Fisheries sustainability — an historical perspective

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Abstract
If we take an historical perspective on fishing, we can blow away several myths that hold us back from developing strategies for restoring the productivity of the oceans and developing an ecologically sustainable fishing industry. Our international research team has shown that we need a perspective that reaches back into deep time – at least back to the end of the last Ice Age – to understand that historical overfishing is the primary driver of the collapse of marine ecosystems. With this perspective we can expose the myths about fisheries management and marine conservation that underpin our present behaviour of seeking a scientifically flawed status quo ante as a basis for our management of fish stocks and marine ecosystems. With the myths dispelled, we can begin to design bold but scientifically rigorous strategies for the sustainable development of the oceans.

Keywords: Fisheries, Sustainable development, Public policy, Conservation, Biodiversity, Anthropocene, Philosophy of science

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Introduction
I've got one of those ‘bad news, good news' stories to tell you, and the problem is, it's true.

There is bad news and good news for the fishing industry, for fisheries science, for the conservation lobby and the indigenous peoples' lobbies, both here in Australia and, indeed, around the world.

The bad news for the fishing industry is that, if you think the fishing is bad today, you ain’t seen nothin’ yet. The world’s coastal ecosystems are set and primed to get unimaginably and very quickly worse. The bad news for fisheries science is that the last one hundred years of effort has been misdirected and wasted — misdirected and wasted to the point where the industry has been the victim of a cruel hoax. The bad news for the conservation lobby is that their focus on biodiversity conservation has actually abetted the destruction of coastal ecosystems. Ecosystems are more like processes than entities, and key processes have been destroyed in coastal ecosystems while we have been diverted over phoney entity issues like biodiversity. The bad news for the indigenous lobby is that native peoples worldwide were up to their armpits in this destruction. The myth of native peoples living in harmony with their environment is just that, a myth.

And now for the good news. The good news for the industry is that we now have the beginnings of understanding about how to restore the productivity of coastal seas to levels we have not seen for thousands of years. For fisheries science, the good news is that the legacy of the catastrophic mistake that it made a century ago is now nearly exhausted. Science is the ultimate self-correcting system, even if it sometimes takes a century or so to show it. Fisheries can now rejoin the mainstream of science, apply some well-tested ideas (that it might find, for a time, novel and challenging), and provide the leadership for restoring coastal seas that we have needed for a hundred years. The good news for the conservation lobby is that the restoration of the coastal seas is possible because the key species are ‘only' ecologically extinct. Unlike the situation on the land, where agro-ecosystems actually replaced the original ecosystems, in the sea we found it hard to kill off every last individual. The good news for the indigenous lobby is that native peoples were no better and no worse than later colonists. Each did his best with the tools available, but in all cases, with spectacularly destructive results. We are the problem: humans are just another predator, and predators never regulate themselves.

We discovered this story as part of an international multidisciplinary study we were making at the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara, California. So to tell the story, I should tell you who we are and what we did, what we found and what it means.

The full story (Jackson et al. 2001) is in the 27 July edition of Science magazine, where we pleasingly got the cover story, and the attention of the world's press.
Who we are and what we did

NCEAS is an unusual research centre. Its basic premise is that we have plenty of data about the way the world’s ecosystems work, but not enough analysis or synthesis. We know a lot of stuff, but don’t actually understand much. So NCEAS gets people together to try to improve our understanding. The US National Science Foundation funds it. Parenthetically, it offers a practical and, as yet, unrealised model for Australian funding agencies in terms of ‘bang for buck’. It uses, as you might expect, lots of heavy duty computing techniques to crunch the data and squeeze out the understanding, but it also uses lots of old-fashioned fossicking and ferreting to find obscure bits of the puzzle. Because of its focus, it tends to be very multidisciplinary, bringing together scientists from all sorts of disciplines to try and crack difficult problems.

Jeremy Jackson, a paleontologist from Scripps Institution of Oceanography, assembled just such a team a couple of years ago at NCEAS. He brought together paleontologists, geophysicists, ecologists, fisheries scientists and archaeologists to try and understand what the coastal seas were like before man started exploiting them, and what happened to them as he did. We were stimulated to do this by the realisation that fisheries science, fisheries policy and fisheries economics – not to mention their conservation equivalents – were all based on ideas of what coastal seas looked like fifty or a hundred years ago when these disciplines first emerged.

We first used ecological and fisheries data to create a picture of what the seas are like today, and then used historical records (such as explorers’ and colonists’ journals), archaeological records (such as from kitchen middens), and paleontological records (such as sediment cores), to push the story back to about 125,000 years ago, when man first started to exploit the seas.

We looked especially at the Caribbean, the east and west coasts of North America and the east coast of Australia. In each of these cases, there is a clear aboriginal signal, followed by a colonial signal, followed by a modern industrial signal. There were two additional critical features that made these coasts especially useful. Firstly, the colonial signal is offset by a century in each case, from the 16th century in the Caribbean to the 19th century in Australia. And secondly, the first human occupation of these coasts is the relatively recent last couple of tens of thousands of years, coinciding with the end of the last Ice Age and the global rise in sea levels. Elsewhere in the world, these signals are terribly confounded.

What we found and what it means

We looked at estuaries and open sea, kelp forests and seagrass meadows, rocky coasts and mangrove coasts, coral reefs and oyster reefs. We found a remarkably consistent story – consistent across different continents and oceans, consistent from the polar regions to the tropics, consistent across different coastal ecosystems and consistent across different historical experiences.

We found that the coastal seas today are a shadow of what they were when man first began to exploit them, and that that exploitation had a particular pattern, and that that pattern has led to particular consequences.

We found that overfishing of shellfish, such as oysters, and large vertebrates, such as whales, seals, crocodiles, turtles, dugongs, sharks, codfish and swordfish, was the first major human disturbance to all coastal ecosystems. This overfishing then led to ecological changes that are strikingly similar across ecosystems. Everywhere the magnitude of losses was enormous in terms of biomass and abundance of large animals that are now effectively absent from most coastal ecosystems worldwide. These species are now mostly ecologically extinct, meaning that their numbers are no longer sufficient for them to interact with other species in the ecosystem. Since they had significant ecological roles, there have been major structural and functional changes in coastal ecosystems beyond the mere removal of their biomass.

Significantly, these changes predate modern ecological investigations and cannot be understood except by historical analysis.

There are three important corollaries to the primacy of overfishing as the key agent of destructive change in coastal seas.

The first corollary is that pollution, eutrophication, physical destruction of habitat, outbreaks of disease, invasions of introduced species and human-induced climate change all come much later than overfishing in the historical sequence of events. This pattern holds regardless of when, for instance, colonial overfishing begins.

The second is that overfishing may often be a necessary precondition for eutrophication, outbreaks of disease, or successful species invasions to occur. Whether eutrophication in Chesapeake Bay, oyster disease in New Zealand’s Foveaux Strait, or outbreaks of crown-of-thorns starfish on the Great Barrier Reef, overfished ecosystems are less able to withstand subsequent pressures than fully functioning ones.

The third is that changes in climate are unlikely to be the primary reason for microbial outbreaks, such as red tides and disease. Anthropomorphic climate change may now be an important confounding factor, but overfishing, in and of itself, has made marine ecosystems more vulnerable to invasions.
Because of the complex feedback processes at work in ecosystems, the growing pressure of overfishing and its interaction with other processes does not result in immediate or even proportional effects. Rather the effect is often delayed and buffered, in some cases by centuries, so that it may go unnoticed until it results in a sudden and significant change in the system. We see this in all the systems we studied.

Our work establishes the existence of a sequence of three such sudden transitions in coastal seas. The first is manifested by the sudden collapse of populations of large vertebrates (such as cod, sharks, turtles, seals, or dugong), the next by the sudden collapse of architectural elements (such as kelps, oyster banks, corals or seagrasses), and the last is the outbreak of microbial populations.

Nearly all coastal ecosystems have now achieved T1, the collapse of the large vertebrates. Most have also achieved T2, the collapse of the system architects. Only a few places have achieved T3, the microbialisation of the system, but all systems that have achieved T2 are now delicately poised and could quickly transit through T3.

And what is the sea like after T3? The Black Sea got there first, for special reasons to do with its enclosed nature and the triumphs of Soviet planning. Essentially we have turned evolution’s clock back more than a half a billion years to Precambrian times when jellyfish and microbes were pretty well all there were, a time when all the energy of the sun was rapidly taken up by lower life forms, when there were wild surges and swings in the abundances of things, and when there was no harvestable biomass to sustain creatures like us. We are not talking about an ecosystem where the fishing is merely poor – after T3, there are no fish. Only if you have a good recipe for grilled jellyfish steaks with red tide jus should you even think of going fishing there.

It couldn’t happen to us, I hear you say, our fishing is not nearly as bad as I seem to be describing. That’s true, but it misses the point that the fishing, in the sense of catch, is the last thing to go. In fact it can be quite good right up to the transition I am calling T3. This is because, by removing the top predators, we temporarily release fish stocks further down the food chain. While fishing down the food chain may temporarily keep fish catches up (as we see everywhere from the Grand Banks to Moreton Bay) it also hastens the onset of T3. The evidence shows that fish catch is a terribly poor indicator of the current or future health of the ecosystem, despite what traditional fisheries scientists might tell you. It is at best useless, at worst deceptive.

What can be done and why history matters

The fossil record shows us what a system made of jellyfish and bacteria is like. It also shows us that, left to themselves, the coastal seas could recover. We know from previous calamities, such as the extinction of the dinosaurs, that recovery could probably take place in ten or twenty million years.

This is not a bad record for a species that has only been around for a million or so years and only really been busy on the coast for a very few millennia.

For those of us who don’t have ten or twenty million years up their sleeves, we need to ask is there anything we can do to help things along. And here we come to the good news.

To understand the importance of this news, we need to understand a little about the terrible mistake fisheries science made a hundred years ago. For as the melancholy Dane said, ‘ay, there’s the rub’.

What fisheries science did all those years ago was to deny the role of history. We can now see that there was a fork in the path of science then. One path, the one fisheries took as it became scientific, assumed that living things could be treated as if they were in some sort of equilibrium with their environment, and that the main job was to understand departures from that equilibrium and how to return things to ‘normal’. It is no coincidence that the sort of pervasive economics we call ‘neoclassical’ followed the same path. This had the terribly practical advantage of setting up fisheries science to work well with fisheries economics and transform living things into natural resources, things not unlike factory stocks. Such equilibrium thinking led directly to ideas like maximum sustainable yields and total allowable catch. But we now know that it was the wrong path to understanding how the world really works. We now know that this path was a scientific blind alley because it missed the crucial fact that living things are more historical process than equilibrium process. It ignored the role of history.

The other path got it right. It explicitly acknowledged the crucial role of history, and, not coincidentally, the need to understand the whole ecosystem, not just a single species. The ideas along this path are the ones that now illuminate our understanding for the simple scientific reason that they are a better fit to the observations we make of the world.

Fisheries science now has an opportunity, one might say a once-in-a-century opportunity, to rejoin the scientific mainstream, discard some silly notions, and actively develop a program for the restoration of the productivity of the world’s coastal seas.

I’ll finish with a sketch of what we need to do.

The historical magnitudes of losses in the coastal seas were so great as to seem unbelievable based on modern observations alone. Thus these ecological ghosts have no place in current equilibrium-based fisheries thinking. However recognition of these losses shows what coastal
ecosystems could be like, and the extraordinary magnitude of economic resources that are retrievable if we are willing to act on the basis of historical knowledge.

Thus the first thing that needs to be done is for fisheries science to come back from Lala-land, where it has languished for a century, and acknowledge history.

The central point for successful restoration is that the loss of economically important fisheries, degradation of habitat, and emergence of noxious microbial blooms and disease are all part of the same standard sequence of ecosystem deterioration that has deep historical roots and is primed and triggered by overfishing.

Thus the second thing that needs to be done is for fisheries science and the fishing industry to acknowledge that history records the primacy of overfishing.

It is clear that responding to a global problem on a case-by-case basis cannot solve these problems. Instead they need to be addressed by a series of bold experiments to test the success of large-scale ecosystem restoration. We now have the ecological theory as well as the historical knowledge to begin to put these systems back together to be something more like they were ‘when they got their genes’.

Thus the third thing that needs to be done is for fisheries science, the fishing industry and the resource managers to acknowledge that the idea of history blows away both the objectives of current fisheries management and also the tools — that ideas based in equilibrium thinking, like stewardship councils, maximum sustainable yields and the like, cannot be coercive in restoring the productivity of the seas.

And the last thing that needs to be done is for the conservation lobby to get real, which is to say, to acknowledge today’s science rather than yesterday’s fantasy, and to work with the industry to restore the productivity of the seas.

At the moment we are just squabbling over the crumbs. We could be having a banquet.

References