ICELAND, WHALING AND ECOSYSTEM - BASED FISHERY MANAGEMENT

PETER CORKERON

WDCS
Whale and Dolphin Conservation Society

Iceland, whaling and ecosystem-based fishery management.

Peter Corkeron Ph.D.

http://aleakage.blogspot.com/

Introduction

Icelanders look to the sea, and always have. Fishing has always been important to them, and they have a good record of attempting to ensure that their fisheries are sustainable. As the Icelandic Ministry of Fisheries stated in a declaration on 17th October 2006, "The Icelandic economy is overwhelmingly dependent on the utilisation of living marine resources in the ocean around the country. The sustainability of the utilisation is therefore of central importance for the long-term well being of the Icelandic people. For this reason, Iceland places great emphasis on effective management of fisheries and on scientific research on all the components of the marine ecosystem. At a time when many fish stocks around the world are declining, or even depleted, Iceland's marine resources are generally in a healthy state, because of this emphasis. The annual catch quotas for fishing and whaling are based on recommendations by scientists, who regularly monitor the status of stocks, thus ensuring that the activity is sustainable.".

Fisheries account for approximately 40% of the value of Iceland's exported goods and exported services, and roughly two-thirds of Iceland's exported goods, minus services. Fisheries and fish processing account for little under 10% of Iceland's Gross Domestic Product (GDP), down from more than 15% in 1980. With a population of just over 300,000 in 2007, Iceland is the world's 178th largest nation, but in 2002 it was still ranked as the world's 13th largest fisheries exporter. So Iceland's economy is heavily dependent on its fisheries sector (although "overwhelmingly dependent" seems stretching things).

Compared with fisheries in many other nations, and particularly compared to the European Union's poor record on fisheries management, Icelandic fisheries aren't badly managed. In the latest advice from ICES (the International Council for the Exploration of the Sea), two Icelandic stocks (cod and haddock) were rated as "Overexploited" when assessing fishing mortality against historically highest yield, and four stocks were classified as "Undefined". Just after this advice was issued, the quota for Icelandic cod was reduced substantially. This might not sound like a great track record, but compare it to the North Sea, where eight stocks were classed as "Overexploited", and five as "Undefined" or "Unknown".

Icelandic fisheries are confronted with environmental issues other than overfishing. Changes in water flows through Denmark Strait (between eastern Greenland and Iceland), are variable, and in recent years have seen warm, saltier Atlantic water moving further north than in previous years. This appears to have affected the movements of the capelin (*Mallotus villosus*) population that occurs in Icelandic waters, making it difficult for Icelandic scientists to locate the capelin, and estimate its abundance. This, in turn, has affected the advice that Icelandic scientists can give on fishing quotas, resulting in smaller landings of Icelandic capelin in recent years.

The UK's Marine Conservation Society lauded a recent decision to cut Icelandic cod (*Gadus morhua*) quotas, noting that British consumers' demand for sustainable seafood was a motivation for the cuts. The cuts to cod quotas were a good step towards sustainability, but it's worth remembering that the size of the Icelandic cod population (formally, the point estimate of its spawning stock biomass), is only

about one-third of what it was 50 years ago (see Figure 2.4.2.1 in the linked pdf). So, despite room for improvement, it's fair to say that Icelanders, as a nation, stand out among Europeans in their enlightened attitudes towards fisheries management. Yet the Ministry of Fisheries' statement above came as part of a declaration on Iceland's return to commercial whaling.

In 2006, Icelanders restarted whaling commercially, for the first time since 1989. Seven fin whales (*Balaenoptera physalus*) were killed from a commercial quota of nine. A much larger quota was under consideration for the 2007/2008 fishing year. Commercial whaling in Iceland started after a separate whaling program, conducted under Article VIII of the International Convention on the Regulation of Whaling (which I'll refer to as Article VIII whaling, and commonly called "scientific whaling") was instituted in 2003, hunting northern minke whales (*B. acutorostrata*). This program finished this year (2007) with a total kill of 200 animals. A commercial hunt of minke whales started in 2006/2007, with a quota of 30.

There's an important distinction in technology between the Icelandic hunts for fin and minke whales. Minkes can be killed by smaller vessels – fishing boats that have a harpoon gun attached for part of the year. Fin whales are too large to be hunted using these smaller vessels. The Icelandic hunt of fin whales in 2006 was carried out from one of the old whaling catcher boats that have been a feature of the Reykjavik harbour for several years now. But it appears that these whale catchers can't be converted to go fishing for most of the year, so to remain operational, they need to be used hunting whales. In turn, this implies the need for a substantially larger quota of these larger whales than the quota of nine fin whales issued for 2006/2007.

This suggests that Icelandic whalers were, and still might be, on the cusp of restarting large-scale commercial whaling for larger baleen whales. There is a limited market for fin whale meat in Iceland (there are, after all, only about 300,000 Icelanders), so the intention was to sell the meat to Japan. But at the time of writing (early October 2007), negotiations over the sale of the meat have not been concluded, so the meat remains in storage in Iceland.

On 24th August 2007, the Icelandic Minster for Fisheries announced that new fin whale quotas for the 2007/2008 fishing year (starting 1st September) would not be issued, as the current meat stockpile had not been sold. Whether the market's invisible hand has forced Icelanders to down their harpoons permanently remains unclear, as are the roles of other factors, such as international opinion and dissent at home. The statements made to date appear to leave room for whaling quotas to be issued if contracts are signed in the near future, and commercial quotas for minke whales for 2007/2008 were issued.

However, there are calls from members of the Icelandic fishing community for a whale hunt, regardless of the market situation, as they claim whales need culling. Such calls have become more common in recent years from people in nations that engage in marine mammal hunts.

Is there merit in these claims? This paper presents a critique of the case being made by people in whaling nations generally, and by Icelanders in particular, for culling whales in the name of "ecosystem-based fisheries management". These calls are contrasted with other initiatives in Iceland to use aspects of the ecosystem approach in their fisheries management.

Culling whales as fishery management.

Iceland was one of the member nations of the International Whaling Commission (IWC) that, in 2006, sponsored the St Kitts & Nevis Declaration. Most of this declaration refers to the sponsors' perception of problems within the IWC, but it also includes the statement:

"ACCEPTING that scientific research has shown that whales consume huge quantities of fish making the issue a matter of food security for coastal nations and requiring that the issue of management of whale stocks must be considered in a broader context of ecosystem management since eco-system management has now become an international standard."

Nations engaged in marine mammal harvests (and their supporters) are claiming that (a) marine mammal populations are negatively impacting the abundance of commercial fish, and (b) culls of marine mammals, ostensibly to benefit fisheries, are part of "ecosystem-based fishery management" (EBFM). The most strident of these calls have come from Japan, and Norway has officially recognized culls as part of its national policy on marine mammals since 2004. Japan even channelled money through the United Nations' Food and Agriculture Organization (FAO) to fund a "research" program in the Caribbean entitled "The scientific basis for ecosystem-based management in the Lesser Antilles including interaction with marine mammals and other top predators".

A few recent examples from the Icelandic press demonstrate that this view – burgeoning whale populations are eating too many of "our" fish - is held by members of the fishing industry and politicians there as well:

- On July 2nd 2007, the Federation of Icelandic Fishing Vessel Owners (LIU) issued a statement (in Icelandic) on the recent cod quota reductions in Iceland, and calling for whaling not only to continue but to be increased. The statement claims that "the large increase in whales has influenced stocks of capelin and cod…as they take between one and two million tons of capelin and a considerable quantity of cod."
- On July 3rd 2007, the Minke Whalers Association (Felag hrefnuveidarmanna) website posted an article entitled, "Hrefnurnar eru smekkfullar af þorski og ýsu" (Minkes smack-full of cod and haddock).
- On July 10th, 2007 Stod 2/ Visir ran an interview with Einar K. Gudfinnsson, the Icelandic Fisheries Minister, regarding the fact that when the new fish quotas were issued, there were no whaling quotas given out. The interview refers to the fact that the Federation of Icelandic Fishing Vessel Owners (LIU) had stated that they believe that increased quotas should be given out for whales, due to the fact that they are eating all of the fish, *and regardless of sales* (my italics). Mr. Gudfinnsson concurred with the concerns, although he did say that whaling in Iceland will be based on whether or not the meat sells.

The idea that marine mammals must be culled to protect fisheries is not new. Such calls have been made for decades, perhaps centuries. For example, when the Norwegian spring-spawning herring (*Clupea harengus*) population collapsed completely in the late 1960s – a direct result of massive overfishing – the government organized a hunt of killer whales (*Orcinus orca*), that were known to eat herring. Over 700 whales were killed between 1969 and 1980 (Øien 1988). What is new is the

notion that culling marine mammals is a *primary* component of effective fisheries management that takes account of ecosystem interactions. How has this come about?

The effects of fisheries on marine ecosystems: a change in thinking.

In order to put this question in context, a very brief overview of the state of the world's fisheries is needed. The Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations (FAO Fisheries) estimates that in 2005, 25% of the world's marine harvest fisheries were overexploited, depleted, or recovering from depletion; 52% were fully exploited; 20% moderately exploited and 3% underexploited. Marine harvest fisheries now land less than they did in the 1980s (Watson and Pauly 2001, Pauly et al. 2003). Worldwide, fisheries are in crisis. The extent of this crisis remains a matter of scientific debate (e.g. Hilborn 2006), but no-one (to my knowledge) is making an argument in the scientific literature[*] that the *status quo* is acceptable.

But something else is happening as well. Our understanding of the effects of fisheries on marine ecosystems has changed substantially over the past decade or so. A series of scientific papers have challenged old views, and introduced the ideas that problems caused by industrial fisheries involve more than just the fish stocks targeted, and fishing has large scale, deleterious impacts on marine ecosystems generally (Pauly et al. 2002, 2005). Immediate problems include those of overfishing - taking too many of a targeted species, and destructive fishing - fishing techniques such as

[*] Where I refer to the "scientific literature" in this report, I'm talking about the peer-reviewed scientific literature – in journals and books that publish articles that have been reviewed by experts in their field.

bottom trawling that, given the mechanics of their action, must have a deleterious impacts on the ecosystems that they traverse.

As well, there is a growing understanding that historically, humans have overfished, and this historical overfishing has had ecological impacts too (e.g. Jackson 2001, Jackson et al. 2001). The marine environments that we live with now are, in many cases, the product of centuries of human disturbance. In times past, some of these marine ecosystems were far more productive than they are now. Recall that the Icelandic cod population is only about one-third of the size it was 50 years ago. What if fisheries managers aimed for a gradual return to a population size similar to what it was in the middle of last century? The sustainable catch from such a population would be substantially greater than today's landings. There are calls in fisheries science (e.g. Pitcher 2001) to find ways to rehabilitate marine ecosystems to their historical productivity, with the eventual aim of more productive, less environmentally destructive fisheries.

These recent developments in the scientific community have led to calls for a more ecosystem-based approach to fisheries (Corkeron 2006). Calls have moved beyond abstract scientific theorizing, and into the international bureaucracy. One outcome of the United Nations' World Summit on Sustainable Development (the Johannesburg Summit) of 2002 was the call to "encourage the application by 2010 of the ecosystem approach" to fisheries.

Put together, these developments amount to a complete shift in our understanding of the effects of fisheries on the marine environment. But as well, they represent an indictment of previous - classical - approaches to fisheries management.

The scientists that have developed these ideas tend to be based at academic institutions in North America. European governments employ many fisheries scientists, whose academic training is in classical fisheries management. These new ideas have received less support from the fisheries science establishment generally, and particularly in Europe (see for example, the papers in the ICES Journal of Marine Science Special Issue on ecosystem indicators, e.g. Cury and Christiansen 2005, Daan 2005) than by ecologists employed in universities.

However, these differences are relatively subtle when compared with the difference between EBFM as it is presented in the scientific literature, and EBFM as imagined by scientists employed by government (or quasi-government) research institutes in whaling nations.

Opposing views of "Ecosystem-based fishery management"

So what is the "ecosystem approach" to fisheries? What does "ecosystem-based fishery management" entail? One definition that encapsulates EBFM clearly and succinctly is that given by Pikitch and coauthors in *Science*, 2004: "EBFM reverses the order of management priorities so that the objective of sustaining ecosystem structure and function supersedes the objective of maximizing fisheries yields" (Pikitch *et al*. 2004, p 1892).

However, there is another view of EBFM, exemplified by Norway's current policy on "managing" marine mammals. This policy "forms part of Norway's efforts to implement the ecosystem approach to the management of its marine resources." (I used this quote, from the English translation of the White Paper that introduced the policy, in previous paper [Corkeron 2006]. The translation has disappeared from

Norwegian government websites.) The policy is part of the Norwegian government's approach to fulfilling its obligation to implement the ecosystem approach to fisheries by 2010. The policy (in Norwegian) states that “ecosystem-based management shall use resource-ecological arguments as the basis for establishing objectives for determining the size of marine mammal populations, and it is necessary to work out reference limits for biologically secure frameworks and precautionary levels.”

I've referred to this approach as “Multispecies Fisheries Management (MSFM) (Corkeron 2006) to differentiate it from EBFM as described above, as this policy maintains traditional management priorities – maximizing yields from industrial fisheries has priority over maintaining ecosystem function – and so does not fit the criteria of EBFM as proposed in the scientific literature.

How scientists make inference from data.

One of the intriguing issues with implementing EBFM is the manner in which academic science, science supported by national governments, and scientific advice to international bodies interact to influence policy and management decisions at national, regional and international levels. In order to understand how these play out, a little background is needed, describing the conceptual tools used by applied ecologists. Ecologists must make inference from data, but the manner in which data are collected affect their ability to make these inferences. Put very simply, there are three ways to collect field data, non-manipulative studies, experiments, and “natural”“experiments”.

- Non-manipulative: We can study the animals that are of interest without perturbing the system under study. These studies may be simple, or may be

sophisticated. Note that conceptually, the lack of manipulation relates to the **ecosystem** of interest, rather than **animals**. So “lethal sampling” - killing animals to look at their stomach contents - is a form of observation, as the scientists aren't actually perturbing the system under study in order to assess the effects of perturbation. Even if they were to kill or displace so many animals (or particular, important animals) that they create a perturbation, it would lack appropriate design, and so would be difficult (probably impossible) to make inference from. By this definition, lethal sampling can be simplistic, as it doesn't necessarily take much design or analytical skill (e.g. Haug et al. 2002, Mikkelsen et al. 2002), but research based on photo-identification, when results are analysed using sophisticated mathematical techniques (e.g. Parra *et al.* 2006a, b), can be sophisticated. Because non-manipulative studies do not perturb the system of interest, they can only make inference on causality by teasing out signal (causality) from noise. They suffer from a classical problem in research design: that correlation does not demonstrate causation.

- Experiments: In order to make stronger inference, we can make changes to the system under study to see what happens. These can be laboratory based, for example studying seals' or dolphins' physiology in captivity, for input into consumption models. In the field, experiments can be conducted at a small scale. An example is the “Seal Exclusion Zone” trial conducted recently by the Canadian Department of Fisheries and Oceans, which aimed to see (a) if it was possible to keep seals out of a bay, and (b) whether this had any discernible effect on fisheries.

- "Natural" "experiments": There are also **"natural" "experiments"** (both in quotation marks because they're not necessarily natural, nor are they truly experiments), where something about the system of interest varies over space, time or both, allowing us to observe differences. For example, the populations of harbour seals in European waters have collapsed twice over the past two decades, due to morbillivirus infection (e.g. Harding et al. 2002). These offer the opportunity to assess the influence of harbour seal predation on fish of interest to fisheries, as harbour seal numbers (and so, predation pressure) have changed dramatically in space and time, and there are places (e.g. northern Norway) where morbillivirus has not impacted population numbers, providing a "natural control". To the best of my knowledge, no-one has undertaken such a study.

The other approach, once data exist, is to create models of the system of interest. Models can be simple or complex (any statistical test on data is really a model). Models can be seen as interesting intellectual tools used to come up with nice ideas about a system, or attempts to mimic reality.

- Modelling: We can **model** system of interest, using mathematical models run inside computers. For example, scientists use population models, coupled with physiological models of marine mammals and fish, to estimate the magnitude of predation by marine mammals. Comparing these model results with fisheries landings can give an idea of the relative importance of marine mammal predation and fisheries on the population status of the fish of interest (e.g. Hansen and Harding 2006, Trzcinski et al. 2006).

Classical fisheries science relies mostly on non-manipulative observation: estimating the size of a fish population; and then modelling to estimate sustainable fishing mortality. Experimentation (other than laboratory-based work to improve parameter input for modelling) is not used as much. Just as any experiment is only as good as the weakest aspect of its design, any mathematical model is only as good as its weakest assumption. The population models used in classical fisheries science are reasonably reliable, although the observational data used as input for the models can be poor.

What happens when we move to EBFM? Not only do we need to describe the **pattern** that we observe - precisely and accurately - we also need to understand the **processes** responsible for these patterns. These processes – how ecosystems function – are more complex and less well understood than those underpinning classical fisheries models. (The best way to make inference on the ecosystem effects of fishing is to include the existence or otherwise of fishing as part of a large-scale experimental approach. This is one [rarely advanced] justification for using no-take marine reserves [places where no fishing is allowed] in EBFM [Corkeron 2006].)

Attempting to understand process has been a focus of community ecology. Community ecologists are far more likely to use field-based experiments, including large-scale experiments, than are population ecologists, although when population ecologists have taken a large-scale experimental approach, the results can be groundbreaking (e.g. Sinclair and Krebs 2002, Sinclair and Byrom 2006). Some national fisheries research institutes employ dozens of scientists, almost all trained in classical fisheries biology and biological oceanography. Instituting EBFM in fisheries

has not resulted in research institutes replacing these people with those trained in community ecology. Institutional inertia ensures that non-manipulative studies coupled with modelling remain the order of the day.

Does this really matter? Who cares if scientists just repackage their old techniques to fit into the latest directive from their political masters? I argue that it does matter, and that if we want to understand humanity's impact on marine ecosystems, we need to expose abuses of the process of conducting science when we encounter them.

I'll take the example of Norwegian research into the commercially important fish populations of the Barents Sea. I use it to demonstrate that by supporting politically palatable - but poorly conducted – science, the Norwegian establishment has not only directed attention towards a non-issue (marine mammal consumption), they have not focused on the real issue – fisheries mismanagement, so allowing the real problems to propagate.

This discussion addresses Norwegian research in the Barents Sea, rather than Icelandic research. But the players, both biological (fish populations, marine mammals), and human (the science and fisheries management establishments of both Norway and Iceland) are similar, sometimes identical. The Norwegian research has been ongoing for longer, and so it's possible to draw some lessons from it.

Background: fish and fishing in the Barents Sea

Capelin is a small fish found throughout the oceans of the Arctic and is an important component in the Barents Sea ecosystem. (However, please remember that this

discussion is of Barents Sea capelin, a different population from capelin found in Icelandic waters.) Capelin feed on the plankton that blossoms in the northern Barents as summer sunlight arrives, then the capelin migrate south to the coasts of Finnmark (northern Norway) and the Kola Peninsula (northwestern Russia) to spawn in the spring.

Russians and Norwegians have industrial fisheries for capelin, and quotas are agreed jointly. The industrial fishery for capelin in the Barents Sea is relatively young. It really got going in the 1970s, and landings peaked at a little under three million tonnes in 1977. At that time, the capelin fishery was the largest single-species fishery in Europe. Norway's capelin fishery in 1977 – a little over two million tonnes (the Soviet Union reported landing over 800,000 tonnes) – was the world's single largest fishery for that year.

In the face of this fishing pressure, the capelin population collapsed to about one-twentieth of its original size - from an estimated maximum of nearly nine million tonnes in 1975 to about one hundred thousand tonnes in 1987. The fishery was closed as a result. In the 20 years from the first closure in 1987 to 2006, the capelin fishery has been open for eight years, and shut for twelve (all information is taken from the October 2006 ICES advice on capelin). *Over the past 20 years, the fishery has been shut for 150% of the time it has been open.* In neither of the two periods when the fishery was reopened (for periods of three and five years) has the total catch summed to that landed in one year, 1977. The fishery was shut - again - in 2004, and remains closed.

Why have the crashes happened? A paper published in 2004 (and so including only the first two crashes) gives some answers (Hjermann et al. 2004). Ecology and fisheries both play a role. Capelin are short lived – to five years at a maximum, and almost all die after spawning just once. Cod eat fatty, adult capelin. Young herring also eat very young capelin. The herring population in the Barents Sea was almost completely fished out in the late 1960s and early 1970s, but had started to recover in the late 1980s (Hjermann et al. 2004). Despite being depleted, the Barents Sea cod, the last great cod population still surviving, is estimated to have a spawning stock biomass of about six hundred thousand tonnes (see Table 3.4.1.3 in this pdf).

Overfishing capelin drove the initial collapse. A problem then became that cod need to eat fatty, adult capelin to build up their energy stores for their spawning migration. So even when capelin are at relatively low numbers, cod still deliberately seek them out. This slowed the recovery of the capelin population. The second collapse (in the early 1990s) 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. And again, cod predation slowed capelin recovery.

The important point in the context of the "whales eat fish" argument is that Hjermann et al.'s (2004) paper models the capelin crashes well by considering **only** the fish populations and the fishery, *suggesting that the effect of marine mammal predation on capelin (relative to fisheries and other ecosystem components – i.e. fish) is - at most - trivial*. Marine mammal predation doesn't need to be included to produce a model that explains the data satisfactorily.

Consumption Estimates

Contrast this paper with nearly two decades of research by several Norwegian scientists, attempting to assess the role of marine mammals *in the same place at the same time, on the same commercial fish species*. The research program was established not long after the first capelin crash, and – theoretically - sought to understand how predation by marine mammals influences the size of fish populations in the Barents Sea. Field work ran through the second and third crash of the capelin population. The work included assessing the stomach contents of harp seals (*Phoca groenlandica*), hooded seals (*Cystophora cristata*) and northern minke whales - lethally sampling of all three species. This work has been published in a series of scientific papers, describing the generalities of what and how much the animals ate (e.g. Folkow et al. 2000, Nilssen et al. 2000,), and then modelling the influence of marine mammal predation on the fisheries of interest (e.g. Bogstad et al. 2000, Tjelmeland and Lindstrøm 2005). The design of the program on minke whales was used as a template by the Institute of Cetacean Research for the "understanding whales' role in the ecosystem" aspects of Japanese Article VIII whaling (see Murase *et al*. 2007 for an example).

It's important to differentiate between **diet studies** – non-manipulative studies to determine what animals eat – and **consumption estimates** – simple models to determine the amount of prey consumed by a population of marine mammals over a set period (usually a year).

Put simply, if we know what whales eat, how much they eat each day, how many days they stay in the area of interest, and the number of whales in the population of interest, we can estimate how much whales eat in the area of interest.

Knowing how whales behave when confronted with different relative amounts of different prey species is useful, too. Collecting the data needed to estimate the amount that marine mammals consume has been a priority of scientists in whaling nations over the past couple of decades (apart from the references above, see, for example, Murase *et al*. 2007).

The estimates for all these input variables are multiplied together in order to derive a final consumption estimate. There are two problems with these multiplications. Each input variable has uncertainty associated with it. Uncertainties come in two forms – **process uncertainty** and **measurement uncertainty** (Hilborn and Mangel 1997). Process uncertainty refers to variability inherent in the system – whales don't always eat exactly the same thing in exactly the same place each year, as their environment varies. Measurement uncertainty is inherent in our ability to come up with values for the variables. Science is not magic, and sampling theory dictates that all of our estimates of these variables – population size, for example – must have some uncertainty about them.

Because the variables are multiplied, these errors all compound. In the end, a point estimate might seem reasonable, but the uncertainties associated with it might make it meaningless. For example, a recent model that assessed the effect of grey seal predation on the non-recovery of cod on the Eastern Scotian Shelf (off eastern Canada) arrived at a point estimate of 16.7 million cod consumed by seals in 2003. But the uncertainty in that estimate was such that its 95% confidence intervals (a standard method for describing uncertainty) were plus or minus 55.4 million cod (Trzcinski *et al*. 2006). Also notable in this paper, set in an area where the cod

population is at a tiny fraction of its historical abundance and where the grey seal population is the highest it has ever been, that the authors still conclude that there was "little evidence that gray seals (*Halichoerus grypus*) were the principal source of natural mortality on the ESS Atlantic cod (*Gadus morhua*) stock" (Trzcinski *et al*. 2006, p 2286).

Another problem with these estimates is that they assume an understanding of the system under consideration that might be hubristic. For example, in Moreton Bay, Queensland, the data needed to derive a consumption estimate for local population of Indo-Pacific bottlenose dolphins, *Tursiops aduncus*, are all available. But there, two separate societies of these dolphins exist – those that feed in association with shrimp trawlers (and so don't eat free-swimming fish as much as those that feed "normally") and those that do not (Chilvers and Corkeron 2001). Failing to account for this behavioural difference would invalidate consumption estimates.

Finally, there is a conceptual problem with the way in which marine ecosystems are viewed by some who are tasked with deriving consumption estimates. This is best exemplified by the language they use when discussing their research. To quote from a very recent example in a scientific journal (Smout and Lindstrøm 2007, p 289): "We therefore suggest 2 important directions for future research into *the impact of foraging by minke whales in the Barents Sea ecosystem*" (my italics).

The implication of this statement is that minke whales are perceived as being somehow separate from their ecosystem (they have an "impact" on the system). Further, it implies that the only ecosystem role that minke whales have that is of any interest is that they eat commercially valuable fish species. This approach ignores (to

take just one example) trophic cascades – unforeseen, large-scale ecosystem changes driven by overhunting upper-level predators – that have been demonstrated in marine systems (e.g. Österblom et al. 2006, Myers et al. 2007).

"Five tons of cod and herring"

Another approach to assessing the effects of marine mammals' consumption of economically important fish has been modelling work – the stated aim of which is evaluate the effects of marine mammal harvest strategies on other fisheries (Hagen and Schweder 2005). (Note that this aim is subtly different from that of the work by Hjermann and coauthors, who sought to understand the reason(s) for the collapses of the capelin population in the Barents Sea.) This set of simulations initially modelled what will happen to fisheries of herring, cod, and capelin in the Barents Sea when northern minke whales are hunted (Schweder et al. 1998, 2000). The simulations were then extended to include harp seals (Hagen and Schweder 2005).

The initial simulations resulted in a simple, elegant statement that has been used repeatedly in discussing marine mammal culls, and is summarised by a line in the current Wikipedia entry on whaling, (as of 5th September 2007) "In the Barents Sea, it is estimated that a net economic loss of five tons of cod and herring per fishery results from every additional Minke Whale in the population due the fish consumption of the single whale.". The quote includes a citation to one of the papers on this modeling exercise, published in a special publication of the North Atlantic Marine Mammal Commission (NAMMCO) (Schweder et al. 2000).

However, careful reading of the two papers on this modeling approach that have been published in the scientific literature demonstrate that the authors are – to

their credit - explicitly saying that *their models are not reality*. For example, “There is still too much uncertainty surrounding this study to allow firm conclusions”; Schweder et al. 1998:92). The models are intellectual exercises aimed at exploring ways to understand the Barents Sea ecosystem. Yet the White Paper that reshaped Norway’s policy on marine mammal management in 2004 includes reference to the five tons, with the minor caveat that the research results were still preliminary (after at least seven years’ work).

When the data on harp seal diet and consumption are included in the “Scenario C” model approach (as it is known), the model produces outputs that are unrealistic (see page 5 of the report of the fourteenth meeting of the NAMMCO scientific committee, page 18 of this pdf). This suggests that something about this modeling approach – the basic data, some assumption(s) of the modeling process, or both – is flawed.

The failure of the “Scenario C” approach to provide a platform for offering advice on the relationship between marine mammal hunts and fisheries is made clear in the comments of the NAMMCO Scientific Committee: “Once again the Scientific Committee was forced to conclude that it could not provide the requested advice on the economic aspects of fishery - marine mammal interactions in the 2 areas (Barents Sea and Iceland) and with the two species (minke whales and harp seals) that have been identified as feasible for this assessment. Working groups established by the Scientific Committee have met on 5 occasions to deal with this and related requests” (see page 5 of the report of the fourteenth meeting of the NAMMCO scientific committee, page 18 of this pdf).

Somehow, this side of these models has not found its way into the public consciousness, the way that the "five tonnes of cod or herring" has.

There is an explanation for the big picture of what's happening with the populations the commercially important fish in the Barents Sea – the ecosystem effects of recovery from overfishing of two commercial fish species in the past five decades. The explanation has been published in the scientific literature. The research approach that detected this signal from the data available began by setting out to understand what had happened in the Barents Sea. In doing this, the study's authors took a very different approach from those running the "scenario experiments" described above. The "scenario experiments" began with the basic assumption that predation by marine mammals was important enough to be worth modeling as a way of understanding fish-fisheries-ecosystem interactions in the Barents Sea.

And despite the failure of Scenario C to provide useful results, what was the conclusion of NAMMCO's scientific committee? To quote them directly, "As in the past, the Scientific Committee emphasized that progress in this area will not be made unless significant additional resources are dedicated to it. Specifically the Committee recommended that work on the "Scenario C" model be resumed in Norway, and that Iceland should continue efforts to incorporate marine mammal consumption in GADGET models for the area" (see page 5 of the report of the fourteenth meeting of the NAMMCO scientific committee, page 18 of this pdf). Note here, that Icelandic researchers, with their "GADGET" program are making a similar basic assumption to that made by Norwegian researchers with Scenario C, i.e. that marine mammal

predation is a major element regulating the population size of commercial fish species of interest. The same thinking is at work.

The scientific approach taken by Hjermann and coauthors, by setting out to assess the data available, produced a workable model for the situation in the Barents Sea. The other approach, taken by Schweder and coauthors, began with a preconceived idea that marine mammal predation must be important, and has not produced a workable model. Yet calls remain for further development of this unsuccessful approach.

What does this tell us about the mindset of the scientists who call for more of this work?

That the ecosystem effects of overfishing are still being felt in the Barents Sea may be unpalatable for those responsible for managing human impacts on this system, but remains the most likely explanation for the current situation. And, given that cod quotas for the Barents Sea are still being set in excess of those recommended by ICES, it is clear that policies and procedures have still not been implemented to ensure that overfishing will not recur. Instead, managers and policy makers have taken an inappropriate path, and supported research that - despite being demonstrably less informative than work by other Norwegian scientists at explaining the system of interest – is more politically palatable than the real alternative.

But that's Norway. Do similar structural problems exist within the marine research community in Iceland (in addition to the conceptual similarities of GADGET and Scenario C)? Ignoring Article VIII whaling here (which is, arguably, an abuse of

the process of conducting science), recent statements by senior staff at MRI, and by the Icelandic Fisheries Minister suggest that similar problems remain there.

Discussions of whale surveys in Iceland

The declaration by the Fisheries Ministry on Iceland's decision to resume commercial whaling (on 20th October 2006) included this statement, "The annual catch quotas for fishing and whaling *are based on recommendations by scientists*, who regularly monitor the status of stocks, thus ensuring that the activity is sustainable" (my italics). Implicit in this statement is the assumption that scientists (a) provide information of appropriate quality, and (b) are not under political pressure to produce results that accord with a particular world view (in this case, the "whales eat too many fish" view). Put anther way, it implies that scientists are relatively independent, and can conduct research without overt political interference.

Two statements arising from recent sightings surveys demonstrate how the use of data can be politicized. On one hand, there is a news item on the NAMMCO website, from 22nd July, quoting a member of the team who conducted aerial surveys of Icelandic waters, at the end of their survey. To quote directly from the site, "However minke whale sightings were fewer than in previous years. White beaked dolphins also appeared to be fewer in number. Substantial numbers of humpback whales were sighted in the northwest, but the concentration seen off eastern Iceland in 2001 was not located this year."

The entry from the survey participant is prefaced by a paragraph (presumably by someone in the NAMMCO secretariat) that includes: "Here follows a log from

Daniel Pike who reports on the survey outcome. Clearly it has been a success, *although it must be emphasized that all comments on relative abundance are preliminary and cannot be interpreted until all TNASS survey data from all areas are in and collated*." (my italics). This is perfectly reasonable – it's inappropriate to make too much of raw data collected on survey prior to analysis.

Yet the next day - on July 23rd, IcelandReview.com reported that "The Iceland Marine Research Institute finishes a count of fin whales this week……..This is the most extensive count of whale stocks which has ever been undertaken and a special emphasis has been put on determining the size of the fin whale stock. *According to whale expert Gísli A. Víkingsson, this stock appears to be the largest since fin whales were first counted*." (my italics). No-one prefaced these comments with the qualifier that preliminary results shouldn't be interpreted too deeply. Instead, Iceland's Fisheries Minister, Mr Gudfinsson was quoted remarking on these results: "That supports our cause as a whaling nation. The whale stocks are very large and continue to increase in size, which has a negative influence on the size on the stocks of other marine species. These results show without a doubt that *there is a biological prerequisite for whaling*."(my italics).

Fin whale counts were up, so this demonstrates, to Iceland's Marine Research Institute (MRI) that there was a "record number of fin whales", and so the fisheries minister can say that "without a doubt"... "there's a biological prerequisite for whaling". But counts of minke whales and whitesided dolphins were down, so comments on them are, for NAMMCO, "preliminary and cannot be interpreted". NAMMCO's approach is appropriate, MRI's is not.

Note further, that MRI staff chose *not* to announce that minke whale counts were down, but that fin counts were up. This incident demonstrates how the same set of raw data can be used in two very different ways, and, in one case, for clearly political purposes.

And yet, Icelandic quotas for a commercial hunt of fin whales have not been set for 2007/2008, so something has changed. Could this change open new possibilities for the way in which Icelanders manage the effects of their fisheries on the marine environment? I suggest that it could.

Future options

Iceland's fisheries are primarily for export. A "Statement on Responsible Fisheries in Iceland" was signed on 7th August 2007 by Iceland's Minister for Fisheries, and representatives of the Marine Research Institute, the Directorate of Fisheries, and the Fisheries Association of Iceland. It is directed to "everyone who is interested in the status of the fish stocks and responsible fisheries, *particularly the numerous parties that purchase and consume Icelandic fish products*" (my italics). The Icelandic fisheries establishment recognises the importance of consumers' purchasing decisions.

The Statement mentions several approaches that fall under the rubric of EBFM: assessing and mitigating the effects of fisheries gear on the marine environment; quotas set according to best available scientific advice; bycatch reduction; strict controls on discarding; effective catch controls and enforcement. Also noticeable – by its absence – is any mention of reducing the size of marine mammal populations in the hopes of improving fisheries landings. The Icelandic

fisheries establishment deserve congratulations for making this Statement, and for taking a difficult decision in implementing it - the recent reduction in their cod quota.

Culls of whales are unnecessary, and are antithetical to the ecosystem approach. There is no evidence that culling marine mammals could enhance fisheries output. The best evidence available suggests that current levels of marine mammal predation on commercial fish are trivial when compared with fisheries. Those who call for culls seem to believe that an “ecosystem approach” to fisheries implies tinkering with some species in marine ecosystems, rather managing fisheries with an aim to restoring ecosystem health.

The “Statement on Responsible Fisheries in Iceland” demonstrates that members of the Icelandic fisheries establishment understand the importance of consumer sentiment in countries that import Icelandic fisheries products. Marine mammal culls, ostensibly to encourage fisheries, are unlikely to be well received by these consumers.

Icelanders have an opportunity to ensure that their marine harvest fisheries contribute to their country’s wealth and humanity’s food security, by taking steps to ensure that their fisheries are sustainable (or better, rebuildable), and do minimal environmental damage. Iceland can show the rest of Europe how the ecosystem approach to fisheries management can work for ecological and societal benefit.

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