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Assessing incidental bycatch of seabirds in Norwegian coastal commercial fisheries: Empirical and methodological lessons

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ABSTRACT

With diminishing seabird populations and little knowledge on incidental bycatch in fisheries in the Northeast Atlantic, this study aimed to screen seabird bycatch in Norwegian coastal fisheries in 2009. The purpose was to 1) quantify magnitude of seabird bycatch rates and estimate total bycatch from the entire fleet by different estimators 2) evaluate data from an access point survey against monitoring data from a reference fleet as methods for collecting data on bycatch mortality of seabirds and 3) give advice on further bycatch studies. The study focused on three small-vessel fisheries (<15 m LOA) outside Northern Norway; the coastal cod (gillnet and manual longline) and lumpfish (gillnet) fisheries and the more offshore Greenland halibut longline fishery. We found no correlation between landed catch and bycatch and upscaling was made based on number of fishing trips. In these fisheries, northern fulmars *Fulmarus glacialis* outnumbered the other species and constituted almost half of the overall bycatch, totalling about 5500 (mostly on longlines) of the >11 000 birds estimated caught. The black guillemot *Cepphus grylle*also stood out as a numerous victim, constituting almost two thirds of the >3000 birds estimated to have drowned in lumpfish gillnets. The two methods were both considered to hold merit and yielded approximately similar estimates of the bycatch in the coastal cod fisheries, however BPUE differs. Further studies are recommended especially on the lumpfish gillnet and Greenland halibut longline fisheries and on temporal and spatial variations in bycatch. More studies are also needed to model effects on seabirds at the population level.

1. Introduction

A large proportion of the seabird species in the Northeast Atlantic are in decline (e.g. ICES, 2013), and many populations inhabiting Norwegian waters have been significantly reduced over the last decades (Barrett et al., 2006, 2014). The situation is especially severe for pelagic species such as northern fulmar *Fulmarus glacialis*, common guillemot *Uria aalge*, Atlantic

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puffin *Fratercula arctica* and black-legged kittiwake *Rissa tridactyla* (Kålås et al., 2010). Thus, there is an urgent need to assess anthropogenic mortality factors that potentially have negative impact on the bird populations (NMR, 2010). One such factor may be unintentional bycatch in marine fisheries.

Most studies of incidental seabird bycatch in fisheries have focused on longline fisheries in the southern hemisphere (Brothers et al., 1999; Tasker et al., 2000; Belda and Sánchez, 2001; Cooper et al., 2001; Baker and Wise, 2005; Anderson et al., 2011), and trawling (Sullivan et al., 2006; Croxall, 2008). There are thus gaps in the literature on bycatch in gillnet fisheries (Tasker et al., 2000; Žydelis et al., 2009), and from the northern hemisphere (but see Dunn and Steel, 2001; Løkkeborg and Robertson, 2002; Løkkeborg, 2003). A few recent studies show, however, that some species might suffer significant mortality from drowning in gillnets (Žydelis et al., 2009; Sonntag et al., 2012; Žydelis et al., 2013). There are also a few older reports of extraordinary events of high bycatch in the Northeast Atlantic (Vader et al., 1990; Strann et al., 1991; Bustnes et al., 1993).

A major reason for limited knowledge about seabird bycatch mortality in marine fisheries is challenges with cost-efficient monitoring. The literature includes many non-representative approaches. These include beached bird surveys, ringed bird recoveries and other non-systematic observations of bycatch (Žydelis et al., 2009). To be able to assess bycatch-induced mortality more systematically, representative and cost-effective approaches are needed. Potential methods include (but are not limited to) interview surveys, independent and randomized observations on vessels, experimental fishing and the use of systematic reports from reference vessels. In addition, standardized reporting on fishing effort and key data on the seabirds caught is needed, including their species, age and sex distribution, as well as any parameters that can indicate the origin of their breeding populations. The practical and scientific challenges of gathering systematic and representative data to assess impacts of seabird bycatch include:

- The economic costs associated with gathering primary data of bycatch that are sufficiently randomized and representative.
- The nature of bycatch: evenly distributed or stochastic?
- The variations in time, space and fleet/gear characteristics, with additional costs when aiming to get an overview.
- The inconvenience and cost for fishermen in a hectic work day to report bycatch sufficiently detailed and accurate.
- The somewhat discomforting character of the theme, with potential problems associated with either lack of responses or with response bias in methods based on self-reporting.

To our knowledge, few studies have focused primarily on aspects related to sampling methods (but see Oliveira et al., 2015) and different estimators used for bycatch assessments. In this paper we aim to fill some of the knowledge gaps as presented above, exploring three identified fisheries outside Northern Norway; the coastal fishery for cod *Gadhus morhua*, the offshore fishery for Greenland halibut *Reinhardtius hippoglossoides* and the coastal fishery for lumpfish *Cyclopterus lumpus*. The purpose was to (1) quantify magnitude of seabird bycatch rates and estimate total bycatch from the entire fleet by different estimators (2) evaluate data from an access point survey (interviewing vessels as they arrive harbours for landing their catch) against monitoring data from a reference fleet as methods for collecting data on bycatch mortality of seabirds and (3) give advice on further bycatch studies. The study objectives should be regarded as essential first steps in solving problems of unintentional bycatch from fisheries (see framework suggested by Broadhurst et al., 2007).

2. Materials and methods

2.1. Fishery characteristics and study area

A pre-study (Christensen-Dalsgaard et al., 2008) identified specifically three target fisheries where it was judged most likely that unintentional bycatch could be significant. These fisheries were all conducted by small-vessels in the coastal fleet operating along the coast of Norway, basically within the 12 mile limit (opposite to the larger and ocean-going fleet that uses trawl, automatic long-lines, nets and different types of seines). In 2009, a total of 6510 fishing vessels were registered in Norway, of which 5417 were recognized as active (Aasjord, 2010). The small coastal fishing vessels are generally less than 15 m in overall length, constituting around 90% of the entire Norwegian fishing fleet. In Northern Norway, an overall total about 3200 vessels participated in the coastal cod-fisheries in 2009 of which about 2700 vessels were less than 15 m length over all (LOA). The range of operation for these vessels <15 m LOA is limited by the distance to the harbour since they have few facilities for on-board processing and storing of the catch, and for longer-term accommodation at sea. In general these vessels are multi-gear vessels, where the type, size and scale of gear is determined by the size of the vessel, number of crewmembers and the seasonal features of the fishery. These vessels have a somewhat similar behaviour in the fishery compared to vessels above 15 m LOA, which have fewer constraints concerning range of operation and length of time spent at sea on each trip.

The following three focus fisheries were selected:

1. *The coastal cod fishery*. The Norwegian fishery statistics describe this as a "bottom fishery with conventional gears, except for seine and trawl", i.e. it is mainly conducted with gillnets and some manual longlines. While the main target is cod, regular and legal bycatches of haddock, saithe *Pollachius virens*, and ling *Molva molva* are included in the catches. In the longline fishery, haddock *Melanogrammus aeglefinus* is also a target species, and we therefore refer to this as the cod-haddock longline fishery in Tables 1 and 2, whereas for gillnets the main target is cod. The fishery is conducted year