Resource and Energy Economics 33 (2011) 589–611

Contents lists available at ScienceDirect

Resource and Energy Economics

journal homepage: www.elsevier.com/locate/ree

A cost-benefit analysis of moose harvesting in Scandinavia. A stage structured modelling approach

Jon Olaf Olaussen [a], Anders Skonhoft [b,*]

[a] Trondheim Business School, Jonsvannsveien 82, N-7050 Trondheim, Norway
[b] Department of Economics, Norwegian University of Science and Technology, N-7491 Dragvoll-Trondheim, Norway

ARTICLE INFO

Article history:
Received 10 September 2009
Received in revised form 21 December 2010
Accepted 11 January 2011
Available online 1 February 2011

JEL classification:
Q28

Keywords:
Moose hunting
Cost-benefit analysis
Stage model

ABSTRACT

A cost-benefit analysis of moose (*Alces alces*) harvesting in Scandinavia is presented within the framework of an age structured model with four categories of animals (calves, yearlings, adult females, and adult males). The paper aims to demonstrate the economic content of such a wildlife model and how this content may change under shifting economic and ecological conditions. Two different harvesting regimes are explored: landowner profit maximization, where the combined benefit of harvesting value and browsing damage is taken into account, and overall management, where the costs and damages of moose-vehicle collisions are taken into account as well. An empirical analysis of the Norwegian moose stock indicates that the present stock level is far too high compared with the overall management scenario, and that the composition of the harvest could be improved.

1. Introduction

The aim of this paper is twofold: first, to demonstrate the economic content of an age structured wildlife population model; and second, to show how this economic content may change under different management scenarios. The wildlife considered is the moose (*Alces alces*) which is studied in a Scandinavian ecological and institutional context where the landowners obtain the harvesting value and bear the cost of the timber browsing damage, but do not pay for possible other damages. Two basic management schemes are analysed; landowner management and overall management where the cost of moose-vehicle collisions is taken into account as well.

* Corresponding author. Fax: +47 73596954.
E-mail address: Anders.skonhoft@svt.ntnu.no (A. Skonhoft).

0928-7655/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.reseneeco.2011.01.001

Analysing structured wildlife harvesting models, i.e., models where the species are grouped in different classes according to age and sex, has a long tradition within biology. Caswell (2001) gives an in-depth overview; see also Getz and Haigh (1989). However, economic analysis plays a minor role in these works. Economic reasoning is taken into account in Skonhoft et al. (2002) who analysed various management strategies for a mountain ungulate living in a protected area and a hunting area. Four stages were included: females and males within and outside the protected area. However, because of the complexity of this model due to the dispersal mechanism it is difficult to understand the various economic mechanisms influencing harvesting and abundance.

The present paper aims to analyse such economic mechanisms more explicitly where a four-stage model (calves, yearlings, adult females, and adult males) is formulated. Ericsson et al. (2000) studied the Swedish moose harvest policy with respect to selective versus random harvest of the different stages. In their simulations, however, they only accounted for hunting profit. Wam and Hofstad (2007) also studied a stage structured moose model in a Scandinavian context. The landowner profit was maximized and the trade-off between meat value and timber browsing damage was considered. Such trade-off will also be analysed here, but, as indicated, traffic damage costs will be taken into account as well. These costs are quite high, and recent estimates indicate that they may be even higher than that of the moose meat value (see below). Another important difference compared to the Wam and Hofstad study is that our model, at least to some extent, is solved analytically. We are thus able to show more directly the driving forces behind the harvesting composition and the various harvesting scenarios. We find that per animal values (meat value plus omitted damage value due to harvesting) are instrumental in determining the optimal harvesting composition. The similarity with the results in the seminal Reed (1980) paper is apparent. In addition, we explicitly model a female-calf harvest restriction as the current code of conduct among hunters prevent that calves are left without their mother their first winter (Section 4). A novelty of our paper is thus to demonstrate the analytical and numerical consequences of imposing such restriction. As in Wam and Hofstad (2007) the model is illustrated numerically where the Norwegian moose stock is used as an example. Just as in Ericsson et al. (2000), we also calculate the benefit of our selective harvesting scheme with a harvest pattern where 'an animal is an animal' as considered in the traditional bioeconomic analysis (e.g., Clark, 1990).

The paper is organized as follows. In the next section, moose hunting in Scandinavia is briefly described. In Section 3 the population model is formulated while Section 4 demonstrates what happens when the hunting is steered by the traditional landowner goal of maximizing meat value. The landowner exploitation is analysed both with and without including the browsing damage cost. In Section 5 we study the optimal sex and age composition as well as the economic consequences when the harvest is steered by the overall manager, and where the traffic damage cost, in addition to the meat value and browsing damage cost, are taken into account. Section 6 illustrates the models by numerical simulations using Norwegian aggregate data and where the various scenarios are compared with recent harvest and stock data. In the basic model, the meat value is assumed to be given by a fixed meat price, and the unit costs related to forest damage and traffic accidents are assumed to be constant as well. In Section 6.3 these assumptions are relaxed and we show some numerical results when stock dependent hunting costs as well as convex forest damage costs are included. Section 7 finally summarizes our findings.

2. Moose hunting in Scandinavia

The moose is the world's largest member of the deer family and is found in the northern forests of North America, Europe and Russia. It is by far the most important game species in Scandinavia, and in Norway and Sweden about 35,000 and 100,000 animals, respectively, are shot every year. The value of this harvest is substantial, and the meat counts for more than 2 percent of the yearly meat consumption in these countries. The moose hunting, which takes place in September and October, is also an important cultural event in a large number of local communities. Moose hunting has traditionally been a local activity, and landowners receive the hunting value. The hunters have been local people, the landowners and their families and friends, and the traditional management goal has been to maximize the meat value, possibly corrected for forest browsing damage, for stable