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Current status of hooded seals in the Greenland Sea. Victims of climate change and predation?

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ABSTRACT

Hooded seals (*Cystophora cristata*) have been harvested for centuries in the North Atlantic. Estimating abundance and monitoring changes in population size are critical for the management of the species. In March 2012, the hooded seal pup production was estimated from aerial photographic surveys over the Greenland Sea whelping areas. From this survey the total pup production estimate was 13,655 (s.e. = 1900, CV = 13.9%). The status of the hooded seal population in the Greenland Sea was assessed by fitting a population model to independent pup production estimates, historical catch data, and reproductive data. The 2013 total abundance (including pups) was estimated to be 84,020 (95% c.i. 68,060–99,980) hooded seals. This is well below the management reference level N_{30} in the established precautionary harvest strategy for hooded seals in the North Atlantic developed by ICES, and a consequence of this is that no catches should be take from this population. The model predicts a decreasing population size of about 7% over the next 10 years, assuming no hunt. Currently there is a very modest hunt for scientific purposes. Predictions including this hunt indicate an 8% decrease of the population over the next 10 years. Possible reasons, including climate change and predation, for this negative trend are discussed.

1. Introduction

Two (possibly three) stocks of hooded seals (*Cystophora cristata*) are assumed to inhabit the North Atlantic Ocean (Sergeant, 1974; Kovacs and Lavigne, 1986). Whelping occurs on the drift ice east off Newfoundland and in the Gulf of St. Lawrence (the Northwest Atlantic stocks), whereas a possible separate whelping stock of hooded seals occurs in the Davis Strait between Greenland and Arctic Canada. Furthermore, hooded seals whelp in the Greenland Sea off the east coast of Greenland. It has proved impossible to detect significant genetic differences (allozymes and DNA) between hooded seals from the Greenland Sea and from the Northwest Atlantic (Sundt et al., 1994; Coltman et al., 2007). Thus, a hypothesis that there is some degree of intermixing between the stocks cannot be rejected.

After a significant decline in the number of hooded seals breeding off the coast of Newfoundland in the early 1920s, Rasmussen (1960) suggested that climate changes with subsequent reductions in suitable breeding habitats may have caused an eastward relocation of animals, i.e., from the Northwest Atlantic to the Greenland Sea. The mechanisms by which such a change might have occurred were, however, far from clear, and Sergeant (1974) emphasized that intensive exploitation (including both pups and adults) previous to the decline in the Northwest Atlantic must have had an impact as well. Recent results from Norwegian satellite tagging programs indicate that hooded seals tagged in the Greenland Sea during breeding and after moult remain within the Greenland, Norwegian and Icelandic Seas for the majority of the year (Folkow et al., 1996, 2010). Recaptures of seals, tagged as pups in the Greenland Sea, are consistent with the satellite tagging results (ICES, 1999). Furthermore, hooded seals fitted with satellite tags in similar Canadian programs, either during breeding (at the Newfoundland Front area or in the Gulf of St. Lawrence) or after moult (in the Denmark Strait, Southeast Greenland), all tended to select habitats localized in Canadian, and to some extent in southern Greenlandic shelf waters (Andersen et al., 2009, 2013). The Northwest Atlantic and Greenland Sea hooded seal stocks are managed separately.

The Greenland Sea hooded seal stock has been subject to commercial exploitation for centuries (Iversen, 1927; Sergeant, 1966; Nakken, 1988; ICES, 2006a, 2013). The hunt increased substantially after 1920, and after a 5 year pause in the sealing operations during World War II, the post-war annual catches quickly rose to levels

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higher than the stock could sustain, and some regulatory measures (mainly to reduce effort) were taken in 1958 (Rasmussen, 1957, 1960; Øritsland, 1959; Sergeant, 1966). The total annual catches have subsequently followed a decreasing trend, primarily due to reduction in catch effort, and quotas were imposed in 1971 (Kovacs and Lavigne, 1986; ICES, 2006a, 2013).

It has been assumed that the stock of Greenland Sea hooded seals has increased ever since the early 1960s, but evidence of the level of increase has been rather imprecise (Ulltang and Øien, 1988; Øritsland and Øien, 1995). Aerial surveys to estimate the hooded seal pup production were attempted, however with rather little success, both in 1959 (Øritsland, 1959; Rasmussen, 1960) and in 1994 (Øritsland and Øien, 1995). More successful aerial surveys were conducted in 1997 (ICES, 1998, 1999), 2005 (Salberg et al., 2008) and in 2007 (Øigård et al., 2010). The results from these indicated that pup production of hooded seals in the Greenland Sea both in 2005 and 2007 were considerably lower than in 1997 (Øigård et al., 2010).

Population assessments are generally based on a population model that estimates the current total population size, incorporating estimates of pup production, historical catch data and historical values of reproductive rates. These estimates are then projected into a future population size for which statistical uncertainty is provided for several relevant catch options. Population modelling of the Greenland Sea hooded seals over the past 70-years period suggests a substantial decline, with subsequent stabilization at a lower level in recent decades (Salberg et al., 2008; ICES, 2013). This is certainly a matter of concern for the management of the stock. Furthermore, the ICES management requires that the population is defined as "data rich" (ICES, 2006b; Øigård et al., 2014). Data rich stocks, in the ICES management system, require that a time series of at least three pup production estimates, spanning a period of 10–15 years with surveys separated by 2–5 years, should be available. This should be supported by data on fertility (no more than 5 years old) and catch statistics. For these reasons, a new survey aimed to estimate the pup production of the Greenland Sea hooded seal stock was conducted in March 2012. In addition to survey all breeding areas historically used by hooded seals in the Greenland Sea (see Øritsland and Øien, 1995; Salberg et al., 2008; Øigård et al., 2010), reconnaissance flights were also carried out in areas to the north and south of the breeding areas. The survey techniques applied were as described in Øigård et al. (2010). The 2012 survey was designed to obtain pup production estimates for both hooded and harp seals, as in 2007 (Øigård et al., 2010). In this paper we present results from the 2012 survey of the hooded seal pup production, and we also assess the status of the stock by fitting a population model to the pup production estimates. The model is also used to explore the effects of various catch scenarios on future population predictions.

2. Material and methods

2.1. Pup production survey

2.1.1. Logistics

An ice-strengthened expedition vessel equipped with a helicopter platform and an Ecureuil AS 350 B1 helicopter was used for reconnaissance and pup age-staging surveys in the Greenland Sea drift ice. Two fixed-wing twin engine Piper Navajo aircrafts were used for reconnaissance and photographic surveys. The aircrafts were mainly based at Constable Pynt (Nerlerit Inaat) airport

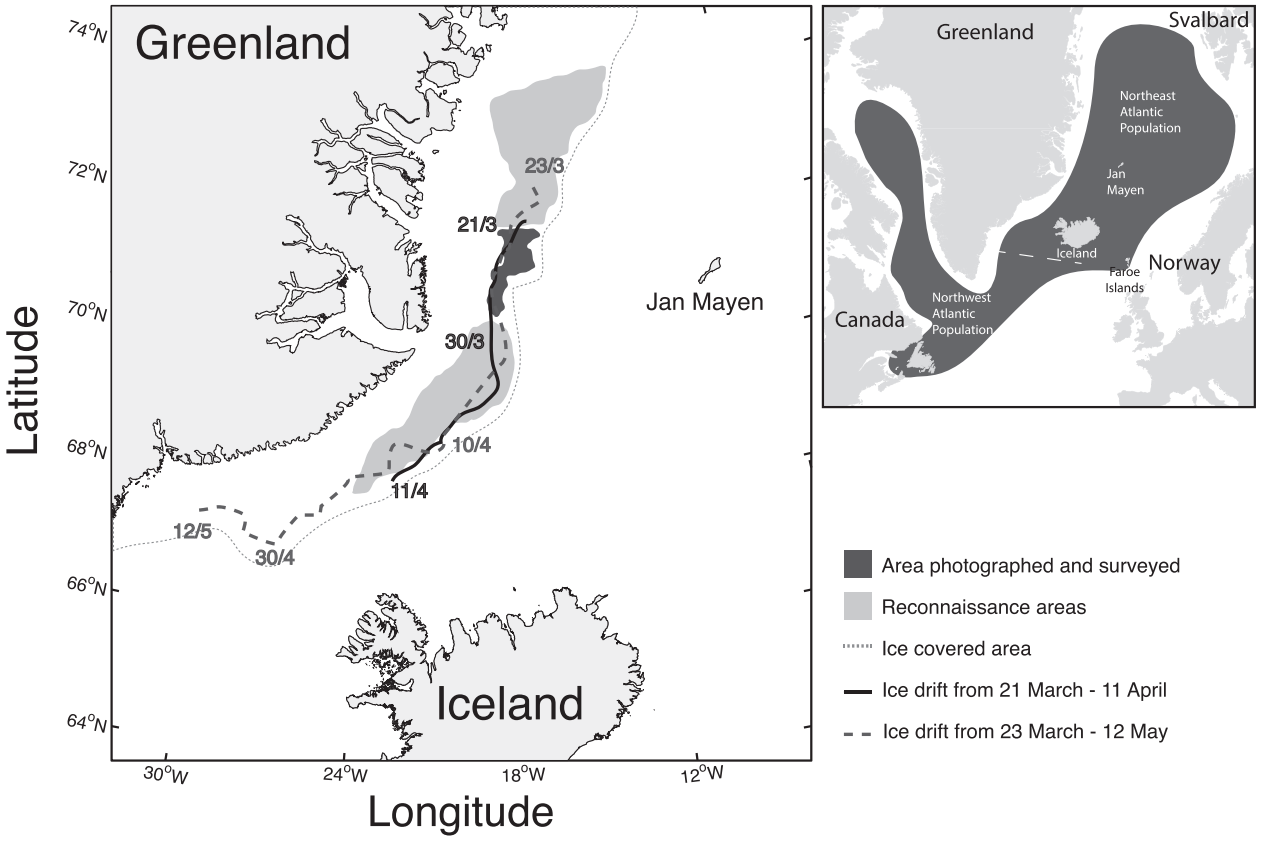

Fig. 1. Area covered by photographic survey over seal whelping patches on 28 March and areas covered by reconnaissance flights conducted by air-crafts (22 March – 1 April) and helicopter (18 March – 1 April). Ice drift in the Greenland Sea during the period 21 March – 11 April and 23 March – 12 May, as observed from two satellite based GPS beacons deployed on the ice.