator-prey relationships in Southeast.

## STUDY OBJECTIVE

To determine the effects of nonhuman predation on population dynamics of Sitka black-tailed deer in Southeast Alaska.

## JOB OBJECTIVES

To determine relative or absolute density of deer within the study area.

To determine relative or absolute density of wolves within the study area.

To determine causes of fawn mortality within the study area.

To determine sex and age composition of the deer population within the study area.

To assess historic trends in deer and wolf populations in the vicinity of the study area.

To evaluate the effectiveness of various methods of reducing the ratio of wolves to deer within the study area.

To evaluate the response of the deer population to reduced wolf numbers.

## STUDY AREA

Mitkof, Kupreanof, and Kuiu Islands in GMU 3 were selected as the study area for this project (Fig. 1). These islands fall within the Kupreanof Lowlands geological region, characterized by relatively broad, poorly drained valley floors separated by rolling ridge complexes with elevations to 1,500 m. Lowlands are dominated by muskeg and noncommercial stands of cedar (Thuja plicata and Chamaecypris nootkatensis) and western hemlock (Tsuga heterophylla). Uplands are dominated by commercial stands of hemlock and cedar. Sitka spruce (Picea sitchensis) occurs along well-drained stream courses. Clear-cut logging of uplands has been extensive on Mitkof Island and is expanding on Kupreanof and Kuiu.

Deer populations on these islands have been protected from hunting since 1975 yet remain well below ecological carrying capacity. Subjectively, it appears that deer numbers have increased slightly on southern Mitkof Island in the last 2 to 3 years, but deer remain exceedingly rare on Kupreanof and Kuiu. Both wolves and black bears occur on all 3 islands.

## METHODS

### Deer Density

Relative density of deer on southern Mitkof Island was determined by using the nightcount technique described by Harestad and Jones (1981). Preselected logging roads (Fig. 2) were driven during late May and early June, beginning at dark. Two high-intensity spotlights were used to search roadside clearcuts, muskegs, and forest stands for deer. Deer were identified from the reflection of light from the choroid layer of the retina and binoculars were used to classify deer by age and sex.

Nightcounts were conducted over a period of 10 days in 1984 and 4 days in 1985. Each night's data were treated as repeated samples from the population. Initially, road sections were treated as separate transects. To standardize the units of the density index for transects with varying lengths, the number of deer observed was divided by the length (km) of the transect. The mean, standard error, 95% confidence interval, and coefficient of variation of deer/km were calculated for each transect. Subsequently, data from road sections driven on the same night were pooled to increase both the length of the sample transect, and the number of deer seen on a transect, to evaluate the effect of total numbers counted on the precision of the estimate as reported by Harestad and Jones (1981).

To evaluate the hypothesis that deer density was unchanged from 1984 to 1985, the results of the 2 years' nightcounts were compared using a t-test (2-tailed,  $P = 0.05$ ). To avoid potential biases due to differential distribution of sampling effort in the 2 years, only results from transects driven during both years were used for comparisons between years.

Finally, because the observers felt the number of deer seen on successive nightcounts was declining, regression analysis was used to assess the significance of changes in the number of deer seen on specific transects. Only those transects with a minimum of 4 replicate counts in any year were used for this analysis.

### Wolf Density

Wolf population size was estimated from aerial track surveys conducted following fresh snowfall in December 1984. Two observers in a Cessna 185 flew along beaches and open muskeg areas until tracks were located. The tracks were then followed until the extent of the pack's movements and the size of the group could be ascertained. Attempts were made to cover all of Mitkof and Kupreanof Islands in the course of searching for or following tracks, to reduce the probability of missing any wolf activity.



### Fawn Mortality

Fawn mortality was assessed using radiotelemetry as described by Hatter (1984). Attempts were made to locate fawns during the course of nightcounts and by driving other logging roads throughout the day. When spotted, fawns were pursued on foot for capture by hand or with a long-handled dip net. The ages of captured fawns were estimated from their mobility, hoof wear, and umbilicus condition. Fawns were weighed, measured, sexed, ear-tagged, and fitted with mortality-sensing radio collars (Telonics Inc., Mesa, Az.).

Collared fawns were located from logging roads daily for 1 or 2 weeks, then once each 48 hours for the next several weeks. After 1 August fawns were located opportunistically 1 to 4 times per month until the collar was shed. If a mortality signal was detected, the collar was located and the vicinity was investigated to determine the cause of death.

### Sex and Age Ratios

Attempts were made in spring to determine the sex and age ratio of the population by classifying deer observed on the nightcounts. Deer were classified as adult males, adult females, fawns, and unknowns.

Aerial surveys of alpine areas on Mitkof and Kupreanof Islands were flown in July 1984 to determine summer age ratios. Deer were classified as adults and fawns.

### Historic Trends

Wolf bounty and sealing records were examined for trends in the harvest. These trends were interpreted as reflective of total wolf population. Deer population trends were deduced from published reports and from data on file regarding deer in recent years.

### Reducing Wolf:Deer Ratios

No work was planned or conducted for this objective during this report period.

### Monitoring Deer Response

No work was planned or conducted for this objective during this report period.

## RESULTS AND DISCUSSION

### Deer Density

Nightcounts were conducted from 30 May to 9 June 1984 and from 3 to 6 June 1985. The mean number of deer/km seen on individual transects in 1984 ranged from 0.1 to 1.7 and in 1985 the values ranged from 0.7 to 3.2 (Table 1). Although the mean values for all transects were higher in 1985, none of the differences were found to be statistically significant at the 95% confidence level.

Nightly results from transects 5 and 6, for each of the 2 years; from transects 5, 6, and 7 in 1984; and from 2, 3, 5, and 6 in 1985, were pooled to increase the length of the sample "transect" for further statistical treatment. Analysis of the influence of the total number of deer counted on a transect, on the coefficient of variation of the mean number of deer seen on repeated counts of that transect (Fig. 3), revealed that longer transects with larger counts were more precise, as was found on Vancouver Island (Harestad and Jones 1981). Accordingly, pooled data were used to retest the hypothesis of "no change" in deer density from 1984 to 1985. In spite of increased precision of the estimates, no statistically significant ( $P < 0.05$ ) difference was found between the values presented in Table 1 for 1984 and 1985. Based on an evaluation of the accuracy of trend assessments (such as nightcounts) that use imprecise methodology (Harris 1984), it appears that 3 to 5 replicates per year, using pooled data from transects 1 through 6, would provide an estimate of the rate of population change that would be accurate to within 10% per year at the 90% confidence level after a minimum of 3 years' counting. Thus, at least 1 more season of nightcounts will be required to provide reasonable statistical confidence as to whether or not the population is changing.

Although the total number of deer counted on the transects was highly variable, the observers had the impression of an overall decline during the course of replicate counts in both years. In addition, observers noted a general trend toward deer being found higher up the slopes in the clearcuts on successive nights. It was felt that this trend might be in response to either a natural, upslope shift associated with advancing phenology or in response to the disturbance of the nightly counts. However, regression analysis of the trend in number of deer counted on any given transect or combination of transects did not permit rejection of the null hypothesis of zero slope for any transect's regression line except T2 in 1984, so the density index estimates appear to be free of any significant temporal trend. Nevertheless, in spite of the lack of statistical significance, we remain concerned that counts conducted over an extended period may be subject to real seasonal and/or behavioral variation and recommend that future counts be conducted over a relatively brief period.

The density indices obtained from nightcounts in 1984 and 1985 are comparable to, or less than, the lowest values reported for areas of Vancouver Island where wolves were responsible for decimation and suppression of deer populations (Hebert et al. 1982, Jones and Mason 1983). Although cutting unit size and other visibility factors which can affect the density index (Harestad and Jones 1981) may differ between Mitkof and Vancouver Islands, the senior author's personal experience in conducting nightcounts in both locations indicates that these differences are not likely to significantly jeopardize comparisons.

The similarity in deer density between these 2 areas is also indicated by winter range pellet group densities which averaged 1.1 groups/20 m<sup>2</sup> on Vancouver Island following the deer decline (Jones and Mason 1983) and averaged 0.9 groups/20 m<sup>2</sup> on southern Mitkof Island in 1984 and 1985 (ADF&G, unpubl. data).

Although no nightcount data are available for other parts of the study area, pellet group data indicate that densities are even lower on Kupreanof and Kuiu Islands than on southern Mitkof Island (ADF&G, unpubl. data). Thus, overall, deer densities in the study area are among the lowest reported for the entire range of the black-tailed deer.

#### Wolf Density

An aerial survey of Mitkof and Woewodski Islands flown on 29 December 1984, 10 days after the last snowfall, resulted in 8 sightings of wolf tracks. Two single sets were observed and 6 sightings were made of 2 or 3 sets. The tracks appeared to have been made by 2 separate packs, one ranging on Mitkof Island northeast of Blind Slough, the other on Woewodski. Each pack was estimated to contain 2-4 wolves. A wolf population on Mitkof and Woewodski Islands in the range of 4-8 wolves indicates the density would be 1 wolf per 75-150 km<sup>2</sup>.

An aerial survey of Kupreanof Island flown on 30 December 1984 resulted in 33 sightings of from 1 to 5 sets of wolf tracks. It appeared that the tracks were made by 2 packs, 1 of 4-6 wolves ranging on the Lindenberg Peninsula and another of 3-5 wolves ranging over the remainder of Kupreanof. A population on Kupreanof of 7-11 wolves results in a density of 1 wolf per 250-400 km<sup>2</sup>.

Although efforts were made to locate and follow all visible tracks on the islands, it is likely that some activity was missed and additional wolves may occur within the study area. For example, a similar track survey flown over the southern half of Revillagigedo Island on 26 December resulted in 8 sightings of from 1-4 sets of tracks made by what appeared to be 4 packs totaling 12-15 wolves (Smith, unpubl. data). However, subsequent intensive ground tracking, trapping, and radiotelemetry revealed that the surveyed area contained at

least 5 packs with a known minimum of 21 wolves (Smith, unpubl. data). Thus the population and density estimates for Mitkof, Woewodski, and Kupreanof Islands must be considered conservative and imprecise.

Although the estimated densities are minimal, even if they were doubled they would be relatively low compared with estimated density on Revillagigedo Island (1 wolf/60-90 km<sup>2</sup>, Smith, unpubl. data) or published values for other areas where deer are the primary prey species, such as Ontario (1 wolf/25.9 km<sup>2</sup>, Pimlott et al. 1969), Minnesota (1 wolf/14 km<sup>2</sup>, Mech 1973; 1 wolf/24 km<sup>2</sup>, Van Ballenberghe et al. 1975) and Vancouver Island (1 wolf/6.4-15 km<sup>2</sup>, Scott 1979; 1 wolf/12-17 km<sup>2</sup>, Hebert et al. 1982).

#### Fawn Mortality

Fawns were observed on 8 out of 23 nights and none of 5 days of searching in 1984. Two of the 8 fawns that were sighted were far enough from the road and sufficiently mobile to evade capture, so no pursuit was initiated. In 5 cases the fawn or fawns were pursued, but managed to out-distance the crew on foot, or were hidden by the doe in dense vegetation and could not be located. In 1 instance a fawn was first observed bedded; it made no attempt to flee when approached.

Fawn No. 1 (male) was captured, processed, and released approximately 5 km west of Woodpecker Cove on 6 June 1984. The doe remained approximately 150 m away throughout the tagging process.

The radio-collared fawn was monitored from 7 June 1984 until it shed its collar in February 1985. During that time it moved over an area of approximately 3 km<sup>2</sup>. The shed collar was recovered within 100 m of the original capture site in May 1985 and the deer was resighted on 10, 11, and 13 June 1985 within 50 m of the original capture site.

Fawns were observed on 4 out of 12 nights and 1 out of 2 days of searching in 1985. Of the 5 sightings, captures were attempted on 3 occasions. Two attempts were successful.

Fawn No. 2 (male), captured while following its mother on a logging road, was processed and released approximately 1.5 km west of Woodpecker Cove on 4 June 1985. Following release the fawn moved downslope from the road. It remained there, ranging over an area of about 1 km<sup>2</sup> through the end of this report period.

Fawn No. 3 (male) was captured in its bed 30 m off the road, in a clearcut 1 km east of Woodpecker Cove, on 5 June 1985. The following day it was still within the cut unit. Over the next 3-5 days it moved gradually upslope toward the old-growth timber. By 17 June it was still within the old-growth timber approximately 1 km from the release site.

On 19 June the signal indicated the fawn was dead. Its remains were located on 20 June, 700-800 m upslope from the edge of the clearcut, in old-growth forest. Available evidence indicated that a black bear had found the fawn bedded at the base of a hemlock, and killed and eaten it. The fawn was completely consumed, except for approximately a quarter of the hide which was turned "inside-out" as is typical of bear-killed fawns (Wilton, in press).

#### Sex and Age Ratios

Attempts to ascertain sex and age ratios from spring night-counts were frustrated by small sample sizes and frequent poor visibility. Of the 10 nights spent on transects in 1984 the total number of deer seen per night averaged only 13 (range 4-27). Of these, fewer than half could be accurately classified on most nights. Rain, drizzle, or fog often prevented sex classification of deer over 100 m from the road and does were rarely seen accompanied by their fawns although their distended udders and response to a "bleating" call indicated many had given birth. Similar difficulties in British Columbia led biologists there to discontinue efforts to classify deer on nightcounts (Jones, pers. commun.)

Although the average number of deer seen per night increased in 1985 to 41 (range = 31-47), no more than 12 deer could be accurately classified on any given night. As in 1984, many postpartous females were not accompanied by fawns.

An aerial survey of alpine ridge areas on eastern Mitkof Island was flown early in the morning on 25 July 1984. The survey took 1.1 hours and resulted in the sighting of 8 adult deer and no fawns. Another survey on the afternoon of 27 July covered the Lindenberg Peninsula on Kupreanof Island and southeast Mitkof Island. This flight also lasted 1.1 hours and resulted in the sighting of 1 adult deer on each island.

The results of these surveys are in contrast to counts made in August 1955 by D. Klein, who reported seeing 151 deer on a 1.3-hour aerial survey of the ridges on eastern Kupreanof, and who classified 85 deer in 2 days of foot surveys on Mitkof and Kupreanof Islands (unpubl. data, ADF&G, Petersburg). Given the current low densities of deer in the study area, it is impractical to determine the sex and age structure of the population. However, as argued by Caughley (1974), age ratio data are unreliable indicators of population dynamics and are unnecessary for determining rate of increase. Inasmuch as this study is concerned primarily with the effect of predation on the rate of increase, not population structure, the inability to accurately assess sex and age composition is not critical to success of the project.

### Historic Population Trends

Numerous authors have reported that deer populations in Southeast Alaska are cyclic and that population lows have occurred following a series of harsh winters (Klein and Olson 1960, Merriam 1970); the most recent series of such winters occurred during the period 1968-73 (Olson 1979). Starvation related to burial of forage under snow during severe winters is believed to be the primary mortality factor operating on the deer herd. Recently, Schoen and Kirchhoff (1983) documented 40% mortality in a sample ( $n = 15$ ) of radio-collared adult deer during the relatively severe winter of 1981-82. Presumably, these losses were all due to starvation, as they occurred after the hunting season, on an island without wolves. It can be safely assumed that juvenile mortality was even higher (Caughley 1976). Thus, under extreme conditions, total mortality in deer populations could exceed 50% per year. Annual starvation losses of this magnitude could quickly reduce deer numbers, regardless of the impact of predation or hunting, and a series of such severe winters could decimate even the largest deer herd.

Evaluations of long-term weather records by Juday (1982) and Smith (1984) support the belief that winter severity is cyclic in the region. Smith (1984) concluded that these cycles are closely correlated with major changes in mountain goat (*Oreamnos americanus*) population levels. The timing of deer population lows reported by Olson (1979) also corresponds with periods of colder-than-average winters.

With respect to the study area, Merriam (1970) indicated that deer numbers had peaked in the mid-1960's and declined in association with increasingly severe winters through 1969. Subsequently, the population was further reduced by additional severe winters in 1970-71 and 1971-72 when starvation-induced mortality was extensive (Merriam and Zimmerman, pers. commun.).

Historically, following major winter die-offs deer populations were reported to recover to high levels within 4 to 5 years (Klein and Olson 1960, Merriam 1970, Olson 1979). This general pattern has continued in GMU 4 (no wolves) where deer numbers rebuilt to high levels by the late 1970's following the 1968-73 decline (L. Johnson, pers. commun.).

Recovery of deer populations was reported to take longer on the mainland and on islands occupied by wolves, but sporadic predator control programs using poison were conducted in the 1930's, 40's, and 50's following severe winters (C. Buckmaster, pers. commun. to R. Stephenson), so it is impossible to draw any clear conclusions regarding the magnitude of the impact of predation on deer population recovery, or natural adjustments in wolf numbers, from early population trends. However, variability in recovery rates of deer

populations in wolf-occupied areas following the most recent decline (1968-73) does provide insight as to potential alternative outcomes.

In GMU 2, including Price of Wales and the outer islands where the greater maritime influence and topographic relief may have moderated winter severity relative to Units 1A, 1B and 3, deer populations have gradually increased and are currently doing well (R. Wood, pers. commun.). In GMU's 1 and 3, declines in deer densities were, in all likelihood, significantly greater than on Prince of Wales Island. Throughout most of the area no recovery of the population is evident after a decade of mild winters. While other factors such as hunter harvest, bear predation, and extent of winter range depletion due to logging may also cause variability in predator-prey dynamics in GMU's 1-3, the observed patterns lend support to the hypothesis that if a prey population is depressed below some threshold level, predators will be able to "trap" the prey population for an extended period of time (Bergerud 1983).

Although direct data on wolf population status are not available, annual wolf harvest in GMU 3 has fluctuated dramatically over the past 24 years (Fig. 4) and is believed to reflect general trends in wolf numbers. Although payment of bounties and other economic considerations during the years of peak harvests may have induced increased trapping effort to some extent, it is not likely that these factors alone could produce changes in wolf harvest on the order of those observed here. The total take, by season, increased from 18 in 1961-62 to over 80 in 1967-68, then declined to former levels of 10-25 for the period 1975-76 through the present.

The rapid increase in wolf harvests (and presumably wolf population) in the mid-1960's followed the suspension of wolf control in 1959 and coincided with the peak in deer numbers described above. The alternating nature of the harvests during the peak years may indicate that a high harvest in 1 year reduced the number of wolves temporarily, but that reproduction and recruitment were adequate to enable rapid recovery of the population. Following the decline in deer numbers associated with the severe winters of 1968-73 wolves may not have been able to recruit sufficient numbers to rebuild the population. Extensive declines in live beaver colonies during the mid-1970's in GMU 3 may reflect increased use of this prey resource by a high density wolf population as deer were declining. A similar shift in predator food habits, in response to changing prey densities, was observed in Minnesota (Van Ballenberghe et al. 1975).

Wolves have now declined to low densities in GMU 3, and appear to be stable. Although there are subjective indications of some increase in deer numbers on portions of southern Mitkof, it remains to be seen whether this increase is real, and whether or not wolves will respond to, and/or limit, this change in prey density.

## CONCLUSIONS

Deer and wolf densities in the study area are currently among the lowest in their sympatric range, and appear to be relatively stable. Nightcounts along logging roads and pellet group counts over a broader area appear to be capable of providing meaningful data on deer population trends. These indices should be continued and expanded. Aerial surveys of wolf tracks during winter were useful for identifying areas of activity and generating minimum population estimates, but the accuracy and precision of such surveys is unknown. Additional surveys, preferably aided by telemetry, are needed to better estimate wolf density in the study area.

Causes, timing, and extent of mortality of fawns are unknown. It may take several additional years to capture a sufficient number of deer to determine the potential role of bears as predators. Deer numbers are too low to permit gathering of adequate data on sex and age structure for making an inference regarding the level of recruitment to the population. Future resources should be concentrated on direct measures of rate of increase over a greater portion of the study area. Historically, deer and, presumably, wolf numbers have fluctuated in a cyclic manner, and they continue to do so in some areas. A peak in the deer population in the study area in the early 1960's was followed by a peak in wolf numbers in the mid- to late 1960's. Both species declined dramatically by the mid-1970's. The continuing nature of the current low densities of both species' populations in GMU 3 may be the result of a number of factors which acted in concert to reduce deer to a level below some recovery threshold. These factors include severe winter weather, habitat loss, wolf predation, and harvest by humans. Bear predation on neonates does occur and may be a significant influence on present deer numbers.

## RECOMMENDATIONS

1. Spring nightcounts should be continued on southern Mitkof Island and additional routes on Kupreanof and Kuiu Islands should be established and monitored annually.
2. Fawns observed on nightcount transects should be captured when possible to assess levels of bear predation on neonates.
3. Pellet group transects in addition to those currently being monitored for management purposes should be established and monitored within the study area.
4. Concerted efforts should be made to live-capture and radio-collar wolves on Mitkof and Kupreanof Islands to aid in estimating total wolf numbers. Radio-collared wolves should be monitored at least monthly.



5. Attempts to measure the sex and age structure of the deer herd should be discontinued.

6. As soon as the population trend for deer can be reliably estimated from nightcounts and/or pellet group transects, wolf numbers should be reduced in an experimental area to monitor deer population response.

#### ACKNOWLEDGMENTS

Alaska Department of Fish and Game biologists R. Ball (deceased), M. Thomas, and R. Flynn assisted with nightcounts and fawn capture activities; technician L. Beier flew wolf tracking surveys and provided valuable historic and local insights on deer and wolves in the study area. Alice Young was a gracious hostess and provided many well-appreciated meals for the crew. Jennifer Owens typed the manuscript.

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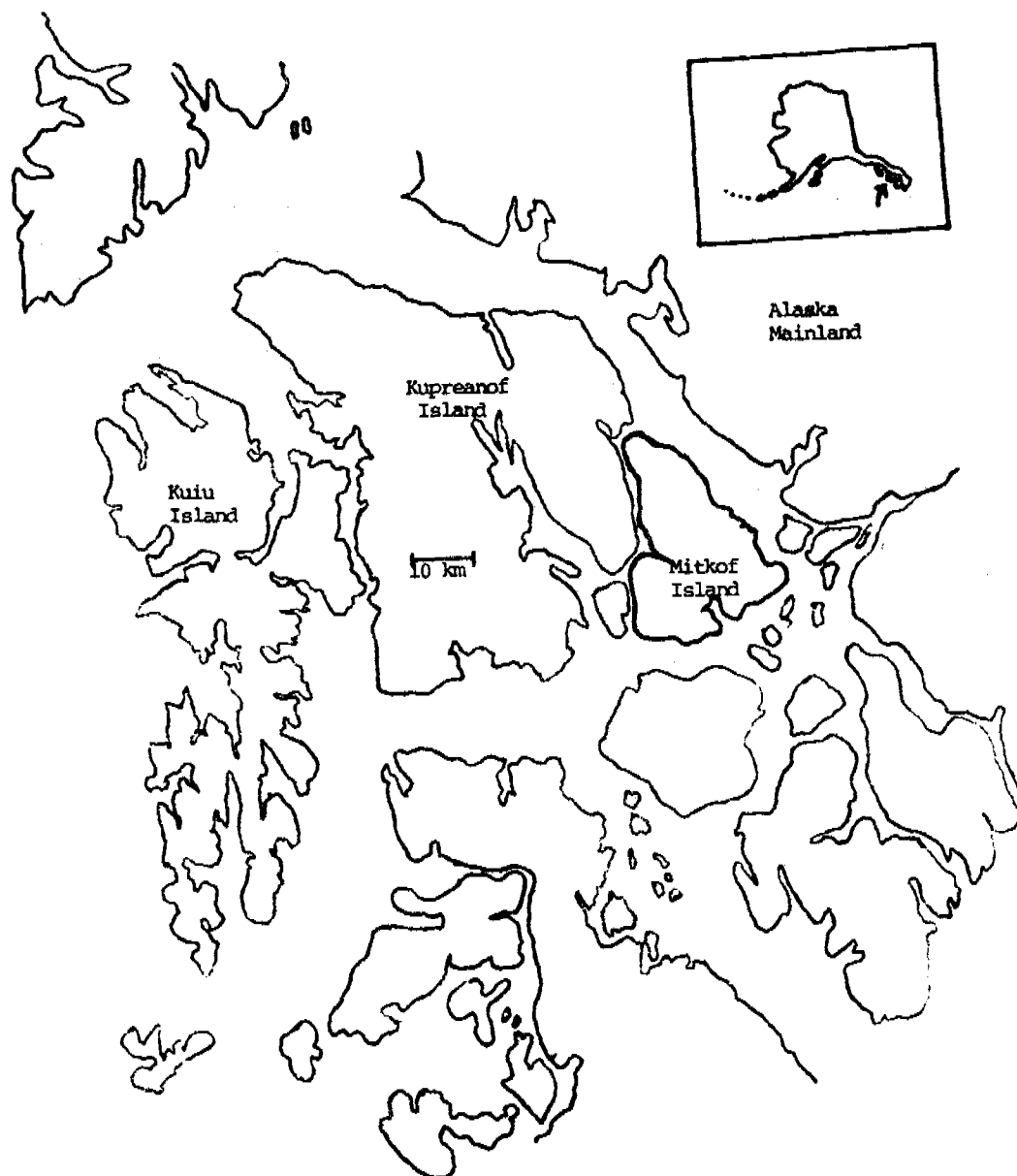


Fig. 1. Location of Mitkof, Kupreanof, and Kuiu Island study area in southeast Alaska.

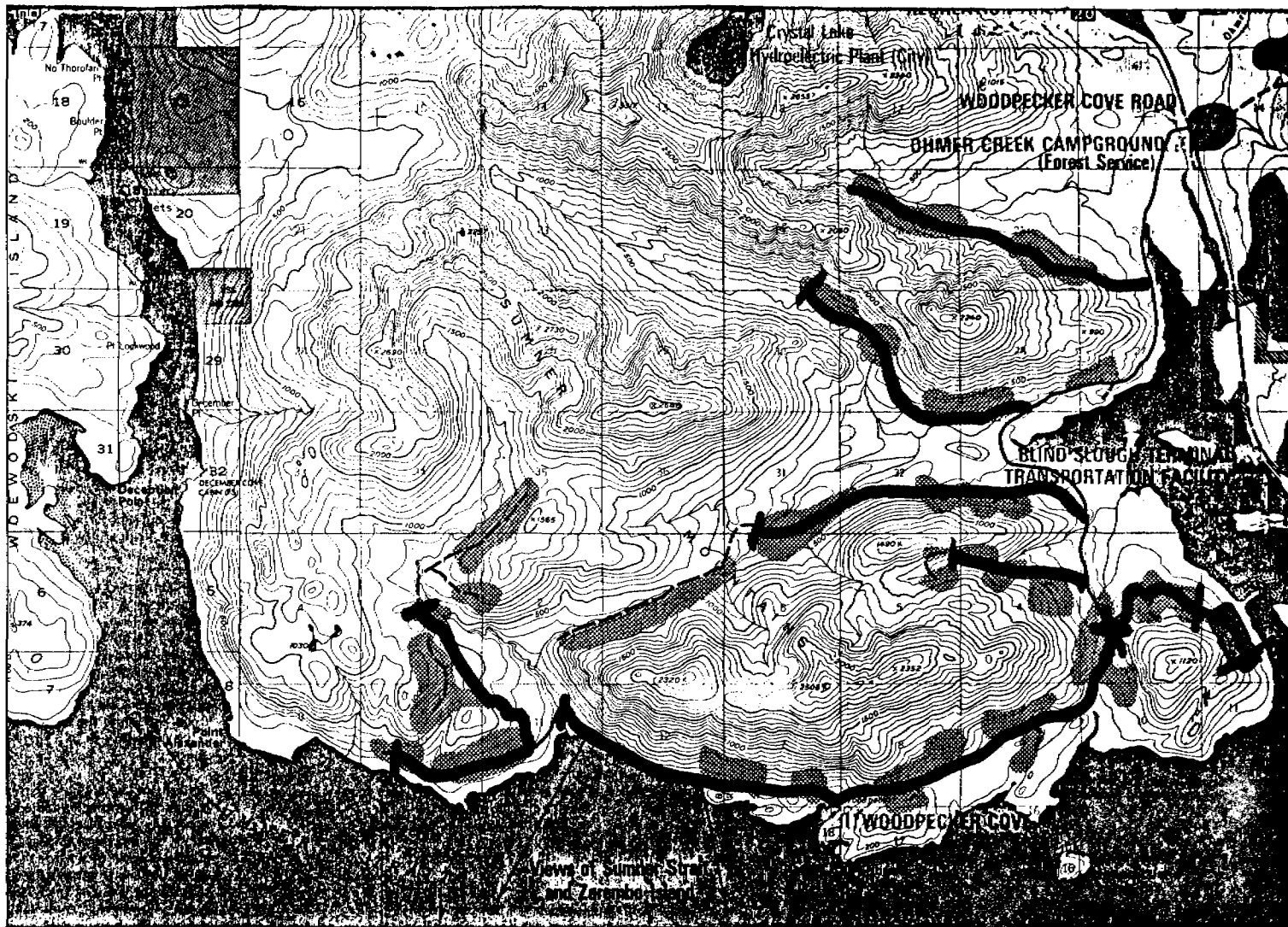


Fig. 2. Nightcount transect routes, southern Mitkof Island, Alaska.

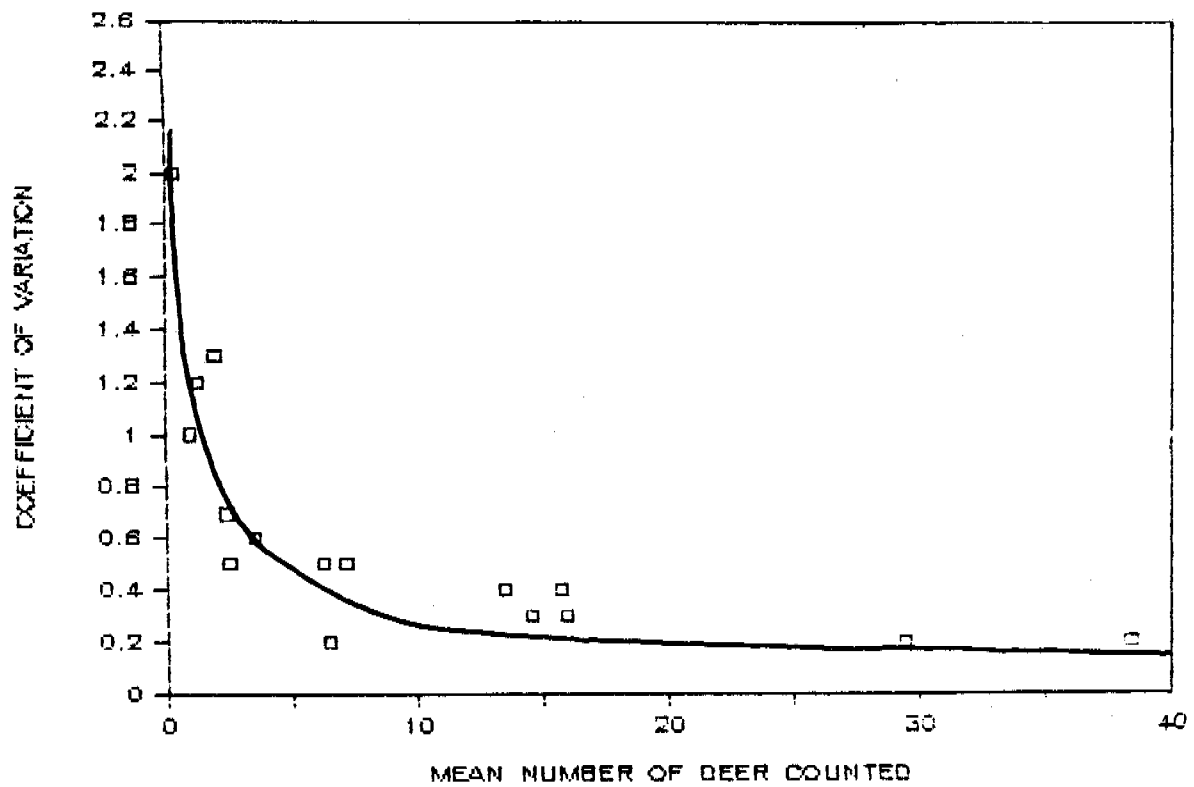


Fig. 3. Influence of the mean number of deer counted on coefficient of variation for nightcounts on Mitkof Island, May and June 1984 and 1985.



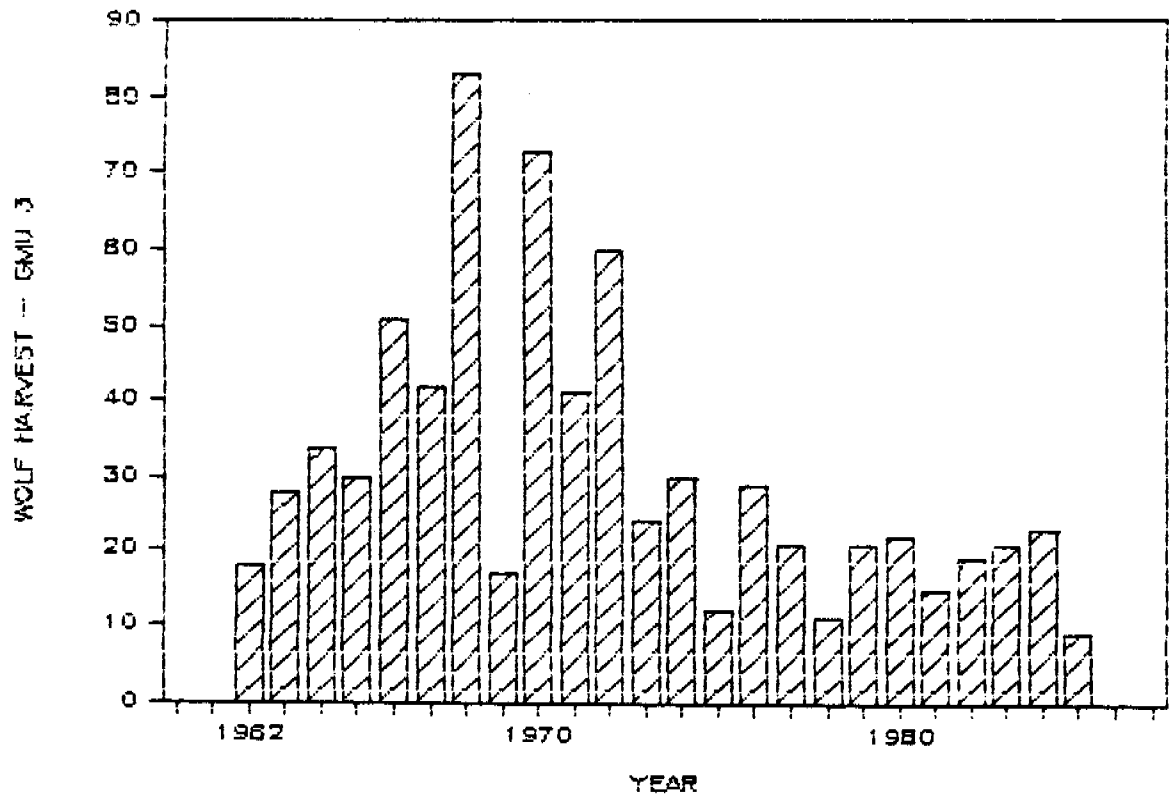


Fig. 4. Annual wolf harvest in Game Management Unit 3 for hunting/trapping seasons in 1962-85.

Table 1. Deer nightcount index (deer/km) for Mitkof Island transects, May and June 1984 and 1985.

Transects	1984			1985		
	Mean	Range	( <u>n</u> )	Mean	Range	( <u>n</u> )
1 (3.2) <sup>a</sup>	0.1	0.0-0.3	4	1.1	0.6-1.6	2
2 (4.3)	0.6	0.2-1.2	5	1.5	1.2-1.6	4
3 (4.3) <sup>b</sup>	0.5	0.0-1.2	3	0.8	0.4-1.5	4
4 (1.4)	--	--	--	0.7	0.0-1.4	3
5 (4.2)	1.7	1.0-3.1	5	3.2	1.4-4.5	4
6 (6.4)	1.0	0.4-1.4	7	2.5	1.7-3.3	4
7 (1.4)	1.1	0.0-2.9	6	--	--	--
5&6 (10.6)	1.4	1.0-2.1	5	2.8	2.0-3.4	4
Combined <sup>c</sup>	1.3	0.9-2.2	5	2.2	1.6-2.6	4

<sup>a</sup> Transect length (km).

<sup>b</sup> Transect 3 shortened to 2.7 km in 1985.

<sup>c</sup> Combined total in 1984 = 5, 6, & 7 (12.0 km); 1985 = 2, 3, 5, 6 (19.2 km).