Report to the Nova Scotia Habitat Conservation Fund on the In-depth Analysis of Harvested Furbearer Data: Population Reconstructions for Nova Scotia Using Current Data and Suggested Improvements to Harvest Data Collection Policies

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Introduction

Hunting and trapping are long standing traditions in Nova Scotia. The harvest of furbearers is regulated by the Department of Natural Resources (NSDNR), and the department has collected long term harvest data for all harvested species. This practice has resulted in a wealth of information which can be used to learn about the wildlife populations in the province.

Historically, harvest data have been used to determine bag limits and seasons, as well as to identify population trends. Our goal was to improve the knowledge of harvested species in Nova Scotia. An in-depth analysis of this harvest data has provided the province with a more thorough view of the current status of furbearers. The information about bobcat, fisher, and otter generated from modeling exercises is invaluable for wildlife conservation and policy in Nova Scotia. Establishing population baselines is essential for future habitat studies. Current mandatory and voluntary returns of furbearers, harvest reports, and NSDNR survey methods were reviewed to determine the effectiveness and usefulness of the information collected and additional or alternative types of data and survey tools were considered. This review recommends ways that the Wildlife Division can improve their management policies. Population trends are good baselines for habitat studies, as they can be used as an indicator of change over time. The primary advantage of this approach is that many government agencies, including Nova Scotia, routinely collect harvest data concerning the age and sex of individuals (Conn 2007). Age-at-harvest data are often used to determine population trends (Conn et al. 2008), to provide support for management, and to illustrate age-specific cohorts for population models (Collier and Krementz 2007). This type of analysis is invaluable to the province in terms of both wildlife management and conservation, and has been identified by the Department of Natural Resources as such.

Furbearer harvester licencing was introduced to Nova Scotia in 1976. The province has long term harvest records for furbearers, which extend back many years, based on mandatory wildlife export permits and furbuyer records. Extensive additional biological data has been collected over the past 40 to 50 years (since the inception of what has become the Nova Scotia Department of Natural Resources- Wildlife Division) for populations of several furbearers including beaver (Castor Canadensis),bobcat (*Lynx rufus)*, Canada lynx (Lynx lynx), fisher (*Martes pennanti*), otter (*Lutra canadensis*), and coyote (Canis latrans). Each species has specific life history traits that can be incorporated into population models. This report will focus on bobcat, fisher and otter.

Bobcat (Lynx rufus)

Bobcats are medium-sized cats that are opportunistic carnivores (Miller et al. 1983). Nocturnal hunters, in Nova Scotia their food ranges from small mammals and snowshoe hare to White-tailed Deer. They are polygamous breeders with litter sizes of between one and six kittens

(Rolley 1987). The cats are territorial and are distributed throughout North America except in the northern boreal forest and on the island of Newfoundland. They were not known to be present in Cape Breton until the 1950s (Evans 1983). Currently there is an open season from November 1 to the end of February and a bag limit of five on bobcat in Nova Scotia (Fur Harvesting Regulations pursuant to the NS Wildlife Act 1989a).

Fisher (Martes pennanti)

Fishers are large carnivores of the weasel family (Douglas and Strickland 1987). Aggressive hunters, they feed on small animals and eggs. Fishers are the sole predator of porcupines (McCord and Saunders 1983). They are polygamous breeders, and implantation is delayed until the following winter, subsequent to which one to four kits are born (McCord and Saunders 1983). Territorial, they are distributed throughout all Canadian provinces and territories (except Newfoundland and Labrador) as well as some northern states and the Pacific Coast ranges (Douglas and Strickland 1987). Fisher has a unique history in Nova Scotia. They were reported extirpated from the province in 1944 and at that point there had been no capture records since 1922 (Nova Scotia 1994). The population was supplemented with 12 additional animals from ranch stock in 1947-1948 and 92 additional animals from Maine in 1963-1966 (Miles 1982). The harvest season was opened in 1976 to allow one accidental catch in a trap lawfully set for another species (Nostrand 1977). It was closed again in 1988 and reopened again in 1995 (Nova Scotia 1989, Nova Scotia 1996). Between 1993-1995, 14 animals were relocated from eastern Nova Scotia (Pictou/Cumberland/Colchester) to the New Ross area of Lunenburg County in an attempt to connect the western and eastern populations within the province (Nova Scotia 1995). An additional 21 fisher were translocated from Cumberland/Colchester in to selected areas in western Halifax County, Hants County, and Kings County (Potter 2002). Currently trappers are allowed one accidental catch per year in a trap lawfully set for another species (Furharvesting Regulations pursuant to the Wildlife Act 1989c).

Otter (Lutra canadensis)

Otter are the most aquatic members of the mustelid family. Specialist fish eaters, they have various physiological adaptations that support foraging underwater, such as ridges that close off the ears and undergoing bradycardia to conserve oxygen during submersion (Melquist and Dronkert 1985). River otters display delayed implantation, with average litter sizes of two to four (Hill and Stardom 1983). Often living in family groups, they are distributed across the North American continent, from Florida to Alaska (Melquist and Dronkert 1985). Currently there is an open season from November 1 to the end of February and no bag limit on otter in Nova Scotia (Furharvesting Regulations pursuant to the Wildlife Act 1989b).

Goals and Objectives

1) Explore modeling opportunities with furbearer harvest data and identify useful models based on harvest data currently collected by NSDNR.
2) Develop predictive population models for bobcat, fisher, and otter.
3) To assess data collection for all harvested furbearers and upland game, as well as large mammals, and identify data requirements to improve wildlife management in the future.

Work completed

A larger, more detailed technical report was prepared for the benefit of NSDNR. It outlines modeling approaches and contains a detailed critique of current NSDNR harvest data collections.

Values from harvest data

Specifically for bobcat, fisher and otter, NSDNR has records spanning from 1989-2009 (20 years of data), though information was not necessarily collected yearly for each species. We used tooth pulp ratio to determine age and blastocyst count from female reproductive tracts to determine fecundity and maternity rates. We developed survival rates through extensive literature review.

Modeling design

To understand the relationship of harvest to market factors, we studied the association of harvest of the three species with pelt price and license sales. Based on the harvest data available and future data collection possibilities, we determined that the most effective population models for fur species harvested in Nova Scotia were the Downing's population reconstruction (Downing 1980), the stochastic catch effort method (Dupont 1983), and the stage-structured population matrix (Akcakaya 2005).

The majority of population assessment techniques rely on an accurate estimation of absolute abundance, or an index that is constantly proportionate to the actual abundance (Cooper et al. 2003). Population indices are often used for large scale studies because they are relatively inexpensive compared to absolute abundance estimates (Pollock et al. 2002). Population indices in the form of abundance rankings, subjective estimates of abundance submitted by trappers with their harvest information each year, were available for each county from 1989-2009. Reconstructed populations were associated with abundance rankings as an approach to the model validation.

Assessment of data collection and surveys

Current data collection and policies in the furbearer and upland game program were reviewed. Suggestions for improvements to current practices were developed as we reviewed the types of data required for various modeling practices.

Presentations
This work was presented at the Trappers Association of Nova Scotia Workshop and the Nova Scotia Federation of Anglers and Hunters Annual General Meeting.

Results

Pelt price versus harvest
Harvest counts were matched with pelt prices from the previous year. Yearly average pelt prices were adjusted using the Consumer Price Index, which was calculated using 2002 as the base year. Harvest number is positively related with the previous year's pelt price. Fisher harvest (Kendall's cor = 0.845) and otter harvest (Kendall's cor = 0.706) show strong correlations with previous year's price, while bobcat harvest (Kendall's cor = 0.09) seems to be independent.

For fisher and otter, this strong correlation suggests that harvest number can be corrected for pelt price. However, we have not corrected harvest number by pelt price for the population models as most modeling approaches reviewed use uncorrected harvest data.

Licence sales versus harvest
Numbers of Furharvester License sales from 1990 to 2008 were obtained from NSDNR records. The Kendall's correlation coefficients were calculated for the three species. The coefficients for bobcat and fisher are -0.422 and -0.398 respectively, which indicate weakly negative correlations, while for otter (cor = 0.215) the correlation is weakly positive. Therefore the number of licence sales is not a good indicator of harvest number.

Population modeling
Various modeling approaches were reviewed and identified as inappropriate for population modeling given the data collected by NSDNR. These approaches included the exponential growth model, which was discarded as it is primarily used for outbreaks or extinctions, and the index removal model, which was excluded as it requires two surveys, one before and one after harvest. Additionally, the change-in-ratio model and the Lang and Woods Pennsylvania method were both excluded as they require knowledge of sex ratios in the population before and after harvest. Finally, virtual population analysis was discarded as it requires knowledge of the proportion of population harvested.

The Downing population reconstruction (Downing 1980) and the stage-structured population matrix (Akcakaya 2005) were identified as appropriate models based on the harvest data that NSDNR has collected over the past 20 years. Harvest counts with age structure are the only data required for the Downing population reconstruction. Using this method we reconstructed the historical populations of the three species. We found that bobcat populations increased from 1988 to 2000, fisher populations increased from 1996 to 2010, and otter populations increased from 1989 to 2008. Because the otter population was calculated in two steps (1989-1991 and 1997-2008), if the period between 1997 and 2008 is considered separately it suggests otter populations have declined from the late-90s, but are still higher than in the late-80s. It is important to note that the Downing population reconstruction produces minimum population estimates and is sensitive to changes in catch effort. This type of population reconstruction is most informative when used as a trend indicator. Although population reconstructions from the stochastic catch effort method will be more reliable (see *Recommendations for improvement*), Downing population reconstructions can be incorporated into stage-structured population matrix models, which are used to identify the impacts of various harvest management strategies that NSDNR may consider in the future.

We also associated the reconstructed populations with abundance rankings. Bobcat reconstructed population was positively correlated with abundance ranking (cor = 0.918), while fisher (cor = 0.143) and otter (cor = 0.480) reconstructed populations were weakly correlated with abundance ranking. This may be explained by the distribution of animals. Bobcats are more uniformly distributed throughout Nova Scotia, such that the estimated average abundance ranking is more accurate than for fishers or otters, which have a more spotty distribution throughout the province.

Recommendations for improvement

- Population modeling through harvest data analysis should be expanded to include other furbearers, upland game and large mammals
- It is necessary to collect hunter/trapper effort information through mandatory harvest reporting to obtain more reliable population models through the implementation of stochastic catch effort population reconstruction.
- The possibility of incorporating predator/prey dynamics within the bobcat model should be considered when NSDNR employs the stage-structured population matrix model on the reconstructed population data
- Research projects that determine life history traits (specific to Nova Scotia) of harvested species should be a priority.

Population reconstruction models that incorporate the catch effort variable would remove the Downing population reconstruction’s sensitivity to catch effort changes. Thus the Furbearer and Upland Game Program will be collecting furharvester catch effort for harvested furbearers starting next season. Obtaining a measure of effort will allow NSDNR to employ the stochastic catch effort method (Dupont 1983). We have developed a model in anticipation of this and NSDNR will be able to start reconstructing populations after three years’ catch effort data are collected. These population reconstructions can be further incorporated into stage-structured population matrix models that can be used to identify the impacts of various harvest management strategies that NSDNR may consider in the future. Bobcat populations depend on snowshoe hare and are tied very closely to their population cycles. Hare pellet group inventory (PGI) data from

Nova Scotia should be reviewed to determine if it could be used as a stand-in for hare population data. Lastly, life history traits information, including natural and harvest mortality, as well as survival rates, do not presently exist for many harvested species, including bobcat, fisher and otter (specific to Nova Scotia and/or eastern Canada). Developing research projects that determine those traits would benefit species management because knowledge of local values for life history traits would increase the accuracy of population models.

Assessment of achievements and lessons learned

Our aim was to improve the knowledge of harvested species in Nova Scotia, and we certainly have achieved this. We developed population estimates for bobcat, fisher and otter from age-at-harvest data, and learned that incorporating catch effort data will lead to more reliable estimates. Catch effort data collection is a must and should be incorporated into harvest reporting immediately. We developed survival and fecundity estimates for bobcat, fisher and otter in Nova Scotia through carcass collection data and the literature review, and were disconcerted to find that that many life history traits of furbearers have not been studied in the eastern Canada. Future studies of furbearers in Nova Scotia should focus on establishing life history traits. We developed a stochastic catch-effort population reconstruction model to use when the harvest effort data are collected. This information (and the current population estimates) will be incorporated into stage-structured population matrix models that can be used to predict the impacts of various harvest management strategies that NSDNR might wish to employ in the future. And finally, we developed "How-to" documents for NSDNR biologists that explain step by step how to develop these models using the freeware R. This allows the biologists to continue using and updating the models as they collect more data. Additionally, we realized that this type of harvest data review and population modeling would be extremely informative and beneficial when applied to sustainable management of other species.

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