



Food for Thought

Maximum sustained yield: a policy disguised as science

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Overfishing is most commonly explained as an example of the tragedy of the commons, where individuals are unable to control their activities, leading to the destruction of the resource they are dependent on. The historical record suggests otherwise. Between 1949 and 1958, the US State Department used fisheries science, and especially the concept of maximum sustained yield (MSY) as a political tool to achieve its foreign policy objectives. During the Cold War, the Department thought that if countries were allowed to restrict fishing in their waters, it might lead to restrictions on passage of military vessels. While there has been much criticism of MSY and its failure to conserve fish stocks, there has been little attention paid to the political context in which MSY was adopted.

Numerous scientific studies have affirmed that many marine species have been over-fished (e.g. [Koslow et al. 2000](#); [Jackson et al. 2001](#); [Myers and Worm, 2003](#); [Berkeley et al. 2004](#); [Worm et al. 2006](#)). These studies, and the patterns they reveal, seem to confirm Garrett Hardin's well-known argument that human self-interest inevitably leads to natural resources depletion; what Hardin famously labeled "the tragedy of the commons" ([Hardin, 1968](#)). When a pasture is open to all, Hardin reasoned, each individual herdsman will inevitably graze his sheep as much as possible, hastening the day when "the inherent logic of the commons remorselessly generated tragedy." Individuals rationally pursuing their own self-interest ultimately bring ruin to all.

Hardin's analysis is so well known that it has been applied to almost every instance of environmental degradation, from fields to fisheries, the atmosphere to the arms race. Although Hardin did not address the oceans in his famous essay, the tragedy of the commons is now widely accepted as explaining why overfishing has occurred and is used by some economists to argue for resource privatization (e.g. [Gordon, 1954](#); [Hannesson, 2004](#)).

But is overfishing an example of the tragedy of the commons? We present historical evidence supporting the thesis that the tragedy of the commons does not explain overfishing. Historical study of post-war fisheries policies and management reveals that the collapse of world fisheries was not caused by individual

fishermen rushing to harvest in their own self-interest. Rather, it was the result of deliberate policies adopted by the industrialized nations after World War II, particularly the USA, who opposed any control or limits on territorial seas that might infringe on the ability of American boats of any kind—fishing or otherwise—to travel the world's oceans. To argue that fisheries have collapsed because individual fishermen failed to control their behavior is to ignore the substantial role of governments in establishing policies that encouraged the building and expansion of a global fishing industry, despite significant evidence, even at the time, that this was leading to severe over-fishing.

Early warnings and responses

In the 19th century, most scientists believed that marine fisheries were inexhaustible. The great Victorian zoologist, T. S. Huxley, famously argued "nothing we do seriously affects the number of fish," ([Smith, 1994](#)). Humans were just one predator among many; fishing was just an increased natural mortality for large fish.

In the 1930s, the picture began to change, as scientists found statistical evidence that fished populations were beginning to decline. The earliest evidence came from the heavily-harvested North Sea, where E. S. Russell, Britain's Director of Fisheries Investigations, suggested that declining numbers of cod and plaice were the result of a special kind of mortality, fishing by

man (Russell, 1942). Even stronger evidence came from the relatively new halibut fishery in the North Pacific Ocean, when W. F. Thompson, the Director of the International Fisheries Commission, presented data that showed evidence of decline after only five decades of fishing (Thompson and Bell, 1936).

Both Russell and Thompson drew attention to inefficiencies produced by declining stocks. As catches fell, fishermen had to pioneer new waters to keep catches high. They also took smaller fish, adversely affecting future recruitment. The more intense the fishing, the fewer younger fish survived until they could spawn. In light of this data, British scientist Michael Graham proposed a startling theory: that *less* fishing was better for fishermen. “Fisheries that are unlimited become unprofitable”, Graham argued in 1943. Without some kind of limits, stocks would be rapidly depleted, and fishermen would have to work harder and harder just to break even. And it wasn’t just in old fisheries, like the North Sea, where this occurred. Indeed, the profitability of fishing on a new stock began to decline almost as soon as fishing started (Graham, 1943).

At a British conference on overfishing in 1943, Graham and Russell proposed a radical new plan: that each country fishing the North Sea restrict the tonnage of its fleet. In the long run, less would produce more. However, where Russell and Graham saw a biological problem, the British Foreign Office and the US State Department saw territorial ones. For both governments, fishing was tied to the freedom of the seas, historic patterns of use, and territorial claims (Jonsson, 1982).

These concerns sharpened dramatically after 1945, as fishing expanded in a world hungry for protein. Government loans funded the integration of new war-time technologies such as SONAR into fishing boats. As it had done since the 1890s, Iceland again began to protest against European boats fishing its waters. On the West Coast of the USA, fishermen pressured the US State Department not to allow Japanese boats back into the salmon-rich waters of Bristol Bay. The Japanese had fished in the bay since the 1920s for bottomfish and king crab, but in 1936 they announced their intent to begin an experimental fishery for salmon (Scheiber, 1989). There was an immediate outcry and the State Department asked the Japanese government to withdraw the request. Japan did so, and the dispute was lost amid more important conflicts, but the fishing industry certainly remembered. With the end of the war, they began to pressure the State Department to ban Japanese boats from the international waters off Alaska.

In 1945, the United States unilaterally adopted the Truman Proclamation, declaring that it had the right to establish conservation zones to protect fish in the high seas contiguous to the US coast. On the face of it, the Proclamation was a move to limit fishing, and its stated purpose was conservation. Its unstated purpose was to argue that Bristol Bay salmon had been managed, that American fishermen had foregone harvest to provide escapement, and that the Japanese did not deserve to reap the rewards for this sacrifice. While the official American policy was open seas outside the three-mile territorial sea, the Proclamation enclosed the international waters of Bristol Bay for American salmon fishermen. Not surprisingly, the British, mindful of the dire state of the North Sea and that its fleet might one day exhaust the cod off Iceland and need to move to New England waters, tried to soften the Proclamation’s language. The USA refused (British Archives, 1945).

Legal scholars have deplored the Truman Proclamation, viewing it as a departure from other American foreign policy concerns because it was unilaterally declared, rather than adopted through multilateral negotiations (Hollick, 1978; Watt, 1979; Scheiber, 2001). But if the Proclamation did little to protect fish, it staked a bold American claim on the high seas, consistent with the unilateral process through which it was created. While the Proclamation was aimed at limiting Japanese access to Bristol Bay salmon, it reflected the intent of the US federal government to *expand* the American fishing fleet in the equatorial Pacific and in Alaska’s Bering Sea (then international waters). Expanded fishing was itself a reflection of American intent to control the Pacific through a line of military bases (Schaller, 1985). The USA also intended to take over the Japanese fisheries in the Pacific, for king crab (*Paralithodes camtschaticus*) off Alaska, and for tuna in the Marshall, Mariana, and Caroline Islands, all now controlled by the Americans. “Tomorrow the Marianas,” promised a headline in the Seattle-based “Pacific Fisherman” in September of 1945, after the Proclamation was issued.

The Proclamation did not go far enough for the salmon industry, which wanted a complete ban on Japanese fishing, but it went too far for the Southern California tuna industry, which was increasingly dependent on catching bait-fish off Latin America. A month after the Proclamation was issued, Mexico adopted an expanded territorial fishing zone. Argentina, Chile, Peru, and Costa Rica followed, arguing that American boats were depleting their bait stocks. Korea filed territorial claims against Japan, and the Soviet Union claimed twelve miles and seized vessels in the Barents Sea. Iceland, citing the Truman Proclamation, declared a 200-mile limit in 1948. With the goal of keeping the world’s oceans open, the USA had triggered a series of enclosures.

Meanwhile, the American fishing industry was facing a series of challenges. The New England groundfish industry was reeling from the impact of low-cost fish fillets from Canada and Iceland. Southern Californian tuna boats were being seized off Latin America and Mexico. The West Coast salmon industry worried about the return of Japanese boats to Alaskan waters when a peace treaty with Japan was finally signed (which did not happen until 1951). The industry saw their problems as firmly rooted in foreign policy concerns, and in early 1946, at a meeting in Los Angeles, they created the Pacific Fisheries Congress to lobby for an increased voice within the State Department. A prominent member of the Congress was Miller Freeman, the publisher of the Seattle-based “Pacific Fisherman”. Miller had been keeping a close eye on Japanese fishing for decades (Freeman papers, undated file).

In early 1947, Secretary of State George C. Marshall agreed to create a position of Under Secretary of State for Fisheries. The State Department wanted an attorney, but the industry backed an ichthyologist from the University of Washington, Wilbert M. Chapman. Chapman had spent 18 months in the eastern Pacific during the war, scouting for fish to feed American troops. He returned to the USA convinced that American fisheries had to move deeper into the Pacific. In letter after letter, he poured out his conviction that the Pacific Ocean was the next American frontier. There was no time to waste in staking an American claim to high-seas fish (Chapman, 1947).

With the appointment of Chapman in 1948, fisheries science became a tool of the State Department. Within months of arriving in Washington, DC, Chapman crafted the US High Seas Policy, which enshrined the policy of “maximum sustained yield”

(MSY) as the goal of American fisheries management. Ten years later, MSY was built into the USA's Law of the Sea negotiations, and it forms the heart of most international fisheries agreements and treaties to this day.

Where did MSY come from?

Chapman defined MSY as making "possible the maximum production of food from the sea on a sustained basis year after year" (Chapman, 1949). The basic idea was to harvest fish stocks until they showed signs of overfishing. At that point, restrictions to slow the catch could be applied. On the face of it, the policy was logical enough, but it rested on four assumptions: (i) that scientists were able to accurately estimate existing stock levels for the major economic fisheries, (ii) that scientists could accurately recognize when stocks had reached the maximum sustainable levels, (iii) that governments would act promptly to curtail fishing when those levels were reached, and (iv) that scientists could accurately identify the levels at which recovery was sufficient to permit fishing to resume. None of these assumptions was supported by a strong empirical base, and all four were subsequently shown to be incorrect (Pauly, 1994).

MSY was also grounded in the belief that fishing was good for fish stocks. The dynamics of fishing stimulated the growth of younger fish, as older, slower-growing fish were thinned (Chapman, 1949). Fish that were surplus to reproductive needs could safely be harvested, and scientists could determine how many fish were surplus. Conversely, when catches dropped and fishing was no longer economic, fishing would halt. Given this economic trigger, there was no need to regulate the catch and there was no risk to expanding the fishing fleet.

And expand it did, through extensive subsidies, including low cost loans for boat construction, the sale of war surplus vessels into the commercial fisheries well below cost, the construction of research vessels to prospect for new fishing grounds and new species worldwide, and the funding of research on new fishing techniques, preservation methods, and ways to market new species. Governments also fostered technology development that expanded the reach and power of fishermen: radar, sonar, fish-finding electronics, sea-bed mapping, and global positioning systems—as well as lighter, stronger nets—all of which allowed fishermen to pursue fish farther and deeper.

What was the purpose of subsidizing post-war fisheries expansion? Public rhetoric stressed the humanitarian goal of relieving world hunger, and no doubt many scientists involved in fisheries management shared this aim. But the increased catches did little to feed the world's poor. One of the fastest growing fisheries was the anchoveta off Peru—catches peaked at 12.2 metric tons in 1970, before abruptly crashing to 2 metric tons the following year (Glantz, 1979)—but only 185 000 tons of that peak year catch (15%) was used for human consumption in Peru (Moreno Ibáñez, 1981). The rest was turned into fish meal that was fed to European and American cattle, pigs, and chickens (Borgstrom, 1965).

Public rhetoric also claimed that the expansion was scientifically based and therefore sustainable. Certainly science played a major role in fisheries throughout the 1950s and 1960s, as scientists produced various estimates of how much could be harvested from the sea; 200 million metric tons a year was considered conservative (Pauly, 2010). But was the basis of post-war fisheries management—the concept of MSY—actually scientific? That is to say, was it based on well-researched, empirically supported science?

The historical evidence suggests not. While post-war fisheries management was based on MSY, there was in fact scant scientific basis for it at the time that it was adopted.

Chapman's 1949 "U.S. Policy on High Seas Fisheries" was not published in a peer-reviewed journal, but in the "Bulletin of the U.S. State Department". It contained no data, no equations, and no results of observations, experiments or modeling. The solitary graph presented to explain MSY had no numerical scale on its axes; it was a theoretical construction with no quantitative dimension. It was, quite simply, an idea, a proposal of how the world might work, but with no evidence to show that this was how it actually did work. By the early 1950s, researchers in Britain, Canada, and the USA were grappling with how to estimate the parameters that the theory required, but by that time the concept was already enshrined in international policy. Nine days after the US High Seas Policy was published, the USA and Mexico signed a fisheries treaty. Shortly thereafter, in January 1949, an agreement was forged to regulate the North Atlantic through the creation of the International North Atlantic Fisheries Commission (INCAP). A third treaty was signed in May 1949, with Costa Rica, creating the Inter-American Tropical Tuna Commission. And in 1951, MSY was essentially imposed on Japan with the signing of the 1951 North Pacific International Fisheries Treaty over extensive Japanese objections (Herrington, 1989). Despite the Japanese objections, the north Pacific salmon stocks would be managed under MSY.

The High Seas Policy solved several pressing political problems for the American industry, but not for long. With the collapse of the Californian sardine fishery due to overfishing during and after the war, more American boats began to fish for tuna off Latin America, and more boats were being seized (NARA, 1952). In 1952, at a meeting in Santiago, Peru, Chile, and Ecuador began to move towards adopting regional law to control access to their waters and their fish.

More ominously, in 1953 the International Law Commission, which had been established two decades earlier to advise on the creation of policy on fisheries, issued a series of recommendations. It suggested the creation of an international organization under the UN to make binding recommendations to settle disputes, and recommended that territorial seas should be expanded to six miles from the commonly accepted three miles. In effect, the Law Commission was recognizing the claims of coastal countries to an interest in their offshore resources. It was a direct challenge to the highly industrialized fishing nations, particularly the USA, for whom freedom of the seas was the cornerstone of post-war foreign policy (Kobayashi, 1965).

The USA continued to oppose any expansion of territorial seas that might infringe on the ability of American boats to travel through the world's oceans. Concerned about the intent of the Latin Americans, the USA asked the UN in December 1954 to sponsor a meeting to give advice to the law commission. The UN agreed to sponsor an international meeting in April–May 1955, at the Rome headquarters of its Food and Agricultural Organization (FAO, 1955).

The Rome conference was described as scientific and technical, but historical documents from both the State Department and FAO attest to its political goals. The main American objective was to prevent Peru, Chile, and Ecuador from creating international law in the region (British Archives, 1955; NARA, 1955). William Herrington, who had replaced Chapman at the State Department, travelled extensively before the meeting, explaining the American position and soliciting support. The meeting was

not just about fishing; in the draft instructions to the delegates, Herrington emphasized that major interests of the US government, “security, naval, maritime, air transport,” were all tied to the principle of the freedom of the sea (Allen, 1955).

The meeting’s recommendations called for countries to fish without restrictions until critical biological points had been reached (FAO, 1955). Crucially, the burden of proof was on the nation requesting action to limit fishing, and that proof had to come from scientific studies. Since only the USA and Europe had the necessary scientific capability, this policy effectively excluded most nations—particularly the Latin American ones—from challenging the US position or US dominance. In effect, it allowed the USA to impose its own preferred policy—limited management through bilateral or multi-lateral commissions—on the whole world. It was a political, if not an actual physical, enclosure of the world’s oceans, but enclosure *not* to limit fishing but to permit it to proceed on US terms.

At first glance, the US advocacy of open seas might seem to support the Hardin thesis. However, it is important to recognize that the US policy was designed to draw the seas—in particular the Pacific—under US influence and control. Thus, while not a physical enclosure, in the sense of fencing in a commons, it was, for all intents and purposes, a “political” enclosure.

The practical effect was that nations with distant-water fleets were free to fish essentially unhindered. This remained the case until the 1970s when countries began to expand their territorial limits. The creation of Exclusive Economic Zones (EEZ) further increased pressure on fisheries as new regulations stipulated that if the fishermen of coastal countries could not harvest all the available fish, foreign fleets could (Weber, 2002).

By the time of the Rome meeting, scientists had finally published mathematical formulas to elaborate the MSY concept, and these became the foundation for modern fisheries management. The Yield per Recruit Theory, by British scientists Raymond Beverton and Sidney Holt (1957), provided equations to estimate the maximum yield from each cohort of a fish population. The Spawner and Recruit Theory, devised by Canadian William Ricker, estimated the optimum number of spawners for each year class of fish. Surplus Production Theory, developed by Milner B. Schaefer, estimated the maximum total harvest of fish every year from a standing population. But did this work really put fisheries management on a firm foundation? Biologist Tim B. Smith has argued that fisheries management failed because biologists were unable to unify the three theories into a comprehensive management regime. The research directive developed at the Rome conference in 1955 “defined narrow terms of reference for the future study of fishery biology,” Smith wrote (Smith, 1994).

Smith’s critique is correct as far as it goes, but there is more to the story: fisheries policy was not based on the *success* of these theories; the success of these theories was based on fisheries policy. Once MSY had been adopted, it became necessary to develop techniques to try to calculate the parameters it required: the number of spawners, the maximum yield from each cohort, and the maximum total harvest for each year. Scientists answered the questions that they were asked, but many other questions—including whether this was the right framework to begin with—remained unasked. As ecologist Henry Regier has written, it was science relevant to harvesting a “relatively undifferentiated mass,” which is exactly how MSY viewed fish. Other potentially relevant factors—evolution, biodiversity, and ecological interactions—were relatively neglected (Regier, 1997).

MSY is an example of the proverbial three-legged stool. It began as policy, it was declared to be science, and then it was enshrined in law. The three partial theories could not be successfully unified into a comprehensive “scientific” theory because MSY was a policy camouflaged as science.

The American pressure to adopt MSY brought criticism from British fisheries scientist Michael Graham, and from D. B. Finn, Director of the Fisheries section of the FAO, among others. During meetings leading up to the conference and in Rome, Graham argued that MSY was not an appropriate goal for fisheries management, because there were other equally valid ways to achieve fishery conservation. The Americans responded that MSY was the only objective that “was likely to receive general backing.” Graham disagreed, pushing for language that reflected the view that the primary objective of conservation “is to control man’s activities so as to produce the maximum sustainable yield of products in the form most useful to man.” (British Archives, 1955) The shift in emphasis is significant because Graham’s focus was on controlling effort to control catch, which is expressly what Herrington did not want. Graham’s language was lost from subsequent drafts.

Graham’s hypothesis was that if a conservative fishing regime were to be put in place while scientists studied the impact of gear changes on fish populations, in the long run this would produce a greater yield of fish and protect stocks that had not yet spawned. He hired Raymond Beverton and Sidney Holt to test his hypothesis. They concluded that fishing restrictions would result in fishermen catching larger fish, having reduced wasteful bycatch, and ultimately earning more money (Beverton and Holt, 1957). Graham’s preferred course of action at Rome—the introduction of restrictions while a fishery was growing—would have supported the political positions of Peru, Ecuador, and Chile—and of Iceland, which had encouraged the UN to hold the Rome conference in the hope that it would recognize the rights of the coastal states to protect their fish stocks. Above all, it would, quite likely, have protected fish.

However, a conservative fishing regime that introduced early restrictions held little interest to the USA. Nor did it appeal to the UK, who sided with the Americans when it came time to a vote. Both the USA and the UK wanted the freedom to fish without restrictions, anywhere in the world.

It is difficult to avoid the conclusion that American and British policy makers pushed for the adoption of MSY as a way to justify their preferred policy of freedom of the seas. In particular, it was a philosophical cornerstone for a foreign policy of open skies and open seas for American planes, ships, submarines, and fishing boats, a policy that also benefitted the British, Japanese, and the Soviet Union. Fishing on the high seas was tightly coupled with foreign policy concerns. The US government, in particular, feared that restricting freedom of passage of fishing vessels would open the doors to restrictions on other vessels, including military ships and submarines. So the USA expanded its fishing fleet and its ability to fish around the world, at least in part, to strengthen its larger political claims, and in particular its political influence in the Pacific. In the process, these US actions significantly shaped American fisheries science.

There was another significant set of criticisms of MSY that has also been lost to history. During the 1957 negotiations between Japan, the USA, and Canada over the Tripartite Treaty, Tomonari Matsushita of the Japanese Fisheries Agency, made a critique of MSY that echoed the comments of Finn and Graham.

MSY was impossible to attain on different stocks because of the way environmental conditions varied. He called MSY a “theoretical yard stick,” and said that what was needed was a “realistic and accurate yard stick” that would be more practical (Allen papers, undated folder).

Conclusion

Between 1950 and 1969, the global fish catch grew from 18.5 to 54.5 million metric tons (Garcia and Newton, 1994). But while overall catches continued to grow, individual stocks were in trouble. Pacific mackerel disappeared in 1933; California sardines in 1949. Norwegian and Icelandic herring stocks waned during the 1950s, followed by South African pilchards in 1960, Peruvian anchoveta in 1962, and George’s Banks herring in 1967 (Beverton, 2002). Ironically—for this was surely not Hardin’s intent—the 1968 publication of his “tragedy thesis” had the effect of sanctioning still more growth, despite mounting evidence of trouble, because the “tragedy” thesis implied that it was impossible to control “commons” – so why even try? This in turn provided justification for those who opposed development of international regulatory regimes. More importantly, by persuading scientists that overuse of resources was virtually a law of nature, Hardin’s analysis drew attention away from the deliberate government policies that had helped to produce the prevailing situation. T. H. Huxley was wrong that fish stocks were inexhaustible, but he seemed to be correct that it was impossible to regulate fishing.

The “tragedy” thesis also drew attention away from the limitations of the science that underlay those policies. The criticism of MSY at its adoption has been lost to sight. There is voluminous criticism of MSY, from both scientists and economists, who have tried to “fix” the science, while ignoring the political context in which the science was created, (Larkin, 1977; Pilkey and Pilkey-Jarvis, 2007). This has led, in turn, to an approach that tacitly assumed that the basic framework of MSY was scientifically warranted. When one considers the political forces that shaped the science—and in particular how the US State Department used MSY as a tool of diplomacy, to achieve foreign policy objectives—it invites a more thorough reconsideration of both the policy and the science.

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