USE OF DOGS AND MARK–RECAPTURE TECHNIQUES TO ESTIMATE AMERICAN BLACK BEAR DENSITY IN NORTHEASTERN OREGON

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Abstract: We estimated black bear (Ursus americanus) population density in the Blue Mountains of northeastern Oregon based on summer mark–recapture surveys in 1996 and 1997. We developed a mark–recapture technique to estimate black bear density using houndsmen with dogs to detect bear scent on driving transects. We conducted 53 surveys and recorded 72 instances where dogs detected bear scent (a strike). We used strike frequency as a bear density index. Strike frequency did not differ between years; dogs detected bear scent at a rate of 1.47 strikes/20 km in 1996 and 1.18 strikes/20 km in 1997. We recorded each scent detection and pursued every bear to determine if the bear was marked or unmarked. On 55 occasions bears were treed after being pursued by dogs from transect routes; 33 of these were marked and 22 were unmarked. Applying the NOREMARK software, we estimated 59 bears in 1996 and 48 bears in 1997 in the 234-km² survey area. We calculated a density of 25.2 bears/100 km² in 1996 and 20.5 bears/100 km² in 1997 in the survey area. This compares with a minimum known population density based on 3 years of marking bears prior to this study of 10.8 bears/100 km² in the 485 km² capture area that encompassed the survey area. We ... other techniques, to more accurately assess density of a black bear population. The advantages, considerations, costs, concerns, and limitations of this technique are discussed.

Key words: American black bear, density estimate, dogs, houndsmen, NOREMARK, Oregon, population index, transect, Ursus americanus

Many approaches have been developed for monitoring black bear abundance. Garshelis (1993) evaluated the effectiveness of several common techniques to assess black bear abundance and found that none of these methods were without problems. Snaring, camera sets, and hair snags are direct-count techniques that typically involve luring bears to baited traps. Trapping with a scent or food attractant can disrupt normal distribution and movement patterns. Rogers (1987) observed problems of over-estimating a bear population when capturing a large number of bears in a small area. Garshelis (1993) expressed concern about the usefulness of distribution data derived from baiting black bears because individual bears may visit more than one bait or baits along some travelways could be used more frequently than others because of their positioning along a favored trail. Beck (1991) and Garshelis (1993) cautioned that bear movement patterns and their relationship to food availability must be understood before estimating population density from bait stations. Miller et al. (1997) described a population estimating technique for brown bears (U. arctos) combining aerial radiotelemetry and mark–resight techniques which overcame problems from altered bear distribution but required visual contact with bears. The methods described by Miller et al. (1997) have statistical strength but do not seem applicable to heavily forested areas or for lower budget surveys with limited flight time.

Dogs have been used effectively to capture black bears in a variety of states (Willey 1980, Allen 1984, Massopust and Anderson 1984, Elowe 1990). Because dogs indicate all bears they scent regardless of sex and age, dog-assisted capture holds potential for sampling the sex and age ratio of a black bear population. Cunningham (1962) found that dog capture produced a representative sample of the sex and age ratios of raccoon (Procyon lotor) populations. However, the assessment of black bear populations may be complicated by diverse movement patterns by bears of different age and sex classifications.

Our objective was to evaluate the potential for using dogs to estimate black bear abundance. We examined the potential for developing a density index based on the frequency of bear scent detection (strikes) along repeatable transects and also used dogs and mark–recapture techniques to estimate the abundance of black bears in our study area.

STUDY AREA

Our general study area was in the Blue Mountains of northeastern Oregon. Most (75%) of the study area is mixed conifer stands of Douglas fir (Pseudotsuga menziesii), grand fir (Abies grandis), western larch (Larix occidentalis), lodgepole pine (Pinus contorta), ponderosa pine (P. ponderosa), and Engelmann spruce (Picea

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engelmannii). Elevations ranged from 840 to 2640 m. The non-forested portion of the study area (25%) was primarily blue bunch wheatgrass rangeland (Elytrigia spicata). Land ownership around our transects was 85% public, and 15% private. The U.S. Department of Agriculture Forest Service managed public lands, while timber companies and cattle ranchers owned most private parcels. Most of the area has been managed for timber harvest. Road density in the larger capture area averaged 0.62 km of road per km². The area sampled by the transects was 234 km². This was included in the 485 km² study area where we previously captured and marked bears. Black bears were legally hunted during a 3-month season from early September through November. Mandatory harvest information indicated that 4–6 bears were harvested from the study area annually according to Oregon Department of Fish and Wildlife records.

METHODS

In 1996 and 1997 we conducted surveys to estimate a black bear population using dogs to locate bear scent along transect routes. During the 3 previous summers prior to initiating surveys, we used dog capture to radiocollar 56 black bears in the general study area. The radiocollared bears included 12 adult males, 23 adult females, 15 subadult males, and 6 subadult females. We radiocollared subadult bears only if they weighed >45 kg. We distinguished between adult and subadult bears in the field based on physical characteristics, dentition, and body weight as described by Beck (1991). Field age estimates were compared with estimates from cementum annuli analysis of premolars extracted during capture (Willey 1974). We documented 1,200 locations of radiocollared bears from aerial telemetry during the 3 summers prior to beginning surveys.

We selected 4 transect routes in the core of the capture area that seemed to give maximum coverage. We established the survey area size and boundary by including the area covered by all radiocollared adult bear home ranges that came in contact with a transect. We calculated bear home ranges using the 95% minimum convex polygon method (Mohr 1947) in the CALHOME program (Kie et al. 1996) based on aerial telemetry locations from 1993–97.

The 4 transects occurred in each of the 4 quadrants of the study area. Transects were on secondary dirt and gravel roads. Each transect was representative of the habitat types, forest management practices, food availability, and road densities found within the area used by radiocollared bears. Transect length ranged from 18.5–24.5 km ($\bar{x}$ = 21 km). We chose this length for transects because it was short enough to allow for survey completion yet long enough to bisect each quadrant of the study area. Transects were primarily on public land where dogs could be used to pursue and capture a bear if a strike occurred during a survey. We conducted surveys along transects from 8 May to 15 August in both 1996 and 1997. Surveys were not started until May to allow bears to physiologically adjust after emerging from dens and snow to melt from roads at higher elevations. Surveys were terminated in August because we found that subadult bears dispersed in August, resulting in a change in the subadult to adult encounter rate on survey routes relative to the May to July survey period. Furthermore, hot, dry conditions in August caused bear scent to dissipate rapidly, which could result in a lower scent detection rate during surveys. One of the 4 transects was randomly selected for each survey. Two surveys were conducted within 24 hours of weekly telemetry flights.

Flights were conducted to determine the number of marked bears available to each transect. Adult radiocollared bears were considered available to a transect route if a portion of that transect was within their home range. We could not use home range as a criterion for subadult males because they were transients and for newly collared bears because their home ranges had not been calculated. Therefore, subadults and newly collared bears were considered available to a transect when they were within 3 km of that transect at the time of the telemetry flight. The 3-km distance was selected based on a posteriori field observations of distances travelled by collared bears in 24 hours.

We used dogs of trailing breeds (Zwickel 1980) to locate bear scent during surveys. Our dogs were mostly crossbreeds of redbone and Walker hounds. Four houndsmen volunteers and a biologist conducted the surveys. At the start of the survey, the houndsman leashed 2 or 3 strike dogs to a hood platform mounted on a pickup truck, where the dogs had an optimal scenting position. Strike dogs have very sensitive noses and are able to detect bear scent from a moving vehicle. Additional dogs were carried in a pickup bed kennel; they assisted with pursuing and treeing the bear. Surveys began at daybreak when the air was cool and calm and the ground was slightly damp, maximizing scenting conditions. Transects were driven at slow speeds (≤10 kph) and strike dogs barked and bayed excitedly when they detected bear scent. The houndsman tried to verify the recent presence of a bear by searching for tracks along both road banks before releasing the dogs. Strike locations were recorded with an odometer reading, and the route of bear pursuit was drawn on the survey map when possible. Special attention was given to documenting any re-crossing of the transect ahead of the strike location. We determined mean chase distances and duration and treeing success. Strike frequen-
cies (strikes per 20 km) were compared between years using the Wilcoxon rank sum test, \( \alpha = 0.05 \).

Bears treed by dogs during transects were individually identified. If the bear was collared, a receiver was used to identify the bear. When unmarked bears were treed and the situation was safe for capture and handling, a capture crew was summoned by radio. While the crew worked on the bear, the houndsman resumed the survey with the dogs. If the situation was dangerous for capture, we used binoculars and a spotting scope to aid with a detailed description of the bear including color, markings, size, and sex if evident. If complications developed, such as a bear being difficult to tree, we called in a second houndsman to complete the survey. We could not complete about 15\% of surveys due to sudden heavy rain, long pursuit distance, or initiating the pursuit in the wrong direction. When this occurred, we completely resurveyed the route at the first available date.

We used the NOREMARK program (White 1996a) to estimate the black bear population based on mark–recapture results from surveys. We selected the joint hypergeometric maximum likelihood estimator within the NOREMARK program for our analysis because it allowed for immigration and emigration (White 1996b). We grouped surveys chronologically into as many 4-part samples as possible. Some quadrants had more replicates than could be used. In these cases we eliminated duplicate surveys that did not contact bears. Surveys from transects 1–4 were combined for 5 sampling units in 1996 and 6 sampling units in 1997. We compared these NOREMARK population estimates with each other and with a minimum known study area estimate based on 3 previous years of capture effort.

**RESULTS**

We began surveys in 1996 with 27 radiocollared bears available for contact along the transects. Eleven unmarked bears captured during the 1996 surveys were radiocollared. However, after hunter harvest and dispersal, there were 25 collared bears available at the beginning of 1997 surveys. We treed a similar proportion of marked bears on surveys in both years (Table 1). During 1996 surveys 57\% of bears contacted were marked, compared to 63\% marked in 1997.

Table 1. Marked versus unmarked black bears treed during surveys and NOREMARK population estimates and confidence intervals in the Blue Mountains in Oregon, 1996 and 1997.

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Marked bears</th>
<th>Unmarked bears</th>
<th>Population estimate</th>
<th>95%-CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>28</td>
<td>16</td>
<td>12</td>
<td>59</td>
<td>45.5–86.1</td>
</tr>
<tr>
<td>1997</td>
<td>27</td>
<td>17</td>
<td>10</td>
<td>48</td>
<td>38.4–68.3</td>
</tr>
</tbody>
</table>

Strike dogs detected bear scent (strikes) 34 times on 22 surveys during 1996 and 38 times on 31 surveys in 1997. An additional 4 strikes that were not bears were recorded in 1996 and 1997; these strikes were 1 mountain lion (*Felis concolor*), 1 bobcat (*Lynx rufus*), and 2 undetermined scents. Houndsmen obtained 1.47 strikes/20 km in 1996 and 1.18 strikes/20 km in 1997 during surveys, with no significant difference in these values (\( \alpha < 0.05 \)). We observed monthly variations in strike frequency during both years (Table 2). There were also monthly variations in the subadult:adult ratio of bears captured on survey routes (Table 3); the proportion of subadults increased in late summer 1996. The ratios of subadult:adult bears and male:female bears captured varied between years (Table 4). Treeing success (bears treed/strike) from transects was 86\% when 1 or 2 strikes occurred during a survey and 63\% when 3 or more strikes occurred. The dogs treed bears after a mean chase distance of 4.2 km, (SD = 3.4, range = 0.1–14.5) and a mean chase duration of 55 minutes, (SD = 65, range = 1–145).

We estimated a population size from the NOREMARK program of 59 bears (95\% CI = 45.5–86.1) for 1996 and 48 bears (95\% CI = 38.4–68.3) for 1997. These estimates indicate a density of 25.2 bears/100 km\(^2\) (95\% CI = 19.4–36.8) in 1996 and 20.5 bears/100 km\(^2\) (95\% CI = 16.4–29.2) in 1997 in the 234 km\(^2\) study area.

**DISCUSSION**

Neither the population estimate nor the population index indicated that this bear population had changed significantly between 1996 and 1997. The wide confidence intervals associated with the population estimates make it difficult to detect changes in population size. However, even the lower confidence limits of both population estimates were substantially higher than the minimum bear density determined from our 3-year capture effort (1993–95). In August 1995 we identified 52 bears in the 485 km\(^2\) capture area and determined a minimum bear density...
of 10.8 bears/100 km\(^2\). The NOREMARK density estimates were greater than the known marked population estimates because the NOREMARK estimate accounted for the unmarked segment of the population not identified in 1995.

We gained insight into the advantages and limitations of using dogs for detecting population changes and estimating black bear densities. The benefits of using dogs on population surveys are: (1) the bear is detected at sites within the normal area used by the bear, rather than at an attractant, (2) unlike trapping, dog surveys do not require set up time, (3) bears can be recaptured without handling, and (4) a strike index and mark–recapture population estimate can be conducted from surveys simultaneously.

There are limitations to the use of dogs for surveys and mark–recapture population estimates. A primary consideration should be the suitability of the area to be sampled. Climates that are too wet will limit the dog’s capability to detect scent. The efficiency of this technique is dependent upon reliable access for vehicles, so roadless or wilderness areas are not well suited. If pursuit and capture are part of the study protocol, private property must be accessible because pursuit direction and duration is usually unpredictable. If a strike index is the objective, a reward opportunity to pursue a bear is necessary for the dogs. Strike dogs will lose interest if they are continually restricted from pursuing the bear scent trail. We believe the techniques we have described will be effective in many situations if these factors are evaluated before developing a study plan or survey.

Our optimal period for conducting surveys was June and early July, during the breeding season and before subadult dispersal; we contacted the most bears with the widest range of age and sex classes during this time. Annual consistency in the dates of surveys is important because bear age and sex class catchability changes through the summer. We encountered a high proportion of subadult bears, 3 years or younger, during surveys in late July and early August. Many of these subadults were likely transient males that would not become study area residents. Their inclusion in the population estimate overestimated the true population. Subadults accounted for 72% of the 1996 captures and 44% of the 1997 captures during surveys. Because a smaller proportion of subadults was marked than adults, the large number of unmarked subadult captures likely further overestimated the bear population and contributed to the large confidence limits. Studies in Colorado (Beck 1991) and Idaho (Beecham and Rohlman 1994) derived estimates of bear population size from population reconstruction by age and sex class to minimize the confounding effect of subadult male dispersal on bear population estimates.

In the Blue Mountains we observed synchronous cub production every other year (Akenson et al. 2000) like that described by LeCount (1990) in Arizona. On our study area this phenomenon created a profusion of newly independent subadult males in 1996 (>43% of total capture) with fewer captured in 1997 (>22% of total capture). A wide variation in annual cub production and subadult dispersal can result in large differences in annual population estimates. These differences in annual population estimates may not reflect changes in the resident adult population; instead they reflect the biennial reproductive cycle of the bear population. Adult males were caught along transects more frequently during June than any other month due to heightened travel activity while searching for a mate.

Food availability and weather influence the ability to detect bears during spring and early summer. Garshelis (1993) identified these 2 independent factors that confound interpretation of data used as population indices. We observed in May that bears were oriented to abundant new grasses and forbs and did not travel far in their food search. Consequently, we recorded greater distances travelled per strike in May than June or July (Table 2). We also experienced more adverse weather during May, when surveys were canceled more often (30%) due to rain than those conducted during mid-summer (10%).

Roads may influence the distribution and movement of bears. LeCount (1982) found higher visitation at scent-stations positioned along trails compared to those placed near gravel roads. Mantey and Immell (1996, Influence of roads on black bear detection at bait stations, Oregon Department Fish and Wildlife, Oakridge, Oregon, USA) showed that bears in western Oregon avoided roads, particularly during late summer when vehicle traffic increased. Vander Heyden (1997) determined that female bears were negatively associated with roads and avoided crossing them. In Idaho, Beecham and Rohlman (1994) determined that feeding bears used areas close to roads in proportion to their availability, but that resting bears and females with cubs avoided roads. In our study area, with
a moderate road density (0.62 km of road/km²), we noticed an increased willingness of radio-collared bears to cross roads during the breeding season and during berry crop production from mid-July into late summer. We observed similar adult male:female ratios in the 1995 marked population from 3 years of intensive capture (0.52:1.00) and the 1996 and 1997 surveys (0.53:1.00). We did not detect road avoidance by adult females during the surveys. Road avoidance or acceptance is important, particularly when considering the development of a population index based on the frequency of strikes from road travel. More information on the influence of roads on bear movement patterns is needed to help validate this technique.

The experience level of the houndsmen and the scenting ability of their dogs greatly influence bear detection. Zwiel (1980:534) cites an applicable comment by the late Doug Pierson who noted, “Only about 1 out of 10 good cat or coon hounds will run black bear successfully.” We were very fortunate to work with skilled volunteer houndsmen, who conducted themselves professionally and accurately read both bear and dog behavior. All crew members adhered to the highest safety standards. No serious injuries occurred to people, dogs, or bears during surveys and captures. Our houndsmen had top quality dogs, which was reflected in the high treeing efficiency from strikes. Elowe (1990) noted that an average-to-good pack of hounds with experienced handlers may tree up to 30% of the bears they run, and an exceptional pack can tree bears on 80% of their chases. He based these comments on observations from over 200 captures in New England. One of our packs had an 85% capture efficiency in 1997. This level of efficiency is rare, and we attributed it to a highly experienced houndsman with very good dogs that were maintained in top physical condition.

The effectiveness of the man and dog combination is a critical element, as it can influence population data, whether the objective is bear capture or scent detection. Houndsmen assemble their dog packs from a variety of breeds, conformations, and scenting capabilities. It is very important to match dog type with the application. Some dogs are cold nosed and can detect bear scent that is 1/2 day old or more, while others are hot nosed and only detect relatively fresh scent. Some dogs are bred for speed, endurance, and tenacity for putting bears into trees. If bear capture is the objective, then dog speed and performance are the key attributes. Conversely, if detailed scent path mapping is the primary need, such as for home range evaluation, then a slower moving cold nosed dog would be the best choice. Vegetation and terrain affect dog travel speed, and this should be considered when making regional comparisons. Allen (1984) reported a mean chase distance of 6.5 km over 3.2 hours from Maine. Massopust and Anderson (1984) reported from their Wisconsin study a mean chase distance of 11.1 km over 1.9 hours. Our dog packs would be considered between hot and cold nosed and fast on travel time, with a mean chase distance of 4.2 km and duration of 55 minutes. These dogs worked very well for treeing bears quickly and getting back to the survey, but their chase route was difficult to map.

We conducted this study at a very low cost because the houndsmen we used volunteered their time and services. Houndsmen frequently volunteered their services to the Oregon Department of Fish and Wildlife in exchange for vehicle mileage and the opportunity to use their dogs to contribute to wildlife research or management. If this type of service were commercially hired, the cost for a houndsman, vehicle, and dog pack would be approximately $250 per day, or $2,500 per month assuming the completion of 2 transects per week.

There are limitations with using dogs for estimating population density. One problem is determining the area actually sampled, considering scent drift and climate variables. Another problem concerns the persistence of scent, or how long after a bear crossed a transect route that a dog can detect scent. Both of these problems are difficult to test, but important for making this a standardized technique. Another limitation concerns marked bear availability to the transect. The NOREMARK program accommodates for variations in availability, but our knowledge of daily bear movements was not adequate to maximize the program’s potential; more intensive aerial telemetry would refine the population estimate. An increase in the proportion of marked bears, especially subadults, and an increase in the number of surveys would improve the density estimate and decrease confidence limits. The combining of 4 surveys for a sampling unit increased the number of bears captured per sample and improved the confidence limits. As a population index, these techniques have the greatest potential, particularly when combined with another detection method such as hair snags or camera sets. Consistency is the key for a successful index. Managers need to select repeatable transects and have access to an accomplished houndsman with top quality hounds.

The techniques we applied in this study hold promise. Surveying transects with bear dogs can provide an index of strikes per linear unit to monitor for changes in black bear populations. We were encouraged by the positive relationship between strike frequency and the annual population estimates; however, more testing is necessary to validate this relationship. Further refinements and comparisons to a known population are needed to utilize the full potential of dog transects for estimating black bear
population composition, size, and trends.

MANAGEMENT IMPLICATIONS

Pursuit dogs can be a very safe and effective tool for collecting bear population data. Consistency of using the same houndsmen and dog packs is important if establishing a density index over time. As Garshelis (1993) indicated, there are bias problems inherent to population estimation regardless of method. This technique allowed us to:

- Contact naturally distributed individual bears.
- Positively identify the bears encountered.
- Document the composition of family groups or breeding pairs.
- Contact previously marked individuals without having to handle or immobilize them.
- Compare estimates with other techniques such as scent station visits.

Most bear managers are limited in their population monitoring strategies by cost. Managers cannot continuously conduct radiotelemetry studies to effectively monitor population change. Garshelis (1993) suggested using a combination of trend indicators to test for population change in an affordable manner. Harvest data, nuisance activity, and visitation at bait, scent, or camera stations are all options for developing population indices. However, used alone all these methods have deficiencies and biases. For instance, in Oregon several wildlife management units have insufficient harvests to establish reliable population trend information, and nuisance activity seems more directly linked to berry crop or other food source failure than population change. Bait or scent station visitation is one of the more widely applied population survey methods. In recent years the addition of hair snags for DNA testing (Koehler et al. 2000) has greatly enhanced the usefulness of bait station information by identifying individual visitors. Bait stations still have a distribution bias in respect to repeat visits and the concentrating influence of the odor. Dog transects could be used to test for distribution bias by sampling road transects that cover the area between bait stations.

Formulating a strike index can serve as an economical alternative or as an additional method for referencing population trends. Because we were conducting a mark-recapture study we pursued bears at every strike. If the objective is to specifically record strike frequency, it is important to allow pursuit every third or fourth strike so the dogs are rewarded for scent detection. This also provides an opportunity to confirm that strikes are bears and not other wildlife species. By not pursuing most strikes, survey speed and efficiency will be increased. Some considerations for using strike dogs for establishing a population index are to:

- Obtain the services of an experienced houndsmen.
- Use the same houndsmen each year for consistency.
- Make certain the strike dogs give priority to black bear scent.
- Establish transects in good bear habitat not biased by a unique food source.
- Position transects on secondary roads with low to moderate traffic.
- Avoid late summer surveys and disproportionate contact with dispersing bears.

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LITERATURE CITED


VANDER HEYPEN, M. 1997. Female black bear habitat selection and home range ecology in the central Oregon Cascades. Thesis, Oregon State University, Corvallis, Oregon, USA.


