Hoko Game Management Unit
Population Estimate, Spring 2002

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INTRODUCTION

I used a Peterson population estimate for elk within the Hoko Game Management Unit (GMU), GMU 601. This technique utilized a helicopter to capture and radiocollar elk and to conduct a flight to count the number of marked groups (containing at least one radiocollared elk) and unmarked groups. The methodology used was similar to that described by Eberhardt et al. (1998)

STUDY AREA

The Hoko GMU is located in the extreme northwest section of the Olympic Peninsula. It is bounded to the north by the Makah Reservation, on the south by the Hoko-Ozette Road, on the west by Olympic National Park between Ozette and the Makah Reservation, and on the east by the Straight of Juan de Fuca between the Mouth of the Hoko River and the northeast corner of the Makah Reservation.

The majority of the landbase in the Hoko GMU is privately owned industrial timberlands. The Washington Department of Natural Resources manages State owned land, of which the largest block is located in the Carpenter Creek area. The Washington State Parks manages additional State owned land along the lower Hoko River. A minor amount of land within the Hoko is developed either as small residential areas, isolated homes, or small ranching operations (primarily fenced pastureland for livestock grazing). These developments are primarily located along Highway 112 between the mouth of the Hoko River and the Makah Reservation and along the Hoko-Ozette Road.

Intensive timber harvest has converted what was historically extensive old growth to second growth forests with stand conditions ranging from grass-forb following clearcutting to closed-sapling-pole sawtimber (Hall et al. 1985). Timber harvest occurs in second growth stands at 50-70 years, thus, these stands never attain old growth characteristics. The only old growth habitat available to elk (optimal habitat) is found outside of the Hoko GMU in Olympic National Park (west side) and on the southwest corner of the Makah Reservation. While timber harvest has resulted in the loss of quality optimal habitat, the older second growth stands probably provide adequate hiding and resting cover for elk and recently clearcut areas are assumed to provide adequate foraging habitat.

Intensive timber harvest has resulted in high road densities. Prior to 1987, the majority of roads on industrial timber lands were open to public access, resulting in reduced elk use of available habitat near heavily traveled roads, increased disturbance of wintering and calving elk, and increased vulnerability of elk to tribal and state hunting. Since 1987, roads on industrial timberlands have been closed to the public. Tribal and state hunting is allowed, however access is limited to non-motorized transportation from locked gates along Hwy. 112 and the Hoko-Ozette Road. This has resulted in a corresponding increase in elk use of available habitat near many roads, a decrease in disturbance during the wintering and calving season, and a decrease in vulnerability associated with hunting.

Elk extensively use the riparian and wetland habitats associated with the Hoko, Sekiu, Sooes, Big, and Ozette Rivers and their tributaries. Because the majority of these areas fall within privately owned industrial timberlands, habitat alterations may temporarily displace herds but there has not been substantial losses of habitat or displacement of herds due to development. However, development along the Hoko and Big Rivers adjacent to the Hoko-Ozette Road has led to habitat loss, disturbance, and displacement of herds in these areas.

METHODOLOGY

Marking/Capture

In March/April of 2000 the Makah Tribe and the WDFW with the involvement of local/regional community members jointly radiocollared 14 cow elk in the Hoko GMU and a portion of the Dickey GMU (7 individual herds). In March of 2001, the Makah Tribe, WDFW, and local/regional community members (with funding provided by the Rocky Mountain Elk Foundation) radiocollared an additional 6 elk. The effort in 2001 increased the sample of individual herds to 9. Additionally, a single cow elk was captured from the ground in the fall of 2001 to augment the number of marked elk in one herd. The collar failed and the animal was recaptured in the spring of 2002 and the collar was replaced.

Adult cow elk were captured using a Bell Long Ranger helicopter and remotely injected darts filled with 3-4 mg of Carfentanil citrate. Ground crews were dispatched to immobilized elk and each elk was fitted with a radiocollar, a blood and fecal sample were taken, the elk was injected with antibiotic and vitamin, then reversed with naltrexone and monitored until standing and able to move away. The ground based captures utilized a telemetry dart to locate the immobilized elk, all other procedures were the same as described above. Capture protocols were reviewed and approved by the Humboldt State University Institutional Animal Care and Use Committee (IACUC).

Sample Size

A total of 21 elk were collared within or adjacent to the Hoko GMU during 2000-2002. Seventeen of the 21 marked elk were available for detection during the survey flight. Four marked elk were lost to predation, malnutrition, or collar failure prior to the survey flight. Based on home range work conducted since 2000, the 17 marked elk were known to represent a minimum of 9 distinct groups within the study area (includes both the Hoko and Dickey GMU).

Survey Flight

I conducted an aerial survey of the Hoko GMU the morning of April 3, 2002 in a Hughes 530F helicopter (Eagle Air Helicopters, Forks, WA) and was accompanied by the pilot and Chris Madsen, wildlife biologist for the Northwest Indian Fisheries Commission (NWIFC). The survey was conducted over 3.5 hours between 6:45 and 10:15. The entire GMU was systematically searched utilizing roughly north/south transects beginning originally at the southwestern boundary of the GMU and working to the east. The observers and pilot both visually located groups. Groups were categorized by the observers as marked if one or more radiocollared individuals were present. Telemetry equipment on board the helicopter was used to determine the identity of any marked individuals present. Additional data gathered included a GPS location, time of day, total number of elk, total number of cows, calves, spikes and branch bulls, and total number of marked individuals.

The aerial survey did not use telemetry equipment to locate elk only to verify the identity of marked elk (or lack of) in the groups encountered. A field technician (Kim Loafman, Makah Forestry) utilized telemetry equipment from the ground to locate marked elk that utilize habitats along the Hoko Ozette Road (boundary between the Hoko and Dickey GMU) during the aerial survey to determine which marked elk were available in the Hoko GMU during the aerial survey. All other marked elk not encountered during the aerial survey were located from the ground after the aerial survey. The marked elk located after the aerial survey were known to reside only within the Hoko GMU based on the collection of 2 years of home range data. The ground effort verified the location of marked elk and verified which marked elk were together. The aerial and ground based survey results determined the total number of marked groups available for detection.

Data Analysis

I used the Peterson estimator described by Eberhardt et al. (1998) to estimate the population size based on the total number of groups in the survey area and the mean group size for the survey area. Population size was estimated twice by calculating average group size in different manners. Estimates of total number of groups followed the methodology outlined in Eberhardt et al. (1998). However, the mean group size was calculated utilizing the size of marked groups located and by estimating the group size for marked groups not located during the aerial survey for estimate 1. The estimated group size for marked groups not encountered during the aerial survey was based on historical composition data collected for the respective groups over 2 years. Estimate 2 used the mean group size calculated from observed groups only (both marked and unmarked). To calculate estimates of variance I resorted to bootstrapping (4,999 replicates). The population and variance estimate was calculated using the program R (http://cran.r-project.org/) with the help of John Fieberg, statistician with the NWIFC.

RESULTS

Survey Flight/Ground Effort

A total of 8 distinct marked groups were present during the survey flight. A total of 6 groups were encountered, 5 marked groups and 1 unmarked group. The total number of elk counted was 185 of which 144 were cows, 39 were calves, and 2 were spikes. Table 1. provides the total number of elk per distinct group encountered and the estimated number of elk in the 3 marked groups not encountered during the survey flight.

Table 1. Actual and estimated group size data for elk in the Hoko GMU used in the estimation of population size.

Herd	Marked	Observed	Number of Elk
1	Y	Y	17
2	Y	Y	60
3	Y	Y	32
4	N	Y	17
5	Y	Y	36
6	Y	Y	23
7	Y	N	42
8	Y	N	32
9	Y	N	49

Population Estimate

The total number of predicted groups in the Hoko GMU was 9.5. The average group size calculated was 36.4 and 30.8 for estimate 1 and 2, respectively. Estimate 1 yielded a population size of 346 elk with a 95% confidence interval ranging from 204 – 787. Estimate 2 yielded a population size of 293 elk with a 95% confidence interval ranging from 200 – 440.

Discussion:

An assumption of the methodology used is that marked elk are randomly distributed in the population to forego the need for a visibility correction. The marked elk available were known to have a high level of fidelity to their home ranges, which may have biased the assumption of random distribution. However, within each distinct home range, which 2 or more marked elk utilize, marked individuals were known to associate with separate sub-groups based on home range data collected since 2000. Eberhardt et al. (1998) indicated that it appears reasonable to assume that the marked animals are randomly distributed in the population if collared elk mix freely within groups. Thus, the assumption of random distribution was probably met and the Peterson estimate of total number of groups was appropriate. Additionally, the fact that visibility bias may cause observers to detect a higher proportion of larger groups does not necessarily bias the Peterson estimate of total number of groups present. If the marked elk are randomly distributed in the population, the sample (estimate flight) can be obtained in any convenient manner. However, estimation of variances are complicated, which is why bootstrapping was used.

Eberhardt et al. (1998) determined average group size during surveys based on the size of marked groups seen from the air and from ground counts of marked groups the same day as the aerial survey. I used historical data to estimate a group size for marked groups not observed during the survey and the actual group sizes of marked groups observed to determine the average group size of elk for estimate 1 which yielded a population estimate of 346 elk. I believed that utilizing average group size data from historical flights and ground based counts (where observer indicated a high level of accuracy) would provide sufficient accuracy. This assumption may have biased the accuracy of estimate 1 as historical data may not have been indicative of actual group size the day of the survey. To minimize bias associated with estimating group size for the unmarked groups, I calculated the average group size based on observed groups only (marked and unmarked) for estimate 2 which yielded a population estimate of 293 elk. Additionally, the group size data collected during the aerial survey was similar to group size data collected during composition flights since 1998 indicating the group size data collected in 2002 was normal.

A mark-resight estimate, conducted in the spring of 2000 for the Hoko GMU indicated a conservative estimate of 242 elk (McCoy 2000). Population estimate 1 for 2002 indicated a total of 346 elk. A population increase of approximately 100 elk over 2 years even with the restriction on cow harvest by the Makah Tribe and WDFW is doubtful. Estimate 1 calculated an average group size based partially on historical data for marked un-observed groups, which probably biased the estimate. Population estimate 2 for 2002 indicated a total of 293 elk. Estimate 2 calculated an average group size based on the actual observed groups, which eliminates any bias in the calculation of population size. Additionally, management in the Hoko GMU has focused on population growth by restricting the harvest of cow elk and an increase in herd size of 50 elk over 2 years is conceivable. Therefore, I believe that the estimate of 293 elk is robust and should be used for management purposes.

I believe a more robust approach for this methodology would be to incorporate a number of aerial surveys/estimates spaced out over a period of 3-4 weeks. This approach may minimize any confounding influences from a single flight, improve statistical confidence in the estimate, and yield narrower confidence intervals.

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Literature Cited

Eberhardt, L. L., R. A. Garrott, P. J. White, and P. J. Gogan. 1998. Alternative approaches to aerial censusing of elk. Journal of Wildlife Management 62(3):1046-1055.

Hall, F.C., L.W. Brewer, J.F. Franklin, and R.L. Werner. 1985. Plant communities and stand conditions, pp. 17-31 *in* E.R. Brown, ed., Management of wildlife and fish habitats in forests of western Oregon and Washington. U.S. Department of Agriculture, Portland Oregon. 302 pp.

McCoy, R.H. Hoko Game Management Population Estimate. Copies available from Makah Forestry, Neah Bay, WA 98357. 8 pp.