Dogfish and seals and dolphin, oh my!
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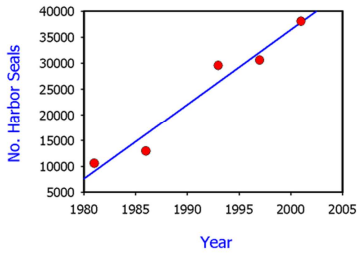
The New York Times on New England groundfish – so seemingly close but so very off target

On December 14 the Times had an article titled *Water warms and cod catch ebbs in Maine* by Michael Wines and Jess Bidgood. Obviously the article focused on the observed water temperature increases in the Gulf of Maine and the impact on local fishermen. After reading it one is left with the feeling that the plight of Gulf of Maine and other New England fishermen is due to some combination of overfishing and increasing water temperatures.

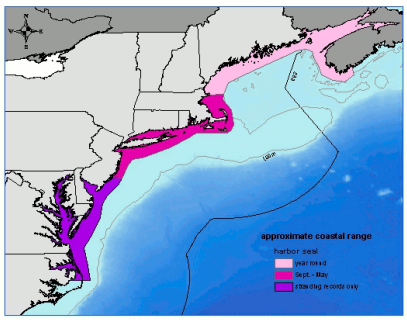
The article wasn't notable for what it contained, but rather for what it ignored, which is the added – and very possibly dominant - impact of predation on our inshore and offshore fisheries.

But the Times isn't alone in ignoring the impacts of predation. Fisheries managers haven't shown much interest in it, possibly because all that they are able to effectively manage is fishing. Why pay any attention to anything that you can't effectively, or for that matter ineffectively, manage? Equally predictably, the anti-fishing ENGOs have shown zero interest, because they seem all too willing to ignore anything above and beyond – or let's make that beneath and below – selling the fallacy that fishermen and fishing are to blame for most of the oceans' ills.

There are many species, primarily marine mammals, that have experienced population "booms" since the passage of the Marine Mammal Protection Act in 1972 and the Endangered Species Act in 1973. Illustrative of this, I've reproduced below a chart (from NOAA's *Ecology of the Northeast U.S. Continental Shelf - Protected Species/seals* at http://www.nefsc.noaa.gov/ecosys/ecology/ProtectedSpecies/Pinnipeds/) which shows the dramatic increase in the minimum estimates of the harbor seal population "*based on direct counts uncorrected for proportion of seals not hauled out on land.*" The same web page reports *"A corrected estimate for the 2001 survey based on replicate surveys and radio tagged seals was 99,340 individuals, compared with an estimate of 38,011 individuals based on the unadjusted counts."*



Below is a harbor seal distribution map from the same report. The pink areas represent the seals' year round range, the red their distribution from September to May, and the purple "stranding records only."

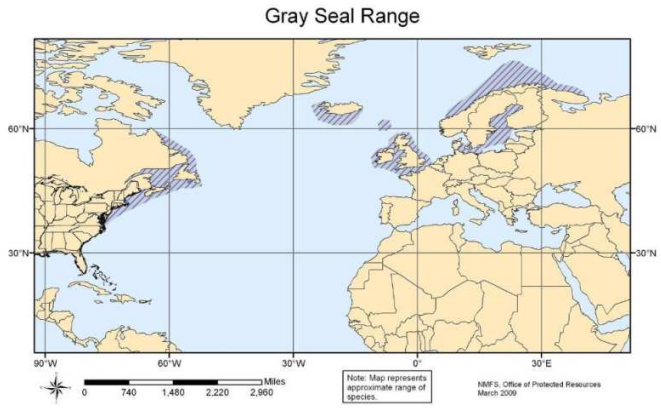


At maturity a male harbor seal can weigh 375 pounds. Assuming an average weight of 250 pounds, the population of harbor seals off our coast has a biomass of perhaps 25 million pounds. They consume 5% of their body weight each day of squid, crustaceans, molluscs, and a variety of fish; including but certainly not limited to rockfish, herring, flounder, salmon, hake, and sand lance (http://seaworld.org/animal-info/animal-infobooks/harbor-seal/diet-and-eating-habits/). For the population delineated above that's one and a quarter million pounds of fish and shellfish daily, and much of their food is either commercially valuable species or the fish and shellfish that those species feed on. Annually they will consume 450 million pounds, about

200,000 metric tons (mt). Total commercial landings of fish and shellfish within their range – from North Carolina to Nova Scotia- are approximately 800,000 mt per year. (Note that the harbor seal population estimate was lowered in a NOAA/NMFS assessment in 2013, but the same report noted "*a trend analysis has not been conducted for this stock. The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and long survey interval" - U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2013 -* http://www.nmfs.noaa.gov/pr/sars/pdf/ao2013_tm228.pdf).

When it comes to predation, however, harbor seals aren't at anywhere near the top of the list. On our side of the Atlantic gray seals are found in just about the same waters as their smaller relatives, but they are significantly larger and significantly more numerous.

The following points were taken from the gray seal page on the NOAA/NMFS Office of Protected Resources website at http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/grayseal.htm:



- Gray seals are sexually "dimorphic" with males reaching up to 10 ft (3 m) in length and 880 lbs (400 kg) and females reaching up to 7.5 ft (2.3 m) in length and 550 lbs (250 kg).
- Gray seals are opportunistic feeders that consume between 4-6% of their body weight per day.
- Food sources include fish, crustaceans, squid, octopus, and even seabirds on occasion.
- Current population numbers for the western North Atlantic stock are unknown but are estimated at over 250,000 animals.
- Within U.S. waters, gray seals have been seen pupping in increasing numbers on isolated islands off the Maine coast, Nantucket-Vineyard Sound, outer Cape Cod, and on Muskeget Island. In 2002, more than 1,000 pups were born on Muskeget Island.
- Gray seals are legally killed by fishermen and are harvested for subsistence, predator control, and commercial purposes in some areas outside of U.S. waters.

Assuming an average weight of 600 pounds, the weight of the minimum biomass of Western Atlantic gray seals is 150,000,000 pounds (ca 70,000 metric tons). Assuming that an average gray seal consumes 5% of its body weight per day, the western North Atlantic stock of gray seals consumes 3,500 mt of fish and shellfish (and occasional seabirds) daily, which is approximately one and a third million tons per year. That's between six and seven times the amount of fish and shellfish consumed by harbor seals, whose geographic range is similar. (Remember that the population estimate is a minimum.)
Commercial fish and shellfish landings from North Carolina to Nova Scotia are approximately 800,000 mt per year, 60% of what gray seals consume.

Grey seals/western North Atlantic stock

Minimum population	Average weight	Biomass	Daily predation (at 5%/day)	Annual predation	Commercial harvest
250,000	**600 lbs**	**68,181 mt**	**3409 mt**	**1,244,303 mt**	**800,000 mt**

In the waters they inhabit only two species of protected marine mammals consume almost twice as much fish and shellfish as commercial fishermen catch. For the full picture on marine mammal predation I'll refer you to *A Summary of Atlantic Marine Mammal Stock Assessment Reports for Stocks of Marine Mammals Under NMFS Authority that Occupy Waters Under USA Jurisdiction* (at http://www.nmfs.noaa.gov/pr/sars/pdf/atl2013_summary_final.pdf). Two things stand out in this summary. The first is the estimated (known) population sizes of what are for the most part voracious predators on the same fish and shellfish that are either targeted by fishermen or are the prey for those targeted species. The second is the number of marine mammals for which population estimates are unknown ("unk" in the summary table). See the above referenced *Marine Mammal Stock Assessment* for even more information and for even more of a feeling for how little NOAA/NMFS knows about and how little the agency is apparently interested in the status of the marine mammals in our waters.

Back in 2008 in *Getting real about ecosystem based management* (at http://www.fishnet-usa.com/ecosystem_management.htm), using data from the 2006 NMFS marine mammal assessment I put together a chart of predation of the marine mammals found in the Northwest Atlantic ocean. The chart shows estimated predation levels running

up to 11 million mt a year (for harp seals, whose annual migrations take them as far south as New Jersey). At the time I estimated that total marine mammal predation in the area was just under 20 million mt a year.

It's kind of difficult to argue with the data that shows that fishermen are competing with marine mammals, particularly when they are considered collectively, and that the fishermen are coming out the losers.

(To show that this isn't a problem limited to the Northwest Atlantic, see the November 2014 article *Salmon Disappearing, Sea Lions Increasing* by John Harrison on the Northwest Power and Conservation website at http://www.nwcouncil.org/news/blog/research-salmon-disappearing-seal-lions-increasing/).

But then we can't forget spiny dogfish.

> *"Voracious almost beyond belief, the dogfish entirely deserves its bad reputation. Not only does it harry and drive off mackerel, herring, and even fish as large as cod and haddock, but it destroys vast numbers of them. Again and again fishermen have described packs of dogs dashing among schools of mackerel, and even attacking them within the seines, biting through the net, and releasing such of the catch as escapes them. At one time or another they prey on practically all species of Gulf of Maine fish smaller than themselves, and squid are also a regular article of diet whenever they are found."* (Fishes of the Gulf of Maine, Bigelow, H.B. and W.C. Schroeder, 1953)

In 2013 the total spiny dogfish biomass off our Northeast coast was estimated to be 766 thousand mt (*Update on the Status of Spiny Dogfish in 2013…*, Rago and Sosebee, 2013, www.mafmc.org/s/2013-Status-Report-and-Projections_final.pdf). That's 1.7 billion pounds of what has been recognized as one of the most voracious predatory fish in the coastal waters from Cape Hatteras to Nova Scotia. Accepting the "official" average of 185 pounds for a U.S. citizen, that's the equivalent weight of 9.1 million of us – the approximate population of New Jersey, North Carolina, Michigan or Georgia).

Researchers Wetherbee and Cortés report that spiny dogfish consume between 0.4% and 2.6% of total body weight per day. If we assume a median level of 1.5% per day, that means each dogfish consumes its own weight every 60 days, or six times its body weight every year. (Wetherbee, B.M. and E. Cortes. 2004. **Food consumption and feeding habits**. Pp. 223-244 in: Biology of sharks and their relatives. Musick, J.A., J.C. Carrier and M. Heithaus, eds.)

With the biomass as it was estimated to be in 2013, spiny dogfish were eating 25 million pounds of fish and shellfish every day That's over 9 billion pounds or 4 million mt a year. As with marine mammals, much (most?) of that is either economically important species or the prey species that support those economically important species.

Bowman et al. concluded in 1984 that predation by spiny dogfish is a significant source of mortality on some commercially valuable finfish and squid species. Their calculations indicated that the biomass of the commercially important species consumed by spiny dogfish was comparable to the amount harvested by man and that accordingly, the impact of spiny dogfish consumption on other species should be considered in establishing harvesting policies (Fisheries Research 39 (1998) *Implications of recent increases in catches on the dynamics of Northwest Atlantic spiny dogfish (Squalus acanthias)*P.J. Rago et al, http://tinyurl.com/RagoEtAl).

In 1984, when they made their calculations, the total spiny dogfish biomass was estimated to be 260 thousand mt and the commercial landings of all species in New England and the Mid-Atlantic were approximately 400,000 mt (321,795.6 mt and 70,103.1 mt respectively). With the estimated biomass of spiny dogfish in 2013, according to their 1984 estimates, the 2.9 times greater spiny dogfish biomass in 2014 would have accounted for predation of commercially important species of approximately 1.16 million mt. In 2013 New England and Mid-Atlantic commercial landings were 550 thousand mt. According to the ratio determined in 1984, in 2013 spiny dogfish were eating almost twice as much *"commercially valuable finfish and squid species"* as commercial fishermen from North Carolina to Maine were harvesting.

> *"From a practical aspect the spiny dog in the Western Atlantic is chiefly important because it is undoubtedly more destructive to gear and interferes more with fishing operations than does any other fish – shark or teleost…. In the Gulf of Maine, the spiny dogfish feed. On a wide variety of species and at one time or another prey on practically all species smaller than themselves. They are regarded as the chief enemy of the cod, and also feed on mackerel, haddock, herring, squid, worms, shrimps, crabs."* (Jensen, Edwards and Matthiessen, *The Spiny Dogfish – a Review*,

1961, Woods Hole Laboratory Report No. 61- -7 available at http://www.nefsc.noaa.gov/publications/series/whlrd/whlrd6107.pdf).

During World War II a large spiny dogfish fishery developed, based on extracting the oil from their livers. After the war the market for the oil dried up and the dogfish population started to rebound in the waters of the Pacific Northwest. This rebound, like the one that the same species is undergoing off our northeast coast today, was having a significant negative impact on the traditional – and far more valuable – fisheries in the region. Starting in 1959, the Canadian government recognized the threat of the vast numbers of dogfish. To bring the population back into balance (and to benefit the affected fisheries) a spiny dogfish "bounty," in the form of a subsidized price for their livers, was offered. While there was a discussion of this program being extended by the U.S. to our waters, there is no record that it ever was. (Jensen, Edwards and Matthiessen, Ibid.) Even with this bounty the dogfish stocks weren't reduced significantly.

Today the total allowable catch (TAC) of spiny dogfish on the East coast is 20,000 mt a year. That's enough to support a reasonable and reasonably developing fishery, but it's definitely not enough to have any impact on the oversupply of spiny dogfish or on their negative impacts on other fisheries.

But of course all of this is irrelevant to the ENGOs. Take, for instance, the spiny dogfish page on the Pew/Oceana website at http://tinyurl.com/OceanaDogfish. It's still there in spite of the fact that there hasn't been any serious talk – how could there be? – of an endangered listing for spiny dogfish since the last attempt at the Convention on International Trade in Endangered Species meeting came to naught ten years ago. It's really hard to argue that their stock can't sustain reasonable levels of harvest considering that only ten years after a severely limited East coast fishery was allowed the population has rebounded to the present undesirable level.

So we have a species that has been recognized as a threat to other, much more valuable finfish and shellfish since at least the end of World War II, that is notorious for its voracious and indiscriminate appetite, that at present has a limited and relatively low-value market and that is in the process of "taking over" much of our ocean to the detriment of many of our other species and many of our other fisheries. And yet the New England Fisheries Management Council and NOAA/NMFS can devote seemingly endless days in attempting to "solve" the New England groundfish crisis by considering every possible way to restrict fishing short of nailing the fishermen to the dock without once considering how to reduce the spiny dogfish population to a realistic level that would be less damaging to our other fisheries. Some management, some research and some reporting!

Integral to what should be the problem of how to more effectively manage fisheries is the way that predation is handled, or not, in the fisheries management process. Basic to any fisheries management plan is an estimate of the Total Mortality (Z) of the fish stock being managed. Non-fishing mortality is called Natural Mortality (M), and because it's a bother to try to estimate accurately, it is generally accepted to be 0.2 (see Siegfried and Sansó, *A Review for Estimating Natural Mortality in Fish Populations* at http://tinyurl.com/MortEstimate). Fishing Mortality is F and Total Mortality is Z. Total Mortality equals Natural Mortality plus Fishing Mortality (Z = F+M).

If the populations of most marine mammals and other highly efficient predators such as spiny dogfish have increased significantly over the past decade or three it's obvious their predation, the largest part of natural mortality, inflicted on their prey species would have increased correspondingly. Yet is this factored into fisheries management programs? It appears not. It appears as if, as is apparently the case in New England, controlling fishing mortality is the only "effective" method (which really means "is the only easily available method") by which managers assume that they can affect total mortality. Fisheries managers have to do something, because the whole fisheries management system is predicated on managing or on appearing to manage fisheries. So the natural mortality of a stock increases because of increasing predation and at this point, given research funding limits as well as limits on what we know about predation, the only way that the managers can compensate, which they are required to do by federal legislation and forced to do by a handful of mega-foundation funded ENGOs with huge bank accounts and droves of lawyers, is by reducing fishing mortality. What comes immediately to mind is a snake busily at work eating its own tail.

The bottom line is that while commercial fishermen from North Carolina to Maine are at work catching on the order of half a million mt of fish and shellfish a year, it appears as if it takes an annual 20,000,000 tons or more to keep all those marine mammals and low-value spiny dogfish and various other predatory fish going. How much of that 20 million tons is commercially/recreationally valuable species or the forage species that sustain them? No one seems awfully interested in finding that out, but they sure should be.

It's very possible – I'd suggest that it might even be probable – that we are trying to control the populations of tens of millions of tons of fish and shellfish of various species by regulating the harvest of a few percent of them while at the same time totally ignoring what's happening with and to the rest of them. As with the Gulf of Maine cod, is it any wonder that no matter how we limit fishermen's total allowable catch, some stocks don't respond as we think they should?

A cursory survey of the populations of the most prevalent marine mammals indicates that estimates of their population growth rates are hovering around five percent annually. The spiny dogfish are doing a bit better than this. Their biomass having doubled from 2003 to 2013, they are increasing at about ten percent a year (this is in spite of the mythical low fecundity that the anti-fishing groups claim that they are subject to). What this obviously means is that, without some significant changes to how we manage our commercial and recreational fisheries, and how we manage our ocean ecosystems in general, in countries where fishermen are forced to toe the unrealistic line that has been drawn with no attention paid to the future of their fisheries, at some point they are going to be forced off the water by some very prolific and extremely efficient predators that enjoy absolute or virtually absolute governmental protections.

Shouldn't Ecosystem Based Management address issues like this?

For the last several years Ecosystem Based Management (EBM) has been touted as a revolutionary and at-long-last effective way of managing our inshore and offshore waters. For an idea of how this somewhat nebulous yet impressive-sounding concept is supposed to be applied, we have to look no farther than the website of Pew/Seaweb:

> ***Ecosystem Based Management - How does it work?***
>
> *Ecosystem-based management is a framework for developing effective management plans based on an accepted set of guiding principles. An ecosystem-based management plan should:*
>
> - *Emphasize the health of the whole ecosystem ahead of the concerns of special interests;*
> - *Be focused on a particular place, with boundaries that are scientifically defined;*
> - *Account for the ways in which things or actions in that place affect each other;*
> - *Consider the way things or actions in this place can influence or be influenced by things or actions on land (like dams or fertilizers in the watershed), in the air (like air pollution), or in different parts of the ocean (like fishing or oil spills); and*
> - *Integrate the concerns of the environment, society, the economy and our institutions.*
>
> *These guiding principles and some of the underlying structure of this Web site are based on the 2005 Scientific Consensus Statement on Marine Ecosystem-based Management and updated peer-reviewed publications (From the Pew/Seaweb website* ***What is Ecosystem Based Management*** *http://www.seaweb.org/resources/ebm/whatisebm.php).*

It's like a breath of fresh air to read of a brand of environmental management that is supposed to be concerned not just with the environment but with society, with the economy, and with our institutions. And a brand of ocean management that is ostensibly concerned with quite a bit more than limiting fishing.

The developing situation with the proliferation of so many marine mammals as well as a very likely unprecedented population of spiny dogfish should be near the top of the priority list of any practitioners or proponents of EBM. Highly efficient predators of/competitors with our most valuable commercial and recreational fish stocks are straining the economic and institutional underpinnings of coastal communities on the Atlantic, Pacific and Gulf coasts. But the guiding principles of EBM, as related by Pew/Seaweb on their website, have extended the concern above and beyond the ecosystem and the organisms in it well into the human realm.

It's a given that a particular area of ocean is going to have a productive capacity that remains relatively stable from year to year and from decade to decade. Based on temperature, energy and nutrient inputs it is going to support a given amount of primary production in the form of vascular plants in the shallower areas and algae in the deeper. That primary production is going to support a given amount of herbivores, which will support a given amount of carnivores. The species mix will vary from area to area, in a given area will vary with time (or with environmental changes, be they seasonal, yearly, decadally, or of longer duration), and is to a large extent dependent on competition and predation. The population size of a particular species in an area that can be maintained indefinitely is the carrying capacity. Control of the populations of carnivores and herbivores so as to not allow them to exceed their carrying capacity has been a management reality in terrestrial ecosystems for several generations, and woe to the ecosystem, or many of the critters in it, when the carrying capacity of a particular species is allowed to be exceeded by a significant amount for an extended time. This is something that has yet to be applied in fisheries (or fishermen's) management, but it will be impossible to put in place effective EBM without it.

Our marine ecosystems are ripe for truly effective EBM. We are now on the verge of understanding intraspecific interactions to such an extent that we can envision using fishing as a management tool. Not enough of (economically, esthetically or culturally) desirable species "X" and too much of not-so-desirable (or undesirable) competing species "Y"? Design incentives to either accelerate the harvest of species "Y" or to in some other way reduce its population size. The growing human population, our

increasing use of the oceans for competing purposes that have nothing to do with and are too often inimical to food production, and our ever-increasing food insecurity (90% of our fish and seafood is now imported) demand it.
Unfortunately neither the provisions of the Marine Mammal Protection Act (MMPA) nor the Magnuson Stevens Fishery Conservation and Management Act (MSFCMA) will allow this to happen. In any conflicts between the well-being of marine mammals, regardless of the health of the particular involved population, and societal, economic, or institutional values, the marine mammals prevail. And the Magnuson Act demands that any fishery be managed to produce the "optimum yield," which by definition can't be greater than the maximum sustainable yield. We are thus held to a requirement to manage for the highest historical abundance of a species, regardless of the impacts that will have on other species. Comprehensive EBM demands that particular species not be given arbitrarily determined favorable treatment. This is something that both the MSFCMA and the MMPA as they are currently written make impossible.

The costs in terms of lost opportunities of local fishermen, of the unavailability of local, fresh caught seafood to consumers (and its replacement with imported shrimp, tilapia, swai and who knows what else), and the strain on fishing communities because of MMPA and MSFCMA restrictions on both the recreational and commercial fisheries are incalculable. The people who participate in these fisheries and the businesses that depend on them are losers in a contest for fish which has been rigged by federal regulation to the point where it's not a contest at all. At this point the only concerns that are being considered are those for "the environment," with the assumption that fishermen in particular and fresh seafood consumers in general are not an important part of it. The continuing and increasing overabundance of non-human predators is guaranteeing that "*society, the economy and our institutions"* all take seats way to the back of the bus (or maybe "all get thrown under the bus") relative to the environment. This isn't comprehensive ecosystem based management, it's management based on focused political pressure and cynically manipulated public sentiment.

The judicious application of real Ecosystem Based Management as proposed (though perhaps not endorsed) by Pew/Seaweb, would inject some reality into these unrealistically written and demonstrably ineffective federal laws.