BLACK BEAR POPULATION ASSESSMENT METHODOLOGY AND DATA ANALYSIS IN NEVADA: A REVIEW

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INTRODUCTION

In response to increased bear-human conflicts the Nevada Department of Wildlife (NDOW) invigorated its black bear program in 1997 when it began actively altering the way it responded to and resolved these conflicts. This included a new policy, *Bear Conflict Management* (1998, revised 2007) and a public education campaign, *I'm Bear Aware, are you?* These facilitated a change in how NDOW handled individual bears. Captured bears considered candidates for release were tranquilized, marked and data recorded. Additionally, conflict bears were routinely released on-site with aversive conditioning rather than being relocated. Wildlife aversion conditioning management was a fairly new technique in 1997 and NDOW was one of the leaders in developing its use. These changes resulted in greater public involvement in the bear program and much more information on the black bear population being collected. The steady increase in bear-human conflicts raised questions about the bear population and these questions became the basis for the on-going long-term study that began in 1999. This research, together with a study from 1987-1990, has resulted in one Master's Thesis, one PhD dissertation, six peer-reviewed articles in professional scientific journals and two Biological Bulletins. These scientific publications cover a variety of topics such as population demographics, reproduction, genetics, aversive conditioning, relocation, denning chronology and home range size, as well as age-specific mortality, fecundity and survival rates of females. The following is a description of the process and methodology used to assess the black bear population in Nevada.

Data Collection

Adhering to the Department's nuisance bear policy and in cooperation with NDOW's research partners, Dr. Jon Beckmann of the Wildlife Conservation Society (WCS) and the University of Nevada, Reno, data have been collected in a rigorous manner on all black bears handled by agency personnel since 1997. This includes every bear that was captured and released or captured and euthanized, and new bears that were recovered as mortalities. Bears were captured in both urban and wildland areas using culvert traps, foot snares or free-range techniques. The data set contains information on date, sex, age, weight, color, physical condition, reproductive status, morphological measurements and conditions of every capture or mortality event. Biological samples taken from individual bears include hair, whole blood, serum and tooth samples. Additionally, this data set contains temporal and empirical data from individual bears wearing VHF, GPS and satellite collars. A summary of the data set is as follows:

- 481 individual bears
- 832 incidences (captures, recaptures, recovered mortalities, etc.)
- 36 percent average recapture rate of marked bears
- 85 collars deployed
- 187 females
    - ✓ average age adults = 8.0 years

- 284 males
  - ✓ average age adults = 6.5 years
- 124 cubs
- 295 documented mortalities in Nevada including:
  - ✓ 85 public safety/chronic nuisance
  - ✓ 147 hit by cars
  - ✓ 20 depredation
  - ✓ 5 illegal
- Beckmann reported urban areas in Lake Tahoe Basin on the Nevada side had the second highest reported density of black bears in North America (Beckmann and Berger 2003a).
- Bears captured through May of 2002 were classified as urban (n=71) or wildland (n=28), based on their proportion of time spent in urban areas. The differences noted here were behavioral only and do not suggest two different breeding populations of bears (Beckmann and Berger 2003b). Since 1997 bears have been marked with tattoos, ear-tags and many were also radio-collared. Defining bears as urban or wildland using the criteria described in Beckmann and Berger (2003a) is only possible for radio-collared bears.
- In 2008 the focus of ongoing long-term research shifted more towards wildland bears. Since that time data have been collected on 12 wildland males and 22 wildland females.

DATA ANALYSIS

The data used to generate the latest bear population demographic figures include:

- Data collected from 1997 through 2008 (12 years).
- 709 total occurrences (each time a bear was handled counted as an occurrence).
- 420 individual bears in the data set that was analyzed.

Note: More than half of these bears (223) were removed from the final analysis because they did not meet the criteria of the analysis program.

- 197 bears were represented in the final analysis by Dr. James Sedinger (University of Nevada, Reno) compared to 58 bears in a previously published analysis by Beckmann (Beckmann 2002, Beckmann and Berger 2003a). This increase of available data in the data set was reflected in lower confidence intervals as well as the noted change in the bear population estimate.
- We used the Jolly-Seber method (Jolly 1965, Seber 1965, Seber 1986) in Program MARK (White and Burnham 1999) to calculate:
  - ✓ Quarterly survival
  - ✓ Annual survival
  - ✓ Seasonal capture probabilities
  - ✓ Population estimate
  - ✓ Rate of recruitment
  - ✓ Finite rate of increase

Black Bear Population Dynamics Estimation Procedure

The following summary of the black bear population dynamics estimation procedure used by NDOW was prepared by Dr. James S. Sedinger, a population ecologist with the Department of Natural Resources and Environmental Science, University of Nevada Reno:

I estimated size of the black bear population in the Carson Range, Lake Tahoe and the Reno-Carson City areas, and rate of change of the population using data from individual bears marked by NDOW staff. I conducted analyses using a software program, Program MARK, designed by Dr. Gary White, Colorado State University. Dr. White is an acknowledged expert in estimation of demographic parameters from wildlife populations. I explain these estimates below.

I estimated size of the population using the Jolly-Seber method. This approach uses the following logic. A sample of animals is captured, marked and released. A second sample is then captured. If the first sample mixed with the entire population the ratio of marked animals to the size of the total sample in the second sample is the same as the ratio of total marked animals (from the first sample) to the size of the entire population. If the size of the entire population is N (which we don't know but are trying to estimate), the number of marked animals released in the first sample is M, the size of the second sample is n and the number of marked animals in the second sample is m, we can write a formula for our estimate of population size as:

$$\frac{M}{N} = \frac{m}{n}$$

$$\xrightarrow{yields} N = \frac{Mn}{m}$$

The Jolly Seber approach is a little more complex because it allows for mortality between the first and second samples (which it adjusts for), and combines the results from multiple samples. The basic logic of the calculation remains the same. It is important to note that these approaches generally produce underestimates of population size. If the first marked sample did not randomly mix, or if some individuals have a greater chance of being caught than others, population size will be underestimated. To see this, think about what happens if some individuals are more catchable. This will cause m, the number of marked animals in the second sample to be too large, because animals caught the first time are more likely to be caught the second time than expected if all animals are equally catchable. This will cause the ratio m/n to be too large, or n/m to be too small. If n/m is too small our estimate of N will be too small.

I estimated the rate of change in the size of the population, λ, using analyses of data from marked animals developed by Roger Pradel. Pradel analyses rely on the pattern of encounters of marked bears. NDOW marks each unmarked bear when it is captured and records all subsequent captures of each marked bear. The data are then structured so a marked bear receives a 1 each time it is caught and a 0 when it is not caught. We defined capture occasions as the 3 month seasons, defined by the solstices and equinoxes. If a bear was caught in a particular season it received a 1 for that season, if not, it received a 0. The analyses produced four kinds of parameters: survival, recruitment, capture probability and λ, the rate of population increase. Capture probabilities are estimated based on the proportion of bears that are missed on a particular occasion but captured later. Survival is estimated from the bears that are never caught again after a particular occasion, after accounting for the probability that some bears were never caught again even though they were alive (accounting for the fact that the capture probability was not 1 for any given season). Estimates of recruitment are based on when individuals first appear in the data (the season when they receive their first 1), accounting for the fact that some bears were present for some period before they were first detected (those capture probabilities again). Rate of population increase just represents the sum of per capita recruitment and survival, and can also be

thought of as the ratio of the number in the population in one year divided by the number in the previous year. That is, λ is the proportional increase in the population from one year to the next. A λ greater than 1 indicates the population is increasing, while a λ less than 1 indicates the population is declining.

Based on this analysis Nevada's bear population in the study area (core population) was estimated to be between 200-300 adult animals at the end of 2008. The rate of population increase as described above was estimated to be approximately 16% annually. Quotas for the bear hunt were recommended using these figures based on the concept of *sustainable yield.* Sustainable yield can be described as the ecological yield (number of animals) that can be removed without reducing the base population. Depending on management goals, the surplus can be managed to maintain the population at the same or an increasing level over time. The recommended quota of 20 bears represents only 50% of the sustained yield estimates for the core bear population. Based on this recommended level of harvest continued growth of Nevada's bear population can be expected.

The estimate for Nevada's portion of the Sierra black bear population has been determined to be conservative because of the following : (1) heterogeneity in the capture probabilities – not all bears had an equal chance of capture; (2) the population estimate represents the core population as described above, but viable populations exist elsewhere and were not represented proportionately in the data set; and (3) 223 bears captured in Nevada were removed from the analysis because of the criteria chosen, even though they were part of the population at the time of their occurrence.

LITERATURE CITED

Beckmann, J.P. 2002. Changing dynamics of a population of black bears (*Ursus americanus*): causes and consequences. Ph.D. dissertation. University of Nevada, Reno. 126 pp.

Beckmann, J. P. and J. Berger. 2003a. Using black bears to test ideal-free distribution models experimentally. Journal of Mammalogy: 84: 594-606.

Beckmann, J.P. and J. Berger. 2003b. Rapid ecological and behavioural changes in carnivores: the responses of black bears (*Ursus americanus*) to altered food. Journal of Zoology 261:207-212.

Jolly, G.M. 1965. Explicit estimates from capture-recapture data with both death and immigration stochastic model. Biometrika 52:225-247.

Seber, G.A.F. 1965. A note on the multiple recapture census. Biometrika 52:249-259.

Seber G.A.F. 1986. A review of estimating animal abundance. Biometrics 42:267-292.

White, G.C. and K.P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46 Supplement, 120-138