

Recent changes in abundance and feeding ecology of minke whales in Icelandic waters; An indication of climate change?

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The common minke whale (*Balaenoptera acutorostrata*) is the most abundant mammalian top predator in Icelandic continental shelf waters with an estimated total consumption of around 2 million tons in the mid-1990's. Recent surveys have, however shown an appreciable decrease in abundance of minke whales in this area. It has been hypothesized that these changes represent a shift in distribution triggered by northward shifts in distribution of important prey species. Recent research into the feeding ecology of common minke whales in Icelandic waters show a pronounced spatial and temporal variation in the diet. The temporal changes include a decrease in the proportion of sandeel in the diet and a corresponding increase in herring and gadoids. The diet also differed markedly from the limited previously available data from Icelandic waters from the period 1977-1997. These changes in diet composition are consistent with recent changes in the Icelandic continental shelf ecosystem including high sea temperatures and changes in distribution of several prey species including sandeel and capelin. Although natural fluctuations cannot be ruled out at this stage, these dietary changes, together with decreased abundance in coastal waters, may reflect the responses of minke whales to a changed environment possibly driven by global warming.

Introduction

The common minke (*Balaenoptera acutorostrata* Lacépède, 1804.) whale is the most abundant whale species in Icelandic coastal waters. with estimates of upto 44 000 in the continental shelf area in recent decades (Borchers et al. 2009). The Icelandic continental shelf constitutes the most important summer feeding ground of the Central North Atlantic population of minke whales judging from the NASS series of large scale standardized sightings surveys (Gunnlaugsson & Sigurjónsson 1990; Borchers et al. 2009; Pike et al. 2009). Abundance in this area has though varied considerably since systematic monitoring of abundance began in 1986 with a maximum in 2001, but the most recent surveys (2007-2009) have shown considerably lower densities in Icelandic coastal waters (Pike et al. 2011). The total prey consumption by minke whales in Icelandic waters has been estimated to be of the same order of magnitude as the total landing of the Icelandic fishing fleet (Sigurjónsson & Víkingsson 1997). However knowledge on the diet composition of this important component of the ecosystem has been poor. Here we report on the first systematic study on feeding ecology of minke whales in Icelandic waters and discuss the results in relation to recent changes in abundance of minke whales in the area and changes in environmental factors of potential ecological importance to minke whales.

Materials and methods

During 2003-2007 a total of 200 minke whales were sampled as a part of a comprehensive research programme (Marine Research Institute 2003). Sampling was distributed proportionally to seasonal and geographical distribution of minke whales as known from past surveys. Samples from forestomachs were processed onboard five sampling vessels and later analyzed in the laboratory using standard methods for stomach content analysis ((Víkingsson et al. 2013). The results are expressed as frequency of occurrence (FO), weighted frequency of occurrence (WFO) and reconstructed weight (RW) as calculated from digested prey remains. Abundance estimates for minke whales were derived from aerial surveys (Borchers et al. 2009, Pike et al. 2009, 2011) and information on distribution and abundance of important prey species were mainly provided by colleagues at the MRI.

Results and Discussion

In total 14 prey types were found in the stomachs including 10 species of fish and 2 species of euphausiids confirming the euryphagous nature of minke whales found in other areas. The results show a pronounced spatial and temporal variation in the diet. The temporal changes include a decrease in the proportion of sandeel in the diet over the study period and a corresponding increase in herring (*Clupea haerengus*) and haddock (*Melanogrammus aeglefinus*) particularly in the southern area. The diet also differed markedly from the limited previously available data from Icelandic waters with less krill and the cold water species capelin (*Mallotus villosus*) and more gadoids and herring in the more recent period. These changes in diet composition are consistent with recent changes in the Icelandic continental shelf ecosystem including increased sea surface and bottom temperatures and changes in distribution and abundance of several fish species. Thus the contribution of sandeel (*Ammodytidae* sp.) to the minke whale diet decreased from 94% and 47% in 2003 to 18% and 12% in 2007 in the southern and northern areas respectively. This is in accordance with a dramatic decrease in sandeel abundance during the study period. Sandeel was largely replaced by increased proportions of herring and gadoids in the diet. Comparison with data from 1977-1984 revealed large decreases in the proportions of capelin and krill and corresponding increase in herring, sandeel and gadoids. These changes are in accordance with changes in the summer distribution and abundance of these prey species. After the turn of the century, large changes have occurred in the Icelandic continental shelf ecosystem, possibly triggered by high sea water temperatures (Astthorsson et al. 2007). Many of these changes appear also to be unfavourable to minke whales, notably less abundance of important prey species such as sandeel, capelin and krill. The diet studies show that minke whales have reacted to this by switching to other prey species, s.a. haddock, cod and herring. However, minke whale abundance has also decreased significantly in coastal Icelandic waters during this period so minke whales appear to have reacted to these changes both by changes in diet and a shift in distribution.

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