Schoen

ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

STATE OF ALASKA
Bill Sheffield, Governor

DEPARTMENT OF FISH AND GAME
Don W. Collinsworth, Commissioner

DIVISION OF GAME
W. Lewis Pamplin, Jr., Director
Steven R. Peterson, Research Chief

INTERPRETATION OF BEAR HARVEST DATA

By

Sterling D. Miller

and

SuzAnne M. Miller

Progress Report
Federal Aid in Wildlife Restoration
Project W-22-5, Job 4.18R

Printed November 1986

PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: None

Project No.: W-22-5 Project Title: Big Game Investigations

Job No.: 4.18R Job Title: Interpretation of Bear Harvest Data

Period Covered: 1 July 1985-30 June 1986

SUMMARY

The overall objective of this project is to improve understanding of the relationships between trends in living brown/grizzly bear (Ursus arctos) populations and corresponding changes in sex and age composition data derived from the harvest of these populations. Preliminary work accomplished in this reporting period includes: 1. conversion of a bear harvest model derived by Tait (1983) to a microcomputer version; 2. identification of a population model developed by Richard Harris for use as a simulation tool; 3. preliminary introduction to staff biologists of the above tools; 4. development of an outline for components needed to simulate harvest rates.

CONTENTS

BACKGROUND

Brown-grizzly bear (Ursus arctos) managers are faced with the problem of establishing acceptable levels of harvest for a species with a slow growth rate, for which no generally accepted techniques for determining changes in population status exist, through either direct or indirect monitoring (Harris 1986). In some portions of Alaska, the need for such monitoring techniques is particularly strong, as managers attempt to lower grizzly bear numbers in order to reduce bear predation on ungulates. Such reductions are difficult to monitor without techniques for evaluating bear population status or population growth potential.

Currently, Alaska's bear managers judge trends in bear populations largely by interpreting sex and age data derived from mandatory registration of hunters' bear kills. These judgments of trends, however, are not conclusive and the same data sets are sometimes interpreted in dramatically different ways. No models are available to evaluate which are the most reasonable or even feasible interpretations. Neither are there models available through which a relationship can be established between bear productivity and sustainable harvest rates. The lack of information in this regard is important because bear productivity can vary widely in different portions of the state.

Better understanding of bear population dynamics is important for interpretation of harvest data and for development of methods for directly assessing the status of living populations. The use of simulation models to mimic the dynamics of the possible responses of a population of animals to a variety of introduced variables is a well-established, relatively inexpensive, and occasionally misused tool of modern game managers who seek to better understand these dynamics (Pojar 1981). For bears, the modeling approach has been most extensively used by Bunnell and Tait (1980, 1981) to model, among other things, sustainable mortality rates (from all causes) as a function of reproductive parameters. Sidorowicz and Gilbert (1981) used a similar model to predict sustainable hunting levels of 2-3%/year for grizzlies in the Yukon. Harris (1984 and unpubl.

data) used the sex and age composition of simulated harvest data from another population model to examine the sensitivity of such data to changes in bear population status or trend and concluded that such data are not very revealing. The bear harvest model prepared by Fraser et al. (1982) is unlikely to work on Alaska data derived from sealing documents because of the absence of effort data from unsuccessful hunters in Alaska.

Tait (1983) has presented a mathematical approach to the analysis of hunter-kill data, which works well on Monte-Carlo simulations of bear populations--but has yet to be tested on real data. Tait's model uses as input exactly the kind of information on bears available in Alaska as a result of a 14-year history of sealing and aging bears. Meetings between Tait and ADF&G biologists have established that his model has promise as a management tool.

No population or harvest simulation models have been developed for use by Alaska's bear managers for use in helping to manage Alaska bears, although sufficient data are available in several areas to do so. These areas include Game Management Units (GMU's) 9 and 13 and the North Slope, and similar data are being compiled in ongoing studies in Kodiak and southeastern Alaska.

OBJECTIVES

1. To identify or construct a bear population simulation model useful to bear managers for improving understanding of the relative importance of various reproductive parameters, harvest rates, and bear vulnerabilities in regard to population growth rates and sustainable harvest rates, and to examine the utility of sex and age composition data derived from harvest records in making conventional interpretations of bear population status.

2. To evaluate Tait's harvest data model (Tait 1983) and, to the extent practical, to adapt it as a management tool for use in interpretation of bear harvest data in Alaska.

RESULTS

The model developed by Tait (1983) is a "maximum likelihood" model designed to evaluate which population conditions would most likely yield a given set of harvest data. This model has worked well in Monte Carlo simulations (Tait 1983) but has yet to be adequately tested using real harvest data. One of the potential problems with real data is that they are imprecise relative to simulation data. In the simulation data sets the bears are all sexed and aged perfectly and all deaths are known. This is not true for real data sets, and, to the degree the real data are imprecise, the reliability of the results may also be imprecise. In this project Tait's model was converted from a relatively unwieldy version on the University of British Columbia's computer system to a version that is workable with IBM-compatible microcomputers. This converted model has been run on a few test data sets and is ready for more extensive testing.

Another model similar to that described by Harris (1984) has almost been completed, by Harris, under contract to the Interagency Grizzly Bear Study Team. This model provides the ability to configure a bear population as desired to represent a declining, stable, or increasing status and to simulate harvest of these populations as desired. The resulting harvest data can be examined to evaluate the sensitivity of various parameters to reflect the status of the bear population from which the simulated data were drawn. Harris' model is still under development but a final version is expected to be available for our use in 1986. This model can be used to provide test data sets for Tait's model and one such effort was conducted at a workshop held in March 1986.

The Second Alaska Interagency Bear Workshop was held at Chena Hot Springs in March 1986. At this workshop biologists were given sets of harvest data derived from Harris' model and asked to interpret the status of the population that yielded these data. Generally, biologists were able to accurately interpret trends in this exercise. However, their ability to predict changes in status (e.g., from stable to decreasing) was typically delayed 7-15 years after the change occurred. As reported by Harris (1984), the adult sex ratio appears to be the most sensitive single parameter in evaluating a change in status based on harvest data.

Current plans are to hold more such workshops to better understand the utility and limitations of sex and age composition of bear harvest data once Harris' model is completed and available. These workshops will be a training exercise for staff involved in bear management.

A technique developed by Miller et al. (in press) gives managers the ability to obtain objective and replicable estimates of bear density. If this estimate is obtained in an area that contains a variety of habitats in the same proportion as a larger surrounding area, then this density estimate can be extrapolated to this larger area to obtain a population estimate. If the harvest of bears in this larger area is known, then managers can divide the number of bears harvested by this population estimate to obtain harvest rate estimates. These estimates can be compared with sustainable harvest rates estimated from population modeling.

Application of this technique in complementary projects in GMU 13 and Subunit 20A will provide field data needed to validate the model's predictions. Trends will be determined using replications of the density estimation procedure described by Miller et al. (in press). Consequently, we anticipate extension of this study to take advantage of these opportunities to validate the models. When this study was initiated, validation of these models was limited by the quality of available population assessment techniques.

Sustainable harvest rates can be modeled following the pattern described by Bunnell and Tait (1980). These authors modeled maximum sustainable mortality from all causes (percent/year) as a function of average age at 1st reproduction and average natality rate (litter size/years between litters). Desirable variables for input into a sustainable mortality rates model based on mortalities from harvests in Alaska are outlined in Appendix A. This outlined model is similar in concept to that under development by Harris; his model may require only slight adjustments to make it fit these needs.

LITERATURE CITED

Bunnell, F. and D. E. N. Tait. 1980. Bears in models and in reality--Implications to management. Pages 15-25 in Bears--Their biology and management. Bear Biol. Assoc. Conf. Ser. No. 3. Kalispell, Mont.

__________ and __________. 1981. Population dynamics of bears and management implications. Pages 75-98 in C. W. Fowler and T. W. Smith, eds. Dynamics of large mammal populations. Wiley. 477pp.

Fraser, D., J. F. Gardner, G. B. Kolenosky, and S. Strathern. 1982. Estimation of harvest rate of black bears from age and sex data. Wildl. Soc. Bull. 10(1):53-57.

Harris, R. B. 1984. Harvested age structure as an indicator of grizzly bear population status. M.S. Thesis. Univ. of Montana. 204pp.

__________. 1986. Grizzly bear population monitoring: Current options and considerations. Montana Forest and Conservation Expt. Sta. School of Forestry, Univ. of Montana, Missoula. Misc. Publ. #45. 80pp.

Miller, Sterling D., E. F. Becker, and W. B. Ballard. In press. Density and structure of black and brown-grizzly bear population estimated using modified capture-recapture techniques.' Intl. Conf. Bear Res. and Manage:7.

Pojar, Thomas M. 1981. A management perspective of population modeling. Pages 241-262 in C. W. Fowler and T. W. Smith, eds. Dynamics of large mammal populations. Wiley. 477pp.

Tait, David E. N. 1983. An analysis of hunter kill data. Ph.D. Thesis. Univ. of British Columbia, Vancouver. 129pp.

Sidorowicz, G. A., and F. F. Gilbert. 1981. The management of grizzly bears in the Yukon, Canada. Wildl. Soc. Bull. 9(2):125-135.

APPENDIX A

OUTLINE OF BEAR POPULATION MODEL

I. BASELINE POPULATION PARAMETERS

- A. Population size
- B. % of population that is adult (adults defined as "mean age of 1st successful reproduction of female" (Section IIA).
- C. Sex ratio of adults
- D. % natural or unreported mortality of bears older than age of weaning (assigned randomly to adults)
  1. If mortality occurs to adult females with cub or yearling litters, assume these offspring die
  2. If mortality occurs to adult females with litters of offspring aged 2.0 or older, treat same as a natural separation ("weaning")

II. RECRUITMENT PARAMETERS (Simple version)

- A. Mean age at 1st successful reproduction (offspring successfully separated from mother are "weaned")
- B. Mean litter size (at weaning)
- C. Mean interval between successful litters (successive successful weanings of litters)

III. RECRUITMENT PARAMETERS (density-dependent version of simple version)

- A. Same parameters as above except where II-A and II-B are specified functions of I-C (sex ratio of adults)

IV. RECRUITMENT PARAMETERS (complex version designed to help identify input parameter values for the simple version)

- A. Mean age at 1st production of offspring (will be younger than II-A)
- B. Mean litter size at emergence from natal den: expressed as % of females with litters of 1, 2, and 3 cubs

C. % cubs lost for natal year of litter to emergence as yearling (randomly assign losses to females and then, those females which lose whole litters will produce new litters as follows, with indicated percentages assigned in consideration of the timing of the losses relative to the breeding season)

   1. x% 1 year later (most of these for complete loss of litter before July)

   2. y% 2 years later

   3. z% 3 years later

D. For yearling year of litter

   1. % of litters weaned in spring of this year (will be 0% in most areas)

      a. % of females with yearlings producing their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

   2. % of yearlings lost (randomly assign losses to offspring of females and then those females which lose whole litters will produce new litters in the next years according to same percentages as in IV.C.1-3, above)

E. For 3rd year of life for offspring (2-year-olds)

   1. % of remaining litters weaned in spring of this year (will be 100% in some areas)

      a. % of females producing their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

   2. % nonhunting mortality for offspring not weaned in spring (assume no hunting mortality and that all of the litters which remain are with mothers until emergence the following year)

      a. % of the above females that have lost a whole litter and that will produce their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

F. For 4th year of life for offspring (3-year-olds)

1. % of remaining litters weaned in spring of this year (will be 100% in some areas)

    a. % of these females producing their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

2. % nonhunting mortality for offspring not weaned in spring (assume no hunting mortality and that all of these litters are with female until emergence the following year)

    a. % of the above females producing their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

G. For 5th year of life for offspring (4-year-olds)

1. % of remaining litters weaned in spring of this year (will be 100% in some areas)

    a. % of these females producing their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

2. % nonhunting mortality for offspring not weaned in spring (assume no hunting mortality and that all of these litters are with female until emergence the following year)

    a. % of the above females producing their next litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

H. For 6th year of life for offspring (5-year-olds) assuming all are weaned in spring

1. % of these females producing another litter in each of the following 3 years (same percentages as in IV.C.1-3, above)

REQUIRED OUTPUTS FROM THIS COMPLEX VERSION MODEL ARE:

Mean age at 1st successful reproduction (litter was successfully weaned)

Mean litter size at weaning

Mean litter size at weaning for each age class of weaned litters (yearling, 2-, 3-, 4-, and 5-year-olds)

Mean interval and range between successfully weaned litters:

No. and % of cub litters that are completely lost
No. and % of yearling litters that are completely lost
No. and % of 2-year old litters that are completely lost
No. and % of 3-year old litters that are completely lost
No. and % of 4-year old litters that are completely lost
No. and % of 5-year old litters that are completely lost
No. and % of all litters, regardless of age class, that are completely lost
No. and % of all offspring (age 0) lost
No. and % of all offspring (age 0-1) lost before weaning
No. and % of all offspring (age 0-2) lost before weaning
No. and % of all offspring (age 0-3) lost before weaning
No. and % of all offspring (age 0-4) lost before weaning
No. and % of all offspring (age 0-5) lost before weaning
No. and % of all offspring (age 0-6) lost before weaning

V. HARVEST PARAMETERS

A. Assign relative vulnerability parameters (in regard to hunters) to following groups of bears:

1. Spring hunting seasons

a. Adult males

b. Adult females without litters

c. Adult females with litters of newborn offspring

d. Adult females with litters of yearling offspring

e. Adult females with litters of offspring aged 2.0 or older

f. Subadult males (from age of weaning to age of reproductive maturity)

g. Subadult females (from age of weaning to age of reproductive maturity)

2. Fall hunting seasons

a. Adult males

b. Adult females without litters

c. Adult females with litters of newborn offspring

d. Adult females with litters of yearling offspring

e. Adult females with litters of offspring aged 2.0 or older

f. Subadult males (from age of weaning to age of reproductive maturity)

g. Subadult females (from age of weaning to age of reproductive maturity)

B. Effort index for season (this is designed so that by increasing these values while holding everything else constant an increased % harvest will result). This index should be set annually to permit, for example, closure of seasons in alternate years

1. Index for spring season

2. Index for fall season

The initial population described in Part I reproduces according to the parameters in Parts II, III, or IV (the parameters for II or III can either be estimated directly or through use of the submodel described in Part IV). This population is harvested according to the parameters in Part V. Model outputs for Part IV are described above. Suggested outputs from the final model include the following:

Harvest data for each year and for variable (specified) numbers of years lumped together:

Number and % of bears harvested in whole population;
Number and % of bears harvested in each sex and age class;
Number and mean age of harvested males older than 5;
Number and mean age of harvested females older than 5;
Sex ratio (% males) of harvested bears older than 5;
Number and mean age of all harvested males;
Number and mean age of all harvested females;
Sex ratio (% males) of all harvested bears.

Population data for remnant population at end of harvest year (or specified harvest period):

Number of bears in population;
Number and % in each sex and age class;

Number and mean age of males older than 5;
Number and mean age of females older than 5;
Sex ratio (% males) of bears older than 5;
Number and mean age of all remaining males;
Number and mean age of all remaining females;
Sex ratio (% males) of all bears.