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## **Seals, cod, ecology and mythology SUMMARY**

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1. Canadian elected officials and Department of Fisheries and Oceans (DFO) staff have stated that the culling of seals will benefit the recovery of Northwest Atlantic cod stocks.
2. In contrast, published reports in scientific journals, including those authored by DFO biologists, unequivocally conclude that seals are having no demonstrable impact on cod recovery.
3. "Common sense" arguments that culling seals will "obviously" benefit the fishery are premised on a mythological view of predators that is unsubstantiated by most scientific evidence.
4. Research conducted in other fisheries has indicated that the complexity of marine food webs, and the diversity of seal diets mean increased seal numbers can sometimes lead to positive effects on commercial fish stocks.
5. Consistently, recent research in terrestrial systems indicates that top predators can have a significant positive impact on numbers of herbivores by reducing numbers of smaller predators.
6. The Canadian political agenda for dealing with the collapse of the cod stocks has evolved to include a subsidised seal cull, and suppression of internal reports contradicting the "common sense" position adopted by the political leadership.

### **Seals, cod, ecology and mythology**

#### **Introduction**

The collapse of the Northwest Atlantic cod fishery has become a metaphor for ecological catastrophe and is universally cited as an example of failed management of a natural resource (MacKenzie 1995). The denial that greeted the first reports recommending massive reductions in cod quotas (e.g. Lee 1990) has given way to a broad acceptance that the cod stocks were abused, and require time to rebuild.

Various hypotheses have been advanced for the demise of these once abundant stocks, some of which are related to physical changes in habitat. Cold water, reduced salinity, and other environmental parameters have been posited as components of the problem by reputable researchers (e.g. Dunbar 1993). Research on other Atlantic cod stocks has

indicated that factors such as temperature can be significant determinants of stock recruitment (Ottersen et al. 1994; Nilssen et al. 1994). There is no unambiguous evidence supporting claims for such a relationship in the Northwest Atlantic, and the only statistically significant relationship that has been demonstrated ties the decline of cod simply to over-fishing (Hutchings and Myers 1994).

Efforts to find a culprit other than the fishery have created a great deal of confusion in media accounts of the issue. The politicians whose decisions permitted the destruction of the stock, and elements of the fishing industry that caught too many fish and is now suffering as a consequence, have been especially prodigious sources of alternative theories. Chief among these has been the contention that seals are eating so many cod that cod population recovery is being constrained (e.g. Whiffen 1994; Jackson 1995).

As recently as July 1994, Canadian Fisheries Minister Brian Tobin apparently rejected this notion. Speaking to reporters while visiting New Zealand he was quoted as saying, "There is no doubt in my mind that man has been a far greater predator on these stocks that disappeared than seals have been" (Canadian Press 1994).

Brian Tobin is now internationally famous (or infamous, depending on your point of view) for his hard-nosed confrontations with foreign fishing vessels in international waters adjacent to the Canadian Grand Banks. In the months after his New Zealand statements he began pointing his finger at the poorly regulated fleet fishing in these waters, blaming it for the continued decline of the stocks.

Now, after a great deal of noise and some gunboat diplomacy, the international issues seem settled, at least for the moment, and the culling of seals is back on the agenda as a proposed method of augmenting the recovery of cod stocks. Speaking at a press conference convened on the Magdalen Islands in June, 1995, Brian Tobin stated "...the government of Canada will work with this community, and all other communities affected, with fishermen generally, to rebuild a viable, hopefully commercially based, but viable, much expanded seal hunt next year."

As justification for this the minister observed, "...that whatever the role seals have played in the collapse of the groundfish stocks, seals are playing a far more important and significant role in preventing, in slowing down, a recovery of groundfish stocks, in my mind is confirmed" (Tobin 1995). As evidence supporting his position, the minister points to internal government reports he claims document both an increase in seal numbers and evidence that seals consume large amounts of cod (Shelton et al. 1995; Stenson et al. 1995, Stenson et al. 1995).

Two months after Brian Tobin's press conference, the prestigious journal *Science* published a study, two of whose authors are scientists working for the Canadian Department of Fisheries and Oceans (DFO), in which it is concluded that predators (including seals) generally play no discernible role in the population dynamics of recovering fish stocks (including cod) (Myers, et al. 1995). In news media interviews with

the report's authors, it was made clear that they believe that culling seals will have no positive impact on the cod recovery, at all (Strauss 1995).

### **The wider problem: Predator mythology and ecology**

The use of seals as scapegoats for the failings of Canadian fisheries management is an example of a global problem in the management of fisheries and wildlife. Whether the system is aquatic or terrestrial, tropical or arctic, the predators of the world are seen as problems to be controlled, not as integral parts of a functioning ecosystem.

Early humans saw the natural world in terms of resources and risks. Large predators occasionally killed humans, and there were presumably direct interactions between humans defending their own kills from hyenas, lions, or wolves, or chasing other predators off their kills. That experience has become a fundamental component of the mythology of many, perhaps all, human cultures. Children in industrialised countries are still raised on stories about fearsome predators that hearken to a distant past with little relevance to contemporary reality.

Today, humans only very occasionally lose resources through direct competition with wild predators (e.g. calves lost to wolves, fish taken from nets by seals, or farmed fish lost to egrets), and even less commonly are preyed upon, but the belief that humans interact in a competitive way with wild predators remains widely accepted. In western Canada, where losses of cattle from stress and injury during shipping substantially outweigh the loss to predators (Thomas 1995), some ranchers expend considerable energy hunting wolves, and demand government co-operation with their efforts (Lavigne 1995; Legault 1995). Similar demands for wolf control are made by hunters and hunting outfitters who feel that wolves compete with humans for prey species such as deer (Lavigne 1993; 1995).

There are various theories that propose mechanisms by which predator populations could limit or halt prey species stock recovery from low levels. The simplest of these describe a phenomenon known as depensation, wherein the per capita rate of population increase is reduced when population size is low. The most common examples are the suppression of reproduction at low population densities, and the increase of predator effects as the number of prey animals per predator falls below some saturation threshold.

There is a more extreme type of predator effect in which populations that fall below a critical size as a result of some disturbance (such as over-fishing) are unable to reproduce rapidly enough to compensate for predator mortality. In such systems the interaction between predator and prey has different results above and below a threshold prey population. In theoretical terms, the system has "multiple domains of attraction", each with its own stable equilibrium. In models based on this theoretical formulation, populations of prey species above a certain level (referred to as a breakpoint) equilibrate at a carrying capacity determined by resource availability. Below the breakpoint, these populations are limited by predation, and may be driven to extinction (see Yodzis (1989) for a discussion of attractors, thresholds, breakpoints, and related phenomena).

This phenomenon is sometimes referred to as the predator pit and is commonly invoked by proponents of predator culls. One early application of the model was an attempt to describe the dynamic of wolf-caribou interactions (Haber and Walters 1979). The most serious difficulty encountered in applying such an analysis is the complexity of real food webs. There are few cases in which a predator population depends exclusively on a single prey item in the way assumed by these models.

Myers et al. (1995) looked for the phenomenon of depensation in 128 fish stocks. They found statistically significant depensation in an Icelandic herring stock and two Pacific salmon stocks. In all cases there was evidence of environmental effects that probably underlay the reduced rate of increase. They concluded that two other stocks showed some evidence of depensation, although statistical significance was low. None of the cod stocks they examined exhibited depensatory dynamics. The report concludes that depleted cod stocks will recover to fishable levels if left alone by humans.

DFO scientists have also done the appropriate research to answer questions specifically related to the role of seals (if any) in the recovery of cod. In an oral presentation made at the 17th Annual Meeting of the Northwest Atlantic Fisheries Organisation (NAFO) meetings held in Dartmouth, Nova Scotia, Sinclair et al. (1995) analysed the impact on cod stocks of predation, by seals and the human harvest. They conclude that there is no evidence of seals exerting any impact on total mortality in cod, but there is clear evidence of an impact from the human harvest. The report was presented by Hutchings, a co-author who is associated with Dalhousie University (i.e. not on DFO staff). At the time of this writing, DFO has not released the report on which the presentation was based.

Although the more commonly encountered view is that seals have had a deleterious effect on the cod stock recovery, it is also possible that seals have a positive impact. The reason for this conclusion is, again, the complex nature of real ecological interactions. Seals eat many things, some of which are cod, some of which cod eat, and some of which eat cod.

In the South Atlantic, South African fisheries biologists and the fishing industry were concerned that Cape fur seals *Arctocephalus pusillus pusillus* were depleting the hake *Merluccius* spp. stock. Initially there was a call for culling of seals. The policy was reversed, however, when close examination of the problem revealed that the seals were involved in a complex relationship that might well be increasing hake production in the fishery (Butterworth et al. 1988; Anonymous 1991; Punt 1994).

In the South African case, fur seals feed on two species of hake, one of which (*M. capensis*) is a significant predator on the juveniles of the other species (*M. paradoxus*). Simple models, in which the only components are seals, hake (lumped into one group), and fishing, display a feeding dynamic that conforms with the mythological view of predator-prey interactions. When seal numbers are reduced, the allowable catch for the fishery goes up. These sorts of models behave like a teeter-totter. When the weight on one side is increased the system tips one way. When the weight is reduced, the system tips back. Natural ecosystems seldom, if ever, work this way (Butterworth et al. 1988).

When the other elements in the web are added, things start looking quite different. Splitting the hake component of the model into two species and incorporating their predation on each other produces a system in which seal predation causes no effect on overall hake abundance, or a net increase in hake numbers (Punt 1994).

This is not a peculiarity of the South Atlantic, or even of marine systems. Similar interactions have been shown in terrestrial systems. The Iberian lynx (*Lynx pardina*) is the top predator in the ecosystem of south-western Spain. Local hunters have historically persecuted the lynx, in part because of the perception that it competes with local hunters for rabbits (*Oryctolagus cuniculus*). Palomares et al. (1995) have shown that areas where lynx have been extirpated have significantly lower densities of rabbits than areas with lynx populations. The critical element in the lynx-rabbit interaction that leads to increased rabbit numbers is apparently the reduction of numbers of Egyptian mongoose (*Herpestes ichneumon*) by lynx predation.

These examples are all fairly straightforward, and represent what may be described as direct effects. Most interactions among components of food webs are not so simple, and may involve the interaction of hundreds of organisms (Figure 1, 78K). At present it is not even known how simple we can make model systems without losing critical descriptive value, much less how changes in seal numbers will affect cod stocks indirectly, through effects on other organisms (Anon. 1994; Woodley & Lavigne 1995).

## **Discussion**

It must be stated baldly that, within the broad debate over how best to manage living resources in the Northwest Atlantic, the most serious conflict is between science and politics. The complexity of the ecological issues in the Northwest Atlantic fishery provides an opportunity to those with an agenda to dissemble and evade fundamental questions, while purporting to pursue an ecologically sound resolution of the problem.

The deeply seated cultural antipathy toward predators provides an easy out for politicians seeking scapegoats for their own errors of judgement. The fishery collapsed because the political class did not understand or believe the conclusions of their own fisheries staff, crippled the department responsible for assessing stocks and recommending quotas, and refused to follow their advice, even when it was obvious that there was a serious problem. All available evidence indicates that seals had nothing to do with the crash, and almost certainly will have nothing to do with the recovery of the cod stock, but they are a convenient dodge for those who made the mess.

Nothing much has changed since the cod disappeared. The political leadership still refuses to accept the analysis of their biologists. The prescription for a seal cull is now being presented as a "common-sense" solution that should be pursued regardless of the data. Common sense, of course, is a term used for mythology, bias, prejudice, and heart-felt belief when its proponents cannot justify their position with facts. Common sense, furthermore, is often very different from good sense.

Although working with incomplete information is often necessary, drawing definitive conclusions from superficial and incomplete analysis of a problem is just bad science. If there is any lesson to be learned from the history of science it is that the obvious explanation for natural phenomena is frequently, unequivocally wrong.

Astronomy provides some instructive examples of how wrong "obvious" or "common-sense" conclusions can be, and how difficult they can be to refute, even when a full analysis shows them to be in error. It was considered obvious that the world was flat and the sun circled our planet. That these beliefs have fallen away is the result of rigorous examination of all relevant facts, not just the obvious ones, and the formulation of explanations based on all available information.

That was not enough for some. Galileo was threatened by the Roman Catholic church with torture and death unless he withdrew his support for the heretical proposition that the Earth was not the centre of the universe. Long after the world had accepted his view, and long after his death, the church refused to acknowledge its error. It finally abandoned its position, only recently, when it became an example of intransigence that undermined its credibility in the modern world.

In Canada, at a time when increased commitment to environmentally sound practices is supposedly part of the government agenda, collapse in the East coast fishery is met with reductions in funding to fundamental research, reduced budgets to the departments responsible for evaluating these resources, and the muzzling of government scientists working on the problem. Although there is a clear need for closer examination of the problem, the little money that is available will apparently be spent on subsidising a hunt that will likely make no difference at all to recovering cod stocks.

It is not difficult to frame the problem in terms that would permit meaningful research. Although we do not have all of the information needed to make definitive statements about interactions among seals and fish stocks, it is possible to draw some general, preliminary conclusions from the limited information available and make some inferences from ecological theory. From these general conclusions it is no great leap to define the investigations needed to provide meaningful answers to the remaining questions.

The example provided by the South African study of Cape fur seals, for example, provides a reasonable starting point for designing a similar exercise in Canada. At the root of that exercise was an admission of ignorance that is entirely absent from the Canadian approach. When dealing with seals, it seems, the decision-making elite are content to employ the same flat-Earth biology that caused the destruction of the cod stock.

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