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Designing hunting regulation under population uncertainty and self-reporting☆

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ABSTRACT

A number of methods exist for estimating the size of animal populations. All methods generate an uncertain estimate of population size, and have different properties, which can be taken into account when designing regulation. We consider hunting regulation when the population size is uncertain and when the self-reported bag is used to estimate the population size. The properties of a population tax and a tax on self-reported bag are analyzed and we begin by considering a baseline situation with full certainty and no use of self-reporting for population size estimation. Here individual hunters self-report a bag on zero and a population tax alone can secure an optimum. Next we show that when facing uncertain population size, a risk-averse hunter will self-report part of the bag to reduce the uncertain population tax payment, making both tax instruments necessary for reaching an optimum. Finally, when self-reported bag is used to estimate population size, we also show that it is optimal for hunters to report a part of the bag and both instruments are again necessary for reaching an optimum.

Introduction

Economists normally assume that individual hunters are interested in their own returns from the activity while a social objective must include the well-being for all actors deriving utility from both hunting and game populations.[1] Thus, a market failure arises due to differences in objectives implying that a private hunter optimum does not maximize total welfare (e.g. Schuhmann and Schwabe, 2000). Consequently regulation of the hunting activity is needed but to regulate in an efficient way, information on population size is required (Skonhoft, 2005). The existing economic literature on regulation of hunting is based on the assumption that population size is perfectly known (e.g. Zivin et al., 2000; Rondeau and Conrad, 2003; Horan and Bulte, 2004) and a number of methods for estimating the population size exist including aerial surveys, winter surveys, mortality counts, disease die-offs, accidental deaths, and self-reported bag.[2] However, all these methods lead to highly

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[1] As examples a social planner may include recreational values for non-hunters and damage on either farm crops or forest regeneration (see Ritz and Ready, 2000).

[2] Bag is the number of shot animals and corresponds to harvest as used in the general resource economic literature.

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uncertain population estimates, or even strategically biased measures, if the hunters do not have an incentive to report the true observation. Therefore, it is important to take into account both population uncertainty and the method of estimating population size when designing regulation.

The purpose of this paper is to analyze the properties of a population tax and a tax on self-reported bags for regulating hunting when population size is uncertain and when self-reported bag is used to estimate the population size. We investigate the properties of the self-reported bag as method for measuring the population size because this allows us to consider regulatory mechanism that reach socially optimal solutions.

Regulation of hunting in practice

The choice of a population tax and a tax on self-reported bag is inspired by the economic literature on fisheries and non-point pollution and now we discuss the possibilities for implementing such instruments in an actual hunting situation by using two cases from Western Europe. In Denmark hunting season restriction is the main regulation instrument (Sunde and Hougaard, 2014), based on an assumption that the time available for hunting affects the aggregated bag size and, thereby, the population size.[3] The annual bag has to be reported to the authorities to renew an annual hunting license, but the self-reported bag is not used directly for regulatory purposes.[4] However, imposing a tax on self-reported bags is practically feasible and for the following analysis the relationship between the self-reported bag and the actual bags is important. Based on both case studies and model assessments, Hansen (2000), Kanstrup (2013) and Sunde and Hougaard (2014) all show that for red deer in Denmark the average self-reported bag constitute between 75% and 85% of the estimated average actual bag. So even though hunters do not report the full bag, a relationship between the actual bag and the self-reported bag can be estimated and in this paper we rely on such a relation in this paper. In France the hunting regulation is much more complex and involves use of taxation, hunting licenses, compensation to landowners from hunter's for crop damages and other administrative regulations (Abildtrup and Jensen, 2014). Crop damage compensation from hunters may be seen as a population tax, since a larger population size implies more damage and more compensation claims.[5] Thus, a population tax would also be possible to implement in practical regulation.

Next we discuss the structure of most actual regulatory systems for hunting in Western Europe. As pointed out by Rollins and Briggs (1996) and Horan and Bulte (2004), a social planner, landowners and hunters are all actors in most privately owned hunting areas. Each of these actors has a different set of objectives and should, in principle, be included in a regulatory model for hunting. However, in the economic hunting literature it is common to only analyze the link between two of the involved actors. Skonhoft and Olaussen (2005) study the link between a social planner and landowners while Zivin et al. (2000) investigate the relationship between landowners and hunters. We follow Keith and Lyon (1985) and focus on the relation between a social planner and hunters, and, thereby, disregarding the landowners. Three arguments may justify this choice: (1) in France many landowners transfer hunting rights to municipalities implying that the landowners can be disregarded (Hasenkamp, 1995), (2) in some countries in Western Europe a part or all rights to hunting is public owned which implies that landowners can be disregarded (Keith and Lyon, 1985), (3) a social planner may regulate the landowners to provide incentives for them to regulate the hunters in an optimal way (Abildtrup and Jensen, 2014). If a well-functioning market for hunting rights exists, this market may be used as regulation instrument (Lundhede et al., 2015).

Related economic literature

A point of departure for the regulatory system analyzed here is the non-point pollution literature. The basic statement in this literature is that individual pollution cannot be measured while aggregate pollution at a given geographical point can be identified and, therefore, an asymmetric information problem arises (moral hazard). The non-point pollution literature normally investigates a flow externality problem, and, therefore, static models are used. Segerson (1988) suggest a tax based on the ambient concentration level in a region, assuming that the taxes can vary between individual polluters. Assuming uncertainty about the ambient concentration level, Xepapadeas (1995) extend the analysis by Segerson (1988) and propose to combine a tax on the ambient concentration level and a tax on self-reported pollution. Unregulated hunting is similar to a non-point pollution problem as the individual bag cannot be observed, while the aggregated bag can be estimated through the population size. Consequently, in this paper we apply the mechanism proposed by Xepapadeas (1995) to hunting but we make two extensions: (1) in the case of hunting a dynamic model must be constructed because a hunting population is a renewable resource, (2) we include a case where the self-reported bag is used not only for taxation but also for measuring the population size.

The literature on taxes on stock size within fisheries[6] is also relevant for this paper. In this literature individual harvest is assumed to be unobservable due to illegal landings and discard, while the aggregate harvest may be identified through stock

[3] Hunting season restrictions are also based on a need for undisturbed periods during migration, breeding or nesting periods.

[4] Within groups of hunters (e.g. a group of hunters sharing the hunting right on a property), an internal bag fee is sometimes applied, but in the context of co-management (i.e. a private agreement).

[5] A theoretical foundation for damage based compensation is given by Rakotoarison et al. (2009).

[6] In fisheries the term "stock" is used instead of "population", and "harvest" or "landings" instead of "bag".