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Conservation of northwest Atlantic harp seals: Past success, future uncertainty?

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ABSTRACT

Harp seals require pack ice as a platform for resting, to give birth and nurse their young. They are also subject to commercial and subsistence harvesting. In the late 1990's there were concerns that the Northwest Atlantic population would decline to very low levels unless a management system using Potential Biological Removals (PBR) was adopted. Canada followed a different approach and high harvests based on an alternative management framework continued throughout the next decade. We examined the status of the Northwest Atlantic harp seal population using a three parameter population model that incorporates information on reproductive rates, removals, and ice-related mortality acting on young of the year. By 1971, the population had declined to a minimum of 1.1 million animals and a quota was introduced, which allowed the population to increase. In 1996, the quota was raised and harvests increased substantially. Population growth continued, even as herd productivity declined. The population reached a maximum of 7.8 million animals in 2008 and has leveled off at around 7.4 million animals. Climate change is expected to result in a decline in the amount of seasonal pack ice in Atlantic Canada, which adds uncertainty to the future of this population. Although the results presented in this paper focused on how the status of this population has evolved over the last 60 years, our integrated modeling approach can also be used to examine scenarios that project into the future, to test the impacts of various management decisions in a changing environment.

1. Introduction

The harp seal (*Pagophilus groenlandicus*) is a medium sized, migratory phocid distributed over continental shelf regions of the north Atlantic. Three populations are recognized (Sergeant, 1991); the White Sea/Barent Sea, the Greenland Sea and the Northwest Atlantic (NWA). All three populations have a long history of commercial and subsistence exploitation throughout their range. The NWA harp seal summers in the eastern Canadian Arctic and west Greenland, but migrates south along the Canadian coast in fall to overwinter and reproduce on the pack-ice off northeastern Newfoundland (Front) and in the Gulf of St. Lawrence (Gulf) every spring (Sergeant, 1991). The pups are weaned after a short lactation period of 12–14 days, but remain on the ice for another few weeks before dispersing (Sergeant, 1991). This population has been harvested commercially since the 1700s (Sergeant, 1991) and it is among the largest wildlife harvests in the world. The United States Whitetail deer (*Odocoileus virginianus*) and European roe deer (*Capreolus capreolus*) sport harvests are probably the largest, each removing over 2.5 million deer annually, followed by the Australian kangaroo (*Macropus* sp.) hunt (1.5 million animals in 2010; Anon, 2012; Burbaite and Csányi, 2009; QDMA, 2014), but the Canadian commercial seal hunt is the largest harvest of marine mammals removing on average 211 000 seals annually between 1996 and 2013, increasing to an average of 305,000 seals annually if the Canadian and Greenland subsistence hunts and incidental catches are also considered (Fig. 1; Stenson, 2014). The Canadian commercial harvest is highly controversial both with respect to the methods used to kill seals and the setting of sustainable catch levels (e.g. Johnston et al., 2000; Leaper et al., 2010; Marland, 2014). Concerns over the future of the population was one of several factors contributing to the adoption of the Marine Mammal Protection Act in 1977, and the 1982 ban on the import of the white lanugo pelts into the European Community (extended to include juvenile (beater) pelts in 2009; European Community, Regulation (EC) 1007/2009).

The abundance of NWA harp seals was thought to have declined considerably during the 1950s and 1960s (Sergeant, 1991). In response, harvest quotas were introduced in 1971, with the objective of allowing the herd to increase (Anon Canada, 1986). The management objective in

Abbreviations: PBR, Potential biological removals; NWA, Northwest Atlantic; YOY, Young of the year; MNPL, Maximum net productivity level.

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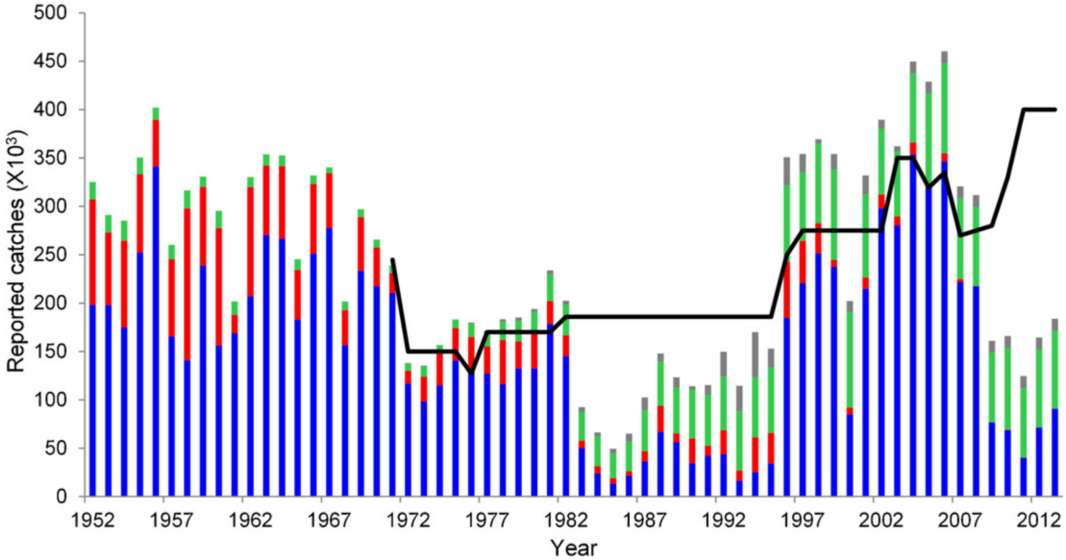

Fig. 1. Reported catches from the Canadian commercial harvest of young of the year (blue bars) and animals aged 1+ years (red bars), the Canadian and Greenland subsistence harvests (green bars), and bycatch from commercial fisheries (gray bars; from Stenson, 2014). The black line represents Canadian quotas established since 1971 for the Canadian commercial harvest. In the model, subsistence and incidental catches were taken into account when setting the quota for the Canadian commercial harvest.

subsequent years was to set harvests at replacement levels, that is to establish harvest levels that would result in the population remaining constant from one year to the next (e.g. Shelton et al., 1996). Critics at the time argued that the Canadian management approach was likely to fail. For example, Johnston et al. (2000) felt that harvest levels (e.g. 1999 Canadian quota = 275,000) were too high because: population estimates were biased due to changes in survey methodologies; not all sources of human-induced mortality (e.g. incidental catch, struck and loss) were accounted for when establishing harvest levels; and there was a failure to take into consideration the impact of uncertainty surrounding model parameters. As a result it was suggested that Canada estimate allowable kills using the Potential Biological Removal approach (PBR; Wade, 1998). PBR is calculated as $PBR = 0.5 \cdot R_{max} \cdot f_r \cdot N_{min}$; where R_{max} is the maximum rate of population increase (assumed to be 0.12 for pinnipeds), f_r is a recovery factor (between 0.1 and 1), and N_{min} is the estimated population size using the 20-percentile of the lognormal distribution (Wade, 1998). PBR requires only a single estimate of the population size to provide an estimate of acceptable level of takes and rigorous simulation testing has shown that PBR is robust when model assumptions are relaxed and plausible uncertainties are included (Wade, 1998). However, following recommendations from McLaren et al. (2001) that the Replacement Yield management objective, be replaced by a more risk adverse approach, Canada adopted a different precautionary approach framework for managing Atlantic seals. The Canadian framework established two categories, 'Data Rich' and 'Data Poor' (Hammill and Stenson, 2007). For populations where there are limited data, but it is possible to estimate abundance (Data Poor), Canada has used PBR. However, for populations considered 'Data Rich' (i.e. recent abundance and reproductive or survival rate data) such as harp seals, Limit and Precautionary Reference levels for the population were established, with a management objective to maintain an 80% likelihood that the population remains above the precautionary reference level which is set at 70% of the largest observed population size (Hammill and Stenson, 2007). These changes resulted in high quotas, averaging 325 000 from 2003 to 2005. Since then, it has fluctuated between a low of 270 000 in 2007 and the current quota of 400 000 animals (ICES, 2013).

Johnston et al. (2000) had concluded that the population in the late 1990s was declining, and if harvest levels continued, the population would only stabilize at levels below (and possibly far below) its maximum net productivity level (Johnston et al., 2000), which is roughly equivalent to maximum sustainable yield levels. They estimated that, based upon PBR calculations, catches should be in the range of 93,500–187,000 seals. However, Canadian commercial harvests remained high until the 2008, averaging 265 000 between 1996 and 2008. During this same period, reported catches of NWA harp seals in Greenland increased significantly, averaging 81 000 annually (ICES, 2013). Incorporating estimates of bycatch and the number of seals killed but not reported (i.e. struck and lost) increased the average estimates of total removals from this population to 450,000 per year. Since 2008 harvest have declined significantly due to reduced markets, averaging 70,000 for the Canadian commercial hunt and 161,000 for the commercial, subsistence and incidental catches in Canada and Greenland.

Against this backdrop of large harvest levels, expert reviews provided by the Intergovernmental Panel on Climate Change make it clear that climate change will induce temperature changes and associated adjustments in ocean circulation, ice coverage and sea level (McCarthy et al., 2001). Harp seals require pack ice as a platform for resting, to give birth and nurse their young. After weaning the young of the year (YOY) remain with the ice, using it as a resting platform, for several weeks. A lack of suitable or insufficient ice appears to result in increased pup mortality (Sergeant, 1991; Stenson and Hammill, 2014). Therefore, any attempt to describe the population dynamics of NWA harp seals needs to consider the impact of a changing climate.

The harp seal is arguably the most abundant pinniped in the North Atlantic and their status is one of continuing interest (Leaper et al., 2010; Marland, 2014; Soulen et al., 2013). In addition to harvesting, they play an important role in structuring the North Atlantic ecosystem (Bundy, 2001; Morissette et al., 2006). Therefore, it is important that we have a good understanding of their abundance and population dynamics. Various approaches have been used to estimate the size of the harp seal population in the Northwest Atlantic. Earlier estimates, based primarily on interpreting age composition data from the hunt, used either the survival index approach (e.g. Cooke, 1985; Sergeant, 1971), sequential population analysis (e.g. Lett and Benjaminsen, 1977) or fitting population models to independent estimates of pup production obtained from mark-recapture studies (e.g. Roff and Bowen, 1986) (termed the population model approach). In this paper, we describe the current population model used to examine the trajectory of the Northwest Atlantic harp seal over the last 60 years and discuss the current status within the context of some of the concerns identified above.