AN EVALUATION OF VISUAL LOCATION DATA FROM NECK-COLLARED MOOSE

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Abstract: Visual location data from moose (*Alces alces*) neck-collared on the Kenai Peninsula, Alaska between 1968 and 1975 were evaluated for identifying populations, key habitats, and seasonal movements. Of 636 collared moose, 438 (69%) were later observed. Of these, 73% were males and 68% were females. For individual moose, 36% were located once and 80% were located ≤4 times with an average of 2.8 locations/moose. Of 1,775 visual locations, 97% were obtained during survey flights or reported by the general public; hunter kills provided 3%. Survey flights averaged 2.7 hours, 2.3 collared moose were observed/hour and the average 1970–76 air charter cost was $17.75/observation. Locations of collared moose were biased by season, road access, habitat type, and collar design. Key winter habitats for moose were identified, but populations, other seasonal habitats, and seasonal movements were difficult to determine. Comparisons of visual and radio collaring costs and benefits are made with recommendations.

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Moose have often been fitted with neck collars (Goddard 1970; Phillips et al. 1973; Roussel et al. 1975; Didrickson et al., unpubl. rep., Alaska Dep. Fish and Game, Fed. Aid Proj. W-17-R, 1980) to determine movements or identify populations by visual observations. A high proportion of neck-collared moose were not seen or were infrequently located in these studies. Phillips et al. (1973) concluded that movements and home ranges of collared moose could not be determined because relocations were too limited and biased by habitat type. In contrast, use of radio collars on moose (Van Ballenberghe and Peek 1971; Phillips et al. 1973; Didrickson et al., unpubl. rep., Alaska Dep. Fish and Game, Fed. Aid Proj. W-17-R, 1980) has allowed most studies to obtain movement information.

The objectives of our study were to identify populations, key habitats, and seasonal movements of moose for management purposes on the Kenai Peninsula, Alaska (LeResche 1972). In this paper we evaluate visual location data from 636 collared moose emphasizing characteristics of the data, methods, costs, and inherent biases, and discuss problems in attaining study objectives.

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STUDY AREA

The Kenai Peninsula lies between Prince William Sound and Cook Inlet in south

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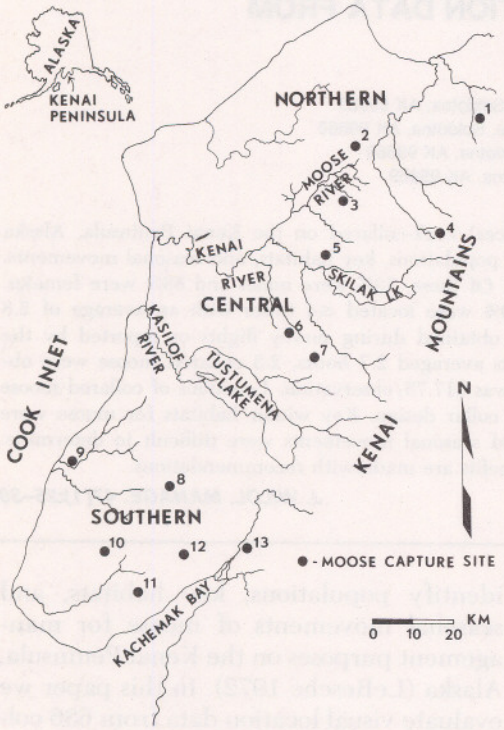

Fig. 1. Kenai Peninsula study area and locations of captured moose (1 = Big Indian Creek, 2 = Moose Research Center, 3 = Moose River Flats, 4 = Mystery Creek Basin, 5 = Skilak Lake, 6 = Funny River, 7 = Benchlands, 8 = Caribou Hills, 9 = Ninilchik River, 10 = Bald Mountain, 11 = Headwater Hills, 12 = Eagle Lake, 13 = Fox River).

central Alaska (Fig. 1). The eastern 60% of the Peninsula consists of mountains rising to 1,890 m, while the western side is gently rolling benchlands or lowlands with numerous lakes. Moose were studied only on the western Peninsula. White and black spruce (*Picea glauca* and *P. mariana*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*) dominate the lowlands, and willow (*Salix* spp.) dominates above-timberline moose habitat in the benchlands (LeResche et al. 1974).

Visibility of moose was comparatively the best in the central region of the Peninsula because of open, above-timberline habitats, and was poorest in the northern and southern regions because of dense spruce-dominated forests. In contrast, public road access was greater in the northern than in the southern region and was poorest in the central region.

METHODS

Moose were captured by darting from helicopters throughout the Peninsula and in fence-line traps (LeResche and Lynch 1973) at selected sites at the Moose Research Center (MRC) in the northern region. Moose were immobilized with succinylcholine chloride or etorphine (Gasaway et al. 1978) and fitted with 1 of several designs of neck collars. At first, braided polyethylene ropes with numbered pendants were used as well as monocolor, quadricolor, and striped canvas-web collars. Later, 15.3-cm wide canvas-web collars with 12.7-cm high sewn-on numbers were found to be effective for identifying moose from low flying aircraft (Franzmann et al., unpubl. rep., Alaska Dep. Fish and Game, Fed. Aid Proj. W-17-R, 1974). Collared moose were also marked with metal ear tags and colored flagging in 1 or both ears.

Moose were first collared in 1968 in the northern region of the Peninsula at the MRC and in Mystery Creek Basin. Moose in other localities in the northern region were collared in 1970, 1971, and 1972 before focusing on other regions. Moose in the central and southern regions were collared between 1972 and 1975 and were collared annually from 1968 to 1975 at the MRC. To locate moose in remote areas, weekly reconnaissance flights were attempted in a Piper PA-18 aircraft. Locations were plotted on 1:250,000 topographic maps from which general habitat types were later assessed.

RESULTS

Observation Success

Of 636 moose fitted with collars from 1968 to 1975, 419 were from the northern, 60 from the central, and 157 from the southern region of the Peninsula. Most moose collared in the northern region were captured near the MRC (197) or Moose River Flats (131). More females (474) than males (162) were collared because the sex ratio of adults was skewed by the harvest of bulls only and females were often selected over males during capture from helicopters. Initial collar design and study methods made it difficult to identify individual moose except by capture site. However, 438 collared moose were identified individually at least once after capture. This accounted for 69% of all collared moose with more males (73%) observed than females (68%).

The highest observation success (3.9 locations/collared moose) was in the central region where all 31 males and 25 of 29 collared females were subsequently located. The lowest observation success (2.6 locations/collared moose) was in the northern region were only 49 of 90 (54%) males and 207 of 329 (63%) collared females were seen. Locally high observation success in the northern region included 131 and 12 moose collared along the Moose River and Big Indian Creek, respectively. These collared moose were seen more frequently than other northern-region collared moose because they seasonally frequented treeless habitats. Southern-region collared moose were seen slightly more often (2.9 locations/collared moose) than northern-region collared moose because they concentrated in restricted wintering areas near public roads and an intensive effort was made to locate collared moose by aircraft in the southern region.

Collared male moose were observed more frequently/individual than collared female moose despite the fact that 3 times as many females were collared. For example, in the central region collared males were seen an average of 4.7 times/individual, whereas females were seen only 2.4 times/individual. Collared males inhabiting open habitats in the northern region were also seen twice as often (2.1 times/moose) as collared males inhabiting dense forested habitats (1.2 times/moose). This suggested males were either more conspicuous than females or inhabited more open habitats than females, or both, an observation also noted by Gasaway et al. (unpubl. rep., Alaska Dep. Fish and Game, Fed. Aid Proj. W-21-R-1, 1980) during transect surveys in interior Alaska.

The average number of observations/collared moose was low during the study. Of 438 collared moose individually identified, 157 (36%) were seen once and 347 (80%) seen ≤ 4 times (Table 1). The 91 collared moose (21%) located 5 times each were frequently near roads, residences, in a mechanically rehabilitated area where visibility was good, or near the MRC. For example, 1 female collared in the southern region was seen 24 times during the 1975–76 winter along a 6-km section of highway. This was 96% of her total observations, but revealed little about her seasonal habits.

Sources of Data

Of 1,775 visual observations of collared moose on the entire Peninsula, 97% were obtained by project personnel or reported by the public and 3% were hunter kills. For the northern region, 97% of 1,104 observations were by project personnel or reported by the public and 3% were hunter kills. For the central region, 94% of 213 observations were by project personnel

Table 1. Number of collared moose located 1 to 5+ times each on the Kenai Peninsula, Alaska, 1968–75.

Region	Public road access[a]	Number of times moose located					Total moose observed
		1	2	3	4	5+	
Northern	1	127	60	20	16	33	256
Central	3	2	15	8	6	22	53
Southern	2	28	25	19	21	36	129
Totals		157	100	47	43	91	438
%		36	23	11	10	21	

[a] Relative scale of accessibility based on length and distribution of public roads (1 = most accessible, 2 = moderate accessibility, 3 = least accessible).

from aircraft, 3% were reported by the public, and 3% were hunter kills. For the southern region, 61% of 458 observations were by project personnel from aircraft, 37% were reported by the public, and 2% were hunter kills.

Because most observations of collared moose were obtained from aircraft, the efficiency and costs of air charter flights were evaluated annually. The average 1970–76 air charter cost was $40.83/hour and each flight averaged 2.7 hours. An average of 2.3 collared moose were visually located/hour at a rate of $17.75/location. Annual variations in cost/moose location were affected by different observers (LeResche and Rausch 1974), weather conditions, remoteness of areas, and density of cover. Cost/moose location generally declined in winter, when searching for moose in treeless habitats, flying with experienced observers, and when the general areas used by moose were known prior to each flight.

Reports of collared moose from the public varied with accessibility of the areas and project publicity. Most reports from the public occurred when they saw collared moose adjacent to roads during winters or when they observed moose during hunting seasons. Because of wide project publicity using posters in the southern region of the Peninsula, many collared moose in that region were reported by local residents. Reports originating from the public had to be viewed critically however because over 300 observations were rejected because of reported nonexistent collar numbers, colors, or designs.

Collared moose taken by hunters provided little, but verifiable, information because metal ear tags or collars were often returned. It was significant that 75% of the collared moose were females and hunters could legally take only bulls during most years. The extent to which hunters avoided legally taking collared moose was unknown, but was probably negligible. The number of hunters refusing to report legally taking collared moose or illegally taking collared moose was also unknown. At least 2 of 419 collared moose in the northern region were in the latter category.

Chance recovery of ear tags or visual collars from carcasses of moose discovered accidentally in the field accounted for 1% of the northern-region observations. Such deaths could result from vehicle accidents, illegal hunting, natural predation, and starvation.

Observational Biases

Visual observations of collared moose were seasonally biased by snow cover and density of cover in habitats used by moose. Most (60%) observations of collared moose occurred from November through April

when snow was present. Reports of collared moose by the public also peaked in the winters when moose concentrated in areas adjacent to roads. Few observations of collared moose occurred during summer (10%) or early fall (13%), and most May–June observations were of collared females calving in treeless wetlands habitats. Gasaway et al. (unpubl. rep., Alaska Dep. Fish and Game, Fed. Aid Proj. W-17-11, 1979) reported that habitat selection by moose was the most critical factor determining visibility of radio-collared moose in winter in interior Alaska. They reported that moose using open habitats were easily seen regardless of search intensity, whereas moose in dense cover were often overlooked except under intensive aerial search patterns. Moose in spruce-dominated habitats were the most difficult to see.

Ground observations of collared moose were biased by the Peninsula's road system. Although roads crossed only 10% of the Peninsula's moose habitat, most ground observations of collared moose were reported along roads. This bias undoubtedly overestimated the importance of near-road moose wintering areas and underestimated the importance of remote wintering areas.

Collar design influenced the reliability of observations and percentage of collared moose individually identified. Although 74 and 67% of 76 and 60 moose with quadricolor and striped collars, respectively, were individually identified, moose with these collars and with monocolor collars (53% of 152) were difficult to identify individually because the colors rapidly faded or became discolored. Relatively few moose (45% of 67) with painted-on numbered collars were individually identified because the paint ("magic" marker) rapidly deteriorated. The most effective and easily discernible collar design for individual recognition (72% of 71 moose) was a blue number on a yellow background.

DISCUSSION

Despite the limited number of observations/individual moose and known observational biases, some study objectives were achieved. Visual locations of collared moose permitted the identification of moose wintering areas (LeResche 1972; Bailey et al., unpubl. rep., Alaska Dep. Fish and Game, Fed. Aid Proj. W-17-3, 1978). Some wintering areas were 60 km from moose summer ranges and others were used by collared moose from widely separated capture sites. Neck collars also lasted many years allowing confirmation of fidelity of moose to specific wintering areas.

Additional information gained was the documentation of traditionally used calving and rutting areas by collared moose. Documentation of traditional rutting areas allowed verification of discrete migratory populations of moose that intermixed with lowland resident moose during winters (LeResche 1972). Direction moose traveled between summer and winter ranges and approximate distances between seasonal ranges were also obtained.

Limitations of data included scarcity of observations during non-winter periods, failure to identify calving and rutting locations other than those in open habitats, unknown locations of many collared moose during the rut, lack of accurate distance moved and home range information, and inability to identify actual migratory routes. The importance of open-cover habitats to moose during calving, rutting, and late winter periods was probably overestimated and the concept of distinct populations of migratory moose may not have been as rigid as initially suggested by visual location data. Frequent

locations of individual collared moose regardless of the density of cover in habitats used by moose do not appear to be feasible on the Kenai Peninsula. To obtain this information, radio-tracking of moose appears necessary.

Use of visual or radio collars on moose will depend on study objectives, study area characteristics and accessibility, anticipated sources of data, and time and funding limitations. Studies requiring frequent locations of moose regardless of habitat cover density or the locations of all study animals during brief or specified periods should not depend on data from visual-collared moose. The initial additional costs associated with a study using radio collars on moose are usually quickly recovered. A comparison between this study and a moose study using radio collars on the Kenai Peninsula (E. Bangs, U.S. Fish and Wildl. Serv., pers. commun.) suggests that radio collars were responsible for a 65% increase in the average number of locations per individual moose per flying hour with a monetary savings of 42% per located moose.

RECOMMENDATIONS

We recommend that visual collars be used to obtain location data on moose only if moose will be inhabiting open cover or restricted areas, or if snow cover is sufficient to enhance moose visibility. A study area should be thoroughly accessible to the public if significant amounts of data from the public are desired or expected. Since visual location data is biased by habitat and season, frequent observations of individual moose or regular observations of moose during specified intervals is unlikely. Such information can be obtained by the use of radio collars at a comparable cost or savings depending on project design. Because visual collars function longer than radio collars and aid in locating and identifying individual moose, we recommend that radio-collared moose also be fitted with a numbered visual collar. Blue numbers on a yellow background appear to be most effective for identifying individual collared moose from aircraft.

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