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*Opinion piece*

# Marine mammals' influence on ecosystem processes affecting fisheries in the Barents Sea is trivial

**Some interpretations of ecosystem-based fishery management include culling marine mammals as an integral component. The current Norwegian policy on marine mammal management is one example. Scientific support for this policy includes the Scenario Barents Sea (SBS) models. These modelled interactions between cod, *Gadus morhua*, herring, *Clupea harengus*, capelin, *Mallotus villosus* and northern minke whales, *Balaenoptera acutorostrata*. Adding harp seals *Phoca groenlandica* into this top-down modelling approach resulted in unrealistic model outputs. Another set of models of the Barents Sea fish–fisheries system focused on interactions within and between the three fish populations, fisheries and climate. These model key processes of the system successfully. Continuing calls to support the SBS models despite their failure suggest a belief that marine mammal predation must be a problem for fisheries. The best available scientific evidence provides no justification for marine mammal culls as a primary component of an ecosystem-based approach to managing the fisheries of the Barents Sea.**

**Keywords:** *Balaenoptera*; ecosystem-based fishery management; ecosystem models; whaling

## 1. BACKGROUND

Managing the way that people impact the marine environment requires understanding the ecological processes being affected, including those driving fish–fisheries systems. There is a long-standing belief in some quarters that consumption of fishes by marine mammals must be a problem for commercial fisheries (Lavigne 2003). Despite research suggesting that marine mammal predation is a relatively trivial issue (e.g. Trzcinski *et al.* 2006), some stakeholders want ecosystem-based fishery management (EBFM, Pikitch *et al.* 2004) to include culls of marine mammals (e.g. Jones 2008).

Culling as part of EBFM is implemented in Norway's current policy on marine mammal management (Corkeron 2006). It is also implicit in the St Kitts & Nevis Declaration, drawn up by the pro-whaling bloc of the International Whaling Commission in 2006 (Anonymous 2006).

Probably the strongest scientific argument for culling comes from Norwegian research into marine mammals' diet and their role in the Barents Sea ecosystem, which has been ongoing for over two decades (e.g. Blix *et al.* 1995; Smout & Lindstrøm 2007). This work includes the 'Scenario Barents Sea Study' (SBS) model (Schweder *et al.* 2000), which indicated that more northern minke whales, *Balaenoptera acutorostrata*, equate to less cod, *Gadus morhua*, and herring, *Clupea harengus*. Results of this model, and other aspects of the programme, were used when developing Norway's current policy on marine mammal management (Norwegian Ministry of Fisheries and Coastal Affairs 2004).

## 2. MODELS OF THE BARENTS SEA SYSTEM

There are (or were) three major finfish fisheries in the Barents Sea, for Northeast Arctic cod, juvenile Norwegian spring-spawning herring and capelin, *Mallotus villosus* (Hjermann *et al.* 2004*a*). Northeast Arctic cod is the largest remaining cod population, with a spawning stock biomass currently estimated at over 600 000 ton (ICES 2008). Having recovered from collapse in the 1960s (Toresen & Østevedt 2000), the Norwegian spring-spawning herring population, at almost 12 000 000 ton (ICES 2007*a*), is the largest fish stock in the eastern North Atlantic, and the world's largest herring stock. Cod and herring are fished. In recent years, herring total allowable catches (TACs) have been set at around those recommended by ICES (2007*a*), but for cod, agreed TACs have generally been higher than advised, and there is also an illegal fishery estimated in the tens of thousands of tonnes per year (ICES 2008). The capelin population in the Barents Sea has gone through three crashes in the past three decades. Since the first closure in 1987, the capelin fishery has been open 8 years and closed for 14 (ICES 2007*b*). A more detailed summary of this system is available in Hjermann *et al.* (2004*b*)

There have been two main approaches used to elucidate the processes driving the fish–fisheries system in the Barents Sea. One has focused on interactions within and between the three fish populations, fisheries and climate, primarily using statistical models: time-series analysis and regressions of varying sophistication (Hjermann *et al.* 2004*a*,*b*,*c*, 2007; Cury *et al.* 2008). Data for most of these models were available for the last two or three decades of last century, and so coincide with the research on marine mammal diet in the same area. These models explained up to over 80 per cent of the variance in the data (Hjermann *et al.* 2004*c*). In these models, other predation—by seabirds, marine mammals and other predators—is unexplained process error.

For example, one model, including cod, capelin, herring, fisheries and competition between herring and capelin, describes the first two capelin collapses and recoveries well (Hjermann *et al.* 2004*a*). The model suggests that overfishing capelin drove the initial collapse. Capelin's recovery was slowed because cod seek out capelin, even when capelin's abundance is low. The second collapse was driven by the recovery of the herring population, and involved a mix of herring eating capelin larvae, and competing for food with older capelin. Again, cod predation slowed capelin recovery.

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The SBS study, on the other hand, took an explicitly top-down approach to the same system approximately at the same time (Schweder 2006). This set of simulations initially modelled what would happen to fisheries of herring, cod and capelin in the Barents Sea when northern minke whales are hunted (Schweder *et al.* 1998, 2000). Extending these models to include harp seals *Phoca groenlandica* produced model outputs that proved impossible to reconcile with reality (Aldrin & Schweder 2005).

## 3. APPLYING THESE MODELS

Both sets of models are mathematical abstractions of ecological systems, attempts to illuminate key processes that may have utility for management or in policy formulation.

Models, particularly 'minimal realistic models', must pare an ecosystem down to the processes considered important by those building the models (Schweder 2006).

In this instance, the two sets of models are structurally dissimilar. One set, which works, is based on fish–fisheries–climate interactions; the other, which fails, on top-down predation by marine mammals. Uncertainty in model structure is an issue when using ecosystem models to inform fisheries management (Hill *et al.* 2007). But when one set of models successfully captures the essence of a system and another set fails, the failed model's structure must be inherently less informative. This is something that scientists, managers and policy makers charged with managing human impacts on this system should consider. In this instance, comparing these two models indicates that predation by marine mammals is relatively trivial in the Barents Sea fish–fisheries system, when compared with other factors.

The initial fish–fisheries–climate models were published in 2004 (Hjermann *et al.* 2004*a*,*b*,*c*). The top-down model's failure was reported in 2005, albeit in a report in Norwegian (Aldrin & Schweder 2005). Despite this, SBS is still being cited in the scientific literature as an exemplar of multi-species modelling in fisheries (Smout & Lindstrøm 2007; Punt & Donovan 2007). It was also used recently to argue that culling can be part of the 'ecosystem approach' to fisheries management (Morishita 2008).

In 2006, the North Atlantic Marine Mammal Commission's (NAMMCO) Scientific Committee (SC) recommended resumption of work on SBS models (Anonymous 2007). A more appropriate recommendation would have been to support further development of the fish–fisheries–climate models by attempting to incorporate predation by marine mammals into them. Whether the additional model complexity inherent in such a reparametrization would be offset by the model's greater explanatory power would help to assess whether marine mammal predation affects fisheries.

The current weight of scientific evidence—since the publication of the fish–fisheries–climate models, and the announced failure of the SBS models (i.e. since 2005)—indicates that marine mammal predation is not an ecological problem for fisheries in the Barents Sea. Despite this, in 2006 the NAMMCO SC 'was forced to conclude that it could not provide the requested advice on the economic aspects of fishery—marine mammal interactions' (Anonymous 2007, p. 5). To arrive at this conclusion, the NAMMCO SC must not have considered the implications of the relative successes and failures of models of the Barents Sea system. They must have either been unaware of this work or failed to appreciate its importance.

Hjermann and colleagues' three papers from 2004 were published in respected journals, so lack of awareness seems unlikely. As 'Norway and Russia have expressed concerns over the current size of the northeast Atlantic harp seal populations and their predation on fish stocks, in particular in the Barents Sea' (Anonymous 2007, p. 6), the latter explanation is more likely. Furthermore, this suggests an *a priori* sentiment within the NAMMCO SC that marine mammal predation must be a problem for fisheries.

The Barents Sea has supplied seafood to Europe for centuries (Hjermann *et al.* 2004*a*). Capelin collapses and ongoing overfishing of cod put this supply at risk. Informative ecosystem models can help achieve better, ecosystem-based, management by illuminating options that have not previously been considered. One example is whether the Barents Sea capelin fishery is worthwhile, given capelin's low economic value but important ecosystem role (Durant *et al.* 2008).

Brundtland (1997, p. 457) argued that 'there is no other basis for sound political decisions than the best available scientific evidence'. If that statement were true, focusing on failed approaches that appeal to long-held beliefs while ignoring useful models would be the antithesis of sound political decision-making. More realistically, politicians tend to accept scientific results that fit preferred policy (Lavigne *et al.* 2006). In this instance, the best available scientific evidence provides no justification for marine mammal culls as a primary component of an ecosystem-based approach to managing the fisheries of the Barents Sea.

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