BIOLOGICAL FEASIBILITY OF TRANSPLANTING ELK IN SOUTHEAST ALASKA

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ABSTRACT

The 1985 Alaska State Legislature mandated that the Department of Fish and Game transplant between 30 and 150 Roosevelt elk (Cervus elaphus roosevelti) to a suitable location in southeast Alaska within 3 years. This report addresses the biological feasibility of transplanting elk to southeast Alaska, with a specific evaluation of 4 proposed transplant sites.

From a review of the habitat requirements and food habits of Roosevelt elk it appears adequate habitat exists on all of the sites to support a viable population of elk. Carrying capacity was estimated based on the amount and composition of the winter range, and ranged from about 300 elk on Zarembo, the smallest island, to 3,600 elk on northern Prince of Wales. Future logging activities could reduce the carrying capacity of all areas for elk, but given existing harvest schedules and assumptions, that reduction is not expected to be large.

There is concern that introduced elk and Sitka black-tailed deer (Odocoileus hemionus sitkensis) will compete for food resources to the detriment of one or the other species. Competition will likely be most severe under deep snow conditions when either species is at high population levels. Currently, deer are at moderate to very low levels on all sites, and competition is expected to be minimal. Establishment of a large elk population may delay or prevent deer from regaining historically high population levels in some areas. There is also concern that an imported species may possess parasites or diseases not already present in native fauna. Elk will be examined before they are imported into Alaska to ensure that they are free of parasites and disease.

The rate of population growth in the transplanted elk herd was modeled under varying assumptions of snowfall, predation, and initial transplant size. Growth of the population is expected to range from zero under conditions of moderate predation and above-average snowfall to 15 percent annually under light predation and below-average snowfall. Significant predation levels and occasional deep snows are likely on all of the transplant sites. We predict the population will grow steadily at an average rate of about 4% annually. If so, an initial transplant of 30 animals will produce a herd capable of sustaining a harvest of 20-25 animals per year after 40-50 years. The time frame required before hunting could be initiated decreases considerably as the size of the initial transplant increases.

An elk management plan has been developed for addressing recommended harvest regulations, controlling off-site elk dispersal, maximizing hunter access, and monitoring the transplanted herd. The relevant physical and biological attributes of the 4 transplant sites have been compared.

INTRODUCTION

Some residents and sportsmen's groups in southeast Alaska have expressed interest in establishing a population of elk (Cervus elaphus roosevelti) in this region. There have been 5 previous attempts to transplant elk to Alaska, the earliest being a 1926 transplant to Kruzof Island near Sitka, and the most recent a 1963 transplant to Revillagigedo Island (Burris and McKnight 1973). The single transplant to an area outside of Southeast, on Afognak Island near Kodiak in 1928, marks the only success to date.

In 1985, the Alaska State Legislature passed legislation mandating that the Alaska Department of Fish and Game transplant between 30 and 150 Roosevelt elk to a suitable location in southeast Alaska within 3 years. An interagency task force was subsequently formed to evaluate the legal, logistical, and biological feasibility of such a transplant. Four potential transplant sites are being evaluated: Zarembo Island, Etolin Island, Kuiu Island, and N. Prince of Wales Island (Figure 1). The following report by ADF&G biologists addresses the biological feasibility of a transplant to Southeast, including: (1) adequacy of existing habitat, (2) predicted elk population growth, (3) impact of elk on indigenous species, (4) a comparison of the proposed transplant sites, and (5) future elk management concerns and options.

I. ADEQUACY OF EXISTING HABITAT

For any transplant to be successful, the proposed relocation site should meet the animal's minimal needs for food, water, and cover, and provide adequate protection from overharvest and high predation. Generally, the degree of similarity between the animal's native habitat and the area proposed for the transplant suggests the potential for success. Earlier comparisons of this sort (Courtright 1960, Courtright and Merriam 1970) suggest that elk may thrive in Southeast. The following paragraphs describe the general habitat requirements, food habits, and effects of roads and logging on elk, primarily in the Pacific Northwest and on Afognak Island. Obvious similarities and dissimilarities between Southeast and other areas are noted. A simple model for calculating the carrying capacity of each island is presented.

General Habitat Use--The distribution of Roosevelt elk (C. e. roosevelti), a subspecies native to the coastal region of Oregon and Washington, makes it a logical choice for a source of transplant stock for southeast Alaska. Like southeast Alaska, coastal areas in the Pacific Northwest are characterized by mountainous, generally forested terrain, interspersed with alpine meadows and grassland. Elk make use of all these habitat types seasonally, using forested areas more intensively during the

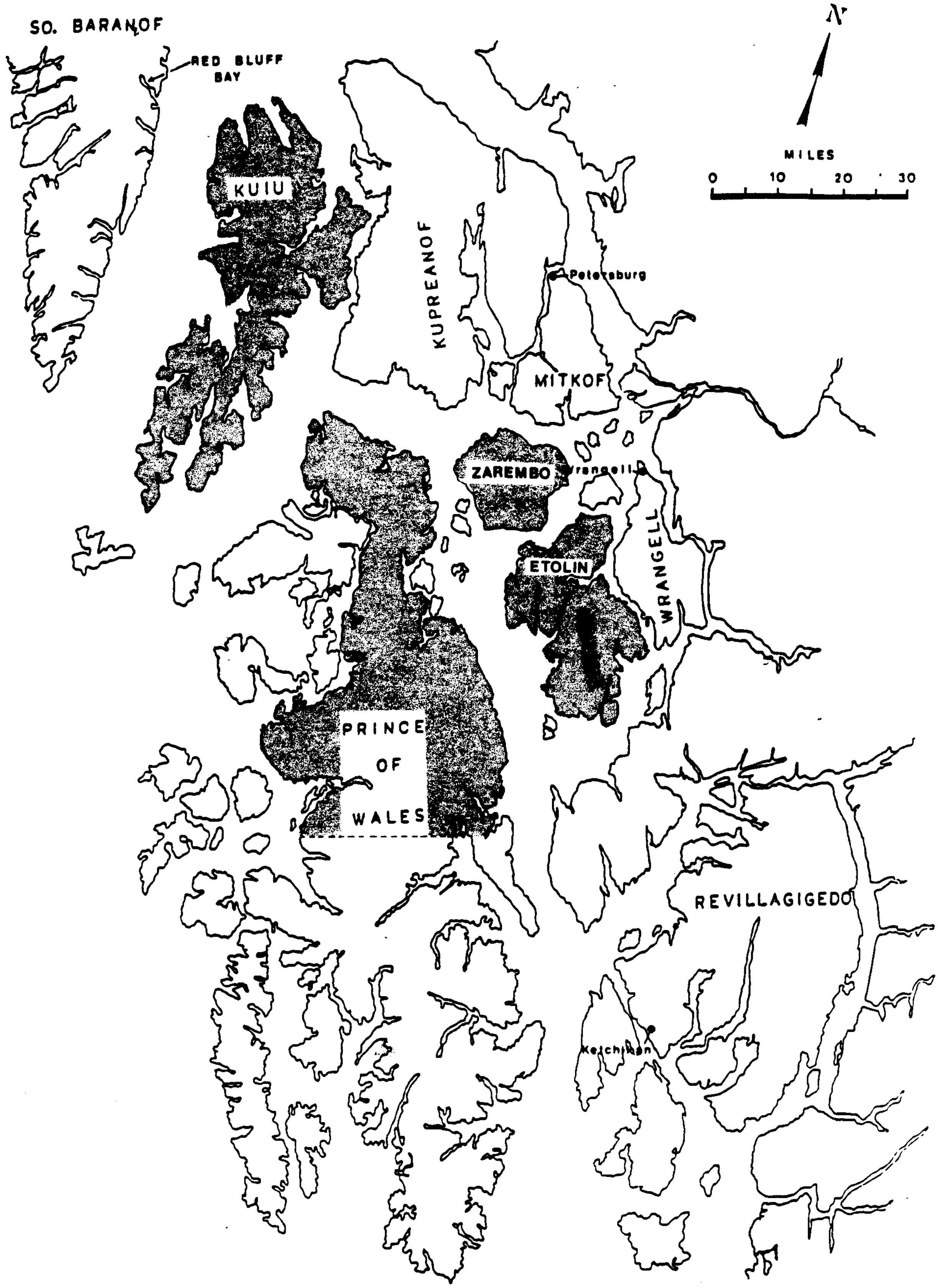

Figure 1. Location of proposed elk transplant sites (shaded areas) in Southeast Alaska.

winter season and open habitats in summer (Schoen 1977). Forest conditions are similar in southeast Alaska and the Pacific Northwest; however, more of the forestland in Southeast exists in an old-growth condition (Society of American Foresters, 1985). Old-growth forest has a greater winter carrying capacity for elk than early-forest seral stages (Taber and Raedeke 1980). Conversely, natural grassland and fallow agricultural land which is utilized heavily by elk (in the absence of snow) elsewhere, is comparatively scarce in Southeast.

Food Habits--Seasonal forage preferences of elk are influenced strongly by availability. In Washington state, grasses (Gramineae), sedges (Cyperaceae), and forbs are very important (Schoen 1977, Nelson and Leege 1982). These plants compose 75-90 percent of the diet in all seasons except winter, when elk turn to woody browse almost exclusively (Nelson and Leege 1982). Similarly, elk on Afognak consume greater amounts of forbs and grasses in spring, and switch to woody browse in fall and winter (Troyer 1960, Batchelor 1965). Major winter foods on Afognak (Troyer 1960, Batchelor 1965) that are also common in Southeast include: Vaccinium spp. (blueberry), Sambucus callicarpa (Pacific red elder), Rubus spectabilis (salmonberry), Rubus pedatus (trailing bramble), the terminal buds of Oplopanax horridus (devil's club), and Athyrium felix-femina (lady fern). On the Olympic peninsula, Tsuga heterophylla (western hemlock) is considered of high importance, and Thuja plicata (red cedar) is highly preferred when available (Schwartz and Mitchell 1945). Plants of "medium" importance include: Alnus sinuata (Sitka alder), Salix spp. (willow), Gaultheria shallon (salal), Polystichum munitum (swordfern), and Blechnum spicant (deer fern) (Schwartz and Mitchell 1945). With the exception of willow, which is uncommon, and salal, which is rare north of Prince of Wales, these plants are common in southeast Alaska (Robuck 1977).

Many of the food plants important to elk on their native range are also available in southeast Alaska, particularly the important winter browse species. Willow and elderberry, which are relatively important browse plants on Afognak Island, are present but not abundant in Southeast. Because the snowpack is generally deeper and persists longer in southeast Alaska than on Afognak or in Washington and Oregon, we anticipate a lower relative availability of forbs to elk over much of the year. Grasses and sedges, important seasonally to elk elsewhere, have limited availability in Southeast during winter. How critical these differences are to long-term elk survival is difficult to determine. The degree to which elk can maintain themselves on locally abundant browse species such as Vaccinium spp., Menziesia ferruginea, and Tsuga heterophylla in winter will probably be an important factor in the transplant's long-term success.

Carrying Capacity--"Carrying capacity," as used here, refers to the number of elk an area can support over an indefinite period of time. It will vary depending on the abundance and quality of forage produced and prevailing snow conditions. Snow accumulation decreases forage availability and increases the energetic costs of locomotion. Predation and/or hunting could limit population growth to some level below the habitat carrying capacity.

Estimates of habitat-specific elk carrying capacities are based on data from similar habitats on the Olympic Peninsula and Afognak Island, with adjustments to reflect differences in the environmental conditions of Southeast Alaska. By multiplying each habitat's carrying capacity (elk per square mile), times the number of square miles of each habitat, the total carrying capacity of each transplant site can be estimated.

We assumed that elk, like deer in southeast Alaska, will be limited by the quantity and quality of their winter range. Winter range was defined as areas below 1,500 feet elevation on south-facing slopes (90-270 degrees), and below 500 feet elevation on north-facing slopes (271-89 degrees). Because inventory data was not tabulated as such for Etolin Island, areas below 1,000 ft on south-facing, and 500 feet on north-facing slopes were used for that site.

The habitat types on winter range included (1) clearcuts (0-25 years old), (2) second growth (26-150 years old), (3) noncommercial and nonforest lands, and (4) commercial old growth. Our definition of habitat types was limited by the existence of carrying capacity information for comparable types elsewhere, and by existing inventory information on the proposed transplant sites. The amount of winter range, by habitat type, on each of the 4 proposed transplant sites is given in Table 1.

Table 1. Number of square miles of elk winter range on 4 proposed elk transplant sites in southeast Alaska.

	Island			
Habitat type	Zarembo	Kuiu	Prince of Wales[1]	Etolin
Clearcut	8.4	2.0	106.9	2.0
Second growth	1.2	6.3	1.8	2.2
NonCFL/NonFor[2]	23.6	173.4	217.2	72.9
Old Growth	41.5	218.8	547.4	124.4

[1] North of the Craig-Hollis road

[2] NonCFL = Noncommercial forest lands
NonFor = Nonforested

Estimates of winter carrying capacity (elk per square mile) for different-aged stands on the Olympic Peninsula are presented by Taber and Raedeke (1980). The carrying capacity estimates of that study were reduced to yield a more conservative estimate in light of the more severe snow conditions in Southeast. The noncommercial and nonforest habitat type was not recognized in the Taber and Raedeke (1980) study, but we have estimated the habitat's value as intermediate between clearcuts and old growth. If elk respond to muskegs similarly to deer, carrying capacity of this class may still be overly optimistic. The assumed carrying capacities of each habitat type in Southeast are: clearcut (2 elk per square mile), second growth (0.5 elk per square mile), nonforest and noncommercial (3 elk per square mile) and old growth (5 elk per square mile). These figures yield carrying capacities similar to those observed for elk using similar habitats on Afognak Island (R. Smith, pers. commun).

Based on the above values assigned to each habitat type, and the amount of each habitat type on winter range (Table 1), the elk carrying capacities for the 4 proposed transplant sites are: Zarembo (296), Etolin (856), Kuiu (1,621) and Prince of Wales (3,603).

Potential Impacts of Logging and Roading--Because elk are larger animals than deer, the amount of energy expended in moving through snow and slash are proportionately less (Parker et al. 1984). Therefore, young clearcuts (less than 25 years old) should constitute better habitat for elk than for deer; this does not imply, however, that elk will do well in clearcuts in Southeast. Elk appear to avoid recently clearcut areas on Afognak Island, although this may be more related to human activity in the area than to habitat conditions (R. Smith, pers. commun). On the Olympic Peninsula, where snowfall is significantly less than in Southeast, the carrying capacity of young clearcuts is about half that of old-growth forest (Taber and Raedeke 1980). The presence of snow and slash further lowers the carrying capacity of clearcuts for elk. Parker et al. (1984) found that 20" of snow in an opening increased energetic costs to elk by a factor of 220 percent. The additive cost of moving through logging slash can be as high or higher, depending on the slash density (Parker et al. 1984).

The carrying capacities calculated above do not consider habitat changes as a result of forest succession and future logging. On Zarembo, for example, 5,514 acres of old growth are scheduled for harvest between 1980 and 2080 (USFS, unpubl. data). Assuming this timber harvest is spread out evenly over the next century, and all harvesting takes place on winter range, we can expect 1,379 acres, or 2.15 square miles of commercial old growth to be replaced by clearcuts in the next 25 years. In that same period of time, all present-day clearcuts will convert to second growth. The net effect on the island's carrying capacity will be a reduction of about 19 elk, to a long-term carrying capacity of 277.

Zarembo is the smallest of the transplant sites, and proportionately, has been the most heavily impacted by logging. Still, the reduction in carrying capacity due to logging is not large (6.5 percent), primarily because those impacts are buffered by the considerable acreage of nonforest land, noncommercial forest, and low-volume old growth on Zarembo which probably will never be harvested. Should future research show high-volume old growth to be of greater value to elk, or low volume and noncommercial old growth to be of lesser value, the impact of logging on elk carrying capacity will be significantly greater.

Given current assumptions and scheduling, the effects of logging on the carrying capacity of the other transplant sites will be lower than on Zarembo. Consequently, a quantitative analysis of potential logging effects on the other transplant sites was not made.

The impacts of logging and related roads on elk populations has been intensively studied. In addition to the acres of habitat lost to logging roads, vehicular traffic and increased human presence affect elk (Black et al. 1976, Lyon et al. 1985). Road-related activity causes elk to disperse from an area, often into less suitable habitat (Lyon and Ward 1982). Elk on Afognak appear to avoid areas easily accessible by either boat or vehicle (R. Smith, pers. commun.). Elk may return, however, to use these areas seasonally (e.g., in winter when logging activity slows), or when a logging entry into a remote area is completed. Restricting nonessential traffic during and following logging would minimize potential adverse impacts of roads on elk. North Prince of Wales Island has far more miles of road than any other island, although the density of roads on Zarembo Island, and portions of Kuiu and Etolin Islands, is comparable.

2. EFFECTS ON INDIGENOUS SPECIES

History furnishes us with many examples of species introductions that have caused indigenous species of plants and animals to decline precipitously, or become extinct. This phenomenon is a major concern of this department and is reflected by a conservative policy regarding transplants unless their introduction "...will not adversely affect the numbers, health, or utilization of resident species. (ADF&G 1980)"

Deer--Our primary concern is directed toward Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) which range across the same area, use many of the same foods, and make seasonal migrations similar to those of elk (Schoen and Kirchhoff 1983, 1985). Although elk and deer ranges overlap in many areas, the published literature provides no clear indication of the degree or significance of deer/elk competition. Some studies indicate that elk do compete with deer for food, especially on lower-elevation wintering areas (Murie 1951, Tanner 1957), while others have shown little competition because of differing habitat preferences

(Harrington 1978, Mackie 1981, Nelson 1982), except in cases of overpopulation by either or both species (Nelson 1982). On Afognak Island, where neither deer nor elk are native, both species appear to be doing well (R. Smith, pers. commun). In southeast Alaska, where the topography is steep and snowfall in some years is heavy, deer and elk will be forced periodically to high-volume, low-elevation timbered areas near saltwater. In these instances, competition for food resources is expected to be significant and 1 or both species will likely suffer increased winter mortality as a result.

Prior to about 1970, deer populations on the proposed transplant sites were very high. Deer populations in the Petersburg area have historically been among the highest in Southeast (Alaska Game Commission 1954, Merriam 1970). Following several severe winters in 1968-69, 1970-71, and 1971-72, the deer population throughout Southeast dropped markedly. In the Petersburg area, deer harvest dropped from 3,700 in 1961 to 40 in 1974, and in 1976 the season was closed (Olson 1979). Despite a history of relatively mild winters over the past 13 years, deer populations on the 4 sites remain generally low. The slow population recovery in these and nearby areas is probably the result of predation by wolves (Canis lupus) and black bear (Ursus americanus), and in specific localities, the loss of important deer wintering habitat because of clearcut logging. Although deer numbers are currently low in much of this area, it is likely that over a period of years, or decades, deer populations will eventually increase to huntable levels.

Of the 4 transplant sites proposed, Prince of Wales has the highest deer density, followed by Etolin, Zarembo, and Kuiu Islands. The density of deer on northern Prince of Wales is moderately high, second only to Unit 4 (Baranof, Admiralty, and Chichagof Islands) in terms of hunter success (ADF&G, unpubl. data). Deer hunter check stations on Prince of Wales Island that were manned during the first 4 days of the 1985 season showed an average hunter harvest of 0.76 deer, with each hunting party seeing an average of 13 deer daily (ADF&G, unpubl. data). The deer density on Etolin is estimated at about half that of northern Prince of Wales. Deer are present on Zarembo and Kuiu Islands, but in such low numbers that they are rarely seen. Aerial and beach surveys on Zarembo in recent years have revealed very little deer sign. On Kuiu the hunting season has remained closed since 1975, and deer are essentially absent from much of the island. Given current deer population densities on the proposed transplant sites, competition between elk and deer is expected to be minimal, except possibly on North Prince of Wales in a harder than average winter. Competition may pose a problem in the future, however, should deer regain former population levels.

The only other ungulate with which elk would compete is Moose (Alces alces), currently found in small numbers on Etolin Island and believed to be wanderers from the mainland. Populations are small, and appear not to be expanding rapidly. We envision no significant competition between moose and elk at this time.

Predators--The wolves and black bears are potential predators on elk, and are found in varying densities on all of the proposed transplant sites. Brown bears (Ursus arctos) are found in small numbers on Etolin Island only. Predation on elk is a concern from 2 standpoints. First, the rate of elk population growth, and perhaps the viability of the transplant itself, will probably be strongly influenced by elk mortality from predation. Secondly, by providing an alternate prey source for predators, we can expect predator populations to increase on the transplant site. If the primary or preferred prey item of predators is deer, increased predator populations may prevent currently low deer populations from recovering.

Elsewhere, wolves have proven to be an efficient predator on elk, particularly elk calves (Weaver 1980). Wolves are considered the primary limiting factor on elk in Jasper Park, British Columbia (Carbyn 1983), where they prey heavily on calves born in May and early June (Carbyn 1974, 1975). In most areas where deer, elk, and wolves coexist (e.g., British Columbia), deer are considered the primary prey species (Hebert unpubl. data, Hebert et al. 1982, Scott and Shackelton 1980).

Wolf population data on the 4 proposed transplant sites are inferred from sealing records, ground and aerial surveys in the early 1970's (Merriam and Zimmerman, unpubl. data), and incidental observations from reliable observers. On the northern portion of Prince of Wales Island (north of the Craig-Hollis Road), 41 wolves have been taken since 1982. For the same period, Kuiu shows a harvest of 8 wolves; Zarembo, 4 wolves; and Etolin, no wolves. Wolf movement between islands in this area is common. Predator densities regularly shift among islands in response to changing prey densities.

Black bears prey on elk calves in Idaho, Wyoming and the Olympic Mountains of Washington, but rarely take adult animals (Murie 1951, Schlegel 1976). Elk calf losses of up to 50% from black bear predation have been reported in an Idaho elk herd (Schlegel 1976). Elsewhere in Alaska, black bears are significant predators on moose calves, accounting for 30% or more of calf mortality in some years (Franzmann et al. 1980). In southeast Alaska, black bears are believed to be significant predators on deer fawns, and they would probably prey on elk calves as well. Black bear populations are currently high on all of the proposed transplant sites except Zarembo Island where they are rarely reported.

Brown bears occur in limited numbers on Etolin Island only. They are capable of taking both adults and calves. Brown bears are significant predators on moose calves in other regions of the state (Ballard et al. 1981), and, we assume, would be equally effective predators on elk calves.

Disease Implications--Elk are potential carriers of a dozen or more wildlife diseases and numerous external and internal parasites, most of which are transmittable to native wildlife. The department will require that all elk considered for the transplant be examined for the occurrence or history of disease. The disease of greatest concern is Brucellosis (bacterium *Brucella spp.*) which is prevalent in some elk herds in the lower 48. Brucellosis localizes in the joints or reproductive tract of the infected animal (including elk, bears, wolves, dogs, domestic livestock, and humans) causing fever, crippling arthritis, abortion, and/or sterility (Kistner 1982).

A second disease which would be cause for rejection of transplant candidates is tuberculosis (bacterium *Mycobacterium bovis*) which has been reported in wild elk, bison, and moose, and is an important disease of domestic animals and man (Kistner 1982). Fortunately, both brucellosis and tuberculosis have a limited history of occurrence in the Roosevelt elk subspecies. Parasites are of somewhat lesser concern since most can be readily detected, treated, and eliminated from elk prior to release.

3. EXPECTED ELK POPULATION DYNAMICS

The rate of growth, or dynamics, of the elk population will vary depending on the size of the initial transplant, sex ratio, productivity rates, and age-specific recruitment and mortality within the herd. These factors, which are variable and interactive, were used in a simulation program (POPII, Fossil Creek Software, Ft. Collins, CO.) to model population dynamics. Population growth rates of 0%, 4%, and 15% were assumed "a priori" based on estimated population growth rates from Afognak Island and elsewhere. The combination of population parameters (recruitment rates, and winter mortality by age and sex class) needed to yield these growth rates were compared with values for elk herds in the Pacific Northwest (Taber and Raedeke 1980) and Afognak Island (Troyer 1960, Batchelor 1965).

Assumptions--The following assumptions were constant for all simulations:

1) The initial transplant occurred in early winter.

2) The initial age composition of transplanted elk was 5% yearling males, 5% 2-year-old males, and 10% in each female age class from yearling through age 9.

3) All transplanted females were pregnant, with half of the females 3 years and older producing 1 calf in spring 1987, and 90 percent producing 1 calf each spring after that.

4) Winter mortality rates (for calves, adult males, and adult females) were held constant from year to year for each simulation, except for 1 "variable winter" case.

5) Winter mortality in adult males was twice that of adult females.

6) A fixed habitat carrying capacity of 250-270 animals was assumed, recognizing that both the carrying capacity and the number of animals harvested would be larger on the larger islands. Once carrying capacity was reached, hunting of adult bulls and cows was used to keep populations below that level.

7) A post-hunt bull:cow ratio of 25:100 was maintained by selective harvest.

Recruitment and Mortality--Population parameters which were varied among scenarios include recruitment rate and winter mortality by age and sex class. Fall recruitment refers to the number of calves per 100 cows that survive the summer. The number of calves that perish over the summer (as a result of abandonment, exposure, accident, and predation) is highly variable (e.g., 10-90%). Summer calf/cow ratios on Afognak Island, where there are brown bears but no wolves, have varied from 29 to 43 calves per 100 cows since 1961 (Batchelor 1965, Smith 1982).

Mortality in all age classes increases in winter months as food becomes scarce and of lower quality, as energy expenditures increase, and as predators become more efficient. Calves, which are smaller and have not built up fat reserves are most vulnerable, followed by mature bulls who have expended valuable energy during the rut, and finally, mature cows. Here again, the number of animals surviving the winter depends on the number of predators and the severity of the winter.

Effects of snow--Deep snow conditions greatly compound the problem of survival for elk. Taber and Raedeke (1980) present abundant evidence that deep snow causes high elk mortality (up to 30 percent) on the Olympic Forest in Washington. Winter calf:cow ratios are reported at 35-40 calves per 100 cows in moderate winters on Vancouver Island, but drop to 18 calves per 100 cows in areas with high wolf numbers (Hebert et al. 1982). On Afognak Island, elk numbers were reduced by 50 percent from 1970 to 1972 due to severe winters (Alexander 1973). Snowfall during each of those winters was about 160 inches, compared with a previous 8-year average of 70 inches (Weather Service data).

Typically, southeast Alaska experiences a cycle of severe winters every 12-15 years (Juday 1984). Southeast snow records at Petersburg (near the proposed transplant sites) show 6 years with greater than 160 inches of snowfall between 1950 and 1975, and a peak snowfall of 212 inches in 1971-72 (Weather Service data). With this amount of snowfall, adult elk losses could very well exceed 35 percent, and over-winter calf recruitment could approach zero.

Scenarios 1-4

Scenario 1--No growth (Moderate predation and above-average snowfall).

Under this scenario, the summer survival rate of calves is set at 50 percent, which translates into a fall recruitment rate of 38 calves per 100 cows. Over-winter mortality is set at 30 percent for calves, 7 percent for prime cows, and 14 percent for prime bulls.

It is likely that severe winters and high predation levels would exist on some transplant sites in some years. Assuming the above recruitment and mortality rates under moderate predation and above-average snow conditions, the transplanted population would not grow, and over time, would not persist. While this scenario is possible, the assumptions regarding winter weather conditions are regarded as pessimistic.

Scenario 2--Four percent growth (Moderate predation and average snowfall).

Under this scenario, summer survival of calves is also 50%, resulting in the same fall recruitment rate of 38 calves per 100 cows as in Scenario 1. The winter mortality rate is set at 21% for calves, 6% for prime cows, and 12% for prime bulls. These recruitment and mortality rates are considered likely under "average" conditions on the transplant sites.

Under these conditions, an initial transplant of 30 elk would survive and grow at a rate of 4% annually. A pre-hunt population level of 279 animals would be reached after 46 years. At that point, we would project an annual sustainable harvest of 20 bulls for the next 10 years, followed thereafter by annual harvests of 20 bulls and 6 cows to maintain the population below carrying capacity and maintain the desired sex ratio.

To reach the desired population size with an initial transplant of 20 animals would take 56 years; with 30 animals, 46 years; with 60 animals, 29 years; and with 150 animals, about 6 years.

Scenario 3--15 percent growth (Low predation and below-average snowfall).

Under this scenario, summer calf survival is set at 77 percent, which results in a fall recruitment rate of 55 calves per 100 cows. Winter mortality is set at 15 percent for calves, 5 percent for prime cows, and 10 percent for prime bulls. These recruitment and mortality rates are viewed as optimistic estimates.

Under these conditions, an initial transplant of 30 animals would reach a pre-hunt population level of 282 after 13 years. At this time, we would project 40 bulls being harvested annually for 2 years, followed by a long-term sustained annual harvest of 33 bulls and 25 cows.

If the initial transplant numbered 20 animals, the desired population would be reached in 16 years; with 30 animals, 13 years; with 60 animals, 8 years; and with 150 animals, about 3 years.

Scenario 4 -- Same as scenario 2 (4 percent growth), except for 3 "severe" winters in years 1996-1998.

Under this scenario, the recruitment and winter mortality rates assumed in Scenario 2 (moderate predation, average snowfall) are used with the following deviations: (1) in 1996 and 1998 the winter mortality rate for calves would be increased from 21 to 30 percent, the prime female mortality rate would be increased from 6 to 7 percent, and the prime bull mortality rate would be increased from 12 to 14 percent, (2) in 1997 the calf mortality would be set at 100 percent, the prime female rate at 17 percent, and the prime male rate at 33 percent.

The major effect of these changes would be to increase the time necessary to reach the desired population level. With a transplant of 30 animals, the time needed to reach a population of 270 increased from 46 to 56 years. If a series of severe winters occurred every 10 years, the population would probably never reach the desired level. If the initial transplant were very large (150 animals), elk would reach desired levels prior to the severe winters, and the major effect would be to eliminate hunting for 5 years following the first difficult winter.

In conclusion, we believe a transplanted elk population would expand steadily at a rate of about 4 percent per year assuming moderate predation and snowfall effects. Even under the mildest of winter conditions, it would probably take 10-15 years for 30 elk to reach sufficient numbers to allow hunting. Transplanting a larger number of elk initially can reduce this lag time significantly. More likely, however, we can expect a series of variable winters over the next 15 years, including several that are quite severe. Under these conditions, it would take many decades before a transplant of 30 elk could grow to a huntable population size.

4. ELK MANAGEMENT PLAN

In the event that elk are successfully transplanted in Southeast, the monitoring and management of that elk population will be the responsibility of ADF&G. Regulations will be established by the Board of Game after input from the department and the interested public. ADF&G species and habitat management policies for elk

(ADF&G 1980) state: (1) Maintenance of suitable habitat is of foremost importance in elk management. Land use practices which maintain or improve elk habitat will be encouraged, and (2) population size will be controlled commensurate with the carrying capacity of the winter range. Sex and age ratios will be manipulated to optimize productivity of the population.

Species Use--Department policy (ADF&G 1980) on elk use states (in part): (1) Elk will be managed on the sustained yield principle for the benefit of the resource and the people of the state. Recreational uses (e.g., hunting, viewing) are generally compatible with sound elk management. (2) In areas with intensive hunter use, elk will be managed for an optimum sustained yield of animals. Management techniques may include, but are not limited to: regulation of access; control of the number and distribution of hunters; regulation of sex, age, antler size and conformation of animals taken; and population manipulation. (3) Recreational observation and photography of elk will be encouraged; certain areas exceptionally suited to viewing elk may be zoned in time or space to restrict other uses in favor of observation of elk.

In order to maximize rate of growth in the transplanted herd, we believe the season should remain closed until the population reaches 250 animals and a minimum harvest of 20 bulls can be justified. Harvest of cows could be allowed, if necessary, to maintain the population slightly below the carrying capacity of its range. Regulations may be proposed to increase harvest of yearling bulls, and decrease harvest rates on older bulls if age-class structure becomes heavily skewed toward young animals. The number of animals harvested will be controlled by season length, registration permit, or some other appropriate method.

Elk Dispersal--Until the biological implications of transplanting elk to Southeast are better understood, it is important that elk dispersal to adjoining islands from the transplant location be minimized. On Prince of Wales (2,231 sq miles), elk could easily disperse over the entire island. Minimal water barriers exist between Prince of Wales Island and numerous small- to medium-size, adjoining islands. Etolin Island (343 square miles) offers ready access to Wrangell Island, and from there, elk could reach the mainland fairly easily. Kuiu is also a comparatively large island (745 square miles), with easy access to Kupreanof Island, and from there, Mitkof Island. Zarembo is the smallest island (182 square miles) and also the most isolated. The most likely avenue of dispersal from Zarembo would be via several very small islands that lead toward the northern portion of Prince of Wales Island. In the event elk become dispersed too widely, or move off the island to which they were transplanted, the department would recommend they be live-trapped and transported to the original site, or eliminated by an open hunting season.

Hunter Access--In order for the transplant to provide the greatest long-term public benefit, the transplant site should be accessible to the largest possible numbers of hunters and nonconsumptive users. Prince of Wales Island is probably accessible to the greatest number of people. Prince of Wales Island is easily accessible by ferry from Ketchikan, and the communities of Craig, Hollis, Hydaburg, Klawock, Point Baker, Port Protection, and Thorne Bay are on the island. Zarembo is the next most accessible island, and is easily reached by the residents of Wrangell and Petersburg. Etolin is accessible primarily to the residents of Wrangell. Kuiu is the least accessible of the 4, with the nearest major population center being Petersburg, about 28 air miles away. Neither Zarembo, Etolin, or Kuiu have any permanent communities.

All islands are readily accessible by boat in good weather, although Zarembo has relatively few protected anchorages compared with the other sites. A well-developed road system would open more habitat to hunting, and facilitate transport of meat back to the beach. Prince of Wales and Zarembo have the best-developed road systems of any site.

Monitoring--Knowledge of population growth rates, sex and age composition, seasonal distribution and movements, habitat selection, mortality (from starvation, predators, and poaching), and range condition can contribute greatly to sound management. Monitoring will also provide invaluable information on the advisability of continued or expanded introductions of elk into southeast Alaskan habitats.

Some elk would be fitted with radio collars prior to release so that seasonal movements, habitat preferences, and time and cause of death can be determined. In addition, other monitoring techniques would be used including such options as: periodic aerial surveys (trend counts, sex and age composition counts), pellet group transects (trend counts, deer-elk habitat overlap, range condition), spotlight surveys (trend counts, sex and age composition), hunter check stations (harvest levels and composition), and public surveys (public interest and benefit).

Monitoring will probably be coordinated by the Petersburg or Ketchikan Area offices of ADF&G, depending on the site selected for the transplant. The larger and more remote sites present greater logistical and cost problems. In this regard, the merits of the proposed sites are similar to those relating to hunter access.

5. COMPARISON OF TRANSPLANT SITES

The biological feasibility, and desirability, of the 4 proposed transplant sites are compared in list fashion in this final chapter. The evaluation criteria used in this analysis are discussed elsewhere in the report. The relative importance of 1 criteria over another is not addressed here. Listed in order of increasing size, the proposed sites are:

Zarembo Island, Etolin Island, Kuiu Island, and Prince of Wales Island (north of the Craig-Hollis Road). The criteria ratings for each site are ranked 1 through 4. The lowest score indicates the most desirable rating for the elk transplant while the highest scores reflect the least desirable traits for habitat sites. Where sites were not appreciably different, they received the same score. This ranking is not to be used as a key to the "preferred site." It is merely intended to display the relative merits of the sites in terms of specific biological and management criteria. Selection of the preferred site, or a no-action alternative, will be influenced by the public, other agencies, and additional considerations raised in the Environmental Assessment to be completed by the U.S. Forest Service.

	Site			
Evaluation Criteria	Zarembo	Etolin	Kuiu	Prince of Wales
1) Extensive winter range	4	3	2	1
2) Low annual snowfall	2	2	1	1
3) Low wolf populations	2	1	3	4
4) Low black bear populations	1	2	4	3
5) Potential competition w/deer	2	3	1	4
6) Insular site (low dispersal)	1	3	2	4
7) Ease of monitoring	1	2	4	3
8) Human access	2	3	4	1
9) Deer/wolf ratio	2	2	3	1

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